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Interpretation of species habitat relationship and animal interaction through remote sensing with reference to spotted deer and langur populations in Kanha National Park, India

Debashis Roy[1#] and Kamonasish Mistry[2 *]

Sammilani Mahavidyalaya, Baghajatin, E.M. By Pass, Kolkata - 94, West Bengal, India.
(Assistant Professor in Zoology[1], Assistant Professor in Geography[2])

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ABSTRACT

The Spotted deer (*Axis axis*) and the Langur (*Semnopithecus entellus*) are the two sympatric herbivorous species that live in Kanha National Park of central India. They belong to two different weight categories under family Cervidae and Cercopithecidae. They share habitat, resources and suffer from the same generalist predators. Determining interactions between sympatric Local populations of spotted deer and Langur, in different spatially apart forest sections categorized, grouped and ranked based NDVI values are our prime target. We considered remote sensing technology, field study, NDVI values and location-based photographs to characterize and categorized the forest vegetation. Then the locations of the animals were specified with in NDVI map differentiated into multiple 1x1 sq.km grids and 250 m circular grids. The grid specific data of forest vegetation and respective NDVI values were taken in to consideration for evaluating the species habitat relationships and possible underlying interaction between two sympatric species, spotted deer and langur, under changing environment. Both the species are found to follow dynamic pattern in habitat usages and in interspecific interactions, either by mutual co-existence (Mutualism: +/+) or by competition (Parasitism +/-) as reported by previous researches.

Key words: *Habitat heterogeneity, Remote sensing, NDVI values; Resources, Mutualism.*

Introduction

Interspecific interactions between two sympatric species are studied for long. The past study mostly concentrated on mammalian populations (Nautiyal & Huffman, 2018; Tsuji et al., 2015)especially between herbivores and primates. Deer of different species across the world were tested while interacting with sympatric primates of different species. In Indian sub-continent, such studies were conducted mainly between spotted deer **(*Axis axis*)** and langur (*Semnopithecus entellus*). Kanha National Park (longitude 80° 262 1022 to 81° 42 4022 E and latitude 22° 12 522 to 22°2724822 N) of Madhya Pradesh ,India is the most explored forest in South–East Asia where behavior of spotted deer and Langur were studied exclusively to understand the ecology and interaction between them. The Kanha national Park is a large heterogeneous forest that composed of dry and wet deciduous Plants (Schaller, 1967) . It serves many large mammalian herbivore and omnivore species of which the spotted deer is predominant. Among the primates, the langur is most abundant. Habitat overlapping between these two spe-

* **Corresponding author's email :** kamonasish79@gmail.com; debashis675@gmail.com

cies is frequent and unavoidable. Therefore, the study of individual behavior and mutual interaction between these two species are a matter of core interest. Earlier scientist reported asymmetric mutualism and parasitic relationships between spotted deer and langur. However, they did not come up with any definite judgments in favor to any of these two antagonistic interactions (Boucher *et al*.,1982; Newton, 1989) . Study in other parts of the worlds between other deer species and primates also gave somewhat similar results. Association between JavanLutung (*Trachypithecusauratus*) and rusa deer (*Rusa timorensis*) in Indonesia (Tsuji *et al*., 2015), Japanese macaque (*Maccacafuscata*) and Sika deer (*Cervus Nippon*) in Japan (Majolo & Ventura, 2004).The red howler monkey *(Alouatta seniculus)* and white-tailed deer (*Odocoileus virginianus*) or collared peccaries (*Tayassu tajacu*) in South Africa (Robinson and Eisenberg, 1985) are resource dependence which is similar to spotted deer and langur in Indian subcontinent (Koda, 2012; Newton, 1989; Tsuji *et al*., 2015). In all the occasions the relationship is beneficial for the ungulatesthrough predator avoidance and increased foraging success (Majolo and Ventura, 2004; Newton, 1989)).Thus associations between herbivores groups with sympatric primates are resource dependence andvary from commensalismor asymmetricmutualism (Majolo and Ventura, 2004; Newton, 1989) and occasional parasitism (Boucher *et al*., 1982; Newton, 1989).

Spotted deer (*Axisaxis*) and langur (*Semnopithecus entellus*) are from different taxonomic families **Cervidae, Cercopithecidae,** and different food habits. They show occasional sharing of foods and resources (Schaller, 1967), in kanha National Park, as the diet of langurs are diverse (Newton, 1992). The resources dropped by the langur from Sal dominated mixed forests, are consumed/gleaned by the spotted deer (Newton, 1989). Spotted deer have shown dependence on the langur for foliage, fruits, flowers, buds (Newton, 1989, 1992; Schaller, 1967) which simultaneously are also consumed by the langurs. The selected season (March- April) produces extensive floral diversities in this dry deciduous forest. The supply of new resources and gradual drying up of grassland areas change the niche habitat relationship of herbivorous animals. The relaxed niche breadths (Farshid, 2012) transform spotted deer from grazers to browsers partially, which have resulted niche overlapping (Pokharel & Storch, 2016) while living with sympatric langurs. Therefore, we concentrated on resources primarily and tried to evaluate the species habitat relationship by which interpretation on interaction between langur and deer were made. In the present study, we tried to evaluate the inter-specific interaction or polyspecific association not through studying animal behavior directly. We used remote sensing technology and NDVI values to understand forest heterogeneity and resources while taking large geographical areas in consideration. Then we linked the animals with the habitat (and resources) differentiated under different grids of different dimensions, through GIS and GPS technology. Remote sensing technology and NDVI (Normalized Difference Vegetation Index) can play important role in predicting climate change impacts on habitats and resources (Krebs, Boonstra *et al*., 2019) (Bähner, Zweig, Leal, & Wirth, 2017), studying biogeography (Johnson et al., 2018; Kundu, Denis, Patel, & Dutta, 2018), understanding animal ecology (Hofmeister *et al*., 2017; Pettorelli *et al*., 2018; Remelgado *et al*., 2018). In addition, ideas on resource partitioning (Joseph, 2007; Nautiyal and Huffman, 2018; Roy and Mistry, 2019) , habitat niche overlapping (Pokharel and Storch, 2016), and niche breadth fluctuations among different sympatric herbivores are beneficial for the future study on animal interactions (Bagchi, 2003; Farshid, 2012; Joseph, 2007) which are not been done by remote sensing. The impact of habitat heterogeneity (Stein, *et al.*, 2014) (Beumer, van Beest, Stelvig, and Schmidt, 2019) on large mammalian (herbivores) sympatric population (Anderson *et al*., 2016) and primates at regional scale gives us ideas on species habitat relationship (Farshid, 2012; Pokharel and Storch, 2016). Works has been done to know how do they are influenced by habitat (de Matos Dias, *et a*l., 2019) and resources (Farshid, 2012; Ferreira *et al*., , 2018; Lakshminarayanan *et al*., 2016) and also to know the way they interact with each other (Tews, 2004; Tsuji *et al*., 2015) but not through remote sensing. Therefore, it becomes important to understand large heterogeneous habitats, species distribution, habitat use and interspecific interactions over large spatial coverage. Remote sensing technology and GIS linking habitats, resources and species, could be very useful to determine animal behavior (Leveau *et al*., 2018; Ossi, *et al.*, 2019; Wang, 2019) and interactions in spatiotemporal scale (Parmar *et al.*, 2018; Saarenmaa *et al.*, 1988; Van Beest *et al*., 2010; Winnie Jr, *et al*., 2008)under the influence of heterogeneous habitats and changing resources (Arellano G, 2017). Research work on polyspecific- association and interspecific interaction between spotted deer and langur solely on basis of remote sensing has not done so far.

Materials and Methods

Surveys were conducted in both the national parks during the month of February - March of 2014 to 2018 from 6 am to 12 noon in the morning and 3:30 pm to 5p.m in the afternoon. Four /five vehicle based transect routes ranging from 25 to 40km were monitored within different zones and subzones of Kanha National Park (Kanha zone, Kisli Zone , Sarhi Zone and Mukki Zone) and Bandhavgarh National Park (Tala Zone and Khitouli Zone) to record spotted dear and langur along with other dominant herbivores (Ramesha, 2012). Data from different forest sections with respect to vegetation and habitat heterogeneity were also collected. During our survey, a total distance of more than 5000 km was covered in both the National Parks. Sites, ranges between 500 m and 620 m, were selected for the purpose of data collection and processing to minimize the effect/ influence of elevational variations on the distribution dynamics of spotted deer and langur and behavioral attributes between them.

A numbers of the different animal especially large mammalian species were taken into accounts during data collections by vote counting method (Gates, 2002) with respect to their location. The different diversity indices like H′ (Shannon Index), H'_{MAX}, Species richness(S) and Species evenness (J′) (Strong, 2016) were used to measure diversity at regional scale (Table 1). Pearson's correlation coefficient, regression curves, regression statistics were carried out while testing correlation between the two species. Chi-square test was done for confirming the impact of habitat heterogeneity on spotted deer and langur population. The assistance of binoculars (Pentax 10x50; XCF) and GPS enabled cameras and mobile devices (Redmi Note 4) were used during the survey work. Over 1400 GPS Location based photographs of animal and plants, of different merits were taken into account while comparing and confirming the habitats and the animals within for ground level verification. These were also used for classification and characterization of forest vegetation through establishing links and relations between the NDVI values and forest substratum (Table 2).

Table 2. NDVI values of different zones of Kanha National Park (Mistry and Roy 2020).

Zones	Minimum value	Maximum Value	Total range
Sarhi	-0.08185	0.2745	0.356
Kisli	-0.05116	0.25252	0.303
Mukki	-0.11972	0.2604	0.38
Kanha	-0.10884	0.27659	0.3854

Total range is the difference between maximum and minimum value.

The satellite images are also taken into account for topology, drainage and vegetational study while comparing and confirming heterogeneity (Roy and Mistry, 2019). The TNT MIPS Version 2016 and Q-GIS Version 2.14 software were used to process and to develop satellite images, geographical data and for subsequent analysis. Landsat 8 image and Sentinel-2 Images of survey period were taken into account from USGS open achieve Earth Explorer for vegetation and NDVI analysis. While the contour and drainage (Fig. 1) systems were extracted through STRM DEM from EarthExplorer and validated form survey of India topographical maps.The Characterization of different forest types based on NDVI values were carried out to understand the similarities and differences in floral diversities among the spatially apart forest sections even with in the same forest zone. The hybrid image of NDVI and contour (Fig. 1) fitted with locations of spotted deer and langur populations were executed to get direct evidences on the animal distribution and aggregation and the forest types or habitat, which they

Table 1. Different diversity indices in different zones of Kanha National parks (Roy and Mistry 2019).

Zones	Shannon Index	Species Richness	Species Evenness	H'_{MAX}
Kisli	1.604	1.945	0.824	1.945
Sarhi	1.571	1.945	0.807	1.945
Mukki	1.381	2.079	0.664	2.079
Kanha	1.491	2.398	0.622	2.398

depend on.

The NDVI image of entire Kanha forest is divided into 1 km x 1 km grids (Fig. 2) on which the species aggregation were mapped forevaluating the contribution of resources and interactions between Spotted Deer and Langur populations (Table 3). A 250m radius buffer zone (Fig. 2) was also created around the point of the species location to understand the mutual influence and its impact on habitat selection when the two species are associated in close proximities.

Results and Discussion

Forest survey in different forest sections in Kanha Bandhavgarh National park gave important data on large mammalian species populations.The overall mammalian diversity and distribution across different part of Kanha National Park were not uniform (Table-1) and found to be significantly different as the ANOVA test suggest, ($F = 20.85$; df = 26; $P<0.01$). Different values of H′ (Shannon Index), H'_{MAX}, Species richness(S) and Species evenness (J′) justify an un-uniform and heterogeneous mammalian species diversity across the entire Kanha forest range (Table 1).

To understand the role of different forest sections on spotted deer and langur populations at spatial scale, we categorized the entire forest section in HRZs (High resource zones) MRZs (Moderate resource zones) and LRZs (Low resource zones). The forest section with largest number of S.deer and langur population were taken as HRZs. Forest sections with moderate and lowest numbers of these two species were taken as MRZs and LRZs respectively. The regression curves (Spotted.deer vs langur) and respective values of R^2 fit better under the condition where the data points were categorized grouped and ranked as HRZs, MRZs & LRZs (Fig: 3). The HRZs show the highest value of R^2 ($R^2 = 0.9918$), whereas the MRZ and LRZ indicates value $R^2 = 0.9946$ and $R^2 = 0.9017$ respectively. The value of R^2 for the two populations is lowest ($R^2 = 0.8385$) and do not fit well, when the data are mixed. The regression statistics (Table 4) gives us significant result ($P < 0.05$) at HRZs (High resource zone) and in LRZs (Low resource Zone); at 5% level of significance. However, in the MRZs (Moderate resource zone) the result become insignificant ($0.1 > P > 0.05$). Thus from these above results it is evident that the two populations of S.deer and langurs apparently do not indicate any definite trend of mutual interaction when the data are mixed. However, we can get some indication on their mutual interaction when the data are grouped in HRZs, MRZs & LRZs.It is our interpretation that different forest sections might play different role on these two species populations and determine their shapes locally. Forest sections of different merits (with heterogeneous resources) might have dynamic influences on these two populations.

It is therefore necessary to track the relationships between these two populations. For that, we carried out Pearson's correlation test. The value of Pearson's correlation coefficient "r" appeared significant and different. The HRZs showed strong positive correlation. ($r = 0.98$) and LRZs showed strong negative correlation ($r = -0.94$). Thus the relationship between S. deer and langurs are not only mutualistic (+/+) but also parasitic/competitive (+/-). We predict that different forest section have variable degrees of resources and different generalist predator pressure. One uniform strategy or interactions between these two species populations under variable circum-

Table 3. Different forest habitats used by spotted deer and langur in association or in separation as appeared from the grid scale analysis

Species Name	Forest types (With area of land cover in Square Meter)					
	Water Body	Marshy Land	Grass land	Sal Dominated Mixed Forest	Bamboo Dominated Mixed Forest	Mixed Forest
Langur Total	0.00	140725.06	1055994.58	2594796.28	204877.45	3606.63
Langur Mean	0.00	35181.26	263998.64	648699.07	51219.36	901.66
Langur and Spotted Deer total	30420.24	939186.41	2874836.26	6637502.41	2311507.42	206547.27
Langur and Spotted Deer Mean	2340.02	72245.11	221141.25	510577.11	177808.26	15888.25
Spotted Deer total	29924.53	546740.65	4418337.73	14813039.06	6785017.25	406940.77
Spotted Deer Mean	1108.32	20249.65	163642.14	548631.08	251296.94	15071.88

stances appear unjustified. Rather two opposite and counter balancing relationships can be more advantageous when survival strategies and survival success of both the species are considered.

To understand the importance and roles of forest heterogeneity on spotted deer and langur populations, in HRZs, MRZs and LRZs we carried out chi-square test. In the HRZs (÷ 2 = 1.4994 ; Df = 4 ; P > 0.05) the results appeared statistically insignificant (Table 4). But in the LRZs (÷ 2 = 24.4798; df = 4; P < 0.05) (Majolo and Ventura, 2004) and in MRZs (÷ 2 = 22.0102; df = 3; P < 0.05) the results appeared statistically significant. In HRZs, forest heterogeneity has no significant role to play on these two populations. Simultaneous (space and time) occurrence of large number of spotted deer and langurs connected by mutualistic relation appear to be the deciding factor for which an insignificant chi-square value is well justified. Here the mutual cooperation has helped the spotted deer to get resource which otherwise not available (Newton, 1992). In LRZs least number of spotted deer and langurs were found to be associated with strong negative correlation that lead to competitive / parasitic (+/-) relationship. Thus a significant Chi-square value in LRZs is well justified.

Table 4. Representing the degree of dependence of spotted deer and langur populations

Forest Zones	χ^2	Regression Statistics	r
HRZ	P > 0.05	P < 0.01	+0.985
MRZ	P < 0.01	P > 0.05	-0.616
LRZ	P < 0.01	P < 0.05	-0.942

Chi-square value = χ^2; Pearson's Coefficient = r

To understand and to validate the above-mentioned statistical outcomes we adopt remote sensing technology. Contour map (Fig. 1), NDVI map (Fig. 1), and drainage statistics of Kanha National park (Roy and Mistry, 2018) were made. The NDVI map was fragmented in to 1 sq. km grids (Fig. 2) for grid scale analysis. 250-meter circular buffer radiuses around species were made for counter verification from close proximities (Fig. 2). The entire vegetation (including water bodies) of kanha national park was then classified in to six different categoriesbased on NDVI values. The classes are, 1) Water bodies (NDVI range -0.159 to 0.100); 2) Marshy lands (NDVI range 0.101 to 0.200); 3) Grass lands (NDVI range 0.201 to 0.270); 4) Sal dominated mixed forests (NDVI range 0.271 to 0.370); 5) Bamboo dominated mixed forest (NDVI range 0.371 to 0.440) and 6) Pure mixed forests (NDVI range 0.441 to 0.540) as derived from DEM (Fig. 2). The marshy land and grassland areas with lower NDVI values were considered as LRZs and Sal dominated mixed forest, bamboo dominated mixed forest and pure mixed forest with higher NDVI values were considered as HRZs.

While considering the species habitat relationships at 1 sq. km grids, we found that the average usage of different forest sections by spotted deer in association with the langur, are more shifted towards the left of the species habitat relationship graph/plot (Fig 4 & 5). The areas with lower NDVI values like grass lands, marshy lands and water bodies were more explored by the spotted deer in association with langur, compared to occasions when they are single. In both the occasions, the deciduous Sal dominated mixed forest, which were full of resources at this time of the year; remain as the most preferred forest section (Fig. 4 & 5) which appeared justified. Interestingly when grid scale analyses were made in a 250m circular buffer radius (Fig. 2) from the point of location of the species, we got almost similar result. Here the plot was shifted (Fig. 4 & 5) more towards the left as we found in 1 sq. km grid scale analysis. However, close observations showed differences between these two graphs in terms of displacement of the habitat used by the spotted deer while living with langur. In 250 m

Table 5. Number of items and proportions (%) of different prey species in predator diets, as derived from the kill and scat data. (Karanth and E.Sunquist 1995)

Prey	Tiger		Leopard	
	Kills (%)	Scats (%)	Kills (%)	Scats (%)
Chital	16 (10.4)	153 (31.2)	69 (83.1)	234 (43.7)
Sambar	44 (28.6)	122 (24.9)	8 (9.6)	72 (13.5)
Gaur	69 (44.8)	85 (17.4)	1(1.2)	39 (7.3)
Langur	0	19(3.9)	1(1.2)	38 (7.1)

buffer radius the spotted deer indicated a directional shift of habitat towards NDVI range somewhere within 0.250 to 0.540 which is a part of dense forest (higher NDVI value).Whereas in 1sq. km grids, the habitat shifted somewhere within NDVI value -0.159 to 0.270 and also within 0.370 to 0.540. Here habitat displacement occurred in both type of forest, dense and partly open areas. The observations of such habitat displacements in both the species habitat relationship curves and respective interpretations on mutual interactions, are summarized below -

1. Spotted deer do not undergo much habitat displacement in zones with low NDVI values in 250 m circular buffer radius. The langur and spotted deer are well connected by mutualistic relation (+/+) in areas with low NDVI values at close proximities (Fig: 5). Our observation and conclusion as described above are in strong agreement with Newton (1989) and Boucher (1982).
2. Spotted deer loose its habitat and show habitat displacement in zones with high NDVI values between 0.250 to 0.540 in 250 m circular buffer radiuses while living with langurs in close proximities. The spotted deer and langur indicate an overall parasitic (+/-) /competitive relationship at the dense forest sections (Fig. 5). Our observation and conclusion as described above is in agreement with ideas of Schaller (1967); Boucher (1982) Newton (1989).
3. Spotted deer regain habitats in zones with low NDVI values between-0.159 to 0.270 in 1 sq. km grid. It can graze more grasslands while associated with langur through mutualism(+/+) even from distance (Fig: 4). Spotted deer and langurs are well connected through alarm calls and alarm behavior from distance described by previous authors G.B. Schaller(1967) & Boucher (1982). Our findings based onone sq.km grid based data also in agreement with the previous findings of G.B Schaller (1967).
4. Spotted deer loose habitat and show habitat displacement in zones with high NDVI values within 0.370 to 0.540 in 1 sq. km grids while living with langurs. It indicates a parasitic (+/-) / competitive relationship with langurs as reported by Schaller (1967); Boucher (1982).

Being from different taxonomic families and food habits, Spotted deer (*Axis axis*) and langur (*Semnopithecus entellus*) shows occasional sharing of foods and resources (Schaller, 1967) as the diet of langurs are diverse (Newton, 1992). Langurs and spotted deer both are mostly being dependent on Sal dominated mixed forest for foliage, fruits, flowers, buds (Kushwaha, 2016; Newton, 1989, 1992; Schaller, 1967), which being consumed and dropped by the langurs (Newton, 1992) and simultaneously consumed/gleaned by the spotted deer (Newton, 1989). The selected season (March- April) produces extensive floral diversities in this dry deciduous forest. The relaxed niche breadths (Farshid S.Ahrestani, 2012) transform spotted deer from grazers tobrowsers partially, which have resulted niche overlapping (Pokharel & Storch, 2016) while living with sympatric langurs. But they have solved the situation by mutualism (Newton, 1989). As many as 44 species of grasses and 35 browse species were eaten by the spotted deer in Kanha National park (Schaller, 1967).

If the resource is one of the primary deciding factors of mutual influences and interactions then the predator pressure is other one, which needs to be considered. The alarm call and the alarm behavior of the two concerned species generate an "interconnecting system" (Schaller, 1967) which will play important part in mutual survival success (Newton, 1989) from generalist predators even from a distance (Schaller, 1967). The spotted deer has a strong sense of smell and strong sense of hearing; whereas the langur from the tree top has a better view that ensure a strategic benefit to monitor the movements of tigers and leopards from distance (Newton, 1989). The spotted deer therefore can graze the distant grassland patches for additional resources while remain protected by the "interconnecting system" generated through alarm calls and alarm behaviors (Schaller, 1967) . Thus, mutualism between spotted deer and the langur has contributed benefits more toward spotted deer with in a range that extent from few meters to 1000 meter as our remote sensing study suggests. The generalist predators, tigers and leopards, in this part of forest opt energy maximizer strategy (Griffiths, 1975) that make the Spotted deer(spotted deer are of larger body weight than langurs) more susceptible. Thus which ever be the primary need either the "resource dependence" or the "protection against the generalist predators," the benefits are parallel. It can be said that a single strategy of mutualism (asymmetric) solves both the problems (problems related to resources and generalist predators) simultaneously.

Conclusion

The present study is focused on species habitat relationships (Karanth and.Sunquist, 1995; Shankar *et al*., 2013) which gives us important clues inter specific interactions (Guisan, 2005; Nautiyal and Huffman, 2018). The two species spotted deer and langur are the two dominant sympatric species of tiger reserves like Kanha national park, India. It is important to understand mutual interactions between them with in wide heterogeneous forest, spatially. Seasonal transition/change not only regulates forest (dry deciduous) resources (Roy and Mistry, 2018) but also tunes the mutual interactions among the herbivores (Farshid, 2012; Roy and Mistry, 2019), and spotted deer and langurs (Newton, 1989) are not exception. The asymmetric mutualistic relationship (+/+) between spotted deer and langur in areas with lower NDVI values are in strong agreement with findings of previous work of P.S .Newton (1989)&(Boucher et al., 1982). In addition, the present study through remote sensing has also tried to evaluate such interactions from close contact (250m) as well as from distance (1 km). While living in close proximities the interaction is resource dependence, as suggested by P.S Newton (1989). However, distance interactions through alarm calls and alarm behaviors are for mutual survival strategy against generalist predators, which is in agreement with previous work of G.B Schaller (1967) and P.S Newton (1989). We also observed a competitive /parasitic (+/-) relation between these two species (Newton, 1989) in forest zones with higher NDVI values. The resources in these parts of forest are plenty yet the numbers of spotted deer and langurs are least. The two species avoid association with each other,in close proximities (250 m circular buffer radius) and from distance (1 sq.km), as the resources are easy available (Newton, 1989). As a result both spotted deer and langurs become equally unprotected/ susceptible to generalist predators (tigers and leopards) which adopt a "number maximiser strategy" while catching prey (Griffiths, 1975; Karanth and Sunquist, 1995). The survival success of spotted deer and langurs does not come through mutual association, which is absent (Table 5). Both of them are equally susceptible to the generalist predators (tigers and leopard) for which strong negative correlation and habitat displacements are justified. It is notable that both the species try to avoid each other's association (Majolo and Ventura, 2004; Newton, 1989) in these zones as our remote sensing result suggest.

Remote sensing technologies and NDVI values (Leveau *et al*., 2018) therefore appear useful in determining habitat heterogeneity (Beumer *et al*., 2019; Roy & Mistry, 2019) ,species habitat relationship (Johnson *et al*., 2018; Nkosi *et al*., 2019), inter specific interaction (Karanth, 2016; Karanth and Sunquist, 1995). Mutual interactions between sympatric mammalian species including herbivores and primates (Desbiez *et al*., 2010; Koda, 2012; Majolo and Ventura, 2004) are of special interest. We recommend the use of remote sensing & GIS while determining the species habitat relationship which have potential to give new ideas on interspecific conflicts and coexistences (de Carvalho Oliveira, *et al*., 2017; Majolo and Ventura, 2004). In addition, it can predict impact of seasonal and climatic changes on vegetations through NDVI values (Kundu *et al.*, 2018) which become new parameter for future research in various fields of ecology and animal behavior.

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