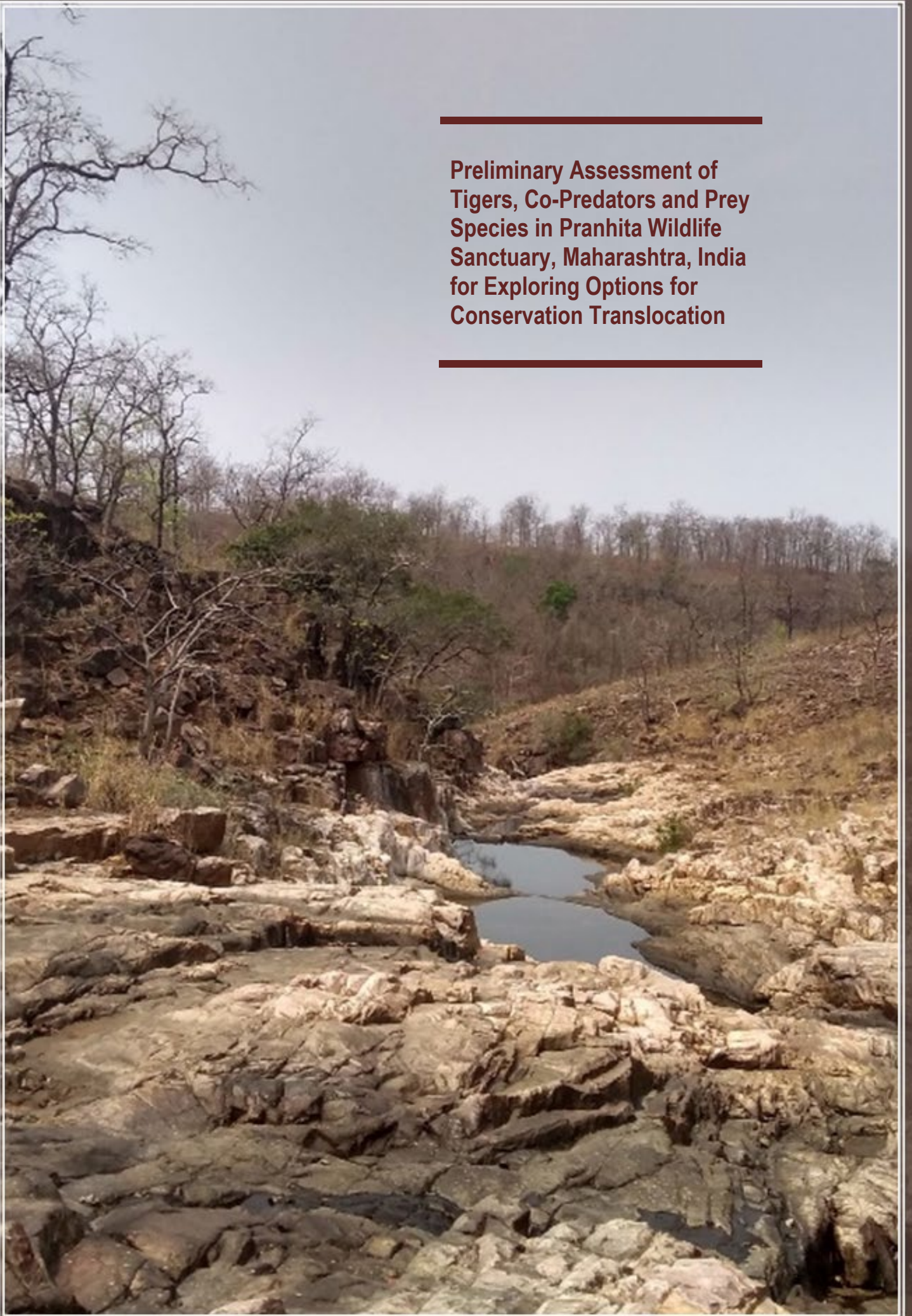

**Preliminary Assessment of
Tigers, Co-Predators and Prey
Species in Pranhita Wildlife
Sanctuary, Maharashtra, India
for Exploring Options for
Conservation Translocation**



Preliminary Assessment of Tigers, Co-Predators and Prey Species in Pranhita Wildlife Sanctuary, Maharashtra, India for Exploring Options for Conservation Translocation

Principal Investigators

Dr. Bilal Habib

Dr. Parag Nigam

Chief Conservator of Forests (Gadchiroli)

District Forest Officer, Sironcha

Researchers

Kunjan Joshi

Pandurang Pawar

Project Completion Report

March 2020



Further Contact:

Dr. Bilal Habib

Head, Department of Animal Ecology and Conservation Biology

Wildlife Institute of India, Chandrabani

Dehradun, India 248 001

Tell: 00 91 135 2646283

Fax: 00 91 135 2640117

E-mail; bh@wii.gov.in

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Executive Summary

As part of the project “Preliminary assessment of tigers, co-predators and prey species in Pranhita Wildlife Sanctuary, Maharashtra, India for exploring options for conservation translocation”, the study was carried out in Pranhita Wildlife Sanctuary in Gadchiroli district of Maharashtra. The fieldwork was carried from January 2019 to June 2019 covering an area of 418.85 km² in southern Gadchiroli. The Eastern Vidarbha Landscape (EVL) holds a high density of carnivores both inside and outside protected areas leading to an increase in human-wildlife interactions. Pranhita Wildlife Sanctuary (PWLS) is a part of EVL and could be an important corridor. To explore new habitats for carnivore species, we conducted a preliminary assessment of tigers, co-predators, and prey in PWLS. The sanctuary mainly is dominated by Southern Tropical Dry Deciduous forest.

We conducted carnivore and ungulate sign surveys and deployed camera traps (n=25) in 40 km² area in Bahmni range. The area was divided into different 1.42 × 1.42 km² grids and at least one pair of camera trap was placed in each 2.0164 km² grid at 20 sites and operated for 24-27 days in Bahmni range. Apart from that random camera traps were placed at 5 sites in Kamlapur and Pranhita ranges for 1 to 7 days during the study period. The camera traps sampling effort was 1030 trap nights and around 33000 images were captured. For prey species density estimation, 24 line transects of 2 km length were walked in 43 beats with 5-7 replicates. For vegetation quantification, we laid a total of 144 circular plots of a 10-meter radius and recorded 43 trees, 37 shrubs, and 13 grass species. We used both spatial and temporal data for occupancy estimation. Data were analyzed using the software Presence for occupancy estimation and Distance 7.2 for density estimation.

A total of 10 carnivore species were recorded directly or indirectly during the study period. According to the IUCN Red List of threatened species, 2 are Endangered and Near Threatened, and 2 are vulnerable. The major carnivore species are leopard, Asiatic wild dog, sloth bear, Indian grey wolf, jungle cat, Indian fox, and rusty-spotted cat. The occupancy estimate (ψ) of leopard in the null model was 0.20 while for other carnivore species like sloth bear, jungle cat and wild dog were 0.70, 0.74, and 0.68 percent respectively.

A total of 14 prey species were recorded during the line transect and sign survey. The major prey species are sambar, Indian gaur, chousingha, Indian giant squirrel, chital, wild pig, nilgai, barking deer, langur sp., rhesus macaque, and Indian peafowl. Among these, 3 species are listed as Vulnerable and 1 as Near Threatened by IUCN Red List. Overall density estimation of major ungulate species was 14.82/km². The encounter rate of cattle was 0.17/km, nilgai 0.039/km, chital 0.059/km, chousingha 0.016/km, and wild pig 0.022/km. Individual density estimate of major ungulate species like chital 2.27/km², wild pig 11.55/km², nilgai 0.72/km², langur 0.55/km², Indian hare 1.78/km², peafowl 0.44/km², grey jungle fowl 1.87/km², chousingha 0.28/km² and cattle were 28.61/km². Occupancy estimate of ungulate species like sambar 0.27%, chital 0.44%, chousingha 0.51%, Indian gaur 0.07% and nilgai were 0.59%.

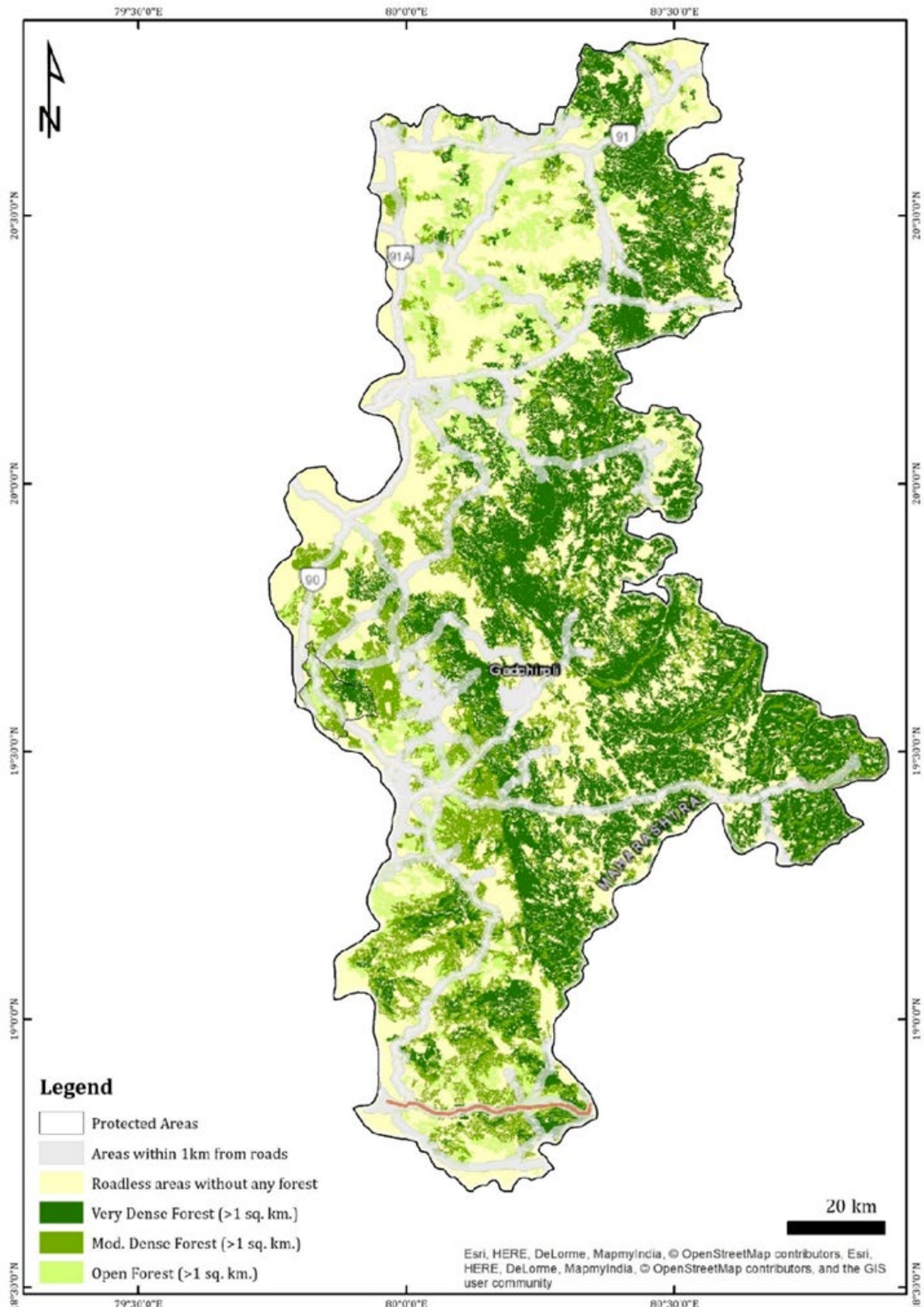
The major threats in the sanctuary areas are hunting for local consumption, tree cutting, livestock grazing, forest fire, roadkill, and electrocution. We have got 28 % usable images of cattle grazing and 4 % of hunting.

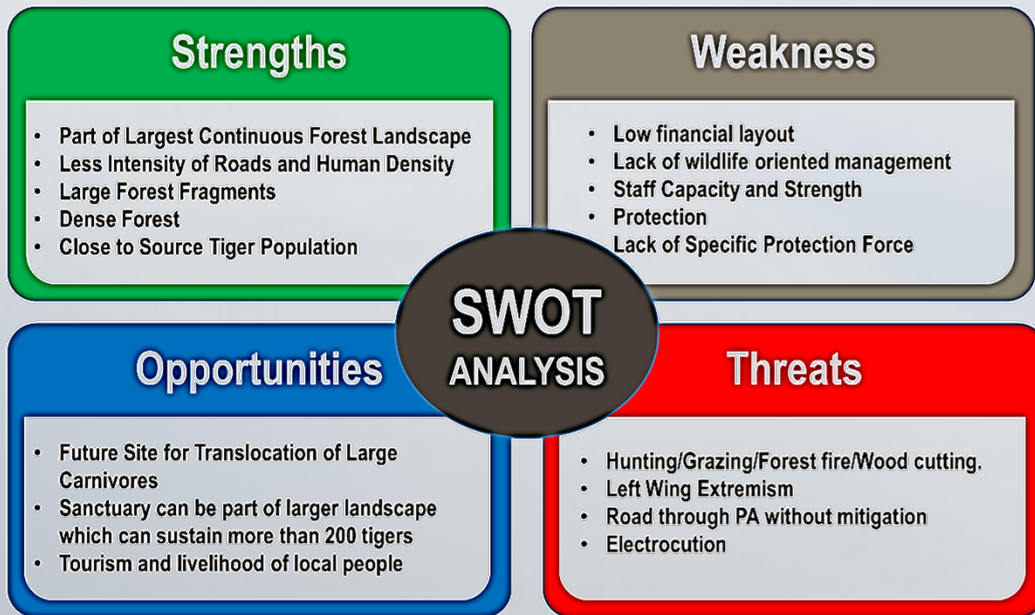
Other administrative lacunas are impractical beat boundaries, unequipped frontline staff, lack of legal action against the guilty, inadequate infrastructure, lack of training and capacity building. There is a consistent trepidation of left-wing extremism in the minds of locals and forest officials. It prevents or demotivates them from working efficiently in the PWLS. These activities directly or indirectly affect wildlife conservation and management in PWLS. This was the first-ever scientific study conducted to document prey and predator presence in PWLS. Further detailed and long-term studies are required for a better understanding of species ecology and their habitat. Such studies will help not only in better management and conservation of species in the area but also in decision-making on conservation translocations.

Based on the preliminary study and SWOT analysis following are measures to be taken before translocation of any large carnivore species to Pranhita Wildlife Sanctuary:

- 1. Capacity building of local staff for effective wildlife management.**
- 2. Enhancement of protection measures in the Sanctuary to reduce poaching, hunting, and other illegal activities.**
- 3. Habitat improvement by grassland management and eradication of lantana and other invasive species.**
- 4. Reducing threats due to electrocution by illegal power fences used for local hunting and protection of crop fields by local farmers.**
- 5. Special forest protection force for Gadchiroli considering extremism issues.**
- 6. Augmentation of the prey base to enhance fast recovery of prey species.**
- 7. Maintaining full-strength dedicated forest staff across all range offices of the division.**
- 8. Building infrastructure such as patrolling roads, forest chowkis etc., across the sanctuary.**
- 9. Involving local people in conservation measures across the sanctuary.**
- 10. Establishment of local ecodevelopment committees.**
- 11. Wildlife-oriented management across the Gadchiroli forest division.**
- 12. The special financial package for Gadchiroli for enhancing wildlife-oriented management.**

13. *Mitigation measures on the existing roads through the sanctuary and other critical wildlife corridors across the division.*
14. *Implementation of Shyamaprasad Mukherjee Jan Van Vikas Scheme for development of villages across the forested landscape of Gadchiroli to achieve sustainable development of these villages and reduce the man-animal conflict.*
15. *Identification of potential areas within the district for designation as Sanctuary, National Park, Conservation Reserve, Community Reserve, and Tiger Reserve.*





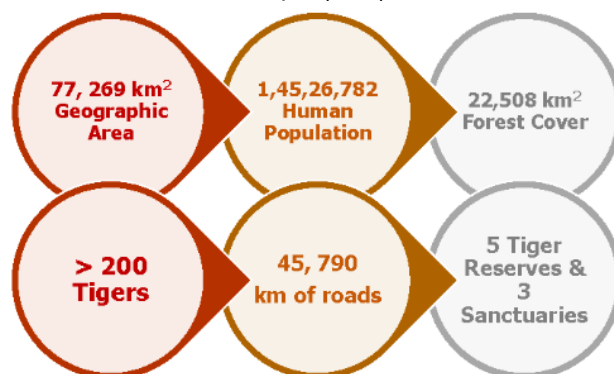


Section I: Introduction, Study Area, and Objectives

1.1 Introduction:

Gadchiroli is situated in the southeast corner of Maharashtra sharing its border with Telangana and Chattisgarh. It holds the highest forest cover in the state of Maharashtra i.e. around 70% of its total geographical area which in turn contributes to 19.93% of the total forest cover in the state (Joshi and Sahay, 2013). The forests of Gadchiroli are contiguous and there is very little fragmentation. Gadchiroli falls in two bio-geographic zones of central plateau viz., 6C Deccan Peninsula Eastern Highlands and 6D Deccan Peninsula Central Plateau (Rodgers and Panwar, 2000). The weather remains hot and dry for the major part of the year. The mean maximum temperature is 45°C and the mean minimum temperature is about 13°C. Gadchiroli is bestowed with sufficient rainfall because of the southwest monsoon winds and with an average rainfall of 1103 mm (Rainfall Statistics of India, 2017). Considering the district's huge forest cover and rich biodiversity, the area has very diverse species of mammals which include tiger, leopard, wild dog, Asiatic wild water buffalo, grey wolf, Indian fox, porcupine, chital, sambar, nilgai to name a few.

Eastern Vidarbha Landscape (EVL) is also called the tiger landscape of Maharashtra currently holds more than 200 tigers (Habib et al., 2018).



Gadchiroli lies in the south-eastern part of EVL and has a prominently high forested area as compared to other districts in EVL. Forest fragment statistics of the Gadchiroli district states that it has a total of 5 contiguous fragmented patches of more than 500 km² each (Habib et al., 2018). Chandrapur which is the tiger hub of EVL has only 1 above 500 km² patch of forest and still holds more than 100 tigers (Figure 1.1 and 1.2). Considering this, Gadchiroli has the potential of holding

District	Fragment Size (Sq. km)					
	1 to 5	5 to 10	10 to 50	50 to 100	100 to 500	Above 500
Bhandara	98	10	8	4	1	0
Chandrapur	412	58	42	4	3	1
Gadchiroli	812	82	66	6	4	4
Gondiya	196	125	18	1	3	1
Nagpur	269	14	19	5	2	0
Wardha	89	13	13	2	1	0
Yavatmal	282	45	35	2	2	0

about 400 tigers.

Figure 1.1: Details of forest fragments in their size across different districts in Eastern Vidarbha Landscape, Maharashtra, India

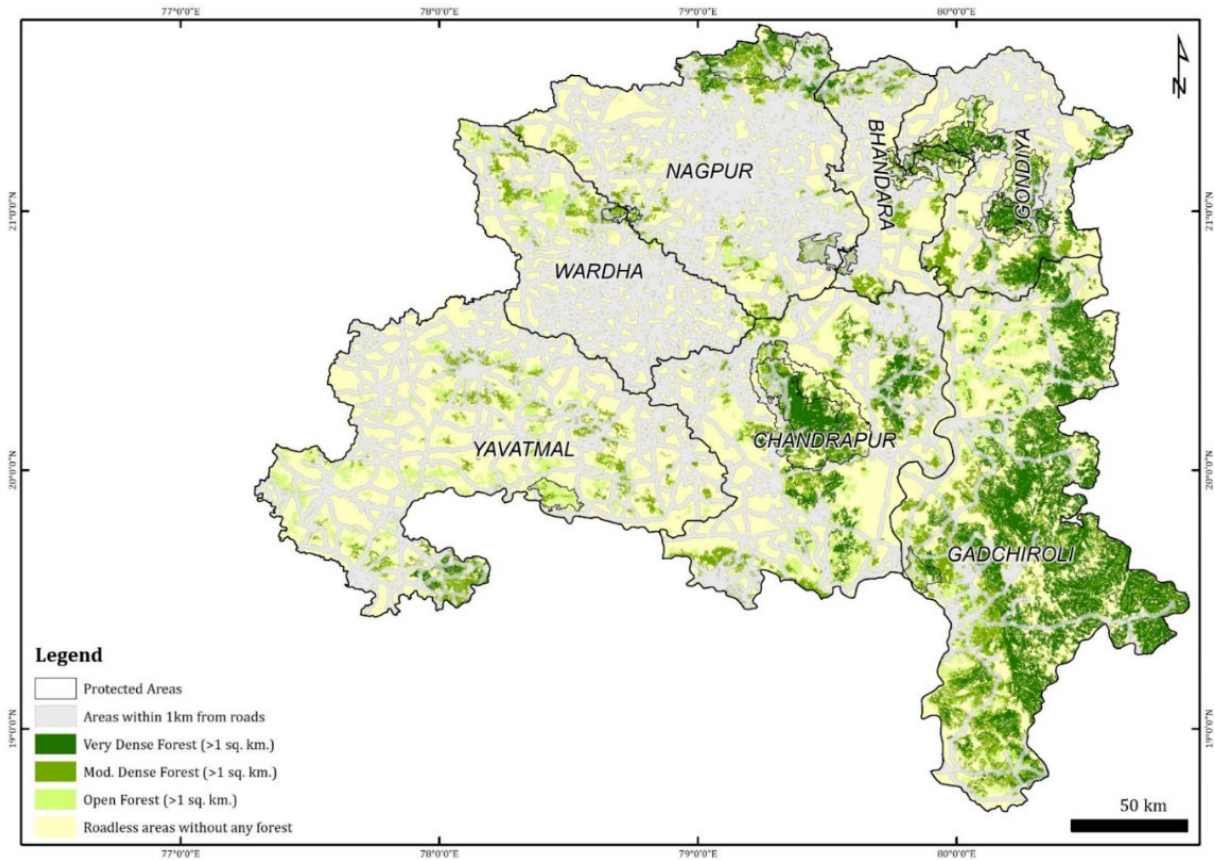


Figure 1.2: Distribution of forest fragments across different districts in Eastern Vidarbha Landscape, Maharashtra, India

1.2 Study Area:

In 2014, the Government of Maharashtra declared Pranhita Wildlife Sanctuary (PWLS) in the Gadchiroli district of Maharashtra. It lies between 79°54'16" to 80°14'09" N and 19°17'47" to 18°59'41" E. A total 148.85 km² area is situated in the southern part of the Gadchiroli district and comes under Sironcha Forest Division. The area is divided into four ranges namely Pranhita, Kamlapur, Jimalgatta, and Bahmani but most of the area is covered by the Pranhita range. The western portion of the sanctuary is bordered by the Pranhita River which also is the State border between Maharashtra and Telangana. On the eastern side of the sanctuary, the Indravati River separates Maharashtra from Chattisgarh. There is another protected area on the east border known as Kolamarka Conservation Reserve (Figure 1.3). It is situated on the Indravati River and connects to PWLS on the eastern side. Kolamarka Conservation Reserve is the

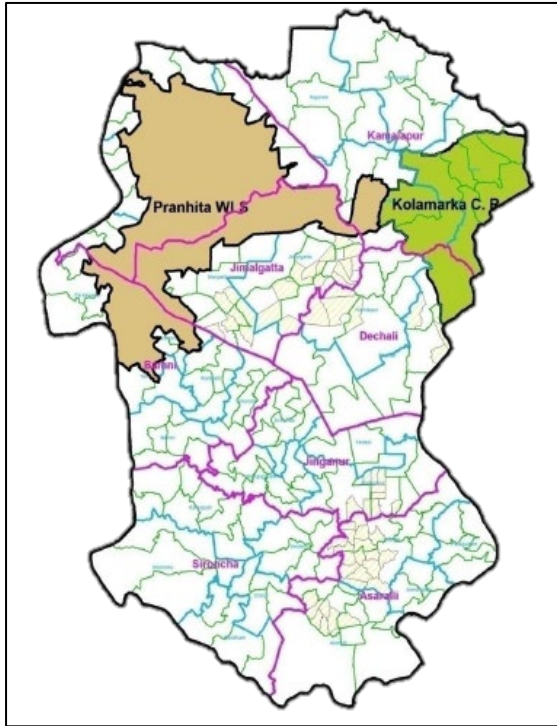


Figure 1.3: Kolamarka Conservation Reserve adjacent to PWLS

only site in Maharashtra that holds a population of Asiatic Wild Water Buffalo and is situated on the eastern border of PWLS with the deciduous forest as dominated land use (Figure 1.4). These two protected areas connect the landscape between Pranhita River on the west and Indravati River on the east part of southern Gadchiroli. PWLS is connected to several tiger reserves, national parks, and wildlife sanctuaries which include, Chaprala Wildlife Sanctuary, Indravati Tiger Reserve, Tadoba - Andhari Tiger Reserve, Pench Tiger Reserve, Nawegaon-Nagzira Tiger Reserve, Umred-Karhandla Wildlife Sanctuary, Bor Tiger Reserve. PWLS is also part of a potential tiger corridor that Tadoba - Andhari Tiger Reserve to Indravati Tiger Reserve in Chattisgarh. Gadchiroli

also connects other tiger reserves down south (Mondal and Habib, 2016) (Figure 1.5).

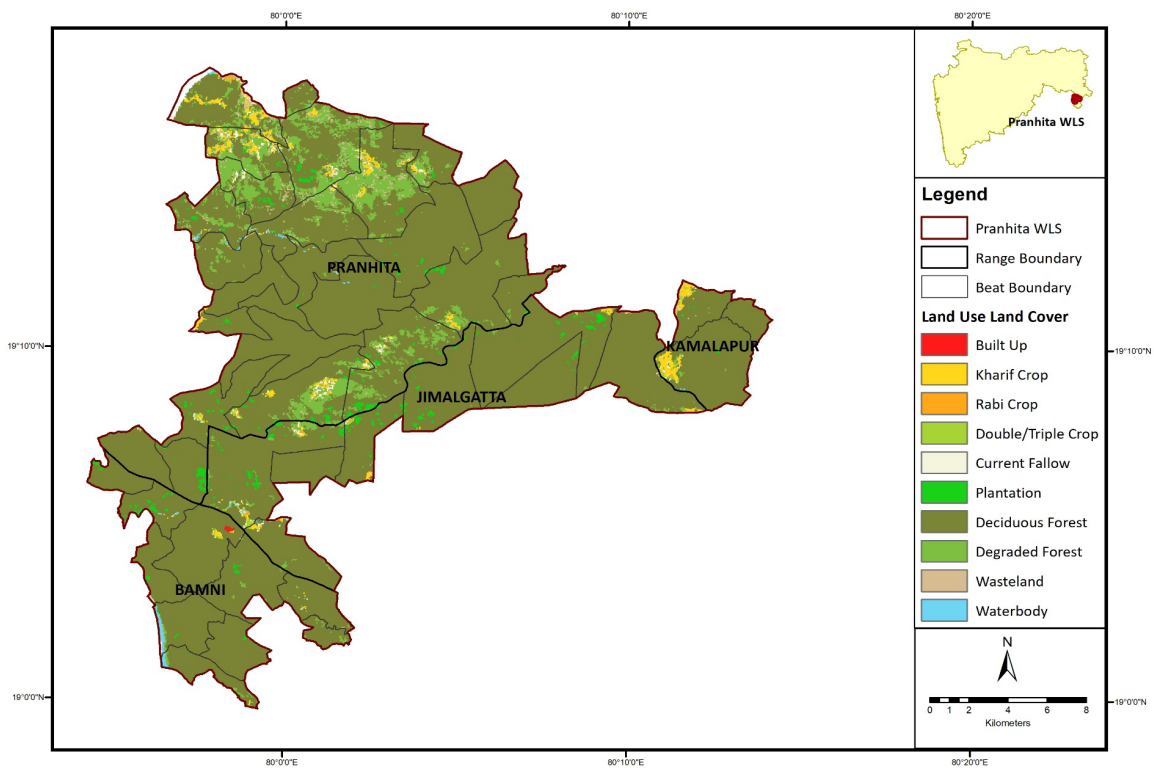


Figure 1.4: Landuse/Landcover Map of the Pranhita Wildlife Sanctuary, Maharashtra, India

Most of the area comprises inaccessible hills, thorny shrubs, rocky surfaces, and plateaus. The area is dominated by Gond and Madia tribal community and their livelihood depends on the forested area of PWLS. Collection of fuelwood, fodder, Tendu leaves, bamboo, and fruit are the basic source of income apart from agriculture. The major languages spoken in this region are Gondi, Madiya, Marathi, Hindi, and Telugu. The area is under the influence of left-wing extremism and there is constant trepidation among the locals and forest officials about the extremist activities. The main forest types of PWLS is Southern Tropical Dry Deciduous (Champion and Seth, 1968) and Teak (*Tectona grandis*) is the dominant species (Shukla and Chavan, 2016). Some of the major tree species found within the protected area are Ain (*Terminalia elliptica*), Arjun (*Terminalia arjuna*), Bhera (*Chloroxylon swietenia*), Dhawada (*Anogeissus latifolia*), Mahua (*Madhuca indica*), Rohan (*Soymida febrifuga*), Salai (*Boswellia serrata*), Tendu (*Diospyros melanoxylon*) etc. The sanctuary has rich floral diversity where various species of shrubs, climbers, grass, and a thick forest of teak trees are found. The lush green forest of Pranhita is spread across the area with different elevational gradients and occasional stretches of grasslands even on the plateaus. The sanctuary has a conspicuous riparian ecosystem with a lot of perennial water sources. These water sources strive population of reptiles and amphibians. They also support rich aquatic life and avifauna and are sites of natural beauty and serenity.



All animals depend on these perennial water sources which do not go dry even in the hot summers. Tribes in this region depend a lot on the forest. Ranging from food, fodder, these tribal populations that reside in the periphery of the forest completely depend on the forests. Tendu leaves, bamboo, and fruit collection is the major source of income for these people apart from agriculture.

Hunting is still prominently seen in these regions wherein the village members hunt wild animals in the forests for consumption. Not just that, the cattle are not tied or kept in a particular place. These cattle roam around in the sanctuary in all potential places for grazing. The presence of cattle disturbs other wild animals especially prey species. This also involves competition with food resources. Several such threats persist inside PWLS and pose a huge threat to the biodiversity of the forest.

Most of the areas of this district are still unexplored and there's negligible research on wildlife in this



district. In 2014, PWLS is declared as a wildlife sanctuary but there are no management practices like other wildlife sanctuaries. It is not well explored and there is a lack of baseline data. There are historical records of tiger presence in PWLS which makes this sanctuary an important site for future tiger reintroduction. Thus, this project was started to assess tigers, co-predators, and prey in Pranhita Wildlife Sanctuary. This was the first scientific wildlife survey carried out from January to April 2019. To generate basic information about the presence of the prey-and-predator species, the Wildlife Institute of India has started this project with the following objectives.

Collection of fruits by local inhabitants inside the Sanctuary.

1.3 Objectives of the Study:

1. To establish benchmark data that can serve as a basis for specific objectives for management and conservation of the in PWLS.
2. To improve our basic understanding of tiger, co-predator, and prey ecology through rigorous field studies, to develop a body of theoretical knowledge that can generate predictive capacity.
3. To provide the baseline information on prey-predators population and species diversity.
4. To evaluate the area for conservation translocation.
5. To identify the existing threats to wildlife conservation.

Section II: Status of Predators in Pranhita Wildlife Sanctuary

2.1 Introduction:

Carnivores play a paramount role in regulating ecosystem processes and conditions because of their positions at the top of the food web. They play a crucial role by limiting large herbivores through predation and meso-carnivores through intra-guild competition, thus structuring ecosystems along multiple food-web pathways and influencing the nature and strength of ecosystem functioning (Ripple *et al.*, 2014).

Conservation of carnivore species necessitates consistent monitoring of their populations and conservation issues need to be resolved to guarantee their survival. To understand the population dynamics of the carnivore species scientific data need to be collected.

2.2 Predator Species Ecology:

The carnivore population plays a paramount role in regulating ecosystems and for better conservation management practices, the ecology of the major predator species must be known to wildlife managers like habitat, diet, prey preferences, activity pattern, behavior, home range, and persistent threats. A brief review of the major predator species in PWLS has given below. Major species found during a field survey in PWLS are Leopard (*Panthera pardus fusca*), Asiatic Wild Dog (*Cuon alpinus*), Indian Grey Wolf (*Canis lupus pallipes*), Sloth Bear (*Melursus urisus*), Indian Fox (*Vulpes bengalensis*), Jungle Cat (*Felis chaus*), Rusty Spotted Cat (*Prionailurus rubiginosus*), Common Palm Civet (*Paradoxurus hermaphroditus*), Small Indian Civet (*Viverriculla indica*) and Ruddy Mongoose (*Herpestes smithii*). Table 2.1 indicates the IUCN and WPA Status of various predator species reported from Pranhita Wildlife Sanctuary.

Tiger (*Panthera tigris*):

Tiger is the umbrella species and most charismatic animal of India. They are widely distributed in their range in tropical dry and moist deciduous forests and riverine forests in central India (Menon, 2014). According to the latest tiger census report, the tiger number has increased to $2967 \pm 2603-3346$ but the available habitat is shrinking to a large extent (Jhala, Qureshi and Nayak, 2019). Tiger is a solitary animal and ambush predator, it can kill larger prey than its size. Tiger may consume 20 to 35 kg of meat in the first meal and may stay with the kill for 1 to 7 days. Tiger does not have a well-defined

breeding season in South Asia. Habitat fragmentation, conflict with humans, poaching, and hunting are the major threats (Johnsingh and Manjrekar, 2013).

Leopard (Panthera pardus fusca):

Leopard inhabits a wide range of habitats includes dry deciduous, moist deciduous, evergreen forest, tropical savannah, woodland, mixed coniferous forest. It is capable of killing much larger prey than its size but mostly it prefers prey of their size or smaller ungulates in the 10-50 kg size class(Hayward *et al.*, 2006). The annual kill rate of Leopard is about 30-35 ungulates per year or one large kill every ten days.

Asiatic Wild Dog (Dhole) (Cuon alpinus):

Dholes are almost exclusively seen in forests and thick shrub jungles and prefer ideal habitats like prey abundance, water, forest interspersed with grassy openings, den sites, and absence of human disturbance. Most often they rest on forest roads, trails, dry stream beds, and open patches and have distinct latrine sites on trails, roads, or intersections, where the whole pack urinates and defecates communally(Johnsingh and Manjrekar, 2013). According to AJT Johnsingh, Dholes do not attack humans even when they occur in a pack and prefers undisturbed area. They hunt in packs and are efficient predators surrounding their prey, cleaning it to the bones within a few hours(Menon, 2014).

Indian Wolf (Canis lupus pallipes):

The Indian wolf rarely lives in a forest and prefers scrubland, grassland, and semi-arid pastoral or agricultural areas (Johnsingh and Manjrekar, 2013). The majority of the wolf population in India occurs outside wildlife-protected areas and subsists on livestock like goats and sheep. Sometimes they even subsist on the black-naped hare, rodents and also eat locusts, reptiles, birds (Jhala and Giles, 1991; Jhala, 1993). It is a social animal and lives in a pack like wild dogs and comprises alpha pair and their offspring of several litters. The major threats for its survival are loss of habitat, combined with poaching of wild prey, resulting in depletion of natural prey densities and non-availability of appropriate denning and rendezvous sites (Johnsingh and Manjrekar, 2013).

Sloth Bear (Melursus ursinus):

It is endemic to the Indian subcontinent, found in a variety of habitats ranging from wet evergreen forest to dry deciduous and degraded scrub forests. The diet of the sloth bear consists mostly of ground-living

ants and termites, honey, sugar-rich fruits of commonly occurring plants like Mahua. They are solitary and face direct threats from poaching and capture of cubs. In western India, the Tarai, Eastern, and Northeastern India, poaching is reportedly the cause for the decline of the sloth bear population (Yoganand, Johnsingh and Rice, 1999).

Jungle Cat (*Felis chaus*):

The major habitats of jungle cats are grassland, shrub, dry deciduous, and evergreen forests and it is also found close to semi-urban areas and villages. It can hunt animals much larger than itself, it can also subsist on very small prey such as lizards, small snakes, mice, rats, and frogs (Menon, 2014).

Common Palm Civet (*P. hermaphroditus*) and Small Indian Civet (*V. indica*):

Common Palm Civet inhabits deciduous, evergreen, and shrub forests that can be found around human habitation. A nocturnal omnivore, it is very fond of the fruit of palms and honey, mainly arboreal and found often on palm trees. Small Indian civet inhabits semi-evergreen, deciduous, bamboo, shrub forest, open land, riverine habitat, it prefers shrub and dry forests to undisturbed evergreen patches (Menon, 2014).

Table 2.1: IUCN and WPA Status of various predator species reported from Pranhita Wildlife Sanctuary, Maharashtra, India

S. No.	Species	IUCN Staus	WPA 1972 Status
1	Leopard	Vulnerable	Schedule- I
2	Asiatic Wild Dog	Endangered	Schedule- II
3	Sloth Bear	Vulnerable	Schedule- I
4	Rusty-spotted Cat	Near Threatened	Schedule- I
5	Indian Grey Wolf	Least Concern	Schedule- I
6	Jungle Cat	Least Concern	Schedule- II
7	Indian Fox	Least Concern	Schedule- II
8	Small Indian Civet	Least Concern	Schedule- II
9	Common Palm Civet	Least Concern	Schedule- II
10	Ruddy Mongoose	Least Concern	Schedule- II

Methodology



Line Transect



Sign Survey



Camera trapping



Vegetation plotting

2.3 Methodology:

2.3A Camera trapping:

The permission was granted by the forest department for a camera trap survey in the Bahmani range by giving the reason for menacing situations on the ground in other parts of sanctuary because of the left-wing extremism (according to the local forest officials). Out of 418.85 km² of PWLS, camera traps were deployed in 40 km² area. The area was divided into 289 grids of 1.42 × 1.42 km² size.

Before camera placement, an extensive carnivore sign survey was carried out along the forest paths, animal trails, dirt tracks, dried stream bed to record carnivore presence through indirect signs (scat, pugmark, scrap/scratches). The area was divided into different 1.42 × 1.42 km² grids and at least one pair of camera traps was placed in each 2 km² grid (Figure 2.1) at 20 sites and operated for 24-27 days



continuously from 27 March to 22 April 2019. Apart from grid-based camera trapping, random camera traps were placed at 5 sites in Kamlapur and Pranhita ranges for 1 to 7 days during the study period.

All the camera traps were placed in a pair with a 4-7 m distance between two cameras. All the cameras were mounted on specially designed metal boxes at the optimum height to maximize the possibility of all carnivore species getting captured. Each camera was given a unique grid number with a date and time setting. The camera delay was set at multi-shot mode with a delay of 5 seconds. These cameras were active for 24 hour period that accounted for one sampling occasion. In addition to that GPS coordinates, geographical features, and habitat types were recorded.

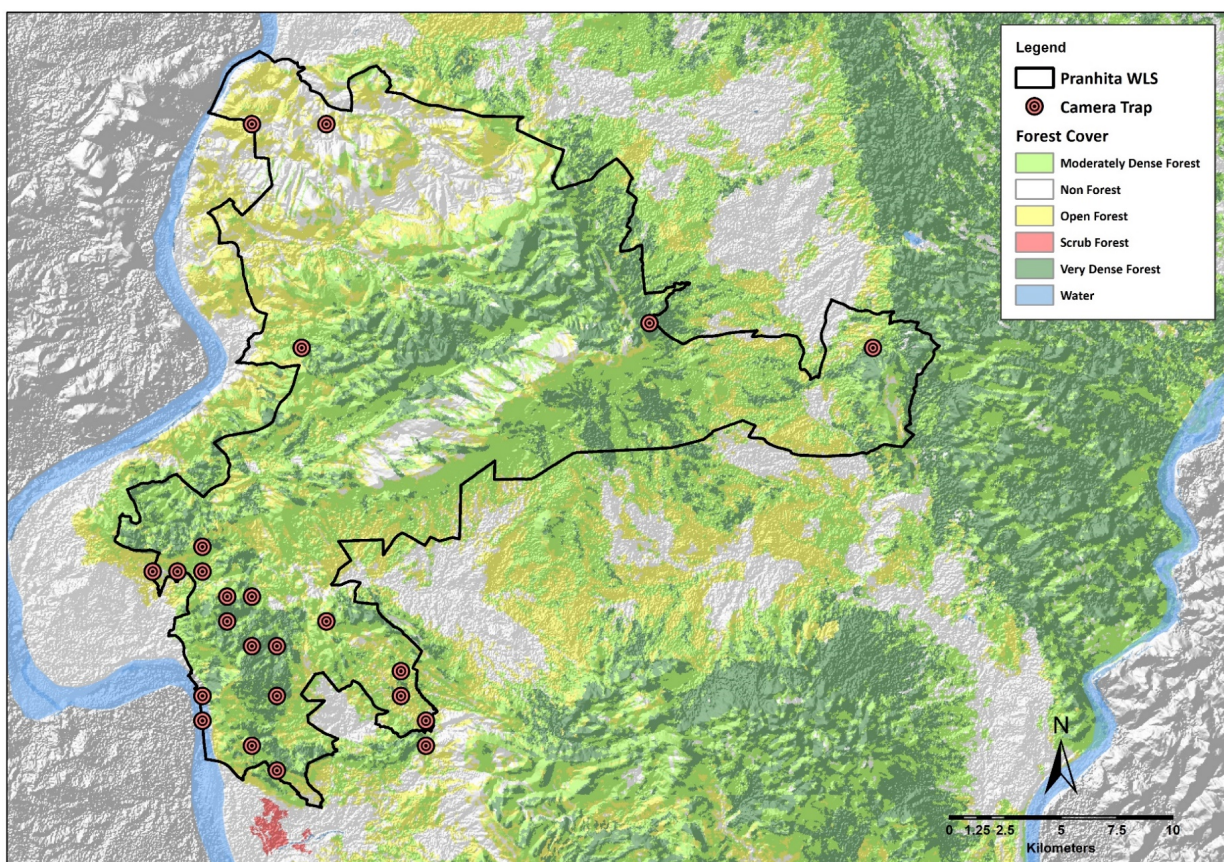


Figure 2.1: Map showing location of camera traps in Pranhita Wildlife Sanctuary, Maharashtra, India

2.3B Sign Survey:

Natural signs are deposited over the course of an animal's normal daily activities. Presence of animals can be verified by observing natural or indirect signs such as pug marks, hoof marks, scats, pellets, scrapes, burrows and tree rubs. Most animals are cryptic and nocturnal especially carnivores, making visual detection rare or impossible. Under these circumstances, surveying for an animal sign is an

effective and low-cost method for establishing species presence and their distribution. Given the inherent uncertainty of identifying species via interpretation of natural signs has often been called art rather than science (Liedenberg 1990; Halfpenny, 1997). Sign surveys can be applied across large geographical areas and are pertinent to many different carnivore species.

Large carnivore and ungulate sign surveys (Jhala et. al, 2008) were conducted throughout the accessible part of the sanctuary from January to April 2019. Signs such as scats (old, fresh, and very fresh), pellets, pug marks, hoof marks, scrapes, vocalization, and direct sightings were recorded along the foot trails. The total survey effort was 410.036km. A team of four researchers was involved in walking each of these sign surveys in the entire area. Due to inadequate roads, inaccessible hills, and dense thorny bushes, all areas couldn't be covered for sign survey.

2.3C Sign Survey Tracks in PWLS

Sign surveys were conducted according to the available beat map and grids. These grids were designed using ArcGIS with a size of 1.42 x 1.42 km² (Figure 2.2). These grids were numbered and were incorporated in the GPS (Garmin eTrex 30x). GPS was used for the entire sign survey and all grids inside every beat were covered by using foot trails, roads, or animal trails. All data was jotted down in datasheets of sign survey with GPS locations. Data like animal species, type of sign, GPS location, habitat type, terrain type was noted in the following datasheet.

Scat samples for large carnivores like wild dogs, leopards were also collected in ziplock bags. Based on the characteristic smell, small size, and deposition pattern, wild dog scats could be distinguished easily. Wild dog scats are found in clusters at the intersection of trails on bare or exposed soil (Acharya 2007; Johnsingh 1983; Karanth & Sunquist 1995; Ramesh 2010). Sloth bear (*Melursus ursinus*) scats were distinguished by their shape, size, the composition of seeds, plant, insects, and animal remains along with associated indirect evidence (track, signs) (Ramesh et al. 2010) (Figure 3.5). Leopard scats were distinguished by size, diameter, and presence of other signs like pugmarks, tracks (Johnsingh 1983; Karanth & Sunquist 1995; Ramesh 2010). Pugmarks of canids and felids differ a lot and can be easily distinguished. Claw marks are visible in the pug marks of a canid whereas felids have retractable claws. Also in the canids, except in the case of hyaena, the gap between the top of the pad and the two middle toes is distinctly more than what is found in felids. When we compare the ratio of the toe to pad size in both cases, canids have comparatively larger toes whereas felids have comparatively larger pads

(Talwar and Usmani, 2005). Pugmarks of a jungle cat, wild dog, leopard, and sloth bear were differentiated by the above-mentioned characteristics and size.

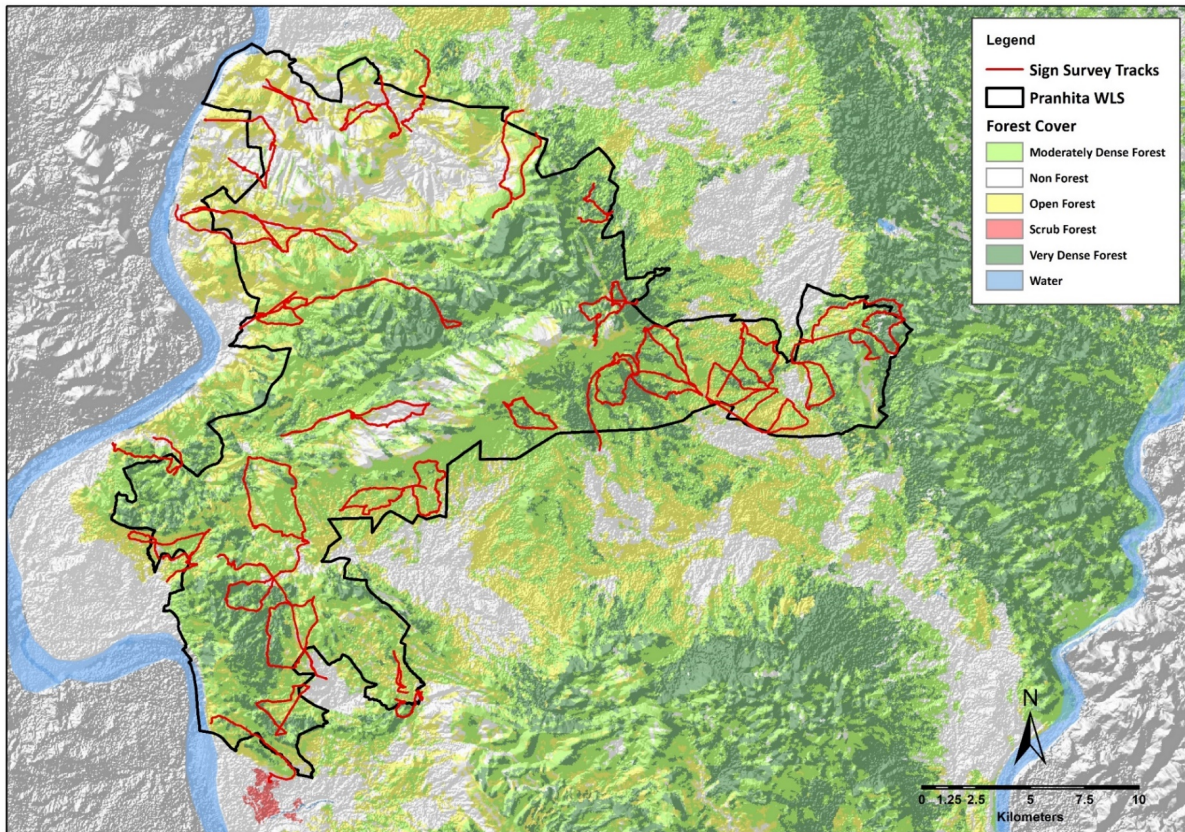


Figure 2.2: Map showing distribution of trails in Pranhita Wildlife Sanctuary used for sign surveys

Similarly, ungulates like sambar have barrel-shaped faecal pellets with a base either flat or concave in shape. The tip of the pellet tapers to a flattish point and the size of the adult sambar pellet ranges from 1.5-2 cm in length and 0.8-1.4cm in diameter. Chital pellets could be confused with pellets of small sambar because of the overlap of size. The faecal pellets of chital are cylindrical with the bottom end rounded and the apical region tapering to a point. The size of adult chital pellets ranges from 1.2-1.8cm but is much slender in comparison to sambar and nilgai pellets. Chital pellets could be confused with goat pellets in a degraded forest or areas with high grazing activity. Nilgai tends to defecate at fixed latrine sites forming dung piles. Several other species defecate around these dung piles. Nilgai pellets are similar to that of sambar but can be distinguished by their cylindrical shape with flat or smooth angular surfaces. The base of the pellets of nilgai is not as flat as that of sambar. The Pellet colour is often dark brown to blackish. Barking deer has the most distinguishable faecal pellet. These pellets are elongated and crinkled often with a twisted look and dented surface. These spindle-shaped faecal pellets have variations in size and shape between individual pellets from the same animal. The size

ranges between 1-1.8 cm and about 0.4-0.7 cm in diameter. Compared to all other ungulates, pellets of chousingha are small in size. The shape varies from ovoid or slightly elongated. The length of pellets varies between 0.6-1.2 cm and the diameter is between 0.6-0.8 cm. (Jhala et. al 2009). It should be noted that an inability to detect spindle-shaped should not be considered an absolute measure of species absence. Natural signs vary in determining the presence of species. However, under certain conditions, they can also be standardized to delineate species distribution, estimate relative and absolute abundance, calculate occupancy has, and monitor trends in population status.

2.4 Occupancy Estimates:

Considering the collected data from camera trapping and sign survey we used occupancy modeling for the analysis of the data. As mentioned earlier that camera trapping was done only in 40 km² of the sanctuary area. Camera trapping was restricted in a certain area and it leads to inadequate photographic captures for the data analysis. To overcome that, we did extensive carnivore and ungulates sign surveys in all accessible sanctuary areas. For the available database, species occupancy modeling would be more appropriate for the data analysis. All the analysis was done using PRESENCE 12.34 software.

Occupancy modeling is the distribution of species over space using temporal and spatial replicates. Occupancy modeling is the probability of presence or absence of the species at the sampling site. To decide the presence and absence of the species, multiple replicates are required for detection probability estimation. We laid 1.42 × 1.42 km² grids in the entire sanctuary area and considered these grids as sampling units. To separate true absence from the presence and non-detection, we did a total of 5 replicates of sign surveys on randomly selected sampling sites. For camera trap data, we clubbed it into a total of 5 intervals to make it uniform with sign survey replicates. Detectability varies among study sites and also depends on the characteristics of a survey on a particular day. This can be covered by using occupancy modeling wherein the software predicts the presence of species in areas that are not sampled. These models use information from repeated observations or replicate to estimate detection probability and occupancy (MacKenzie et al. 2002, 2003, 2004).

Sign survey was divided into 1 km spatial tracks using the split tool in ArcGIS and considered it as a geographic replicate in the occupancy analysis (Hines *et al.*, 2010). As we had taken sign records of multiple species during our sign survey, thus these records are fed in an excel sheet in presence/absence format i.e. if species is present then it is denoted as 1 and if species is absent then

0. The areas which were not sampled were denoted by (.) or dot. This excel sheet shows data on species presence in all the sampled grids. For camera trapping, every pair of camera traps act as a temporal replicate. Photographs of these camera traps show the presence of multiple species. Each species were marked in the presence/absence format (1, 0) similar to that of the sign survey.

As the sampled area for camera trapping was limited, we combined both the spatial and the temporal replicate data in two sets using the design matrix in PRESENCE 12.34 Software to bring robustness in data. As the camera traps were conducted grid-wise and for 25 days, we converted 5 days of camera trapping to 1 replicate. This made 5 replicates of camera trap (25/5) and species presence/absence were recorded in an excel sheet. Combining both sign surveys and camera traps gave a total of 10 replicates. We used a total of 8 site covariates which include Normalized Difference Vegetation Index (NDVI), Forest types, Elevation, and Distance from the nearest water source. Forest type includes dry deciduous, bamboo mixed, dry deciduous scrub, grassland, and agriculture. Each of these forest types was used as an individual covariate. These covariates were prepared for each of the 289 grids. NDVI was extracted from a Moderate Resolution Imaging Spectroradiometer (MODIS). Elevation data was downloaded from Bhuvan's website and extracted in ArcGIS. All these data were extracted by using ArcGIS application. Covariate data needs normalization before analysis. We normalized all covariates except NDVI before analysis. Normalization means the elimination of the different units of the different data and making it uniform. The data analysis was done using simple single season in Presence software.

The entire data were bootstrapped by 100. Bootstrapping is a resampling technique which means that the sample would be resampled 100 times for better results. We selected a pre-defined null model based on the lowest AIC value. As a data output, occupancy estimate and detection probability for individual species per sampling unit were used to represent the spatial distribution of these species. For this, we incorporated Occupancy modeling results in ArcGIS and used the Kriging tool for further analysis. Kriging is a spatial interpolation method that is based on statistical models that include autocorrelation that is, the statistical relationships among the measured points. Because of this, geostatistical techniques not only have the capability of producing a prediction surface but also provide some measure of the certainty or accuracy of the predictions (Oliver and Webster, 1990). Spatial distribution maps were created for individual species wherein the high occupancy estimate is denoted by red and the low occupied area is denoted by blue colour. Figure 2,3 shows the outline of various steps for generating presence maps for various species in the study area.

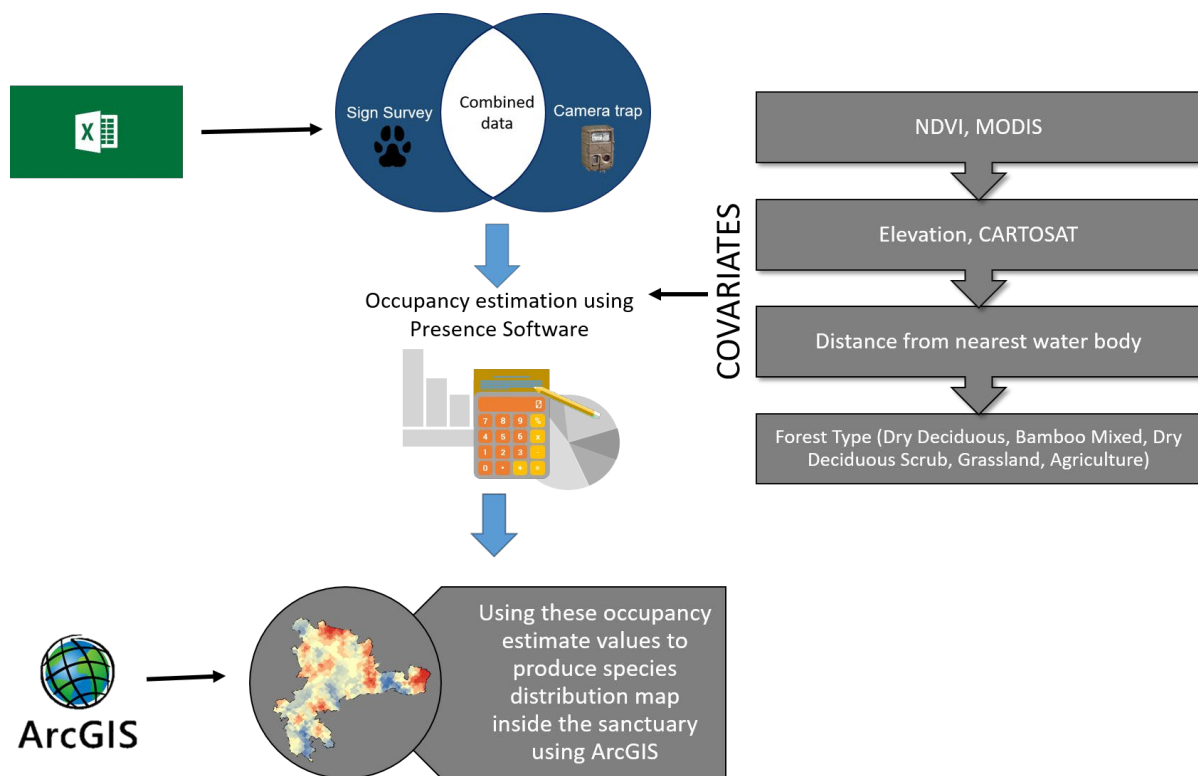


Figure 2.3: Schematic representation of various steps for generating species use maps using sign survey and camera trap data for Pranhita Wildlife Sanctuary

2.5 Results:

Carnivores:

A total of 10 carnivore species were recorded using direct and indirect signs. Following species were recorded like Leopard, Asiatic Wild Dog, Sloth Bear, Rusty-spotted Cat, Indian Grey Wolf, Jungle Cat, Indian Fox, Small Indian Civet, Common Palm Civet, and Ruddy Mongoose. Due to limited data set we were able to generate occupancy estimates only for 4 carnivore species, the details of detection probability and occupancy estimates of these four carnivores species are given in Table 2.2 and Figure 2.4.

Table 2.2: Occupancy estimates and detection probability of four carnivore species from Pranhita Wildlife Sanctuary, Maharashtra, India

Predator Species	Occupancy Estimate	Detection Probability
Leopard	0.20±0.07	0.21±0.08
Wild Dog	0.68±0.12	0.28±0.04
Sloth bear	0.70±0.11	0.26±0.04
Jungle Cat	0.74±0.10	0.24±0.03

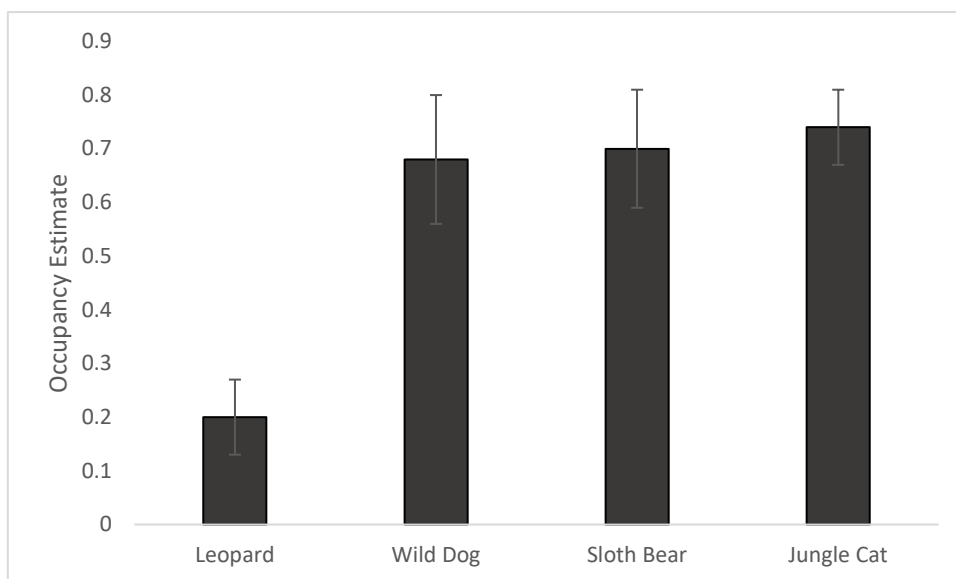


Figure 2.4: Occupancy estimates of four carnivore species from Pranhita Wildlife Sanctuary, Maharashtra, India

The occupancy estimate was highest for jungle cat followed by Sloth Bear, Dhole and was least for leopards. Figures 2.5 to 2.8 show the occupancy of Leopard, Dhole, Sloth Bear, and Jungle Cat in Pranhita Wildlife Sanctuary respectively.

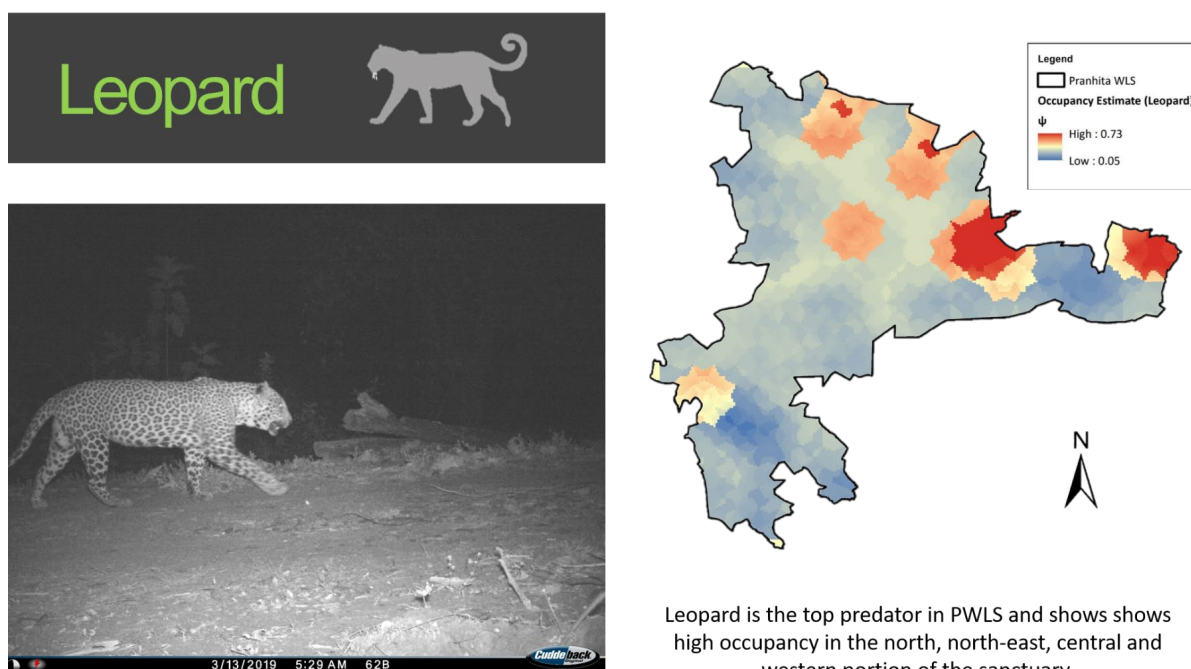
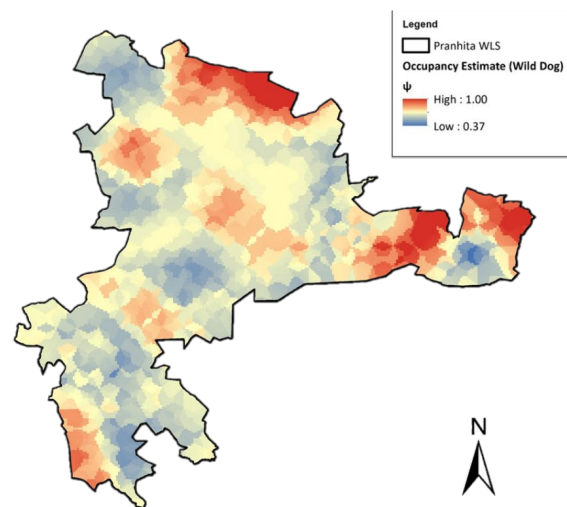
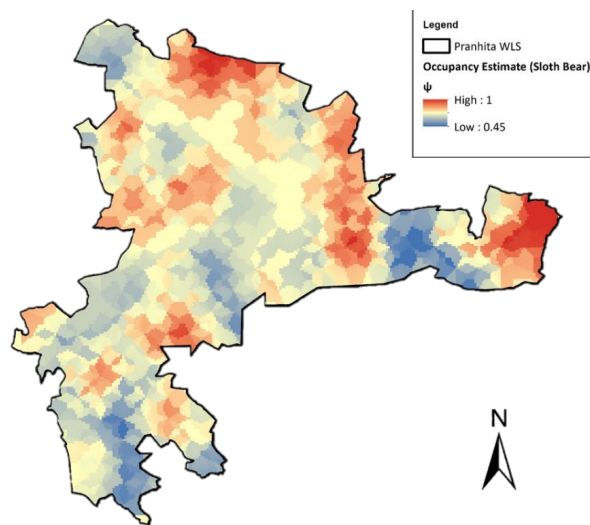
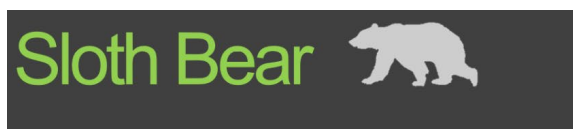


Figure 2.5: Leopard occupancy pattern in Pranhita Wildlife Sanctuary, Maharashtra



Wild Dog is an Endangered species according to IUCN and shows highest occupancy towards the north, east and near Pranhita river i.e. west of PWLS.

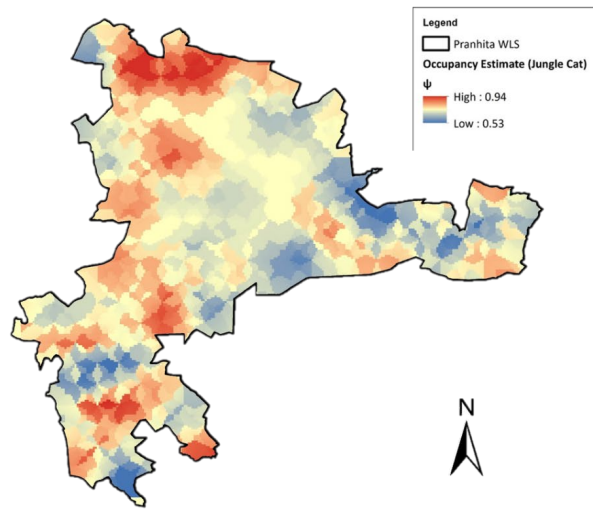
Figure 2.6: Wild Dog (Dhole) occupancy pattern in Pranhita Wildlife Sanctuary, Maharashtra



Sloth Bear is a widely distributed species in PWLS. Signs of Sloth Bear can be seen in the entire sanctuary with maximum signs in east, northeast, north and central part of PWLS

Figure 2.7: Sloth Bear occupancy pattern in Pranhita Wildlife Sanctuary, Maharashtra

Jungle Cat



Jungle cat shows the highest occupancy estimate value among all the species and is widely distributed inside the sanctuary

Figure 2.8: Jungle Cat occupancy pattern in Pranhita Wildlife Sanctuary, Maharashtra



Section III: Status of Prey Species in Pranhita Wildlife Sanctuary

3.1 Introduction:

The presence of keystone species indicates the health of an ecosystem and to sustain the predator population availability of prey plays a paramount role in their abundance (Power *et al.*, 1996). Estimation of prey population is important to know the status of the ecosystem for better management of any wildlife sanctuary. To maintain the prey-predator population dynamics in an ecosystem, viable populations of both the species are essential and estimation of prey and predator population to monitor the health of an ecosystem is the first step in the management of wildlife sanctuary. Among prey species, ungulates are the major contributor and play a crucial role in maintaining ecosystems by influencing the vegetation structure, plant species composition, and nutrient cycling (Bagchi and Ritchie, 2010). Net primary production can increase or decrease in response to ungulate grazing. It also influences the fire regimes by altering the quality and quantity of fuels available for combustion (Hobbs, 1996) and it can control forest fire incidences to a certain extent especially in those areas where forest fires are regular phenomena as we observed during a field survey in Pranhita wildlife sanctuary. Maintaining and monitoring ungulate populations is, therefore, an important objective of conservation management.

Based on direct or indirect evidence during the study period we observed prey species like Indian Bison/Gaur (*Bos gaurus*), Barking Deer/Bhedaki (*Muntiacus muntjak*), Chital (*Axis axis*), Sambar (*Rusa unicolor*), Nilgai (*Boselaphus tragocamelus*), Chousingha (*Tetracerus quadricornis*), Wild Pig (*Sus scrofa*), Grey Jungle Fowl (*Gallus sonneratii*), Indian Peafowl (*Pavo cristatus*), Black-naped Hare (*Lepus nigricollis*), Rhesus Macaque (*Macaca mulatta*), Langur (*Semnopithecus sp.*) and a large number of domestic livestock (cattle) graze in almost all parts of the sanctuary. The IUCN and WPA status of various prey species reported from Pranhita Wildlife Sanctuary is given in Table 3.1.

Although several techniques have been developed for monitoring of ungulate and large herbivore populations (e.g. distance sampling using line-transect or point counts; Burnham *et al.* 1980, Strip transect; Eberhardt 1978, Track count; Sulkava and Luikko 2007, Dung count; Laing *et al.* 2003), they appear to perform differently under different field conditions (Singh and Milner-Gulland 2011). Estimating ungulate abundance in densely forested areas especially remains a challenge due to their low visibility and low detection probability (Habib *et al.*, 2016). In addition to the above challenges, there are other factors like rocky mountainous terrain and thorny scrubland with almost no trails or roads

inside sanctuary area, prevalent trepidation of left-wing extremism among locals and forest staff largely restricted our movement inside the core area during the study period and thereby we could not cover the entire area of PWLS for distance sampling. We observed huge anthropogenic disturbances inside sanctuary areas like cattle grazing, fuelwood collection, and bamboo cutting etc. in the early morning hours, and thereby detection probability of prey species may largely be affected. In this study, populations of prey species, in PWLS were estimated using line transect-based conventional distance sampling method (Buckland *et al.*, 2004).

3.2 Prey Species Ecology:

For better conservation management practices on the ground, knowledge about the ecology of the prey species like habitat, activity pattern, behavior, diet, and persistent threats must be known. A brief review of the major prey species' ecology has given below.

Sambar (Rusa unicolor):

Sambar inhabits mixed deciduous forest, arid forests, shola grasslands, pine, evergreen forest and prefers moist habitat with undulating terrain. River and stream banks are chosen for daytime rests. They often feed in shallow water and move through forests very silently for their exceptionally large size (Menon, 2014). It feeds on grasses, water plants, foliage, fruit, great variety of shrubs and trees (Geist, 1998). Sambar is essentially a non-social species and the average group size is reported to be 4 to 5 individuals. The estimated mean home range of Sambar in Sariska is 4 km² and the annual home range was nearly 15 km² (Sankar and Goyal, 2004).

Indian Gaur (Bos gaurus):

Suitable habitats for Indian Gaur are moist deciduous forest, bamboo, teak forest with open grasslands along with the semi-evergreen and evergreen forest. It is also found in dry deciduous, shrub and plantation. Behaviour of Indian Gaur is very calm for a creature of its size, it rarely attacks unless tormented and it has an acute sense of smell (Menon, 2014). It prefers a wide variety of plants, preferably leaf blades, seeds, flowers of grass species, and steams (Shukla and Khara, 1998). Gaur is a gregarious and sociable animal and group size may range from 2 to 16 animals. The summer home range of male and female gaur in Pench Tiger Reserve was 12.61 km² and 7.25 km² respectively. It is an obligatory drinker, gaur needs water every day and may visit water bodies twice a day during the hottest periods (Sankar and Goyal, 2004).

Chital (Axis axis):

Chital is mainly found in grasslands, deciduous forests, riparian forests, and shrublands and has a fairly unique association with langurs as it feeds on leaves fruit drops by langurs from trees (Menon, 2014). It is a grazer as well as browsers and feeds on grasses, young shoot etc., and prefers a flat and undulating terrain. Chital is essentially a social animal, rarely seen as a solitary individual. The mean home range of Chital in Sariska was around 3.5 km² (Sankar and Goyal, 2004).

Chousingha (Tetracerus quadricornis):

It inhabits dry deciduous forest and scrub, prefers undulating terrain and it requires specific vegetation composition for foraging like fruit, flower-bearing trees, and a variety of herbs and shrubs. It often lives near water, it uses the same latrine sites regularly for defecation, and lay dropping in piles like Nilgai and prefers to live solitary or in very small groups (Sankar and Goyal, 2004).

Barking Deer (Muntiacus muntjac):

It is a solitary deer likely to be found in moist forest habitats that are closed enough to conceal them from a human observer. Muntjac feed on fruits, buds, freshly sprouted leaves, and small seeds (Sankar and Goyal, 2004).

Blue Bull/Nilgai (Boselaphus tragocamelus):

Nilgai the largest antelope in Asia inhabits dry deciduous, open shrub and agricultural land, it prefers well-watered habitat and avoids dense forest. It defecated at regular latrine sites, forming large clumps of saucer-shaped droppings. It is a very swift runner despite its large size (Menon, 2014). Nilgai lives in a group ranging from 1 to 10 individuals and prefers a variety of trees, grass, fallen leaves, and fruits. Its annual home range was 7.3 km² in Sariska (Sankar and Goyal, 2004).

Wild Pig (Sus scrofa):

Wild pigs occupy a wide variety of habitats from semi-desert to tropical rain forests, temperate woodlands, grasslands, and reed jungles and often venture into agricultural land to forage. They are omnivorous, living on crops, roots, tubers, fruits, and carrion, and live in a group (Sankar and Goyal, 2004).

Table 3.1: IUCN and WPA 1972 Status of various prey species reported from Pranhita Wildlife Sanctuary, Maharashtra, India

Prey Species			
1	Sambar	Vulnerable	Schedule- III
2	Indian Gaur	Vulnerable	Schedule- I
3	Chousingha	Vulnerable	Schedule- I
4	Indian Giant Squirrel	Near Threatened	Schedule- I
5	Chital	Least Concern	Schedule- III
6	Wild Pig	Least Concern	Schedule- III
7	Nilgai	Least Concern	Schedule- III
8	Barking deer	Least Concern	Schedule- III
9	Langur	Least Concern	Schedule- II
10	Rhesus Macaque	Least Concern	Schedule- II
11	Indian Peafowl	Least Concern	Schedule- I
12	Grey Jungle Fowl	Least Concern	Schedule- IV
13	Black-naped Hare	Least Concern	Schedule- IV
14	Indian-crested Porcupine	Least Concern	Schedule- IV

3.3 Distance Sampling:

Distance sampling is the most established method to estimate the density of ungulates in an area using the line-transect method. Considering the above-discussed limitations line transect are laid randomly in all accessible sanctuary areas and sightings of all prey species are recorded along with habitat and terrain features. A total of 24 transects of 2 km length were marked first-ever in PWLS. Each line transect was walked 5-7 times during the period from 12 February to 21 April 2019 to record prey species including cattle across the 418.85 km² area of PWLS. Thus a total of 353.41 km effort has been invested in line transect surveys which generated a total of 11 types of prey species including cattle. Some of the species like sambar, barking deer, rhesus macaque, and langur species sightings were very low so we excluded these species from the distance analysis. It is worth it to mention that Sambar (3 observations - 5 individuals), Barking deer (2 observations - 2 individuals), Rhesus Macaque (2 observations - 2 individuals) sightings were recorded during the transect survey (Table 3.2)

This includes the major prey species like Sambar (*Rusa unicolor*), Four-horned Antelope/Chousingha (*Tetracerus quadricornis*), Chital (*Axis axis*), Wild Pig (*Sus scrofa*), Nilgai (*Boselaphus tragocamelus*), Barking Deer (*Muntiacus muntjak*), Langur (*Semnopithecus sp.*), Rhesus Macaque (*Macaca mulatta*),

Indian Peafowl (*Pavo cristatus*), Grey Jungle Fowl (*Gallus sonneratii*) and Black-naped Hare (*Lepus nigricollis*). Although Indian Gaur and Barking Deer were sighted multiple times directly during the line transect survey these two species were not observed.

During the transect walk, data on species, number of animals seen, group composition, the bearing of the animal, angular sighting distance were recorded, and based on these data perpendicular distance have been calculated. To record the distances accurately Nikon PROSTAFF 3i Laser Range Finders were used and to give spatial reference to every observation Garmin etrex 30x Global Positioning System (GPS) was used. The GPS coordinates of the transect were also recorded.

Total sighting of all species numbered 878 including of which 654 are cattle which indicates huge anthropogenic disturbances inside the sanctuary area (Table 3.2). The data were analyzed in Distance program 7.3 software. The Individual Density, Group Density, Effective Strip Width, Average Group Size, and Encounter Rate of 8 species were reported during the study period in Pranhita wildlife sanctuary, Gadchiroli, Maharashtra.

Table 3.2: Details of line transect efforts and number of sightings of various prey species reported from Pranhita Wildlife Sanctuary, Maharashtra, India

Number of transects		24	
Length of each transect		2 km	
Number of replicates		5-7	
Total distance covered		353.41 km	
Number of Species recorded		11	
Species Recorded	Number of sightings	Individuals recorded	Average group size
Chital	21	52	2.47
Wild Pig	8	67	18.01
Nilgai	14	18	1.47
Langur	8	19	2.00
Chousingha	6	7	1.16
Indian Peafowl	6	8	1.33
Grey Jungle Fowl	20	25	1.33
Black-naped Hare	16	19	1.18
Cattle	63	654	10.50

3.4 Results:

All prey species (sum of all the individuals prey species density) density estimated is 19.46 per km². Species wise density of Wild Pig (11.55 ± 10.80) was highest followed by Chital (2.27 ± 0.69), Grey Jungle Fowl (1.87 ± 0.68), Indian Hare (1.78 ± 0.63), Nilgai (0.72 ± 0.29), Langur (0.55 ± 0.41), Peafowl (0.44 ± 0.33), Chousingha (0.28 ± 0.18) (Table 3.3). We excluded Sambar, Barking Deer, and Rhesus Macaque from analysis because of very less number of sightings during line transects and data is inadequate for distance analysis. The best fit model for detection probability is shown in figure 3.1.



Table 3.3: Individual Density, Group Density, Effective Strip Width, Average Group Size and Encounter Rate of all Prey Species Reported during 12 February to 21 April 2019 in Pranhita Wildlife Sanctuary, Gadchiroli, Maharashtra, India

Parameters	Chital	Wild Pig	Nilgai	Langur	Hare	Peafowl	Grey Jungle Fowl	Chousingha	Cattle
Individual Density (No of Animals/km²)	2.27	11.55	0.72	0.55	1.78	0.44	1.87	0.28	28.61
Standard error	0.69	10.80	0.29	0.41	0.63	0.33	0.68	0.18	7.53
Percent CV	30.68	93.52	41.14	74.60	35.78	75.60	36.37	65.04	26.33
95 % confidence interval	1.25-4.12	2.04-65.34	0.32-1.58	0.14-2.07	0.89-3.57	0.11-1.69	0.93-3.77	0.79-1.00	17.18-47.64
Group density (No of groups/km²)	1.03	0.64	0.48	0.46	1.52	0.29	1.48	0.24	3.12
Standard error	0.28	0.32	0.19	0.34	0.53	0.21	0.52	0.15	0.66
Percent CV	27.32	50.51	40.04	73.50	34.91	73.08	35.29	63.45	21.21
95 % confidence interval	0.62-1.76	0.24-1.68	0.22-1.06	0.12-1.71	0.77-3.01	0.80-1.10	0.75-2.93	0.69-0.84	2.06-4.72
Effective strip width	28.68	17.65	40.45	21.36	14.80	28.53	17.12	34.99	28.08
Standard error	5.22	5.69	11.04	7.25	3.56	11.01	3.35	17.18	3.44
Percent CV	18.21	32.25	27.29	33.96	24.10	38.62	19.60	49.09	12.28
95 % confidence interval	19.68-41.80	8.38-37.13	22.67-72.18	9.51-47.93	8.92-24.56	10.94-74.40	11.37-2579	10.599-115.56	21.98-35.86
Average group size	2.47	18.01	1.47	2.00	1.18	1.33	1.33	1.16	10.50
Standard error	0.34	3.32	0.12	0.43	0.10	0.21	0.11	0.16	1.23
Percent CV	1.84	78.71	9.43	21.82	8.49	15.81	8.57	14.29	11.73
95 % confidence interval	3.31	3.29-98.50	1.19-1.80	1.17-1.65	1.00-1.42	1.00-2.52	1.11-1.59	1.00-1.68	8.31-13.26
Encounter rate	0.059	0.022	0.039	0.019	0.045	0.016	0.050	0.016	0.17
Percent CV	20.37	38.88	29.30	65.19	25.26	62.05	29.35	40.19	17.29
95 % confidence interval	0.39-0.88	0.10-0.47	0.22-0.69	0.61-0.64	0.27-0.73	0.54-0.52	0.28-0.89	0.79-0.36	0.12-0.24
Probability of a greater Chi-square value, P	0.72	0.81	0.93	0.78	0.79	0.96	0.91	0.31	0.57

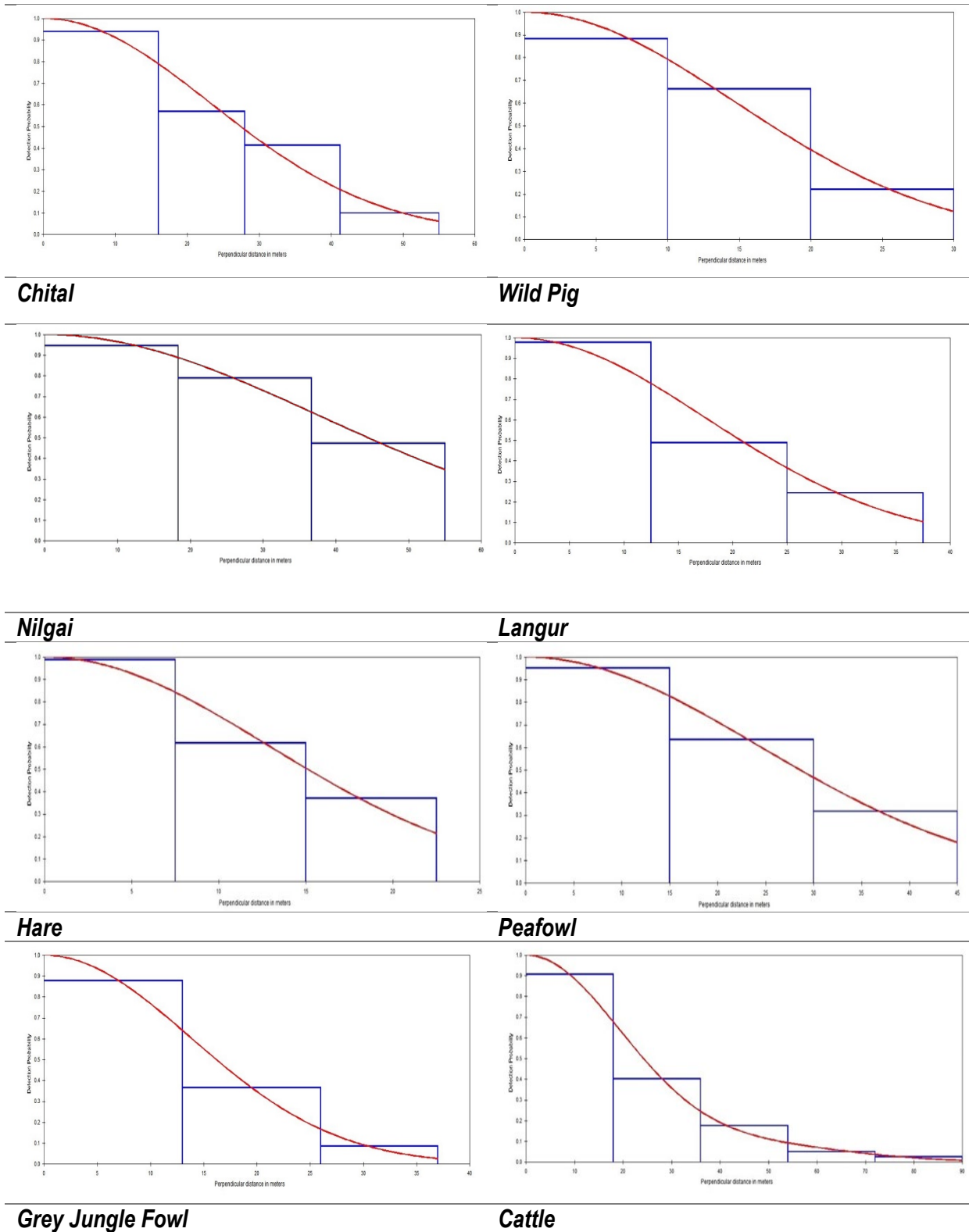


Figure 3.1: Detection function of best-selected model for prey species in Pranhita Wildlife Sanctuary, Gadchiroli, Maharashtra, India

Ungulate Occupancy Estimates:

A total of 14 prey species were recorded directly or indirectly in PWLS during the study period. Following species were recorded like Sambar, Indian Gaur, Chousingha, Indian Giant Squirrel, Chital, Wild Pig, Nilgai, Barking deer, Langur, Rhesus, Macaque, Indian Peafowl, Grey Jungle Fowl, Black-naped Hare, and Indian-crested Porcupine (Table 3.2; Figure 3.2)

Table 3.2: Occupancy estimates and detection probability of ungulate species from Pranhita Wildlife Sanctuary, Maharashtra, India

Prey Species	Occupancy Estimate (SE)	Detection Probability (SE)
Sambar	0.27±0.07	0.26±0.06
Chital	0.42±0.09	0.26±0.05
Chousingha	0.51±0.10	0.30±0.05
Nilgai	0.59±0.08	0.28±0.04

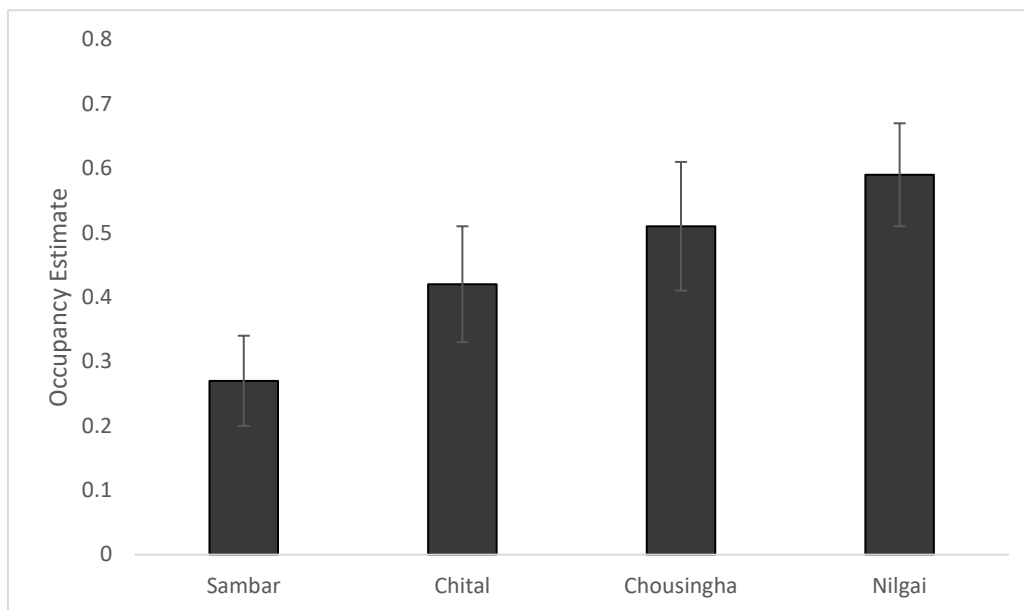

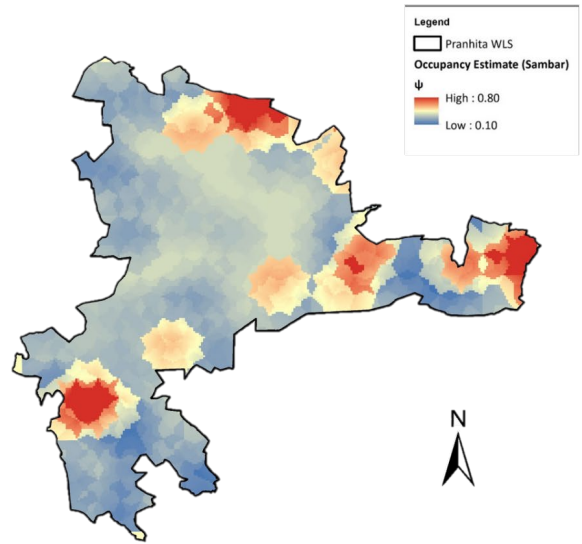


Figure 3.2: Occupancy estimates of ungulate species from Pranhita Wildlife Sanctuary, Maharashtra, India

The occupancy estimate was highest for Nilgai (0.59) followed by Chousingha (0.51), Chital (0.42), and Sambar (0.27). Figures 3.3 to 3.6 show the occupancy of Sambar, Chital, Chousingha, and Nilgai in Pranhita Wildlife Sanctuary respectively.


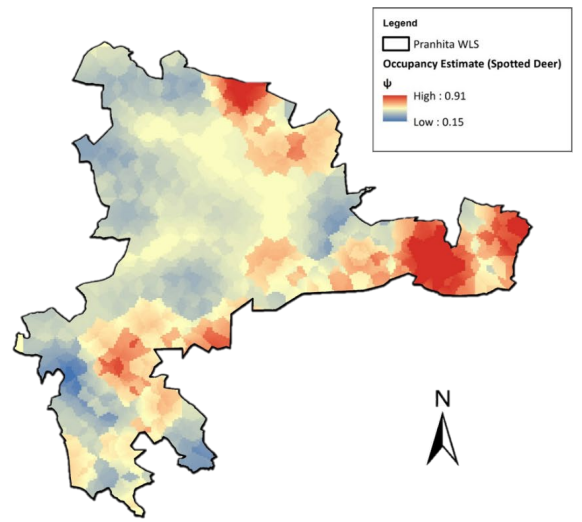
Sambar

Sambar is listed as Vulnerable by IUCN. It has mainly occupied the north-east, south-west and the eastern part of the sanctuary

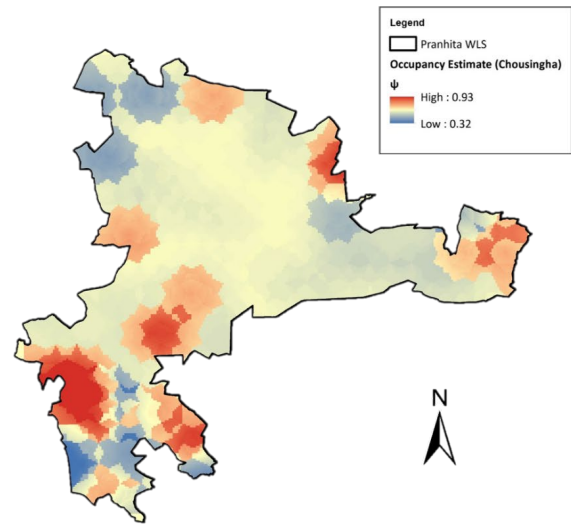
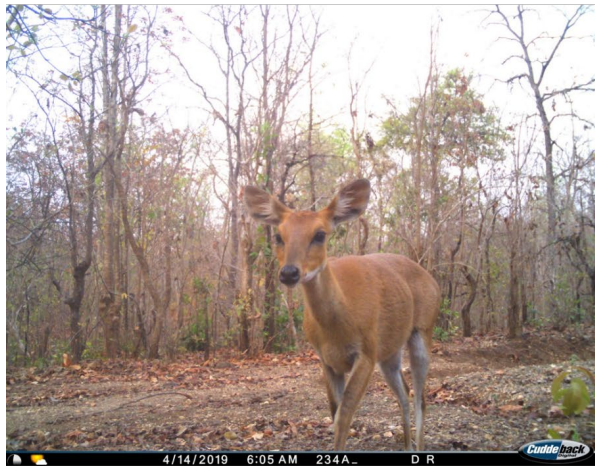
Figure 3.3: Sambar occupancy pattern in Pranhita Wildlife Sanctuary, Maharashtra

Spotted Deer

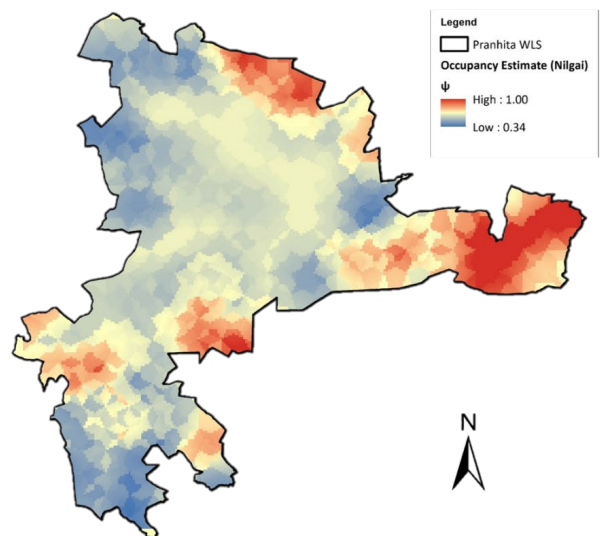
Sambar shows the least occupancy estimate value among all the ungulates. It has mainly occupied the north-east, west and the eastern part of the sanctuary

Figure 3.4: Chital occupancy pattern in Pranhita Wildlife Sanctuary, Maharashtra



Chousingha is listed as vulnerable by IUCN. It shows high distribution towards the south-west, south north east, central and east part of PWLS

Figure 3.5: Chousingha occupancy pattern in Pranhita Wildlife Sanctuary, Maharashtra



Nilgai shows the highest occupancy estimate value among the major ungulate species. It shows wide distribution inside the sanctuary with highest occupancy in the east, north, central part and the western part.

Figure 3.6: Nilgai occupancy pattern in Pranhita Wildlife Sanctuary, Maharashtra

that 10 m radius. We also recorded the number of trees with signs of lopping, woodcutting, grass cutting, forest fire, and pellets in that 10m radius. For shrubs, we took a plot of 3 m from the observer and noted the plants below 6 ft in the shrub category. Grasses and herbs were sampled at around a 1m radius and species were noted. We also recorded the approximate height of trees, shrubs, herbs, and grasses and their respective cover in percentage. Apart from that, we also did ground cover estimation wherein grass, stone, sand, barren ground, herb, litter, and others were estimated in percentage in a 10m radius.

Distance from the metalled road, unmetalled road, water source, and habitation was also recorded during the vegetation quantification. Total 96 vegetation plots were laid in PWLS during the study period. The detailed list of tree, shrub, grass species with their local and scientific names is provided in Table 4.1. The plant species were identified by the locals and forest guards. These local names of plant species were confirmed using the checklist of Gadchiroli (Jagtap and Mukherjee, 2013). R package “rich” was used in R for the species richness data analysis. The entire data was recorded in the given datasheet.



Results:

Species richness is to estimate the number of species that occur in an area. Species–area relationship is concerned with the number of species in areas of different sizes irrespective of the identity of the species within the areas (Ugland, Gray and Ellingsen, 2003).

1) Tree:

A total of 43 species of trees were recorded during the vegetation sampling survey. The following graph shows the 95 % confidence interval and mean of species richness. Species richness curve attained an asymptote at 60-65 number of plots and showed 30-35 number of tree species in the sampled area (Figure 4.2).

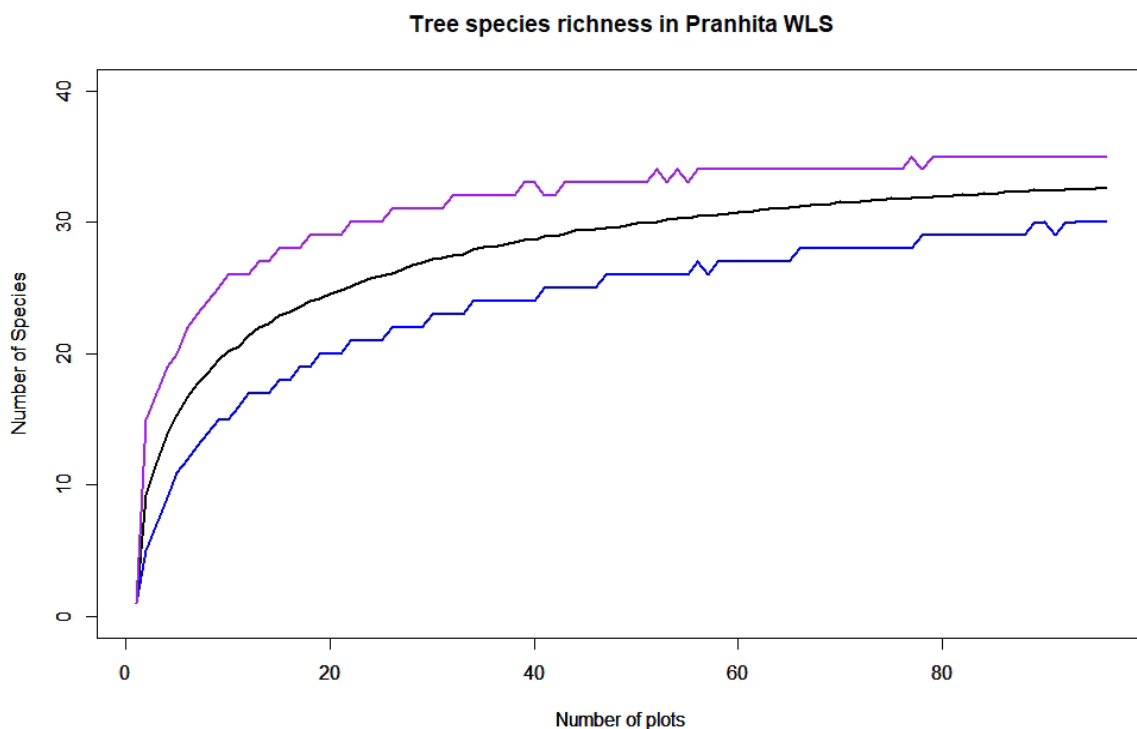


Figure 4.2: Number of plots vs Tree Species Richness in Pranhita Wildlife Sanctuary, Maharashtra

2) Shrub:

A total of 34 shrubs were recorded during the vegetation sampling survey. The following graph suggests mean of species richness at 95% confidence interval. The species richness curve shows an increase in the number of species richness and doesn't reach an asymptote. The graph shows 25-30 species of shrubs but the value is still increasing. This suggests that further sampling was required for shrubs (Figure 4.3).

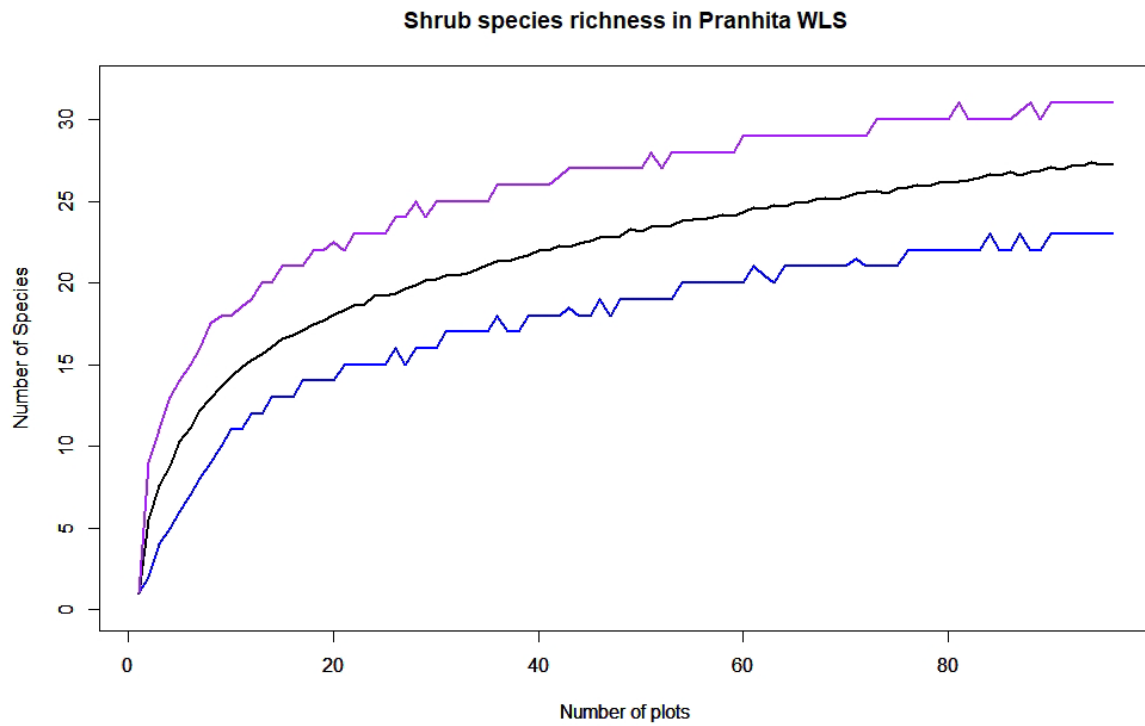


Figure 4.3: Number of plots vs Shrub Species Richness in Pranhita Wildlife Sanctuary, Maharashtra



3) Grass:

A total of 10 species were recorded during the vegetation plotting. The following graph suggests mean species richness at 95% confidence interval. Species richness curve reaches an asymptote at 35-40 number of plots and shows 8-9 species of grasses in the sampled area. Less number of grass species is because of the high intensity of forest fire in all the sampled areas of the sanctuary (Figure 4.4).

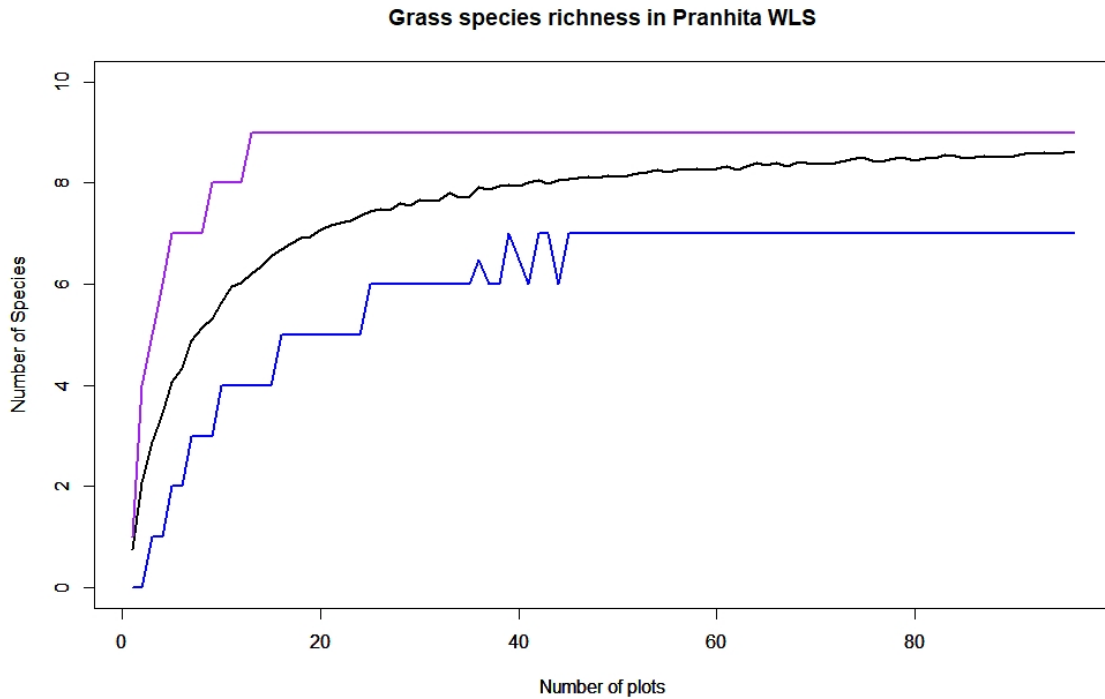


Table 4.1: List of tree and shrub species recorded during the vegetation quantification, Pranhita Wildlife Sanctuary, Maharashtra

S. No.	Tree Species	Scientific Name	Shrub Species	Scientific Name
1	Aapta	<i>Bauhinia racemosa</i>	Awala	<i>Phyllanthus emblica</i>
2	Ain	<i>Terminalia elliptica</i>	Ain	<i>Terminalia elliptica</i>
3	Amaltash	<i>Cassia fistula</i>	Amaltash	<i>Cassia fistula</i>
4	Anjan	<i>Hardwickia binnata</i>	Anjan	<i>Hardwickia binnata</i>
5	Apta	<i>Bauhinia racemosa</i>	Apta	<i>Bauhinia racemosa</i>
6	Arjun	<i>Terminalia arjuna</i>	Awala	<i>Phyllanthus emblica</i>
7	Awala	<i>Phyllanthus emblica</i>	Bhera	<i>Terminalia bellirica</i>
8	Bhera	<i>Terminalia bellirica</i>	Bija	<i>Pterocarpus marsupium</i>
9	Bija	<i>Pterocarpus marsupium</i>	Palas	<i>Butea monosperma</i>
10	Charoli	<i>Buchanania cochinchinensis</i>	Charoli	<i>Buchanania cochinchinensis</i>
11	Chichwa	<i>Albizia odoratissima</i>	Chichwa	<i>Albizia odoratissima</i>
12	Chilati	<i>Acacia torta</i>	Chilati	<i>Acacia torta</i>
13	Dhaman	<i>Grewia tiliifolia</i>	Gulmohar	<i>Delonix regia</i>
14	Dhavda	<i>Anogeissus latifolia</i>	Dhaman	<i>Grewia tiliifolia</i>
15	Dhoban	<i>Dalbergia peniculata</i>	Dhavda	<i>Anogeissus latifolia</i>
16	Dikamali	<i>Gardenia lucida</i>	Dikamali	<i>Gardenia lucida</i>
17	Garadi	<i>Cleistanthus collinus</i>	Garadi	<i>Cleistanthus collinus</i>
18	Ghogar	<i>Gardenia latifolia</i>	Haldu	<i>Haldina cordifolia</i>
19	Gulmohar	<i>Delonix regia</i>	Hirada	<i>Terminalia chebula</i>
20	Haldu	<i>Haldina cordifolia</i>	Hivar	<i>Acacia leucophloea</i>
21	Hirada	<i>Terminalia chebula</i>	Jambhul	<i>Syzygium cumini</i>
22	Hivar	<i>Acacia leucophloea</i>	Khair	<i>Acacia catechu</i>
23	Jambhul	<i>Syzygium cumini</i>	Khirani	<i>Manilkara hexandra</i>
24	Jangali Halad	<i>Curcuma longa</i>	Kuda	<i>Holarrhena pubescens</i>
25	Kadam	<i>Neolamarckia cadamba</i>	Kusum	<i>Schleichera</i>
26	Kadu Nimb	<i>Azadirachta indica</i>	Lendi	<i>Lagerstroemia parviflora</i>
27	Karai	<i>Diospyros melanoxylon</i>	Lokhandi	<i>Ixora pavetta</i>
28	Karai	<i>Sterculia foetida</i>	Moha	<i>Madhuca longifolia</i>
29	Kateain	<i>Bribelia retusa</i>	Rohan	<i>Soymida febrifuga</i>
30	Khair	<i>Acacia catechu</i>	Salai	<i>Boswellia serrata</i>
31	Khirani	<i>Manilkara hexandra</i>	Shatavari	<i>Asparagus racemosus</i>
32	Kuda	<i>Holarrhena pubescens</i>	Surya	<i>Xylia xylocarpa</i>
33	Kusum	<i>Schleichera</i>	Teak	<i>Tectona grandis</i>
34	Lendi	<i>Lagerstroemia parviflora</i>	Tendu	<i>Diospyros melanoxylon</i>
35	Lokhandi	<i>Ixora pavetta</i>		
36	Moha	<i>Madhuca longifolia</i>		
37	Mohai	<i>Lannea coromandelica</i>		
38	Palas	<i>Butea monosperma</i>		
39	Rohan	<i>Soymida febrifuga</i>		
40	Salai	<i>Boswellia serrata</i>		
41	Surya	<i>Xylia xylocarpa</i>		
42	Teak	<i>Tectona grandis</i>		
43	Tendu	<i>Diospyros melanoxylon</i>		

Table 4.2: List of herbs and grasses recorded during vegetation quantification, , Pranhita Wildlife Sanctuary, Maharashtra

S. No.	Herb Species	Scientific Name	Grass Species	Scientific Name
1	Bhuinimb	<i>Andrographis paniculata</i>	Bamboo	<i>Dendrocalamus strictus</i>
2	Bhutganja	Lamiaceae	Bhurbhushi	<i>Eragrostis tenella</i>
3	Awala	<i>Phyllanthus emblica</i>	Ganpati Durva	<i>Cynodon dactylon</i>
4	Bhera	<i>Terminalia bellirica</i>	Kusali	<i>Heteropogan contortus</i>
5	Hirda	<i>Terminalia chebula</i>	Lavhal	<i>Cyperus rotundus</i>
6	Shatavari	<i>Asparagus racemosus</i>	Sindhi	<i>Phoenix sylvestris</i>
7	Khair	<i>Acacia catechu</i>	Waghnakhee	<i>Digitaria sanguinalis</i>
8	Jangali Halad	<i>Curcuma longa</i>	Zadu Gavat	<i>Thysanolaena maxima</i>
9	Kadu Nimb	<i>Azadirachta indica</i>	Honganne	<i>Alternanthera sessalis</i>
10	Lavhal	<i>Cyperus rotundus</i>	Agadha	<i>Achyranthes aspera</i>
11	Salai	<i>Boswellia serrat</i>		
12	Kuda	<i>Holarrhena pubescens</i>		
13	Chichwa	<i>Albizia odoratissima</i>		

Section V: Capacity Building

5.1 Capacity Building Program:

Capacity building of forest officials is a continuous process of research and management at the Wildlife Institute of India. Wherever WII conducts a scientific study, it involves a capacity-building program through field training of local forest officials for wildlife conservation and management. During the field survey in PWLS, the training was conducted on 26th January in Kamlapur and Pranhita Range. On 3rd February 2019, training for Jimalgatta and Bahmani range was conducted. Major objectives of the training program were:

- 1) To improve the theoretical and practical knowledge of forest officials.
- 2) To enhance field monitoring skills of the forest officials with a scientific approach.
- 3) To upgrade the scientific knowledge and skills of forest officials for the collection of field data.
- 4) Training for line transect, camera trapping, vegetation quantification, scat identification and use of field equipment in the forest.



The training program was conducted twice in such a way that all the staff members from the 4 ranges could be covered. In the first training program, Pranhita and Kamlapur were conducted, and later for Bahmni and Jimalgatta ranges were covered.

Trained forest staff is one of the most important aspects of conservation in any of the protected areas. Most of the data in the forest have to be collected by beat guards. Therefore, we had conducted a training program for all the ranges lying in PWLS. The training involved the following components.

5.1A Technical Session:

The first technical session was started with the introduction of the Wildlife Institute of India and the researchers' team with the project objectives in PWLS. A brief review of wildlife and conservation followed by prey-predator species ecology. All the theoretical aspects of wildlife like habitat, behaviour, activity pattern, diet composition of wildlife were explained in detail. Other aspects like control of forest fire, the importance of regular monitoring, reduction of hunting activities, tree cutting, and their impacts were covered. Theory of field techniques like line transect, camera trapping, and vegetation quantification was explained in detail.

5.1B Practical Session:

I) Equipment Functioning: Equipment hands-on training was given to all the guards on a personal basis. GPS is one of the most important pieces of field equipment for any guard entering the forest. For the training purpose, GPS (Garmin eTrex 30x) was used. Use of compass (Sunto 2015 KB-20/360R G) during the line transect was demonstrated to each guard. The use of a range finder (Nikon PROSTAFF 3i Laser) which is important equipment that gives the distance from the observer to the object was also demonstrated.



II) Line Transect: Line transect is one of the most important sampling techniques for ungulate population estimation. This technique is being performed by the guards without proper knowledge, field equipment, and a basic understanding of the technique. With inappropriate methods, there is a lot of data loss and discrepancy. Therefore, proper field techniques with the use of field equipment are very important for data collection. But lack of field equipment is one of the major issues faced by the guards in this area. The front-line staff are the people who know the entire area properly and are the one who collects the data. For the collection of data in a more scientific manner, training is very important.

III) Sign Survey: Training for sign survey was also conducted to understand the presence of carnivore species. Differentiating pug marks of different carnivore species can be a challenge without understanding the basics. Therefore during the training, different pug marks of all common carnivore species were shown to all the guards according to Monitoring tigers, co-predators, prey, and their habitats by Jhala *et. al* 2009.

IV) Camera Trapping: Camera trapping was also demonstrated to all the guards with all settings required during the deployment of a camera. This technique would help in future camera trapping in PWLS.

5.2 Outcome:

As an outcome, field staff would be able to conduct Line Transect and camera trapping surveys on their own using all field instruments like GPS, Compass, and Range Finder. They can collect field data on their own. Field staff would be able to understand the basic ecology of the species and their conservation importance.

Section VI: Threat Assessment - PWLS

6.1 Threats and suggestions for wildlife conservation and management in PWLS:

Threats to wildlife species are principally due to habitats degradation, habitat fragmentation, excessive grazing, hunting, poaching, climate change, and human-wildlife conflict. In PWLS, the forest is dense and barely fragmented. But still, the number of species observed during various surveys was very low. These low sightings could be repercussions of threats that persist for the wild animals present in this sanctuary. These threats include hunting, excessive livestock grazing, unregulated wildfires, illicit cutting of wood, road-kills, electrocution, and left-wing extremists.

6.1A Anthropogenic activities and feral dogs:

The dependency of the locals on the forest has led to huge anthropogenic pressure. Locals collect wood, fruits, leaves or hunt animals inside this sanctuary. We captured a total of 5472 photographs out of 15,619 (35%) usable images which suggest a very high human presence in the sampled area. Apart from that, these locals are followed by feral dogs which possess a huge threat to wildlife. We got 697 captures of feral dogs (4.5%) out of all the usable images. In this region, dogs are used to facilitate hunting, protect households, or reduce human-wildlife conflicts by protecting livestock from predators. Dogs spread several diseases, harass or kill wildlife and compete with endemic species (Figure 1). Dogs carry several transmissible pathogens for diseases such as parvovirus, canine distemper virus (CDV). Dogs are a major threat to the native wildlife and cause a significant population decline of these species (Woodroffe, 1999). 60 parasite species are common for humans, cats, and dogs (MacPherson, 2005). Thus proper management is required to reduce such anthropogenic pressure and feral dog population inside the sanctuary.

6.1B Hunting:

The first and biggest threat in PWLS is hunting. As mentioned earlier, PWLS is dominated by Gond and Madia tribes. These tribes hunt for their consumption and other religious beliefs. Following the tradition of their ancestors, these locals still hunt for the sole purpose of food. They use different hunting equipment like spears, bow and arrow, snares, slingshots to kill animals and birds. (Figure 5.2). There are historical records of tigers in PWLS (1989 census by Forest Department) but currently, there are no tiger records which suggests that either these tigers have migrated to different areas or been wiped out due to all mentioned threats. We captured 616 images out of 15,619 (4%) of the usable data of hunters with different equipment.



Youngsters carrying slingshots inside PWLS as captured in a Camera trap



Local hunters captured in a Camera trap carrying spears for hunting

Poachers use equipment like spring traps/steel traps to hunt these animal species. Tribals in PWLS believe in witchcraft and often hang animals like giant Indian squirrels, langurs, or other animal heads at the entry point of the villages to drive away evil spirits. Such beliefs and superstitions are a major threat to wild animals. The animals preferred for hunting are sambar, chital, porcupine, giant squirrel, wild boar, hare, and peacock. However, it is not for selling, and in most cases, it is for their consumption. Regular patrolling and legal actions should be taken against the guilty. Hunting activities of any animal are illegal as per Wildlife (Protection) Act, 1972. Lack of law enforcement in PWLS, hunting is still very prominent inside the sanctuary. Thus, legal actions should be taken strictly to control hunting activities. Regular patrolling day and night, awareness programs, etc. may help to reduce these activities

5.1C Livestock grazing:

Apart from hunting, there is extensive cattle grazing inside the sanctuary. Cattles here are not tied and are left free to roam in the sanctuary area. More than 50% of PWLS is under grazing pressure and all



Cattle grazing captured in a Camera trap inside PWLS

this livestock is unattended. Cattle showed the highest detection probability and density during the line transect survey. Apart from that, we got 4375 captures out of 15,619 (28%) usable images which suggest high livestock grazing pressure in the forests.

This has led to high competition for available resources and can cause a huge impact on other wild ungulates. Apart from that, disease from cattle could be a major risk wherein these diseases could be transmitted to wild ungulates in this area.

More than 50% of PWLS is under grazing pressure. This activity must be prohibited to reduce the impact on other wild animals. The owner of this livestock should be identified and strict actions must be taken.

6.1D Forest Fire:

Another threat in this region which is very prominent during the summers is unregulated forest fires. Forest fire is one of the most common threats in the central Indian landscape. However, the issue of forest fire in PWLS is much larger than other protected areas. During our entire field period, Gadchiroli shows the highest number of fire incidences which are incomparable to other districts in Maharashtra (Global Forest Watch Fires)

These wildfires are generally man-made. One of the reasons for these wildfires is the mahua collectors. These people light fire under the fruiting tree for their ease to collect fruits. This fire spreads through the connected leaf fall and destroys the entire forest. Similarly, for the tendu leaves collection, locals ignite a fire in the forest for a better yield of tendu for next year. In this way, thousands of hectares of forests are gutted for tendu which affects the regeneration of green cover.

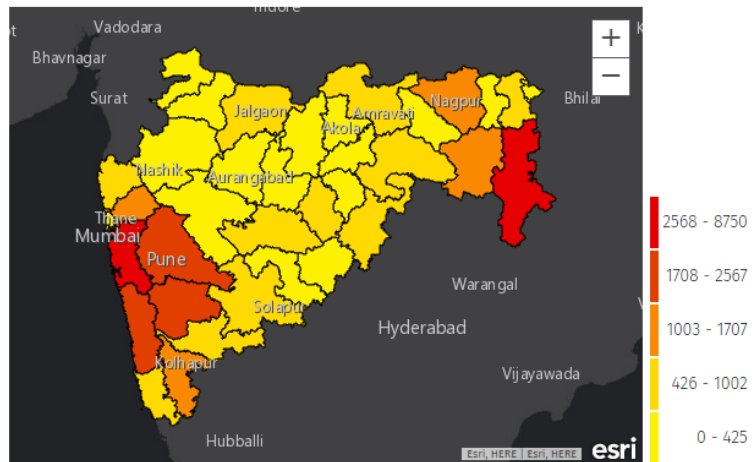
Forest fires in PWLS are quite common during the summers. To reduce these fires, there must be enough fire lines inside the sanctuary area. Apart from that, there should be an increase in the number of fire watchers during peak fire season. The main reason is the Mahua collection as we mentioned before. An awareness programme should be carried out to control the forest fire at the village level and other strategies need to be built accordingly.



Forest fires inside PWLS

GREATEST NUMBER OF FIRE ALERTS BY DISTRICT 20 JAN 2019 - 25 APR 2019

District	State	#
Garhchiroli	Maharashtra	8750
Raigarh	Maharashtra	2567
Ratnagiri	Maharashtra	1987
Satara	Maharashtra	1961
Pune	Maharashtra	1942
Chandrapur	Maharashtra	1707
Thane	Maharashtra	1584
Kolhapur	Maharashtra	1472
Nagpur	Maharashtra	1402
Yavatmal	Maharashtra	1002



Forest fire incidents in Gadchiroli Forest Division from Jan – April 2019

6.1E Illicit wood cutting:

Woodcutting is a common practice in PWLS. Tree cutting can be easily noticed in PWLS as the majority of the villages are located in the periphery of the sanctuary and they use timber to build their homes, cowshed, and farm compounds. These villagers depend on this forest to a very high extent. Wood from these forests is used by these villagers as fuelwood, fencing, or poles. Apart from that, there are reports of the illegal trade of timber. Teak cutting is one of the major issues in the sanctuary and there are very few areas with teak left. Several other tree species are being exploited for several other purposes. Some species of trees like Bija, Hiwar, Jamun, Dhawda, and khirmi are lopped for feeding livestock but this activity is not prevalent in all the areas. Locals completely depend on forests for wood. This has led to a short-scale fragmentation inside the part of forests that are closer to the villages. These activities must be reduced and should be prohibited. Strict actions must be taken for such actions.



The incident of wood transport was captured by camera traps and evidence of lopped tree.

6.1F Road-kill:

Road kills have been a major threat to wildlife in all parts of India. Though there are very few roads in PWLS, there is one road NH 353C which cuts right through the sanctuary. This road connects to Telangana and is used by heavy trucks and other carrier vehicles. Most of these vehicles travel overnight and there are several road-kills on this road. (Figure 5.10) We found road-kills of some species including reptiles which are the most susceptible taxa to road-kills. There are several roads kills on this highway that goes unreported and these roads have no or inadequate mitigation measures.



Road-kill of a Jungle Cat on NH-353C passing through Gudiguddam, PWLS

6.1G Electrocution:

Presently there are 19.22 km electric lines of 11KV inside PWLS (PWLS Management Plan). Poachers use connecting power lines for killing wild animals. One such case happened in the nearby wildlife sanctuary in Chaprala in 2017. A collared tigress was electrocuted after a successful translocation.



Collared tigress electrocuted because of illegal power fence in Garchiroli.

6.1H Left-wing extremism:

Left-wing extremism remains a threat in PWLS. These armed men take shelter inside the dense forest of this sanctuary. There is a consistent trepidation in the minds of locals and forest officials. It prevents or demotivates them from working efficiently in the PWLS. This activity indirectly affects wildlife conservation and management in PWLS.

6.2 Other Suggestions:

1. Impractical Beat Boundaries and Inefficient Frontline Staff: The sanctuary is divided into 4 ranges. Each of these ranges has several beats. Every beat has a beat guard but considering the size, hilly terrain, and inaccessibility, it is impossible to patrol the entire beat. Beat boundaries are randomly marked and it is almost impossible for beat guards to patrol some areas. Even the beat guards are not sure of the beat boundary in this area as they do not have GPS devices and proper maps. Thus, it is

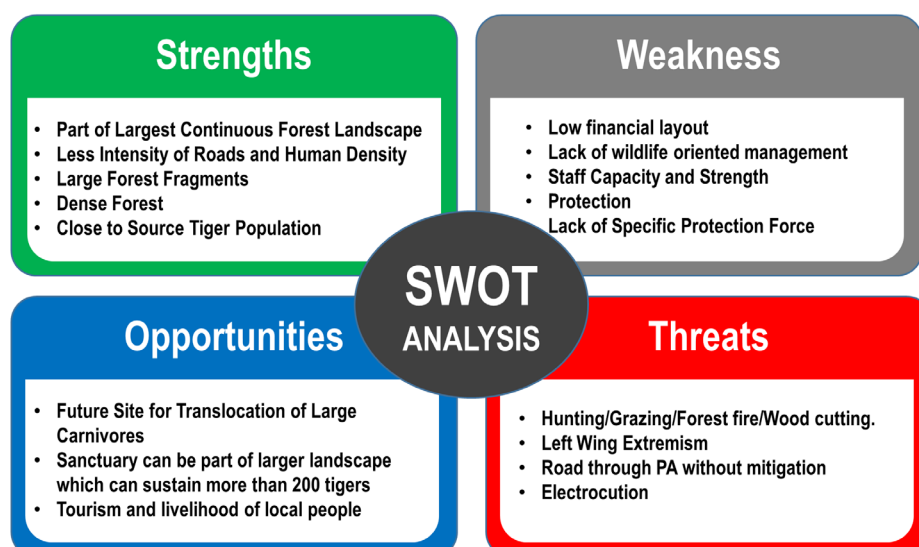
important to prominently mark and reshape these beat boundaries according to the terrain, ease of movement, and availability of roads.

2. Lack of Legal Action: Illegal activities thrive where law enforcement agencies are inefficient. In PWLS, we have observed negligible law enforcement to control unlawful activities. Widespread local hunting, tree cutting, and grazing are prominent in PWLS.

3. Inadequate Infrastructure: There are almost no guard huts or inspection huts inside the sanctuary. Most of the infrastructure is situated on the periphery of the sanctuary. For proper monitoring of the forest, there must be adequate huts inside the sanctuary for the ease of forest staff. It would help for the better patrolling by forest staff and ultimately leads to reduction of illegal activities, control of forest fire, and regular patrolling.

4. Forest Officials training: Staff training is an important aspect for better wildlife conservation and management. Fitness with field knowledge is essential for better results. The front-line staff training helps in better data collection and gives a better picture of wildlife and habitat conditions in the sanctuary. Regular capacity building of forest staff is necessary to improve the functioning and motivation of the forest staff. We also conducted a capacity-building programme for PWLS forest officials.

5. Lack of Field Equipment: Availability of field equipment like GPS, Compass, Range Finder, Wind Blower, and other necessary equipment. We notice that there are only one GPS and Compass per range. There must be one GPS and Compass per beat guard. These field equipment will help them to work efficiently e.g. to precisely reach the forest fire location, to record animals sighting on the line transect, etc.





Suggestions for Wildlife Conservation in Pranhita Wildlife Sanctuary, Maharashtra, India

Section VII: Pranhita Wildlife Sanctuary - Potential Site for Conservation

Introduction:

For the conservation of our National Animal Tiger, the Government of India has shown strong commitments through several initiatives such as creating National Tiger Conservation Authority, amending Wildlife Protection Act (1972), delineating inviolate critical core areas in an existing tiger reserve, declaring new tiger reserves, incentivized voluntary relocation program and identifying critical corridor areas connecting major tiger landscapes for long term conservation planning. All these measures by the Govt. of India have led to an increase in tiger population from 1708 in 2010 to 2226 in 2014. The increase in tiger population reflects the implementation of various measures by the State Governments. These initiatives and their implementation by respective State Governments have been critical in securing the survival of key tiger populations, the biodiversity, and the ecosystem services of the forests they inhabit. The core critical tiger habitats provide innumerable ecosystem services. A recent study of quantitative and qualitative estimates for as many as 25 ecosystem services from select tiger reserves, indicated that the monetary value of flow benefits emanating from select tiger reserves ranges from 8.3 to 17.6 billion rupees annually. In terms of the unit area, this translates into Rs. 50,000 to 1,90,000 per hectare per year. Other than flow benefits, these tiger reserves protect and conserve stock value in the range of 22 to 656 billion rupees. The report released by the Honorable Minister of Environment and Forests, Govt. of India emphasizes that adequate investment in tiger reserves is essential to ensure the flow of ecosystem services in the future. To conserve these ecosystem services and ensure their flow for our future generations, it is essential to integrate the management of tiger reserves into the border landscape and enhance/restore ecological connectivity among these tiger reserves and their wide environment.

Efforts by the Government have resulted in locally abundant tiger populations in the State of Maharashtra and especially in the Eastern Vidarbha Landscape Complex. With humans increasingly encroaching on even the most remote areas, understanding how large carnivores and humans can share the same landscape is emerging as a pressing concern in the conservation of large carnivore populations. To maintain coexistence at the level which is acceptable to people and which allows movement of the animals across the landscape, it is required that conservation communities and management think of conservation translocations. Conservation translocation is the deliberate movement of organisms from one site for release to another. It must be intended to yield a measurable conservation benefit at the levels of a population, species, or ecosystem, and not only provide benefit to translocated individuals.

Conservation Translocations - Considerations for the State of Maharashtra:

Most of the tiger reserves in the Eastern Vidarbha Tiger Landscape complex have shown an increase in the number of Tigers. As per 2014 All Indian Tiger Population Estimation, the TATR landscape supports more than 100 tigers. Brahmapuri, which is a territorial forest division supports more than 40 tigers and 100 leopards. UKWLS has more than 3 litters to disperse from the sanctuary. On average there are 20 – 30 cubs each year in Tadoba. The effective protection and management in these protected areas have resulted in an increase in tigers. This increase warrants effective management to reduce conflict in the surrounding areas to achieve co-existence for a longer duration at larger landscapes. Conservation translocation seems to be one of the tools to be considered for the State of Maharashtra for the management and conservation of species.

Points to be considered before Conservation Translocation:

The fundamental points to be considered before conservation Translocation for the site are mentioned below;

1. Conservation through intervention is now common, but with increasing evidence and appreciation of the risks. Consequently, any conservation translocation must be justified, with the development of clear objectives, identification and assessment of risks, and measures of performance.
2. Promoting conservation translocation over any other form of conservation action, and specific elements should not be selected in isolation to justify a translocation.
3. There should generally be strong evidence that the threat(s) that caused any previous extinction/reduction in numbers have been correctly identified and removed or sufficiently reduced
4. The present conditions at the site of the release meet all the species' biotic and abiotic requirements,
 - *Be appropriate habitat for the life stage released and all life stages of the species,*
 - *Be adequate for all seasonal habitat needs,*
 - *Be large enough to meet the required conservation benefit,*
 - *Have adequate connectivity to suitable habitat if that habitat is fragmented,*
 - *Be adequately isolated from sub- optimal or non-habitat areas which might be sink areas for the population.*
5. The individuals to be transferred should be from similar genetic variations, otherwise, the species will lose local adaptive capabilities.

Pranhita as Potential Sites in the State of Maharashtra for Conservation Translocation:

Pranhita Wildlife Sanctuary is a part of the Gadchiroli Forest Division. Almost 80% of the area is forested. The area is very close to the Tadoba and adjoining landscape. The landscape has the potential to sustain more than 200 tigers and is also part of the North-South tiger corridor. This is one of the ideal sites in the state for Conservation Translocation. The efforts will not only benefit tigers but will also bring conservation to the main stage by providing employment opportunities to the local people. Based on the preliminary study and SWOT analysis following are measures to be taken before translocation of any large carnivore species to Pranhita Wildlife Sanctuary:

- 1. Capacity building of local staff for effective wildlife management.***
- 2. Enhancement of protection measures in the Sanctuary to reduce poaching, hunting, and other illegal activities.***
- 3. Habitat improvement by grassland management and eradication of lantana and other invasive species.***
- 4. Reducing threats due to electrocution by illegal power fences used for local hunting and Protection of crop fields by local farmers.***
- 5. Special forest protection force for Gadchiroli considering extremism issues.***
- 6. Augmentation of the prey base to enhance early recovery of prey species.***
- 7. Maintaining full-strength dedicated forest staff across all range offices of the division.***
- 8. Building infrastructure such as patrolling roads, forest chowkis etc., across the sanctuary.***
- 9. Involving local people in conservation measures across the sanctuary.***
- 10. Establishment of local ecodevelopment committees.***
- 11. Wildlife-oriented management across the Gadchiroli forest division.***
- 12. The special financial package for Gadchiroli for enhancing wildlife-oriented management.***
- 13. Mitigation measures on the existing roads through the sanctuary and other critical wildlife corridors across the division.***

14. Implementation of Shyamaprasad Mukherjee Jan Van Vikas Scheme for for development of villages across forested landscape of Gadchiroli to achieve sustainable development of these villages and reduce the man-animal conflict.

15. Identification of potential areas within the district for designation as Sanctuary, National Park, Conservation Reserve, Community Reserve and Tiger Reserve.

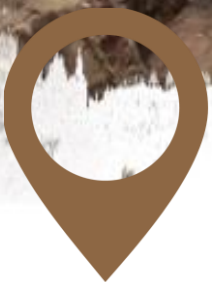


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Dr. Bilal Habib
Head Department of Animal Ecology and Conservation Biology
Wildlife Institute of India, Chandrabani
Dehradun, India 248 001
Tell: 00 91 135 2646283
Fax: 00 91 135 2640117
E-mail: bh@wii.gov.in



महाराष्ट्र वन विभाग

 भारतीय वन्यजीव संस्थान
Wildlife Institute of India