Painganga Wildlife Sanctuary

Status of Tigers, CoPredators & Prey

2021

Report Title:
Status of Tigers, Co-Predators and Prey in Painganga Wildlife Sanctuary

Project Title:
Long-term monitoring of tigers, co-predators and prey in tiger bearing areas of Vidarbha Maharashtra

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Contents

Executive Summary

Phase IV monitoring for the Painganga Wildlife Sanctuary was conducted from February – April 2021 as part of the project "Long Term Monitoring of Tigers, Co-Predators and Prey species in Vidarbha Landscape, Maharashtra, India". The exercise aimed to cover an area of 399.98 km2 of the entire sanctuary. The objective of Phase IV Monitoring is to estimate the minimum number of tigers in the sanctuary using Spatially-Explicit-Capture-Recapture Sampling and density estimation of prey base using Distance Sampling. 45 pairs of camera traps were placed in the forested area of Painganga Wildlife Sanctuary following a sampling grid of 2 sq. km. in one block. The camera traps were active for 30 days yielding a sampling effort of 1722 trap nights of data which is used for further analysis. The minimum number of tigers and leopards individuals identified are 2 and 10 respectively. Tiger density per 100 sq. km. based on the Spatially Explicit Capture-Recapture (SECR) model could not be estimated due to low sample size while that of leopards based on the same method was 3.86 (SE ±0.165). To estimate prey density, 66 line-transects were laid randomly all over the division and were sampled 7 replicates during the sampling period, with a total walking effort of 924 km. The observations include Chital (Axis axis), Sambar (Rusa unicolor), Nilgai (Boselaphus tragocamelus), Chousingha (Tetracerus quadricornis), Langur (Semnopithecus sp), Wild Boar (Sus scrofa), Chinkara (Gazella bennettii), Blackbuck (Antilope cervicapra), Indian Hare (Lepus nigricollis) and Peafowl (Pavo cristatus). As per the observations, Nilgai (n = 236) is the most observed species followed by Langur, Chital, and Wild Boar. The overall prey density of Painganga WLS is 35.142 (SE ± 4.2723). Due to a low number of observations density estimation was not carried out for Chousingha, Chinkara, Blackbuck, Indian Hare, Peafowl, Sambar.

To study the activity, we used the camera trap images. The times recorded on camera trap photos provide information on the period during the day that a species is most active. Species active at the same periods may interact as predator and prey, or as competitors. Sensors that record active animals (e.g. camera traps) build up a record of the distribution of activity over the day. Records are more frequent when animals are more active and less frequent or absent when animals are inactive. The area under the distribution of records thus contains information on the overall level of activity in a sampled population.

We used IDW (Inverted distance weighted) to map the intensive area used by different animal species.

1. Introduction

The tiger (Panthera tigris) is the largest extant cat species on the earth. 100 years ago it was easy to see a tiger in its natural habitat - around 100,000 of them roamed across Asia, including several sub-species that are now extinct. Today the number of tigers in the wild has declined exponentially. The remaining population of tigers is threatened by habitat destruction and habitat fragmentation. They require large patches of undisturbed territories to sustain their dietary needs. While tigers are generally found throughout Southeast Asia and China, India remains the most prolific home of these magnificent animals and also boasts of having the highest population.

Being a charismatic umbrella species, the tiger is also a crusader for the protection of other species. India is known to harbor the highest population of tigers amongst the 13 range countries in Asia; Central India being one of the last strongholds of the big cat. As an apex predator, the tiger shapes the community structure of the ecosystem. It also prevents over-grazing by limiting herbivore numbers and maintains the ecological integrity of the ecosystem.

The tiger bearing areas of the Vidarbha landscape (Fig. 1) include Melghat Tiger Reserve, Pench Tiger Reserve Maharashtra, Navegaon Nagzira Tiger Reserve, Tadoba-Andhari Tiger Reserve, the Brahmapuri (Territorial) Forest Division, Umred-Paoni-Karhandala Wildlife Sanctuary, Tipeshwar Wildlife Sanctuary (TWLS), Pandharkawda Forest Division (Territorial), Painganga Wildlife Sanctuary and Bor Tiger Reserve. Vidarbha holds two-thirds of Maharashtra's mineral resources and three-quarters of its forest resources and is a net producer of power. It has a forest cover of 28% and a tiger number of 315 despite having a human population of more than 5.2 million.

Painganga WLS is a protected area, situated in Southern Vidarbha. The Sanctuary lies in the Yavatmal district of Maharashtra and comes under the jurisdiction of the Pandharkawada Wildlife Division. The Sanctuary has a geographic area of 399.96 km^2 (Fig. 2) and lies within the confines of 77°58' to 78°12'East(longitude) and 19°28''' to 19°42' North (Latitude) (Wanjari et al. 2013). The Sanctuary has been named after the river Painganga which flows along the northern and south-eastern boundary of the sanctuary. The sanctuary lies very close to the state border dividing Telangana and Maharashtra and also lies on the boundary dividing the Yavatmal and Nanded districts of Maharashtra. The sanctuary is now divided into four ranges namely Kharbi, Korta, Sondhabi, Bitargaon.

The Painganga WLS falls in the 6B central plateau of Biotic province under the Paleotropical bio-geographic kingdom as per the zonation by Wildlife Institute of India. This zone shows an undulating landscape and various riverine systems which are rich in floral and faunal diversity. Painganga is the major river encircling three forth of the sanctuary's periphery forming a fertile riverbed by alluvial deposits. The sanctuary belongs to 5A/C1 southern tropical dry-deciduous forest type where teak is the major plant species with the associated species as Dhavda (*Anogeissus latifolia*), Kalamb (*Mitrigyna parviflora*), Haldu (*Haldina cordifolia*), Tendu (*Diospyros melanoxylon*), Mohua (*Madhuca longifolia*), Ain (*Terminalia alata*), Tendu (*Diospyros melanoxylon*), Sehna (*Lagerstroemia parviflora*), Bherra (*Chloroxylon switenia*), Palash (Butea monosperma), Beheda (*Terminalia bellirica*), Salai (Boswellia serrata), Bija (*Pterocarpus marsupium*), Anjan (*Terminalia arjuna*) etc. However, the associated species of teak also vary depending on the physiographic feature of the habitat. Wad (*Ficus bengalensis*), Umber (*Ficus glomerulata*), Anjan (*Terminalia arjuna*), and Kalamb (*Mitrigyna parviflora*) are found in moist areas along the watercourses. The understorey is not well defined due to the heavy biotic pressure of grazing. The distribution of Bamboo is sparse mainly found along the banks of nallas and rivers. Certain areas are fairly dense with trees where tree density in less than 0.6 shows fair grass growth during the monsoon season. The region is rich in black cotton soil and it is no wonder that cotton is the major cash crop for farmers in the region.

The climate of this region is characterized by three distinct seasons summer, monsoon and winter. May is the hottest month (maximum temperature 44^{0}C and December is the coolest with a minimum recorded temperature 8⁰C. However, sometimes cold waves affect these areas lowering the temperature to 4⁰C at night. The rainy season lasts from June to August with the rainfall ranging between 530mm to 1300mm. The precipitation in this area mainly occurs by the southwest monsoon. The Sanctuary is also home to a diverse set of flora and fauna. The sanctuary is largely isolated and has very limited connectivity with Kawal Tiger Reserve in Telangana to the South and Melghat Tiger Reserve to the North.

Painganga WLS is also home to a host of faunal species like Tiger (*Panthera tigris*), Leopard (*Panthera pardus),* Dhole (*Cuon alpinus),* Wolf (*Canis lupus*), Golden Jackal (*Canis aureus*), Sloth Bear (*Melursus ursinus*), Striped Hyaena (*Hyaena hyaena*), Jungle Cat (*Felis chaus*), Wild Boar (*Sus scrofa*), Rhesus Macaque (*Macaca mulatta*), Langur (*Semnopithecus spp.),* Sambar (*Rusa unicolor*), Nilgai (*Boselaphus tragocamelus*), Four Horned Antelope (*Tetracerus quadricornis*), Chinkara (*Gazella bennettii*), Blackbuck (*Antilope cervicapra*), Ratel (*Mellivora capensis*), and Pangolin (*Manis crassicaudata*). The reserve is home to almost 180 species of birds, 29 species of mammals, a host of Arachnids, and 26 species of reptiles.

As a part of the research project titled "Long-term monitoring of Tigers, Co-predators and prey in Tiger reserves and other Tiger bearing areas of Vidarbha, Maharashtra", the Wildlife Institute of India has initiated this study in 2021 having the following objectives:

Objective 1: Status of tigers, co-predators, and their prey in the landscape

a) Field surveys will be conducted to detect the presence of tigers, co-predators, and prey species using animal signs (tracks, scats, direct sightings, calls, etc.) in an occupancy-based framework. The data will be analyzed in the occupancy framework to estimate the occupancy of the target species. Single-season or multiple-season occupancy models will be used depending on data collection approaches. These occupancy field surveys will be carried in all the tiger areas. The data collection will be followed by modeling and estimation approaches described in detail by Mackenzie et al., (2002, 2006).

b) Density, abundance, and demography of tigers and co-predators will be carried by using camera traps in all the tiger areas followed by analyzing the data in the capture-recapture framework. Rigorous field methods will be followed to achieve a small CV and high precision. These field surveys will be conducted in all the tiger-bearing areas.

c) Estimation of abundance and density of the key ungulate species will be conducted using distance sampling employing line-transect survey protocols. These field surveys will be conducted in the entire Painganga WLS area. The survey protocols and analyses of this data set will be based on the modeling and estimation approach developed by Buckland et al. (2001, 2004).

d) Estimation of recruitment, survival, transience, temporary emigration, permanent emigration, and dispersal rates of tigers and leopards. Will be based on data collected from radio-telemetry. The information will be supplemented by data generated by camera trap surveys.

e) Scat analysis is an indirect, non-invasive, and unbiased technique for recording the frequency of occurrence of prey in the diet of large carnivores, and hence it is most widely used (Johnson et al., 1983; Leopold and Krausman, 1986; Jhala, 1993; Mukherjee et al., 1994a, b; Spaulding et al., 1997; Jethva, 2002; Biswas and Sankar, 2002). Scats will be collected at regular time intervals, generally every week. The scats will be collected in polythene bags, labeled, and sun-dried in the field. Information on habitat, substratum where scat will be found and its GPS location will also be recorded.

Objective 2: Development of database on tigers across the landscape

The photo database generated by the methodology delineated above will be collated at every tiger area level. Identification of unique individuals will be done from these collated photographs and a database of identified tiger individuals will be generated. New photographs from every camera trapping session will be compared with the existing database, whereby recaptured individuals will be noted and any new individuals found will be added to the database.

Objective 3: Identification of tiger dispersal in the landscape

On an event when a previously captured individual goes missing in pictures from the current camera trapping exercise, or when a new individual is discovered, it will be cross-checked against tiger databases of adjoining areas. This will enable us to find out if a missing individual has dispersed to a new area.

Objective 4: Development of feedback for management intervention at reserve and landscape level

The outputs of the project will help in developing management feedback for the State of Maharashtra to effectively manage tiger populations.

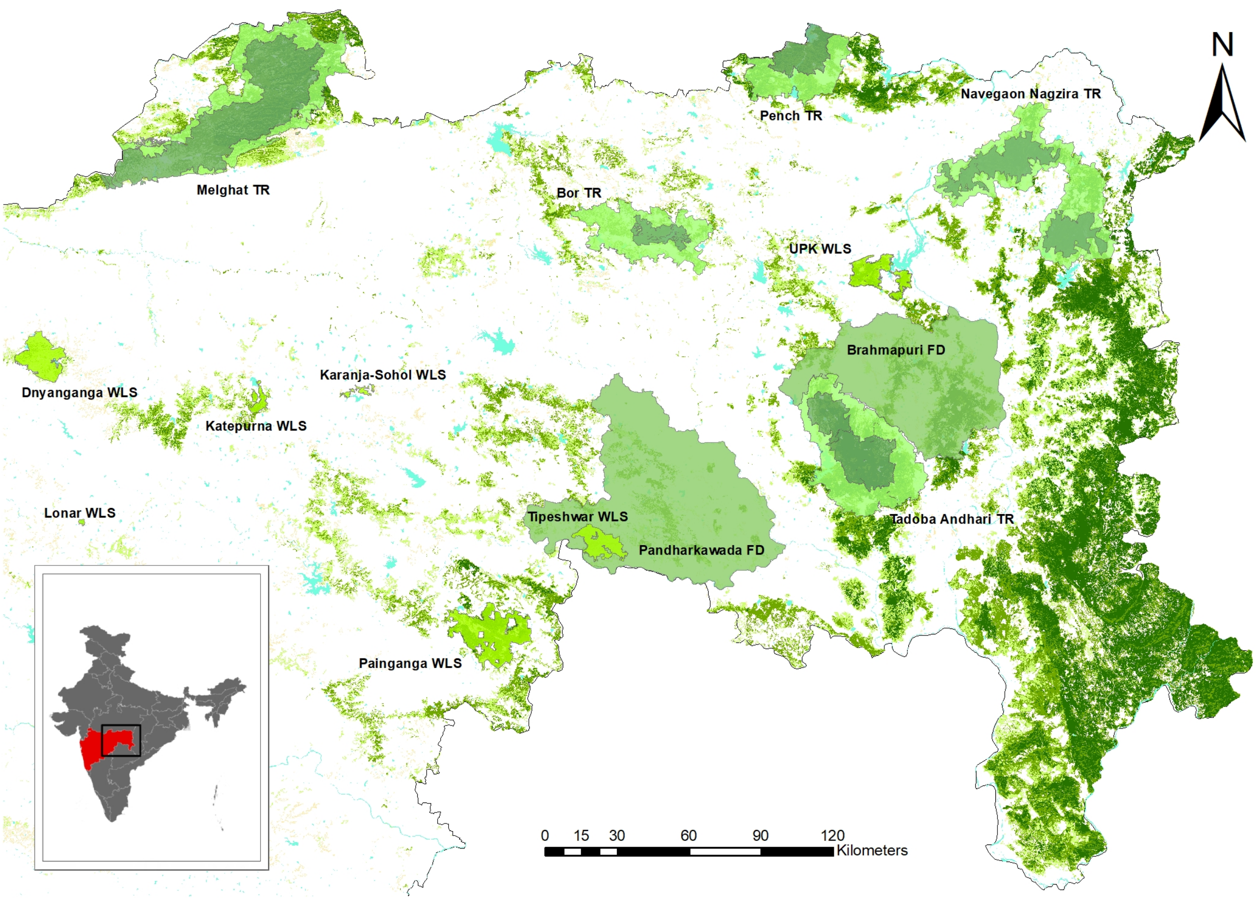


Figure 1: Map showing the study sites in Vidarbha Landscape, Maharashtra, India

2. Status of Prey in Painganga Wildlife Sanctuary

Introduction

The presence of wild herbivores is vital for the survival of large carnivores (O'brian et al. 2003). It has been observed that herbivore density and abundance play a crucial role in determining the distribution of large carnivores. herbivores also play an important role by influencing the vegetation structure and the nutrient cycle in an ecosystem (Valeix et al. 2007). That is why maintaining a healthy population of herbivores is very important to conserve the predator population and also the habitat of the species. For that, the estimation of the prey density is very important, both for management purposes and ecological study purposes. But, due to many field conditions and the elusive nature of the ungulate, it has become very difficult to estimate the population.

Among many techniques like dung count, strip transects, track count, etc. distance sampling by line transects has been the most established method to estimate the abundance and density of wild ungulates (Jathanna et al. 2003).

Distance sampling

Distance sampling is the most established method to estimate the density of prey species in an area using line transect. Transects lines of uniform, pre-determined lengths are laid randomly so that all the vegetation and terrain types of the study area get covered. All the animals (species, sex, number, age class) that are observed during the walk are recorded along with the habitat, terrain type features, the perpendicular distance from the line, and GPS location.

A total of 66 transects of 2km length are marked in 66 beats of Painganga Wildlife Sanctuary (Table 1). Transects are randomly distributed all over the 399.98 km^2. area of the Sanctuary (Fig. 2). Each transect is walked 7 times (February 2021). A total of 924 km of effort (Table 2) has been invested in line transect and a total of 603 observations of all types of major prey species have been recorded.

Table 1: No. of transects in each range of Painganga Wildlife Sanctuary in 2021

Sr. No	Range	Total number of transects in each range
1	Kharbi	14
2	Korta	13
3	Bitargaon	14
4	Sondhabi	14

Table 2: Transect monitoring effort and species reported from Painganga WLS during Phase IV Monitoring,2021

Survey details	
Number of transects	66
Length of each transect	2 km
Number of replicates	7
Total distance covered	924 km
Beats	66
Number of species recorded	10

The observations include chital (*Axis axis*), sambar (*Rusa unicolor*), nilgai (*Boselaphus tragocamelus*), chousingha (*Tetracerus quadricornis*), Langur (*Semnopithecus sp*), Wild boar (*Sus scrofa*), Indian hare

(*Lepus nigricollis)*, peafowl (*Pavo cristatus*), Chinkara (*Gazella bennetii*) and Blackbuck (*Antilope cervicapra*).

As per the observations, Nilgai (n= 236) is the most observed species followed by Langur (n= 144), chital (n= 63), Chital (n=63) and Wild boar (n= 52). Table 3 shows the number of observations for each species and the total number of individuals observed of each species.

Table 3: No. of observations and the total number of individuals seen of different prey species in Painganga Wildlife Sanctuary

Sr. No	Species	No. of observations	Total no. of individuals observed
1	Nilgai	236	976
2	Chital	63	304
3	Wild boar	52	440
4	Chousingha	8	16
5	Chinkara	10	28
6	Blackbuck	7	45
7	Indian Hare	28	38
8	Langur	144	1630
9	Peafowl	31	76
10	Sambar	3	8

The overall prey density of Painganga WLS is 35.142 individuals per km^2 (Table 4). Langur has the highest density of 18.763 (± 3.523) individuals per km^2 followed by Nilgai having the density of 6.742 (±1.001), Chital and Wild boar having the density of 3.1682 (±0.793) and 4.572 (±1.226) respectively. Due to a low number of observations (n<30) density of sambar, chousingha, peafowl, blackbuck and chinkara could not be estimated. Detection function graphs for major prey species are given further ahead in the report (Fig. 3).

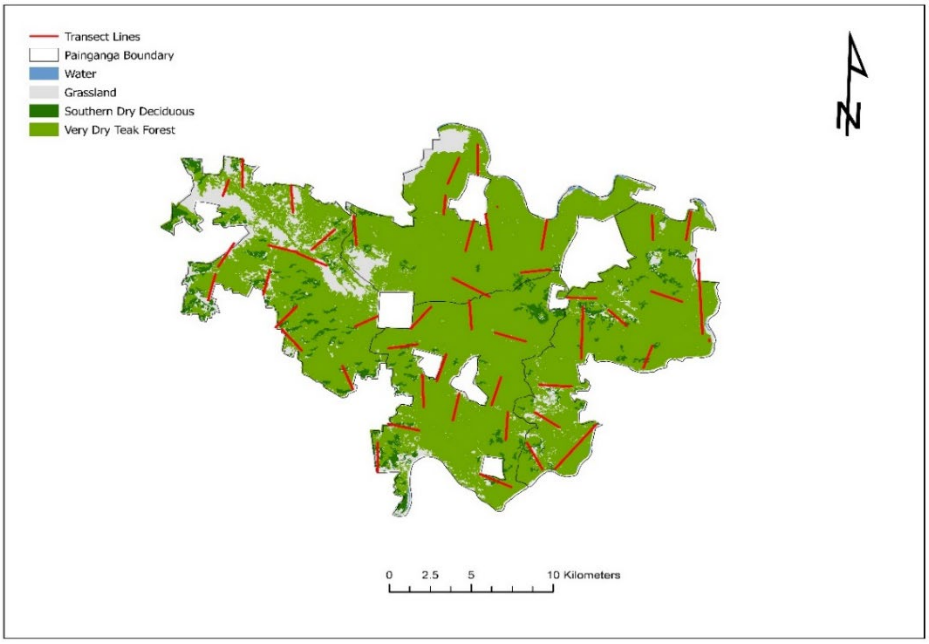
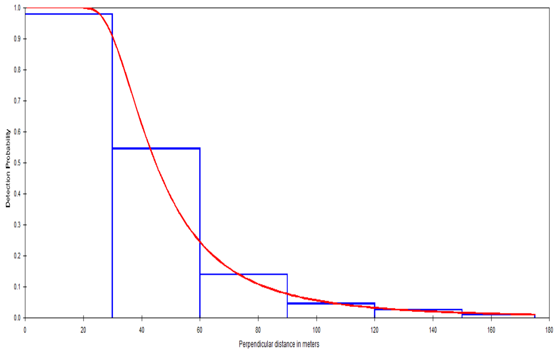


Figure 2: Map of Painganga WLS showing transect lines surveyed during Phase-IV Monitoring 2021.

Table 4: Density, group density, Effective strip width, average group size, P-values of major prey species in Painganga WLS

Parameters	All Prey	Langur	Nilgai	Chital	Wild Boar
Density(individual/sq.km)	35.142	18.763	6.742	3.1682	4.572
Standard error	4.2723	3.5231	1.0017	0.7931	1.226
Percent CV	12.16	18.78	14.86	25.03	26.83
95%CI	27.648-44.667	12.983-27.118	5.037-9.024	1.946-5.158	2.7156-7.6962
Group density (Number of groups/sq.km)	5.653	1.8231	1.633	0.656	0.540
Standard error	0.645	0.315	0.211	0.1467	0.124
Percent CV	11.41	17.29	12.93	22.34	22.87
95%CI	4.5104-7.0868	1.2967-2.5631	1.265-2.108	0.424-1.0172	0.345-0.8455
Effective strip width (ESW) in meters	52.393	37.767	67.315	47.529	47.675
Percent CV	4.05	6.48	5.88	9.51	10.44
95%CI	48.391-56.726	33.230-42.922	59.951-75.583	39.319-57.459	38.679-58763
Average group size	6.215	10.292	4.1271	4.825	8.4615
Standard error	0.26032	0.7542	0.302	0.545	1.186
Percent CV	4.19	7.33	7.32	11.30	14.02
95%CI	5.7251-6.7483	8.9051-11.895	3.573-4.766	3.8526-6.0438	6.3943-11.197
Probability of a greater chi square value (P)	0.86933	0.89482	0.853	0.86451	0.514



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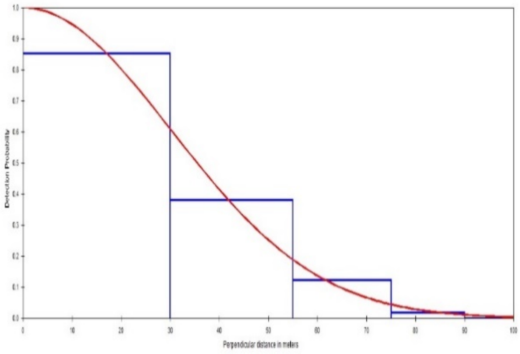

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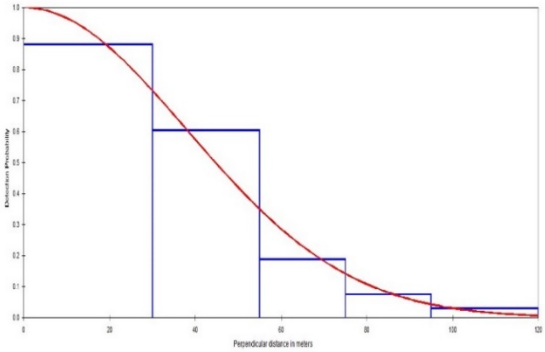

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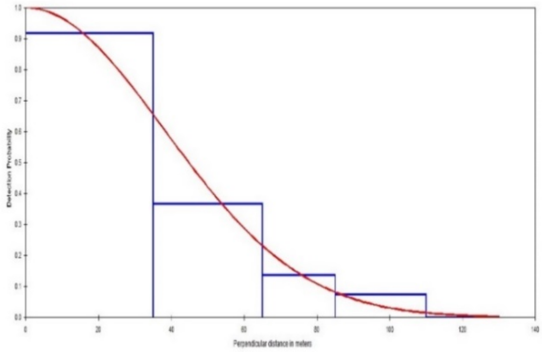

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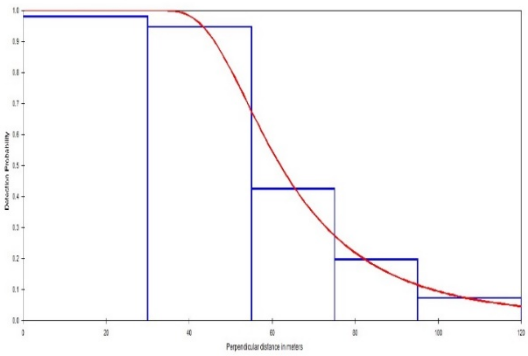

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Figure 3: Detection functions of the best-selected model for prey species during prey estimation survey in Painganga WLS, Phase-IV monitoring, 2021 A) All prey species, B) Chital C) Langur D) Wild boar and E) Nilgai.

3. Status of Predator in Painganga Wildlife Sanctuary

Introduction

The persistence of an ecosystem is majorly dependent on its biodiversity. Predators play a crucial role in maintaining the ecosystem's health (Talbot, 1978). The ecological role of predators is widely recognized because they exert a top-down effect that controls the population of other animals. The conservation of tigers is difficult because of their elusive nature, long-ranging behavior, low detectability of indirect signs. Especially, it is hard to infer the absence of tigers based on the signs. The collection of quantitative data on the abundance of tigers is limited by small data size, low detectability, and many other logistical issues.

Camera trap is one of the most robust, cost-effective, and minimally invasive methods to estimate the population of tigers. Camera trapping has become very popular in the ecological study of many species of wild animals (Burton, 2015).

Monitoring of large carnivore populations is important to guarantee their survival, to adapt management practices to changing situations, and for the conservation of habitat in the long run. The need for long term scientific monitoring of large carnivore populations arises from three considerations:

1) To objectively audit or evaluate the success or failure of earlier management measures and conservation interventions to react adaptively and solve problems (Walters, 1986; Nichols et al., 1995).

2) To establish benchmark data that can serve as a basis for specific objectives for management and conservation efforts.

3) 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 the predictive capacity to deal with new situations and contributes to the general advancement of scientific knowledge.

Camera Trapping

The success of camera trapping is dependent on the sites that we choose to deploy the camera traps. The traps are deployed at trails, dried streams, dirt roads, etc. to maximize the probability of capturing the target animal. Before camera trapping, a survey is done in the area to look for signs like pugmarks, scat, rake marks, scrape marks, etc. Since there is already an established system of patrolling and recording in Painganga WLS, the camera trap sites were chosen based on the data collected by the forest department staff. The exercise followed the protocol prescribed by Karanth and Nicholes (1998). Potential locations for the camera traps were mapped using ArcGIS Pro. The size of the grid was 2.0164 km^2 (1.42km x 1.42km). A total of 45 sites were chosen for the camera trap deployment (Fig. 4). A pair of Cuddeback cameras were deployed at each site facing each other to capture both of the flanks of the tiger, leopard, and other co-predators. The camera traps were tied up on tree trunks 35-40 cm (knee height) above the ground.

Each camera was set at no delay, multiple shot mode. It should be mentioned that both cameras should not face each other directly because the flash from one might burn the image of the other. The tigers are identified individually by matching their stripe patterns with each other. The existing tiger booklet has been used to do that. Similarly, leopards are identified individually by matching their rosette pattern.

Each camera trap was operational for 24 hours. Each trap was given a unique ID and each capture recorded the time, date, and temperature of every occasion. Every tiger and leopard were given a unique id after examining the stripe and rosette patterns respectively. For the closed population estimation, there is one critical assumption which is that the population is supposed to be demographically and geographically closed (Otis et al. 1978). To maintain that, the sampling effort was kept minimum (30 days). Capture history was analyzed using the R package od 'SECR' (Efford, 2015) using a model developed for closed populations. The best model was chosen based on the Akaike information criteria (AIC). The density was estimated with the maximum likelihood calculated from the model fitted with 'SECR'.

Population estimation of predators

During 30 days of camera trapping for tigers and co-predators, a total sampling effort of 1722 trap nights in Painganga wildlife sanctuary. For estimating the density, we used Spatially Explicit Capture-Recapture (SECR) method.

Spatially explicit capture-recapture (SECR) is a set of methods for modeling animal capture-recapture data collected with an array of 'detectors.' The methods are used primarily to estimate population density and have advantages over non-spatial methods when the goal is to estimate population size (Efford and Fewster 2013). SECR methods overcome edge effects that are problematic in the conventional capture-recapture estimation of animal populations (Otis et al. 1978). Here detectors are camera traps that take photographs of tigers and leopards and they are recognized by their natural marks and stripes. Camera-traps are proximity detectors because they can detect multiple animals within an occasion, and they do not detain detected animals, which remain free to be detected by other camera traps within each occasion. Like other statistical methods for estimating animal abundance (Borchers et al. 2012), SECR also combines a state model and an observation model. The state model describes the distribution of animal home ranges in the landscape, and the observation model (a spatial detection model) relates the probability of detecting an individual at a particular detector to the distance of the detector from a central point in each animal's home range. Unlike the maximum-likelihood and Bayesian estimation methods, it is not based on an explicit likelihood function and does not have the same inference foundation as these methods. In SECR the basic parameter for the population is density instead of the number. The detectors in this case are the camera traps. The photographs are then manually scanned for identification of individuals based on their stripe or rosette pattern.

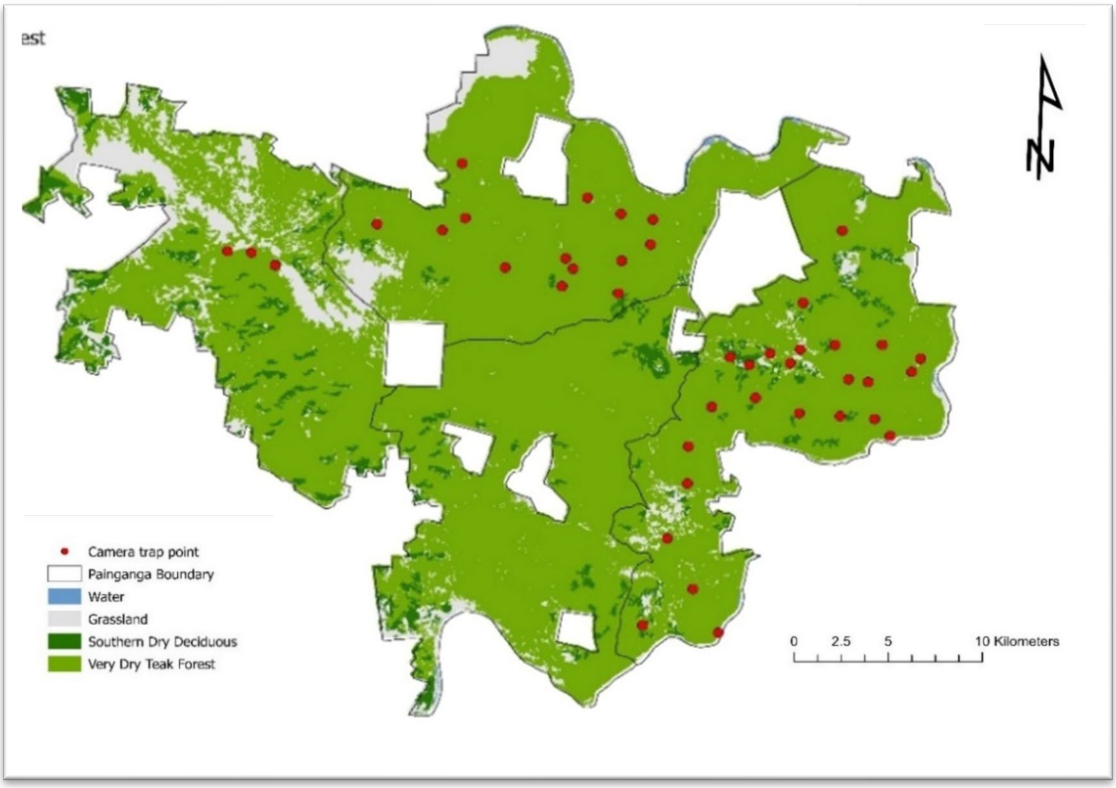


Figure 4: Camera Trap points of Painganga Wildlife Sanctuary in 2021

From the camera trap photographs, 2 unique tigers and 10 unique individuals of leopard have been identified. The density of tigers per 100 sq. km could not be estimated using SECR due to a low number of samples (n=2) and leopard density per 100 sq. km based on the SECR null model was estimated to be 3.16 (SE ±0.98) for Painganga WLS. The best model for the density estimate is selected according to the AIC (Akaike Information Criterion) values. Details are given in Table 5. The MCP of Tigers and Leopards are given in Figure 5 – 8.

Table 5: Density estimates of leopards using Spatially Explicit Capture-Recapture Models in Painganga WLS, Maharashtra for the year 2021.

Parameters	**Leopard**
m(t+1)	10
Model	Null
Detection Function	Half-normal
Density Estimate (Indv/100 sq.km)	3.15859
Density SE	0.98
Density CI	1.73-5.74
g0 Estimate (pmix1)	0.135
g0 Estimate (pmix2)	0.135
g0 SE(pmix1)	0.0031
g0 SE(pmix2)	0.0031
g0 CI (pmix1)	0.0085-0.0214
g0 CI (pmix2)	0.0085-0.0214
Sigma Estimate(pmix1)	4.036km
Sigma Estimate(pmix2)	4.036km
Sigma SE(pmix1)	0.484km
Sigma SE(pmix2)	0.484km
Sigma CI(pmix1)	3.19-5.10km
Sigma CI (pmix2)	3.19-5.10km
Estimated Population	12
Estimate population SE	1.33
Estimated population CI	10-18

Figure 5: Minimum Convex Polygon of male and female tigers of Painganga WLS, Phase-IV 2021

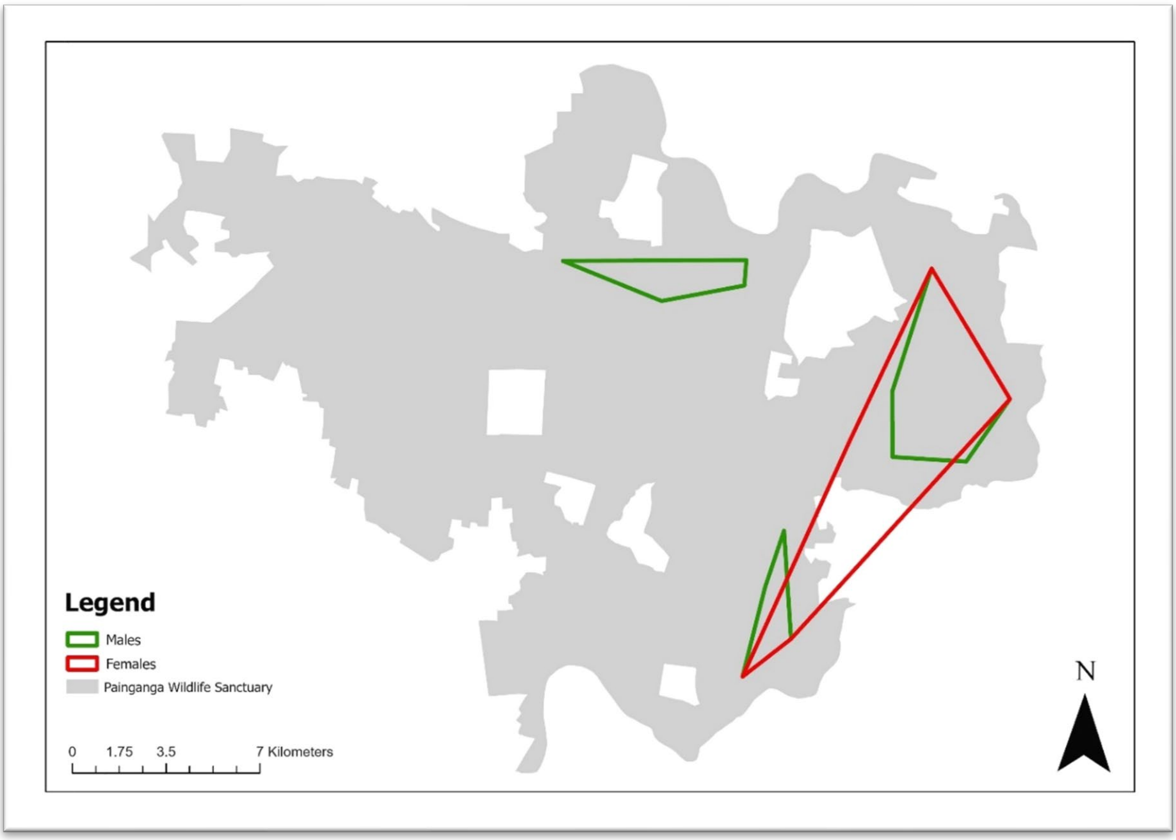


Figure 6: Minimum Convex Polygon of Leopards of Painganga WLS, Phase-IV 2021

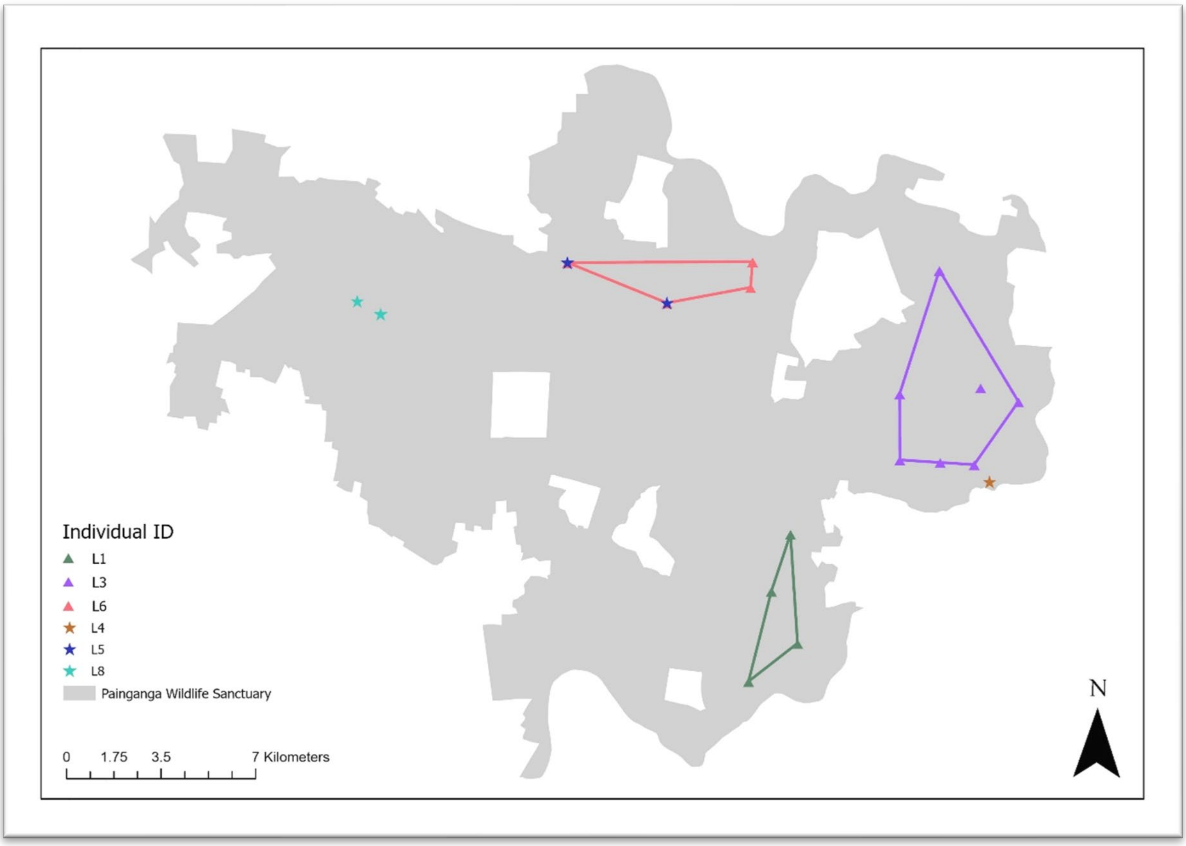


Figure 7: Minimum Convex Polygon of Male Leopards of Painganga WLS, Phase-IV 2021

Figure 8: Minimum convex polygon of Female Leopards of Painganga WLS, Phase-IV 2021

4. Modeling Spatially Explicit Intensive Use Areas: Predator & Prey Species in Painganga WLS

Introduction

Camera trap locations with the number of captures of each species were modeled in a GIS domain using IDW (Inverse distance weighted) interpolation technique to generate spatially explicit capture surfaces. Inverse Distance Weighting (IDW) interpolation is mathematical (deterministic) assuming closer values are more related than further values with its function. IDW function is used when a set of points is dense enough to capture the extent of local surface variation required for the analysis. IDW assumes that each measured point has a local influence that diminishes with distance. It gives greater weights to points closest to the prediction location, and the weights diminish as a function of distance, hence the name inverse distance weighted. IDW is an exact interpolator, where the maximum and minimum values (Fig. 9) in the interpolated surface can only occur at sample points. The output surface is sensitive to clustering and the presence of outliers. IDW assumes that the phenomenon being modeled is driven by local variation, which can be captured (modeled) by defining an adequate search neighborhood. Based on IDW, the intensive use areas for various species are provided in Fig.10 – 20.

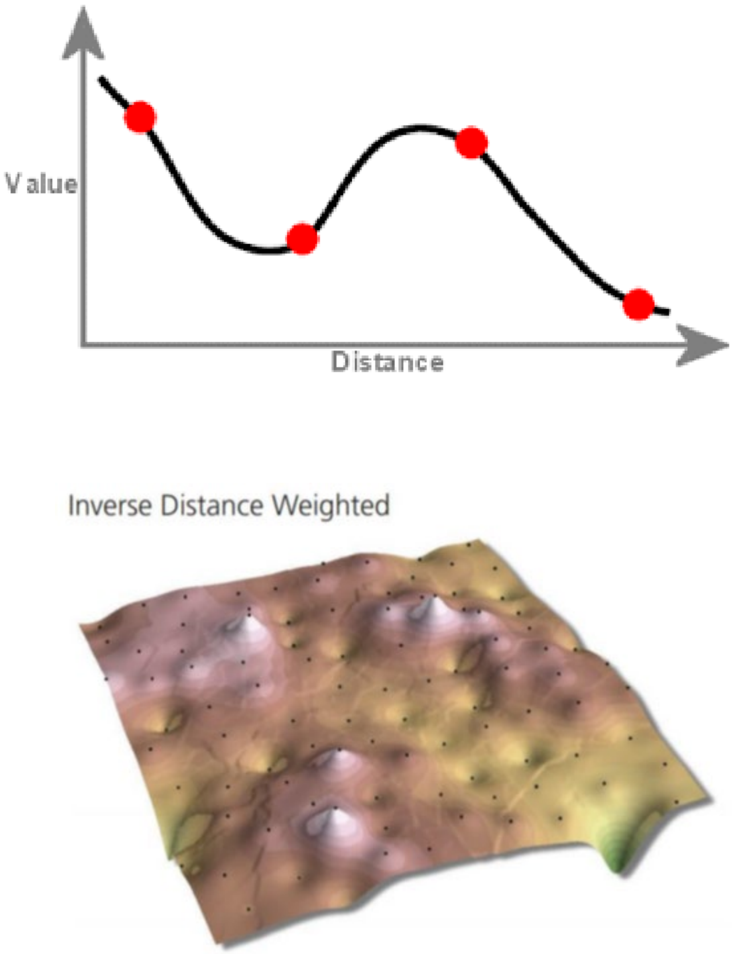


Figure 9: Visual representation of Inverse distance weighted (IDW)

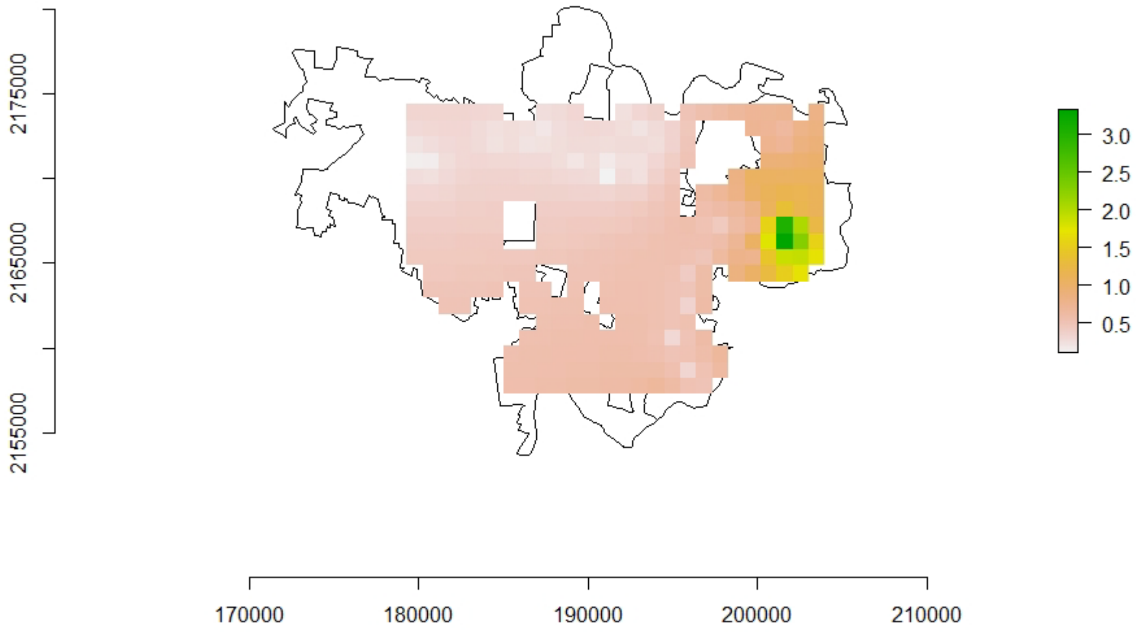


Figure 10: Intensive area used by Tiger in Painganga WLS, Maharashtra

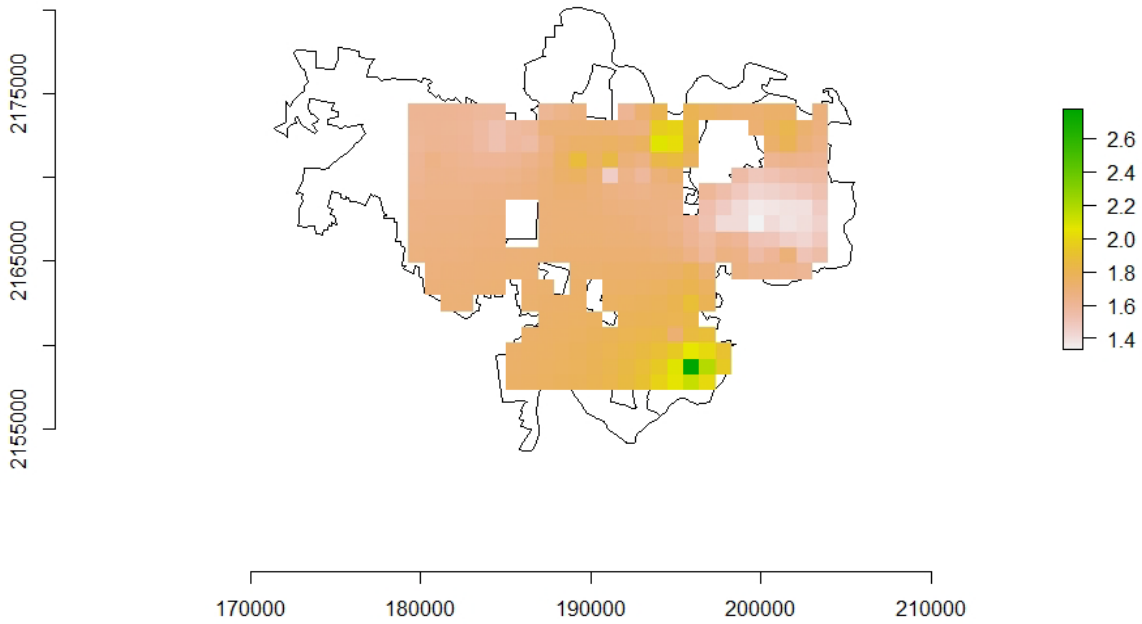


Figure 11: Intensive area used by Leopard in Painganga WLS, Maharashtra

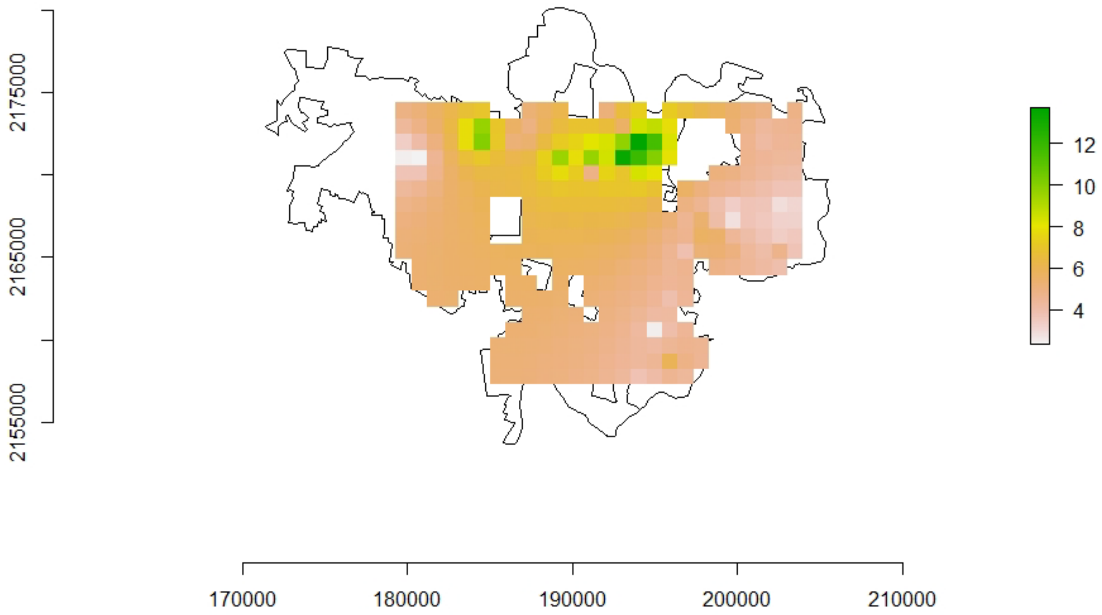


Figure 12: Intensive area used by sloth bear in Painganga WLS, Maharashtra

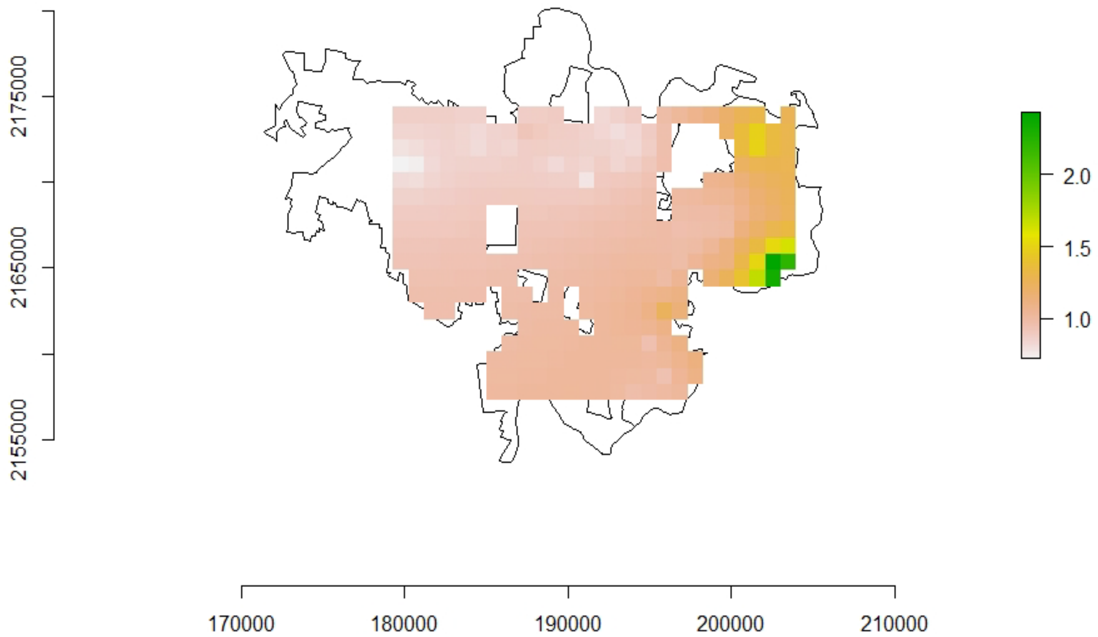


Figure 13: Intensive area used by Wolf in Painganga WLS, Maharashtra

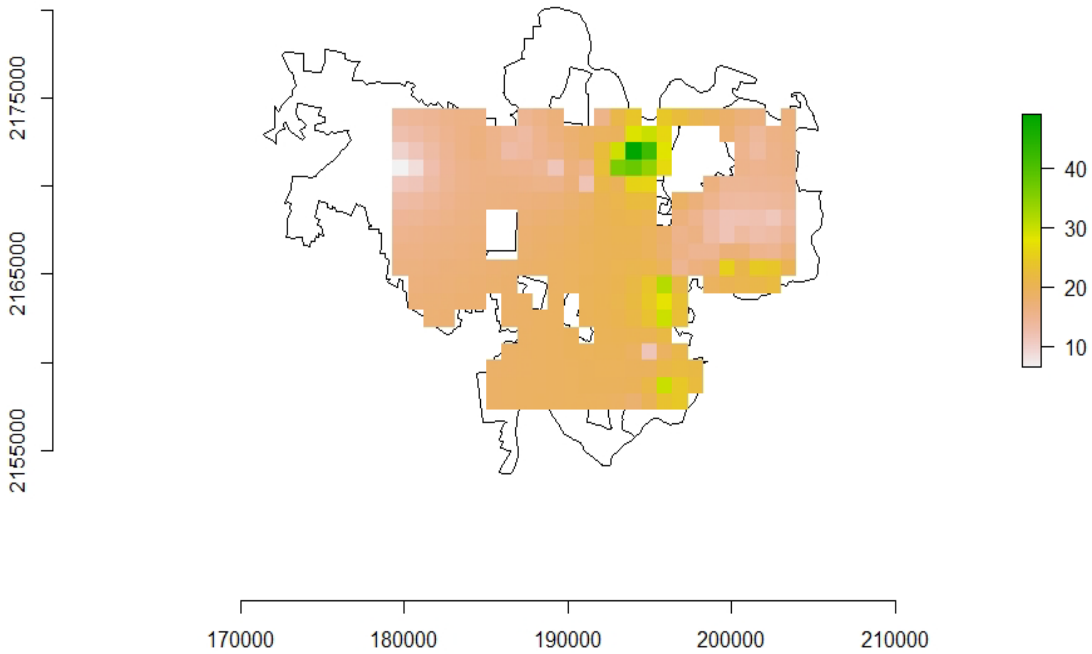


Figure 14: Intensive area used by Nilgai in Painganga WLS, Maharashtra

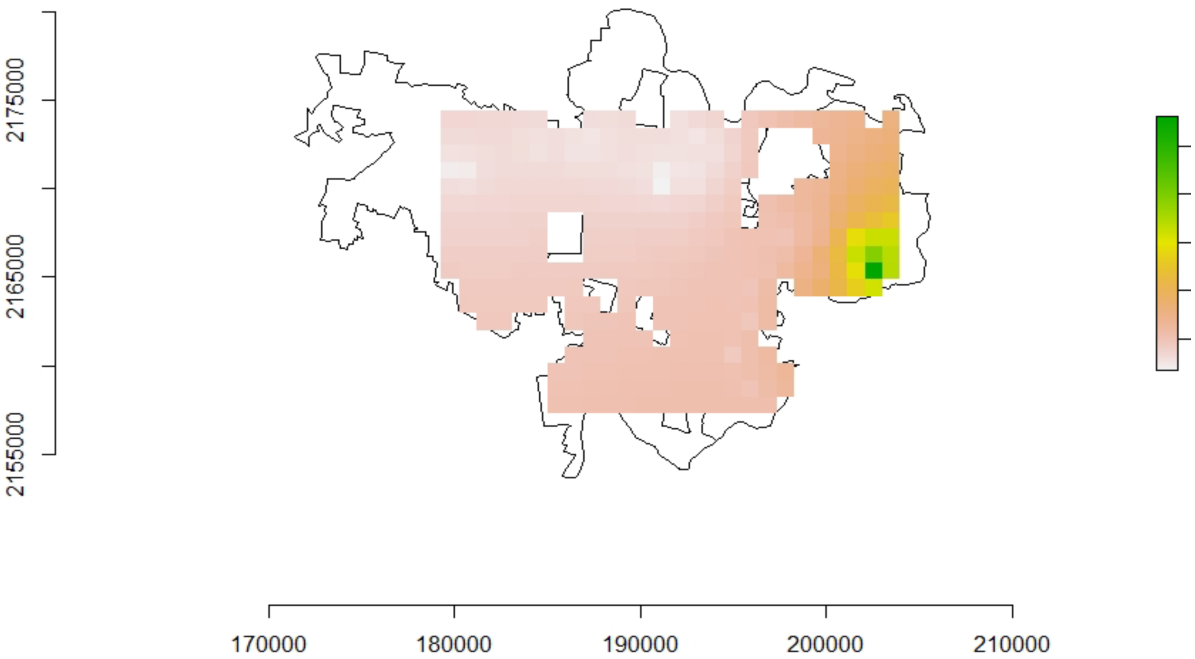


Figure 15: Intensive area used by the Chital in Painganga WLS, Maharashtra

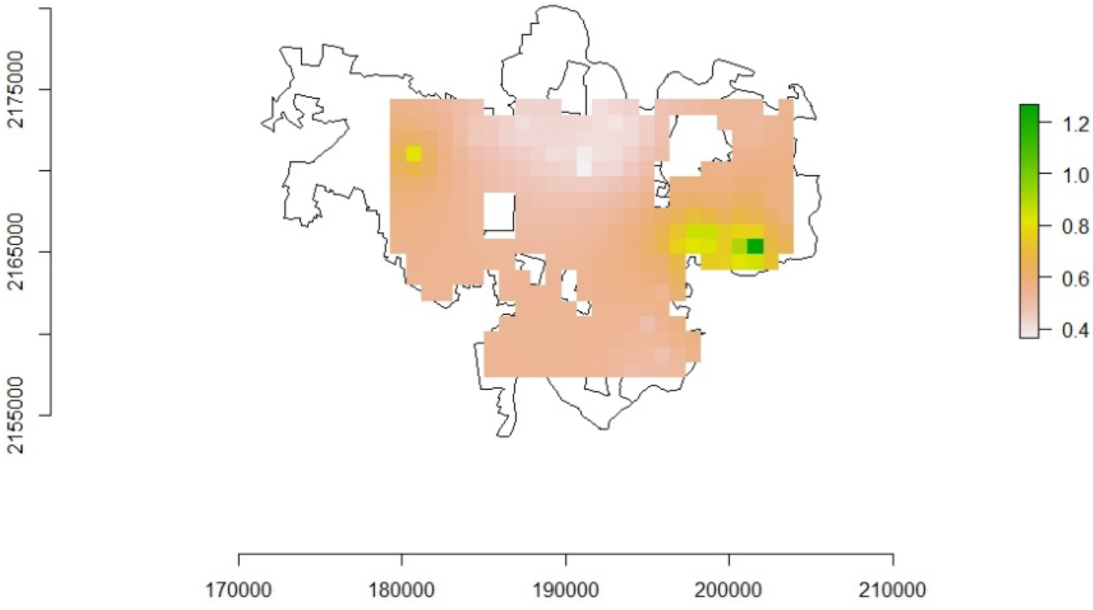


Figure 16: Intensive area used by Sambar in Painganga WLS, Maharashtra

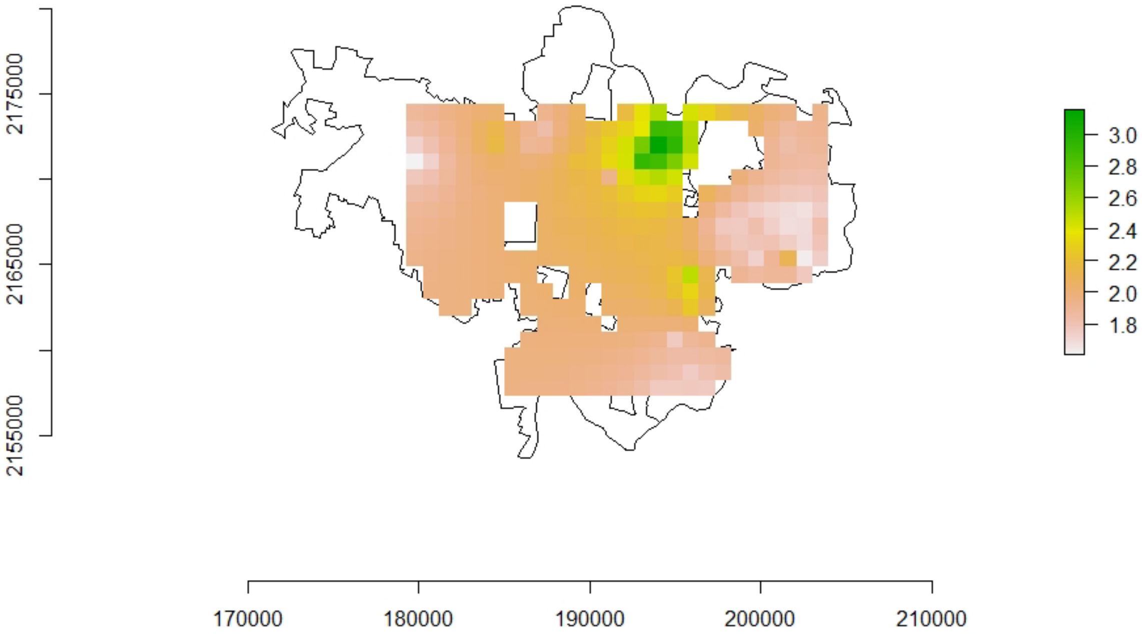


Figure 17: Intensive area used by chousingha in Painganga WLS, Maharashtra

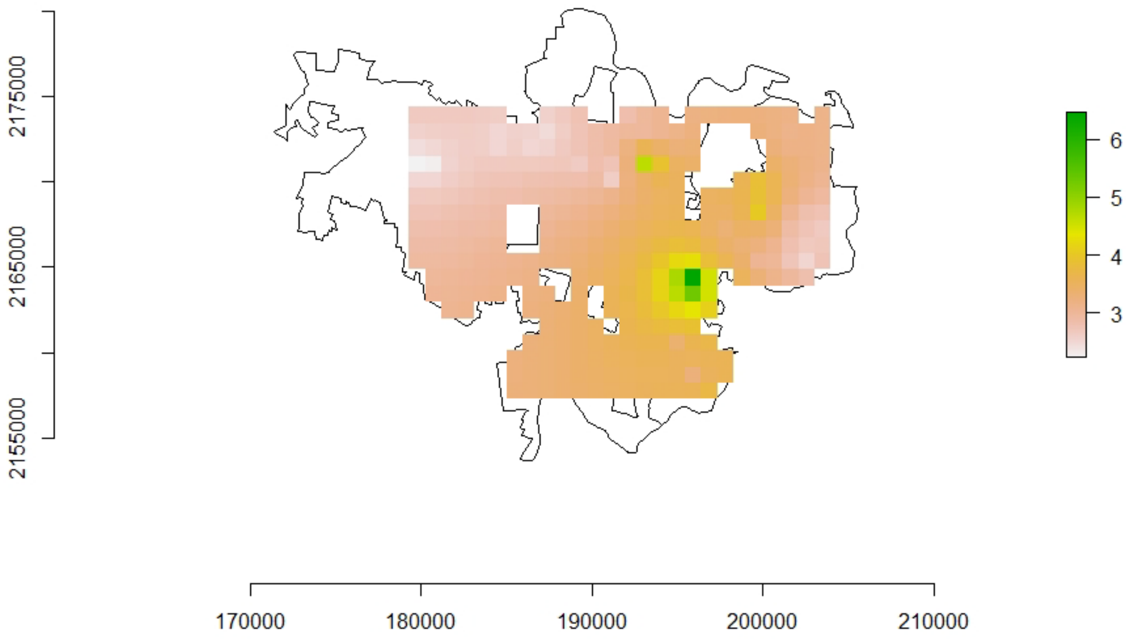


Figure 18: Intensive area used by chinkara in Painganga WLS, Maharashtra

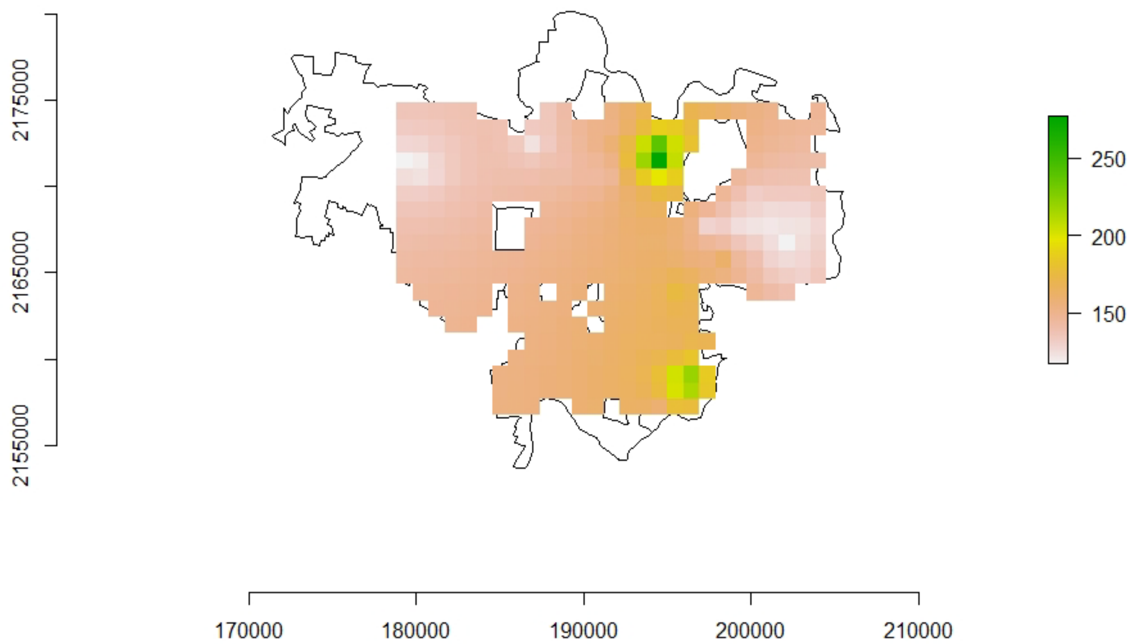


Figure 19: Intensive area used by Langur in Painganga WLS, Maharashtra

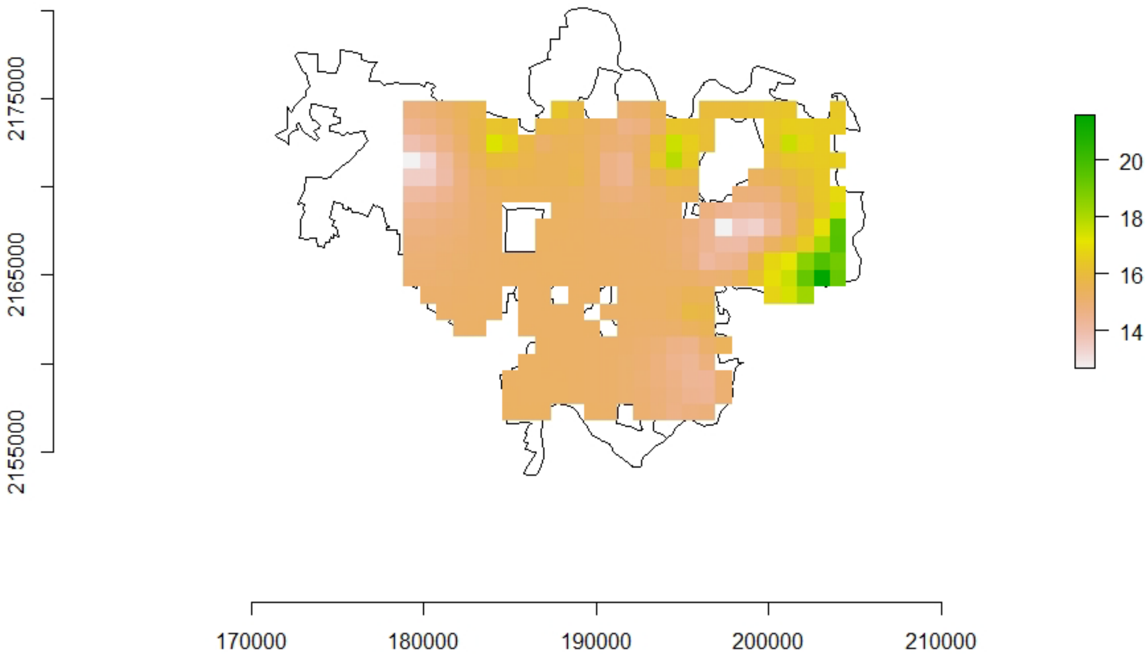


Figure 20: Intensive area used by Wild Boar in Painganga WLS, Maharashtra

5. Temporal Activity of Predator and Prey Species in Painganga Wildlife Sanctuary

Introduction

Predators and prey are involved in an evolutionary arms race that modifies their behavior and activity. Predators always look to exploit the vulnerability of prey to maximize hunting success and prey, in response, trade-off optimal foraging area to avoid the predator. Depending on the intensity of the competition among the predators and the interaction with prey species the activity pattern changes (Lima 1988). Landscape characteristics also play a crucial role in shaping up this dynamic relationship. The activity of animals is primarily dependent on the acquisition of food (Suselbeek et al. 2014). Thus, it makes sense to study the activity patterns of prey and predators both spatially and temporally complimenting it with an understanding of their actual diet through scat analysis. Time-stamped camera trap images are widely used to study the temporal activity pattern of different species in a community, such as niche partitioning and activity overlap. The camera trap photographs have the time which shows when the animal was active. The number of photographs of a particular species will be more frequent in its activity period. Activity overlap indicates inter-specific competition or predation.

Methods and Results

The temporal pattern of the predators and their prey were analyzed using R statistical software (version 3.6) and Microsoft Office Excel 2013. The approach established by Linkie and Ridout (2009) was used to study temporal activity patterns and the package “overlap” which estimates the coefficient of temporal overlap non-parametrically using kernel density estimates was used. In the package ‘overlap’, data are regarded as a random sample from the underlying distribution that describes the probability of a photograph being taken within any particular interval of the day. The probability density function of this distribution is then referred to as the activity pattern, which assumes that the animal is equally likely to be photographed at all times when it is active (Ridout & Linkie 2009). It is a two-step process. In the first step, each activity pattern is estimated nonparametrically, using kernel density estimation. The kernel density estimates used a bandwidth parameter, which is selected following the procedure developed by Taylor (2008). For the second step, a measure of overlap between the two estimated distributions was calculated. Ridout and Linkie (2009) reviewed several alternative measures of overlap between two probability distributions, favoring the coefficient of overlapping, Δ (Weitzman 1970), which ranges from 0 (no overlap, e.g., one species entirely diurnal, the other entirely nocturnal) to 1 (complete overlap). This is defined as the area under the curve that is formed by taking the minimum of the two density functions at each time point. A useful interpretation of the coefficient of overlapping is that for any period during the day the proportion of activity that occurs during that period differs between the two distributions by $<1-\Delta$. 1000 bootstrap samples are used to derive the confidence intervals.

These estimators use kernel density estimates fitted to the data to approximate the true density functions f(t) and g(t). Schmid & Schmidt (2006) propose five estimators of overlap:

Dhat1 is calculated from vectors of densities estimated at T equally-spaced times, t, between 0 and 2π:

For circular distributions, Dhat2 is equivalent to Dhat1, and Dhat3 is inapplicable. Dhat4 and Dhat5 use vectors of densities estimated at the times of the observations of the species, x, and y:

$$\hat{\Delta}_1 = \frac{2\pi}{T} \sum^{T} \min\{\hat{f}(t_i) - \hat{g}(t_i)\}$$

$$\hat{\Delta}_4 = \frac{1}{2}\left(\frac{1}{n}\sum_{i=1}^{n}\min\left\{1, \frac{\hat{g}(x_i)}{\hat{f}(x_i)}\right\} + \frac{1}{m}\sum_{j=1}^{m}\min\left\{1, \frac{\hat{f}(x_j)}{\hat{g}(x_j)}\right\}\right)$$

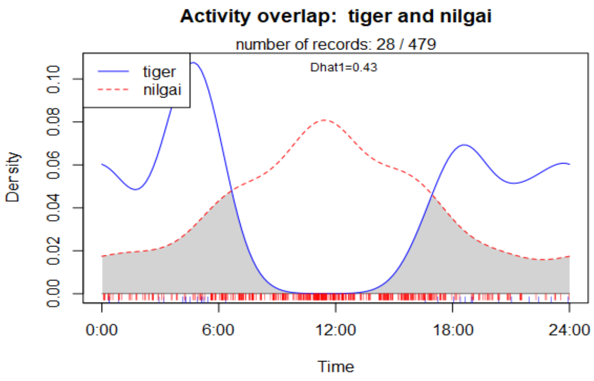
$$\hat{\Delta}_5 = \frac{1}{n}\sum_{i=1}^{n} \mathrm{I}\{\hat{f}(t_i) < \hat{g}(t_i)\} + \frac{1}{m}\sum_{j=1}^{m} \mathrm{I}\{\hat{f}(y_j) \geq \hat{g}(y_j)\}$$

Where n, m are the sample sizes and I is the indicator function (1 if the condition is true, 0 otherwise). The kernel density estimates of overlap of daily temporal activity patterns of different predator-prey species are shown in Table 6 and overlap of predator-predator species is given in Table 7. From the kernel density estimators, the tiger and leopard were observed to have a high degree (0.80) of overlap as indicated by the estimated overlap coefficients. Similarly, it has been observed that the tiger has a high degree of overlap with Wild boar (0.73) which is one of its main prey species. Leopard has been observed to have a high degree of overlap with wild boar (0.79).

Table 6: Activity overlap of predator and prey in Painganga WLS

Species	Tiger	Leopard	Wolf
Chital	0.44	0.4	0.73
Sambar	0.67	0.58	0.50
Nilgai	0.43	0.41	0.67
Wild boar	0.73	0.79	0.57
Langur	0.20	0.17	0.47
Indian Hare	0.75	0.82	0.42

Daily temporal activity overlap between the predator and prey species in Painganga WLS, India are given below. The lines represent the kernel density estimates based on individual photograph times. The overlap is shown by the shaded area in each plot (Figure 21, 22, and 23).



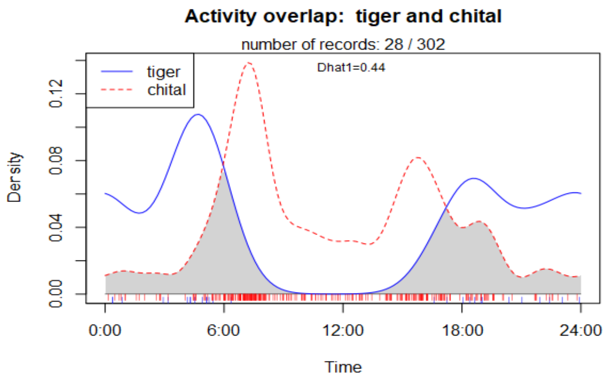
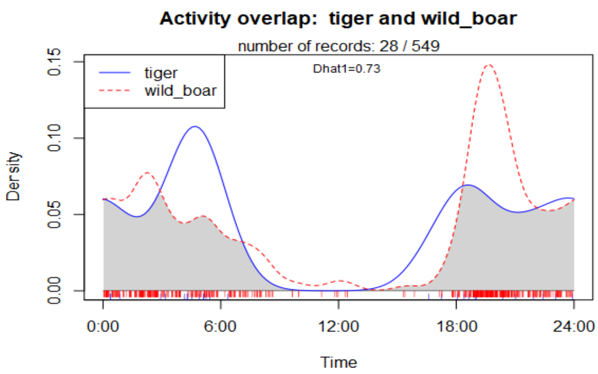


Figure 21a: Tiger vs Nilgai

Figure 21b: Tiger vs Chital



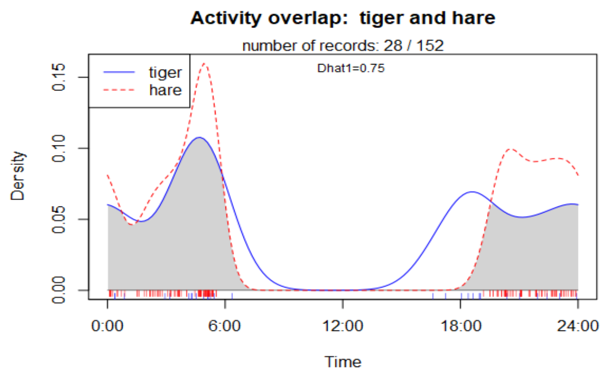
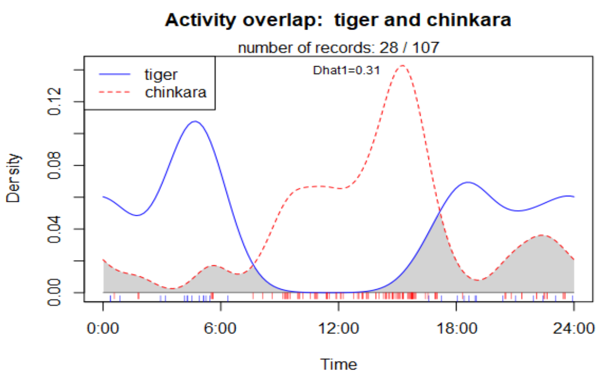


Figure 21c: Tiger vs Wild Boar

Figure 21d: Tiger vs Hare



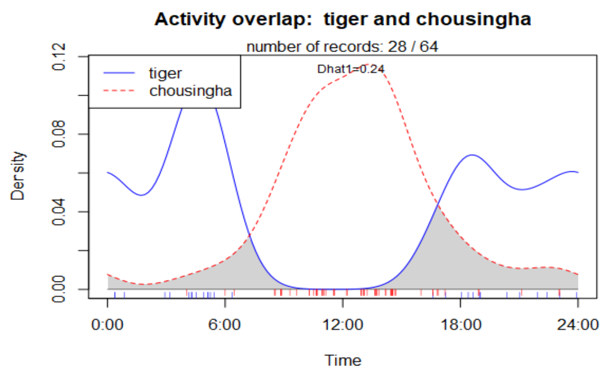


Figure 21e: Tiger vs Chinkara

Figure 21f: Tiger vs Chousingha

Figures 21 (a-f): Daily temporal activity overlap between the Tiger and prey species in Painganga WLS, Maharashtra during the year 2021

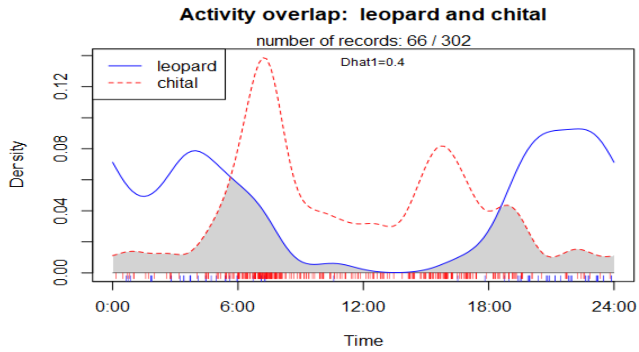


Figure 22a: Leopard vs Chital

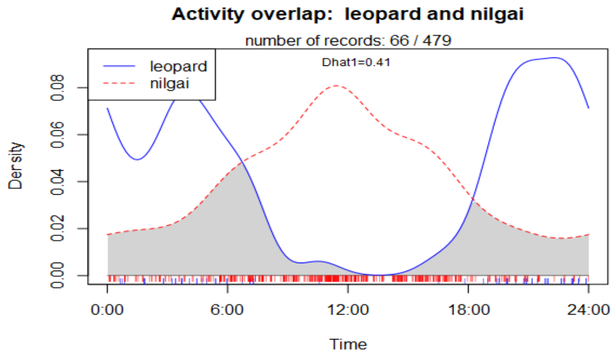


Figure 22b: Leopard vs Nilgai

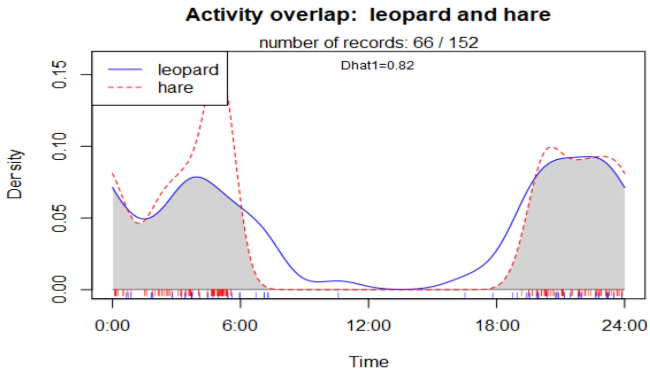


Figure 22c: Leopard vs Hare

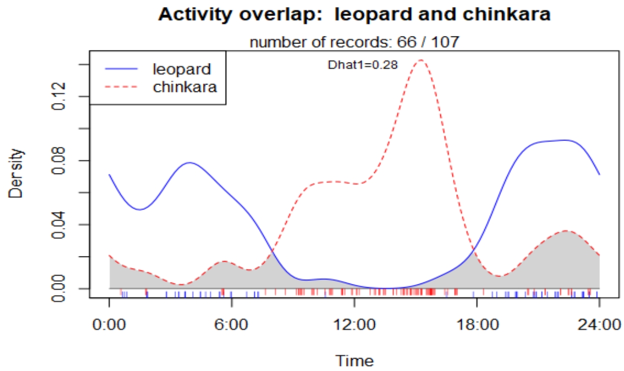


Figure 22d: Leopard vs Chinkara

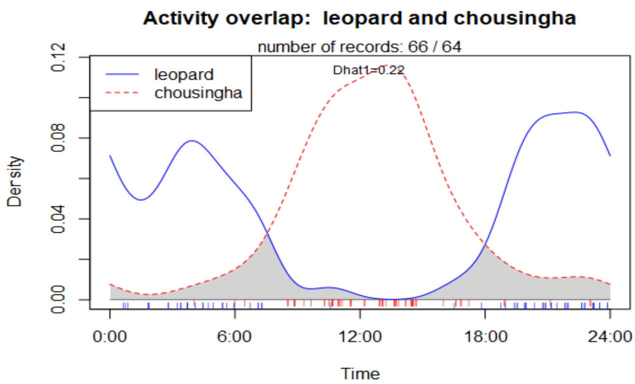


Figure 22e: Leopard vs Chousingha

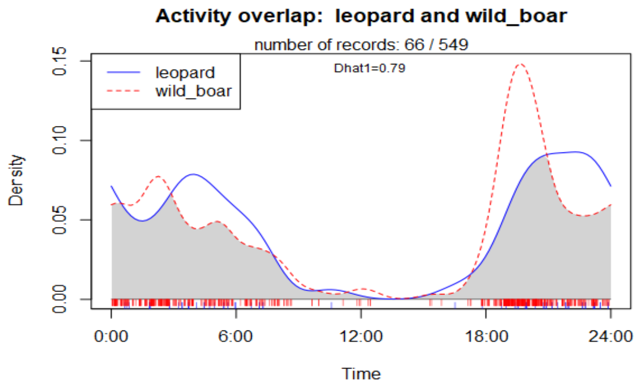
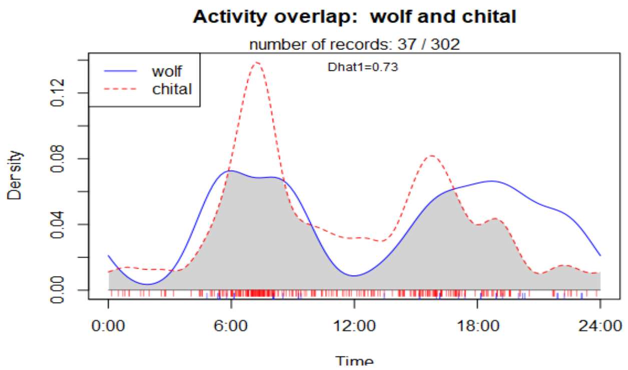


Figure 22f: Leopard vs Wild boar

Figures 22 (a-f): Daily temporal activity overlap between the Leopard and prey species in Painganga WLS, Maharashtra during the year 2021



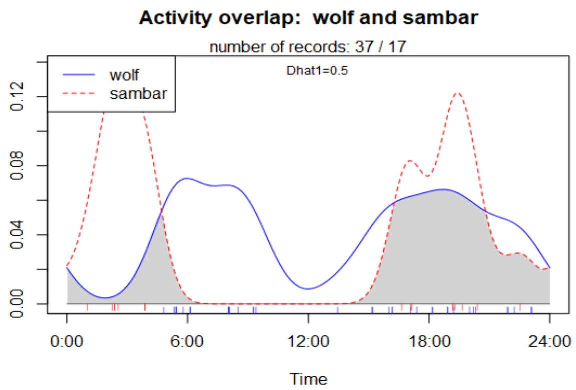
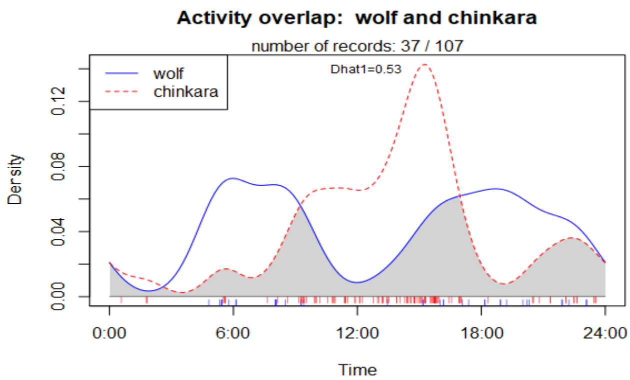


Figure 23a: Wolf vs Chital

Figure 23b: Wolf vs Sambar



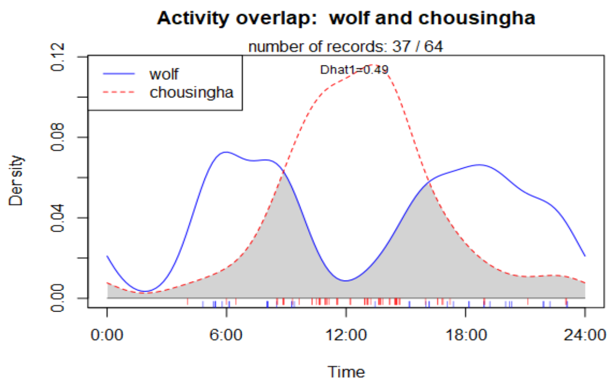
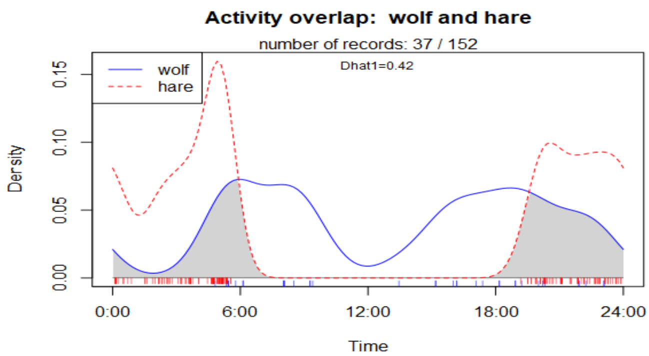


Figure 23c: Wolf vs Chinkara

Figure 23d: Wolf vs Chousingha



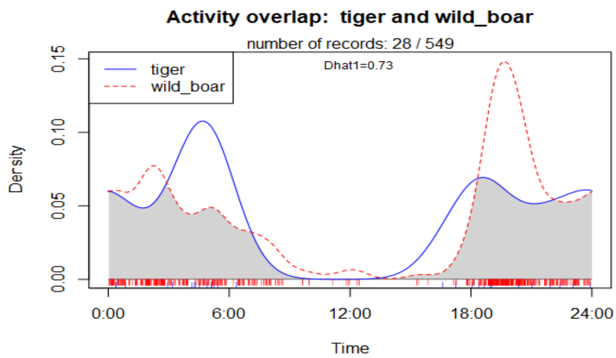


Figure 23e: Wolf vs Hare

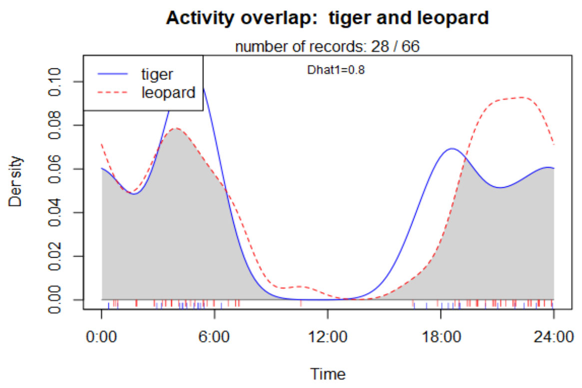
Figure 23f: Wolf vs Wild boar

Figures 23(a-f): Daily temporal activity overlap between the Dhole and prey species in Painganga WLS, Maharashtra during the year 2021

Table 7: Activity overlap of carnivores in Painganga WLS

Species	Tiger	Leopard	Wolf	Sloth Bear
Tiger	NA	0.80	0.66	0.82
Leopard	0.80	NA	0.58	0.78
Wolf	0.66	0.58	NA	0.77
Sloth Bear	0.82	0.78	0.77	NA

Daily temporal activity overlap between the predator species in Painganga WLS, Maharashtra are given on the next page (Figure 24). The lines represent the kernel density estimates based on individual photograph times. The overlap is shown by the shaded area in each plot.



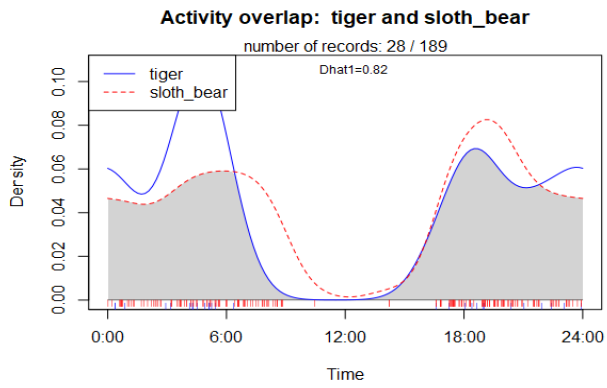
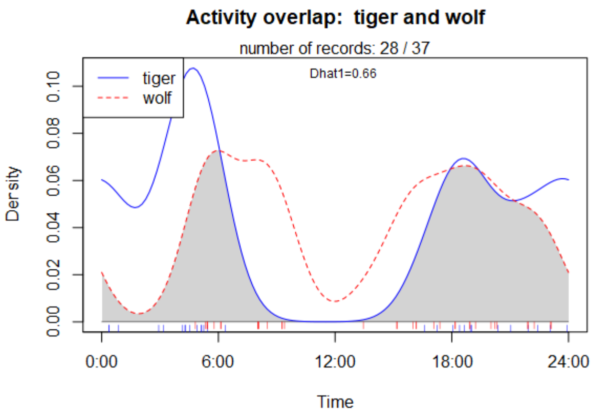


Figure 24a: Tiger vs. Leopard

Figure 24b: Tiger vs Sloth Bear



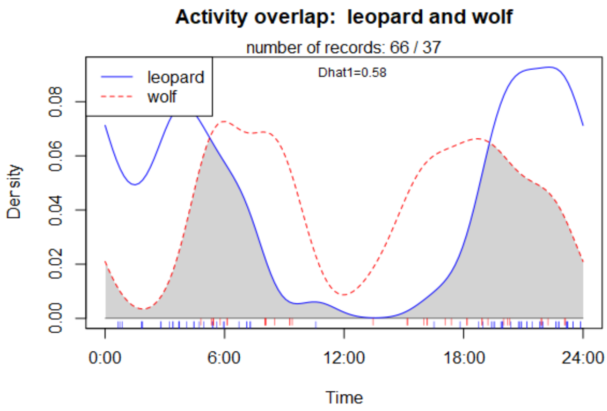
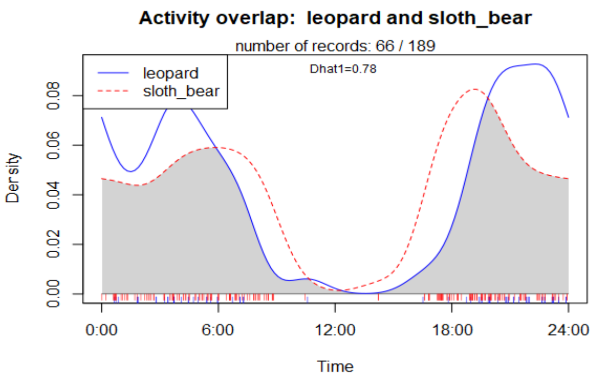


Figure 24c: Tiger vs. Wolf

Figure 24d: Leopard vs. Wolf



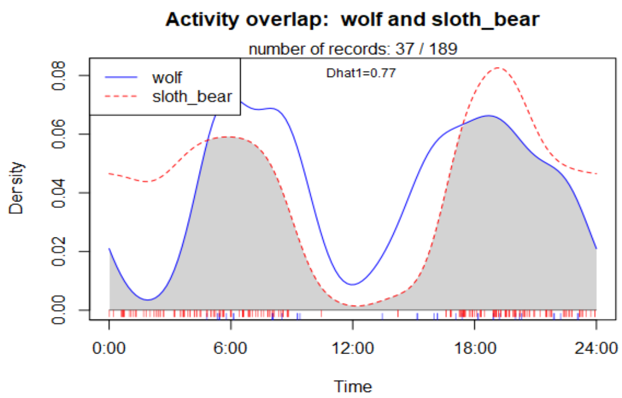


Figure 24e: Leopard vs. Sloth Bear

Figure 24f: Wolf vs. Sloth Bear

Figure 24(a-f): Daily Temporal activity overlap among the predators in Painganga WLS, Maharashtra 2021

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महाराष्ट्र वन विभाग

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Wildlife Institute of India