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COMMUNICATION

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COMMUNICATION

Diet ecology of tigers and leopards in Chhattisgarh, central India

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Abstract: Wild prey base is a potential regulatory parameter that supports successful propagation and secured long term survival of large predators in their natural habitats. Therefore, low wild prey availability with higher available livestock in or around forest areas often catalyzes livestock depredation by predators that eventually leads to adverse situations to conservation initiatives. Thus understanding the diet ecology of large predators is significant for their conservation in the areas with low prey base. The present study reports the diet ecology of tiger and leopard in Udanti Sitanadi Tiger Reserve and Bhoramdeo Wildlife Sanctuary, in central India to know the effect of wild prey availability on prey predator relationship. We walked line transects to estimate prey abundance in the study areas where we found langur and rhesus macaque to be the most abundant species. Scat analysis showed that despite the scarcity of large and medium ungulates, tiger used wild ungulates including chital and wild pig along with high livestock utilization (39%). Leopards highly used langur (43–50 %) as a prime prey species but were observed to exploit livestock as prey (7–9 %) in both the study areas. Scarcity of wild ungulates and continuous livestock predation by tiger and leopard eventually indicated that the study areas were unable to sustain healthy large predator populations. Developing some strong protection framework and careful implementation of the ungulate augmentation can bring a fruitful result to hold viable populations of tiger and leopard and secure their long term survival in the present study areas in central India, Chhattisgarh.

Keywords: Food habit, large predators, livestock depredation, wildlife conservation.

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Author details: Krishnendu Basak's responsibilities at Wildlife Trust of India (WTI) include mitigating man-animal conflict mostly with tiger and study conflict dynamics in the Sundarban landscape. Moiz Ahmed is actively involved with the state forest department in Wild Buffalo conservation program, snake rescue, and release project in state capital Raipur and also conducted tiger monitoring and population estimation exercises in Chhattisgarh. M. Suraj actively participated as a researcher during Phase IV tiger monitoring and All India Tiger Estimation, 2018 across various protected areas of Chhattisgarh, trained forest staff on snake rescue and AITM data collection procedure, and assisted in data collection and management for the same. B.V. Reddy (IFS) was the deputy director of Udanti Sitanadi Tiger Reserve, Gariyaband during the study period. O.P. Yadav (IFS) was the field director of Udanti Sitanadi Tiger Reserve, Chhattisgarh during the study period. Dr. Krishnendu Mondol is presently associated with Ministry of Environment, Forest and Climate Change.

Author contribution: KB provided technical inputs for the study, guidance for data collection and technical writing. MA conducted field work, data collection, and management. MS managed field work, data collection, training, and capacity building. BVR and OPY provided permissions for the study and logistical & financial support. KM provided technical inputs for the study, guidance for data collection, and technical writing.

For **Acknowledgements** and **Hindi abstract** see end of this article.

INTRODUCTION

Investigating diet composition of a predator is vital to indicate the adequacy of prey base and understand prey requirements. Fluctuations in prey abundance may induce changes in dietary selection and the rate of prey consumption by predators (Korpimäki 1992; Dale et al. 1994). Prey selection by large carnivores is a vital strategy to maintain their population growth and their distribution in space and hence, it becomes essential to understand the life history strategies of carnivores for better management practices (Miquelle et al. 1996).

Generally, the tiger *Panthera tigris* as a large solitary predator requires >8 kg of meat daily to maintain its body condition (Schaller 1967; Sunquist 1981). It hunts a varied range of prey species based on their availability in a particular landscape; this may include large bovids such as Indian Gaur (Karanth & Sunquist 1995) to small animals like hares, fish, and crabs (Johnsingh 1983; Mukherjee & Sarkar 2013). Tigers, however, prefer prey species that weigh 60–250 kg and this indicates the conservation significance of large-sized prey species in the maintenance of viable tiger populations (Hayward et al. 2012). Whereas, plasticity in leopard *Panthera pardus* behavior (Daniel 1996) enables them to exploit a broad spectrum of prey species which makes them more adaptable to varied range of habitats. Large carnivores show high morphological variations (Mills & Harvey 2001) across their distribution ranges which in turn regulate their dietary requirements. The number of prey items in a leopard's diet can go up to 30 (Le Roux & Skinner 1989) or even 40 species (Schaller 1972). Leopards consume prey items ranging from small birds, rodents to medium and large-sized prey such as Chital *Axis axis*, Wild Boar, Nilgai and Sambar to domestic prey like young buffalo, and domestic dogs in the Indian subcontinent (Eisenberg & Lockhart 1972; Santiapillai et al. 1982; Johnsingh 1983; Rabinowitz 1989; Seidensticker et al. 1990; Bailey 1993; Karanth & Sunquist 1995; Daniel 1996; Edgaonkar & Chellam 1998; Sankar & Johnsingh 2002; Qureshi & Edgaonkar 2006; Edgaonkar 2008; Mondal et al. 2011; Sidhu et al. 2017). Hayward et al. (2012) categorized Leopard as a predator that exploits over one hundred prey species but prefers to kill prey items within 10–50 kg body weight which may deviate to 15–80 kg (Stander et al. 1997), depending on their hunger level, hunting efforts and sex (Bothma & Le Riche 1990; Mondal et al. 2011).

Apart from the natural prey-predator relationship, tigers and leopards are reported to consume domestic ungulates as a large proportion of their diet during scarcity of wild prey. Hunting and habitat destruction are the major reasons behind the decline of wild prey availability. The distribution ranges of tigers and leopards are mostly interspersed and overlapped with human habitations. In such situations, there are abundant records of carnivores hunting livestock which in turn frequently leads to retaliatory killing of the predators or escalates human tiger or leopard conflict. It has become a serious issue and can be considered as one of the toughest hurdles to resolve in large carnivore conservation and management. In India these large carnivores are gradually confined within the fragmented forest habitats that share sharp boundaries that home dense human populations. Areas like these experience intensive grazing by domestic and feral cattle, and simultaneous forest resource utilization by local people have been degrading tiger habitats in terms of retarded growth of vegetation, increase in abundance of weeds and ultimately depletion of natural prey base (Madhusudan 2000). As a consequence of increase in livestock and depletion of natural prey base, carnivores are compelled to prey on the domestic livestock (Kolipaka et al. 2017).

Studies have already been conducted to understand the feeding ecology of tiger and leopard in many parts of the Indian sub-continent but, there are only few studies available where diets of both the top predators have been studied together (Sankar & Johnsingh 2002; Ramesh et al. 2009; Majumder et al. 2013; Mondal et al. 2013). To gather knowledge on the complex diet ecology and prey-predator relationship of tiger and leopard, the present study was conducted in two different protected areas in Chhattisgarh, central India with the objectives to understand the food habits of leopard in absence of tiger (in Bhoramdeo Wildlife Sanctuary) and in presence of tigers but with low prey abundance (Udanti Sitanadi Tiger Reserve). The present study was conducted in Bhoramdeo Wildlife Sanctuary (BWS) from March 2016 to June 2016 and in Udanti Sitanadi Tiger Reserve (USTR) from December 2016 to June 2017. Studying large predator diet is always useful for park managers because it provides very relevant information on prey species utilization by large carnivores. The present study will eventually attribute to such important aspects of resource management of the large carnivore populations in both the study areas.

MATERIALS AND METHODS

Study areas

BWS is spread over 351.25km^2 and situated in the Maikal Range of central India (Figure 1). It provides an extension to the Kanha Tiger Reserve as well as serves as a corridor for dispersing wildlife between the Kanha and Achanakmar Tiger Reserves (Qureshi et al. 2014). Bhoramdeo is mostly dominated by *Shorea robusta*. A mixture of tropical dry and mixed deciduous forest types with bamboo brakes formed the vegetation of the sanctuary (Champion & Seth 1968). Tiger, leopard, Sloth Bear *Melursus ursinus*, and Dhole *Cuon alpinus* are reported as large carnivores in the area. Major ungulates are Chital *Axis axis*, Barking Deer *Muntiacus vaginalis*, Sambar *Rusa unicolor*, Four-horned Antelope *Tetraceros quadricornis*, Indian Gaur *Bos gaurus*, Nilgai *Boselaphus tragocamelus*, and Wild Boar *Sus scrofa*. Two commonly found primates in BWS are Northern Plains Gray Langur *Semnopithecus entellus* and Rhesus Macaque *Macaca mulatta*. Smaller carnivores include the Jungle Cat *Felis chaus*, Indian Fox *Vulpes bengalensis*, and Golden Jackal *Canis aureus*.

USTR is spread over 1842.54km^2 of Gariyaband and Dhamtari districts of Chhattisgarh, central India (Figure 1). It is constituted with Udanti and Sitanadi Wildlife Sanctuaries as cores and Taurenga, Indagaon and Kulhadighat Ranges as buffer. The topography of the area includes hill ranges with the intercepted strips of plains. The forest types are chiefly dry tropical peninsular sal forest and southern tropical dry deciduous mixed forest (Champion & Seth 1968). Sal is dominant, mixed with *Terminalia* sp., *Anogeissus* sp., *Pterocarpus* sp., and bamboo species. The Tiger is the apex predator in the area and other co-predators are Leopard, Dhole, Indian Grey Wolf *Canis lupus*, Striped Hyena *Hyeana hyena* and Sloth Bear. Chital, Sambar, Nilgai, Four-horned Antelope, Barking Deer, Wild Boar, Gaur, and Indian Mouse Deer *Moschiola indica* represent the ungulate prey base in USTR. Smaller carnivores include the Jungle Cat *Felis chaus*, Rusty-spotted Cat, *Prionailusrus rubiginosus*, and Golden Jackal *Canis aureus*.

USTR is contiguous with Sonabeda Wildlife Sanctuary (proposed tiger reserve) in Odisha on the eastern side and forms Udanti-Sitanadi-Sonabeda Landscape. This connectivity has a good future if the entire tiger landscape complex (Chhattisgarh-Odisha Tiger Conservation Unit) can be taken under significant wildlife conservation efforts.

Prey abundance estimation

Line transect method under distance sampling technique was followed to estimate the prey abundance in both the study areas (Anderson et al. 1979; Burnham et al. 1980; Buckland et al. 1993, 2001). In total, 29 transects in BWS and 108 transects in USTR were laid according to their areas and surveyed during the study period (Figure 1). Each transect was 2km in length and walked three times in BWS and 5–6 times in USTR between 06.30 and 08.30 h on different days. The total effort of the transect samplings was 174km and 974km for BWS and USTR, respectively. The data were recorded for six ungulate species, viz., Chital, Sambar, Gaur, Wild Boar, Barking Deer, and Nilgai in both the study areas. The other species recorded during the transect walk were Northern Plains Gray Langur and Rhesus Macaque. On each sighting of these species the following parameters were recorded, a) group size, b) animal bearing, and c) radial distance (Mondal et al. 2011). Radial distance and animal bearing were measured using range finder (HAWKE LRF 400 Professional) and compass (Suunto KB 20/360), respectively.

The key to distance sampling analyses is to fit a detection function, g(x), to the perpendicular distances from the transect line and use it to estimate the proportion of animals missed by the survey (Buckland et al. 2001), assuming that all animals on the line transect are detected (i.e., g(0) = 1). The assumptions of distance sampling have been discussed by Buckland et al. (2001). Program DISTANCE ver. 6 was used to estimate prey density. The best model selection was carried out by the generated values of Akaike information criterion (AIC; Akaike 2011). Population density (D), cluster size, group encounter rate and biomass (body weight of prey species x density) for each species was calculated in the present study.

Food habits estimation

The food habits of leopards and tigers were estimated following scat analysis methods (Sankar & Johnsingh 2002; Link & Karanth 1994; Mondal et al 2011; Basak et al. 2018). Tiger and leopard scat samples were collected during the sign survey along the trails in the study areas. Scats were collected opportunistically whenever encountered, irrespective of fresh or old condition to increase sample size. Scat samples were collected from entire BWS and North Udanti, South Udanti, Taurenga, and Kulhadighat ranges of USTR. In total 100 leopard scats were collected from BWS, 30 tiger scats and 121 leopard scats were collected from USTR for diet analysis. Tiger and leopard scats were differentiated on the basis

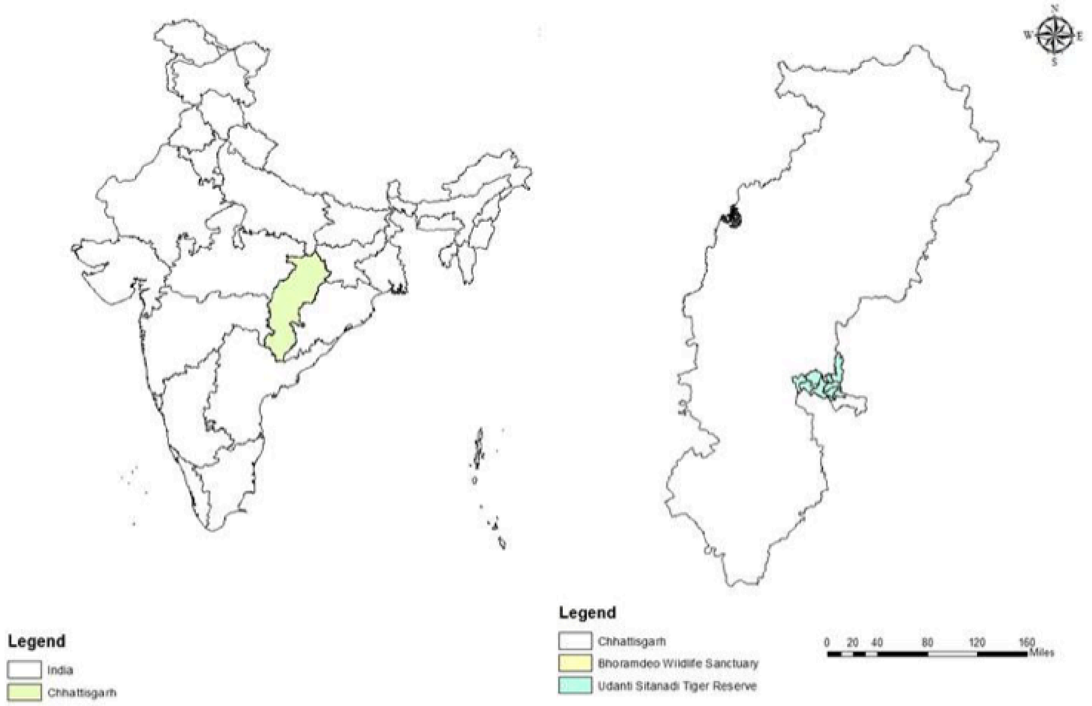

Figure 1. The locations of Udanti-Sitanadi Tiger Reserve and Bhoramdeo Wildlife Sanctuary in the state of Chhattisgarh, central India.

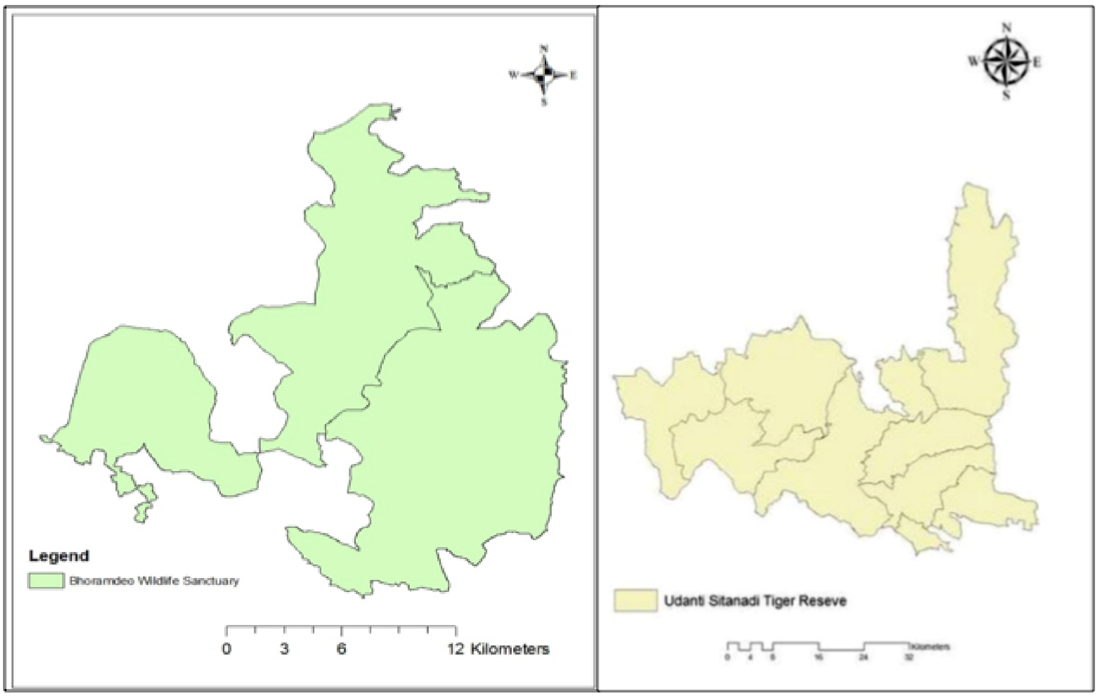

Figure 1a. Bhoramdeo Wildlife Sanctuary on left side and Udanti Sitanadi Tiger Reserve on right side.

of degree of lesser coiling and larger gap between two constrictions in a piece of tiger scat (Biswas & Sankar 2002). Scat analysis was performed to derive frequency of occurrence of consumed prey items in the scats of tiger and leopard (Schaller 1967; Sunquist 1981; Johnsingh 1983; Karanth & Sunquist 1995; Biswas & Sankar 2002).

Scats were first sun-dried then washed using sieves and collectible hairs, bones, feathers were filtered out.

The hair samples were dried and collected in zip-lock polythene bags for further lab analysis. In laboratory, hairs were washed in Xylene and later mounted in Xylene (Bahuguna et al. 2010) and slides were studied under 10–40 X using a compound light microscope. For each sample at least twenty hairs (n=20 hairs/sample) were selected randomly for diet identification and species level identification has been done based on species-specific hair medulla pattern of prey items as described by Bahuguna et al. (2010). To evaluate the effect of sample size on results of scat analysis (Mukherjee et al. 1994a,b), five scats were chosen at random and their contents analyzed. This was continued till n=100, n= 30 and n=121 scat samples were analyzed and cumulative frequency of occurrence for each prey species was calculated to infer the effect of sample size on the final result (Mondal et al. 2011). Quantification of prey biomass consumed from scat was computed by using the asymptotic, allometric relationship equation; biomass consumed per collectable scat/predator weight = $0.033–0.025\exp^{-4.284(\text{prey weight/predator weight})}$ (Chakrabarti et al. 2016). Prey selection of tigers and leopards was estimated for each species by comparing the proportion of the prey species utilized from scats with the expected number of scats available in the environment for each of prey species consumed (Karanth & Sunquist 1995) in SCATMAN (Link & Karanth 1994). Prey selection was also determined by using Ivlev's index (Ivlev 1961), where E= (U-A)/ (U+A), U=relative frequency occurrence of prey species in predators' scat and A=Expected scat proportion in the environment.

RESULTS

Prey abundance

In BWS, Rhesus Macaque was found to be the most abundant species and its estimated density was 24.03 animals ± 7.34 (SE)/km^2 followed by langur 21.82 animals ± 2.45 (SE)/km^2. Among ungulates, Chital density was found to be the highest (12.86 ± 5.85 (SE)/km^2) followed by Wild Boar (7.1 ± 2.9 SE/km^2), Nilgai (5.82 ± 2.53 SE/km^2), Barking Deer (5.74 ± 1.3 SE/km^2), and Sambar (0.95 ± 0.48 SE/km^2) (Table 1). The density of hare was found to be 1.04 ± 0.48 SE/km^2 and for Indian Peafowl it was 6.55 ± 2.65 SE/km^2 (Table 1).

In USTR, Northern Plains Common Langur was found to be the most abundant species (35.06 ± 7.01 (SE)/km^2), followed by Rhesus Macaque 22.94 ± 9.45 (SE)/km^2. Chital density was found to be the highest (3.77 ± 0.96 (SE)/km^2) among the ungulates and it was followed by Wild Boar (2.30.1 ± 0.46 SE/km^2), Barking Deer (1.86 ± 0.33 SE/ km^2), and Nilgai (0.53 ± 0.18 SE/ km^2) (Table 2).

Food habits

In BWS, nine different prey items were identified from the collected leopard scats (n=100). No new prey species were found after analyzing 50–60 scats, as shown by diet stabilization curve (Figure 2A). The relationship between contributions of all nine prey species in the diet of leopards showed that minimum of 50–60 scats should be analyzed annually to understand the food habits of leopard, and the sample size (n=100) in the present study was adequate (Figure 3A). Among all the prey species, langur contributed the most (43.65%) to the diet of leopard whereas wild ungulates contributed only 29.35% and separately livestock contributed 6.34% of the total consumption. In BWS, presence of Sambar and

Table 1. Density, cluster size and group encounter rate of different prey species in Bhoramdeo Wildlife Sanctuary, Chhattisgarh (2016–2017).

Species	Number of sightings	Cluster size		Density (per km^2)		Biomass (kg/per km^2)
		Mean	SE	Density	SE	
Chital	25	10.84	2.08	12.86	5.85	578.70
Sambar	8	2.13	0.30	0.95	0.48	123.5
Nilgai	17	3.29	0.50	5.82	2.53	855.54
Wild Boar	17	5.71	1.20	7.10	2.90	319.5
Barking Deer	41	1.70	0.15	5.74	1.30	143.5
Common Langur	25	12.52	1.23	21.82	5.34	218.2
Rhesus Macaque	17	13.588	2.02	24.03	7.34	185.03
Hare	9	1.11	0.11	1.04	0.48	2.80
Peafowl	20	3.15	0.34	6.55	2.65	22.27

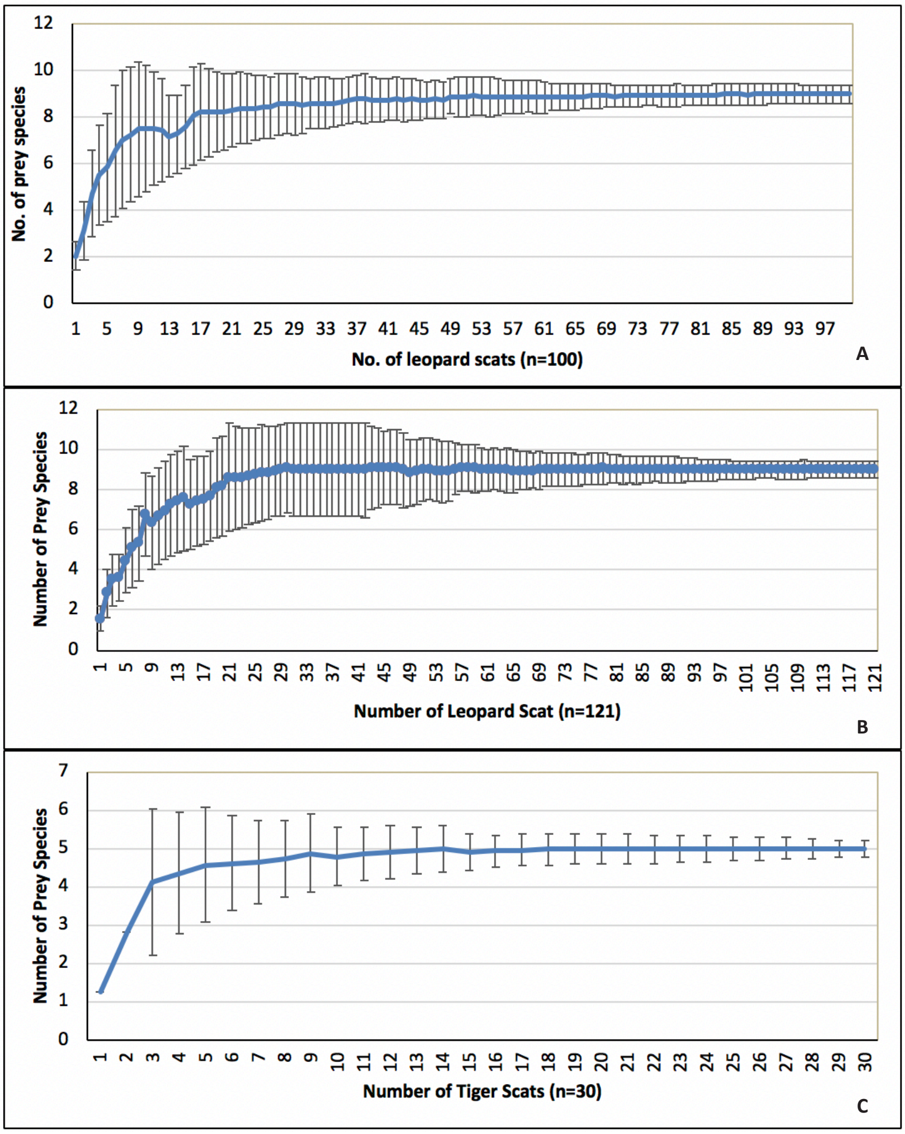

Figure 2. Diet stabilization curve of A—Leopard in Bhoramdeo Wildlife Sanctuary | B—Leopard in Udanti-Sitanadi Tiger Reserve | C—Tiger in Udanti-Sitanadi Tiger Reserve.

Four-horned Antelope were recorded but were never represented in leopard scats. Hare and other rodents were found to contribute frequently (11.9%, 7.14%) to the leopard diet (Table 3) but porcupine was found negligible, found only in the 1.58% of all leopard scat. All the wild ungulates together represented 42.89% of total biomass consumption by leopard whereas langur alone contributed the highest at 43%. Livestock represented 9.93% of the consumed biomass by leopard which was higher than the contributions made by any other wild ungulates in BWS (Table 3). Ivlev's index of prey selection criterion indicated Chital, Wild Boar and Nilgai were not significantly utilized as per their availability. Whereas Barking Deer, Indian Hare and Common Langur were the selected prey species by leopard (Figure 4) in the area.

Similarly, in the diet of leopard in USTR, nine prey

Table 2. Density, cluster size and group encounter rate of different prey species in Udanti-Sitanadi Tiger Reserve, Chhattisgarh (2016–2017).

Species	Number of sightings	Cluster size		Density (per km²)		Biomass (kg/per km²)
		Mean	SE	Density	SE	
Chital	41	3.13	0.30	3.77	0.96	169.65
Sambar	10	-	-	-	-	-
Nilgai	21	2.22	0.37	0.53	0.18	77.91
Wild Boar	36	3.23	0.33	2.30	0.46	103.5
Barking Deer	67	1.16	0.44	1.86	0.33	46.5
Common Langur	88	18.45	1.92	35.06	7.51	350.6
Rhesus Macaque	43	18.15	2.92	22.94	9.45	121.582

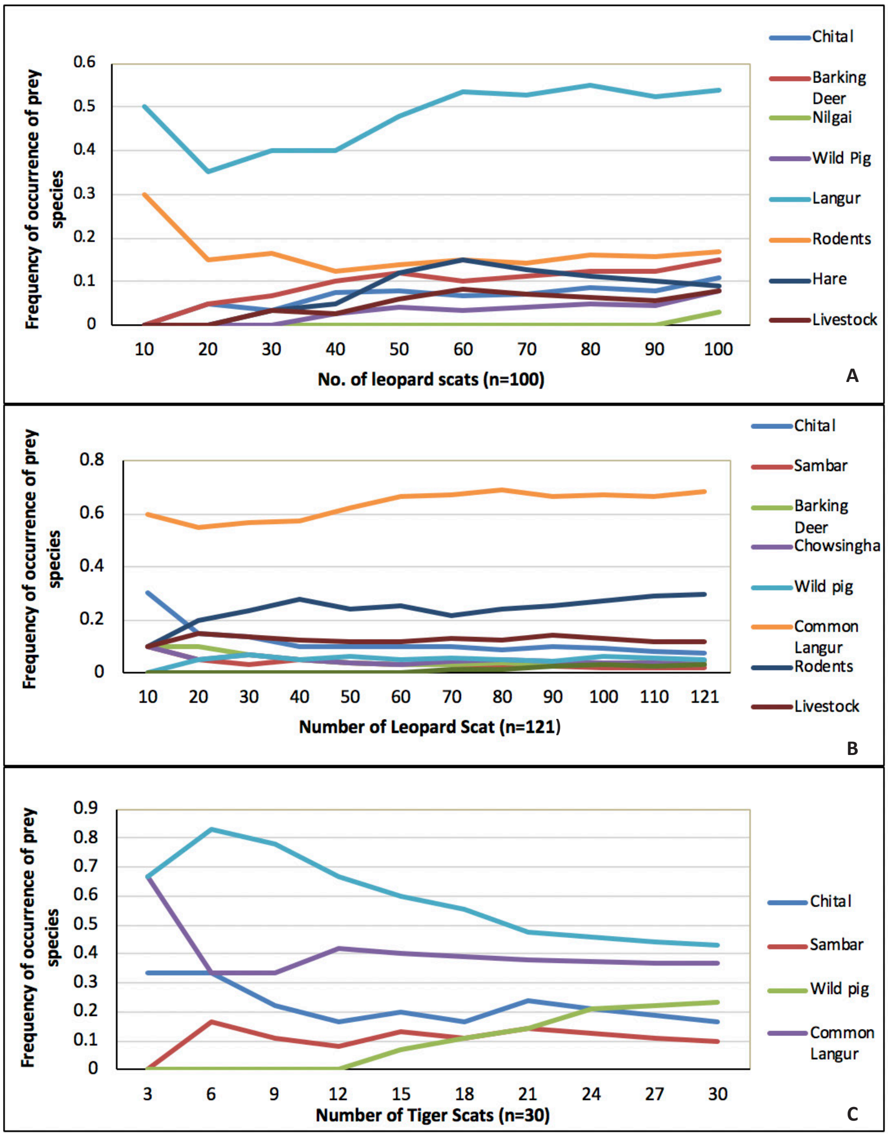

Figure 3. Relationship between contributions of prey species in the diet of A—Leopard in Bhoramdeo Wildlife Sanctuary | B—Leopard in Udanti-Sitanadi Tiger Reserve | C—Tiger in Udanti-Sitanadi Tiger Reserve.

items were identified from the scats (n=121). It was also found that after analyzing 40–50 scats, no new species were identified (Figure 2B) and from the relationship between contributions of nine prey species in the diet of leopard in Udanti Sitanadi Wildlife Sanctuary, it was understood that analysis of more than 50 scats is enough to understand the food habits of leopards (Figure 3B). Among all the prey species, Common Langur contributed maximum (50.92%) to the diet of leopard followed by rodents, livestock, Chital, Wild Boar, Barking Deer, Four-horned Antelope, sambar and birds (Table 4). Common Langur was found to be contributing maximum (57.79%) in leopard's diet in terms of biomass consumption. All the wild ungulates together contributed 26.71% of total biomass consumed by leopards, whereas livestock alone contributed 15.50% (Table 4). Ivlev's selection index indicated only Common Langur as a selected species by leopard in USTR and all other species were utilized less than their availability in the sampling area of USTR (Figure 5).

Five different prey items were identified in the diet of tiger as analyzed through scats (n=30) in USTR. After analyzing 20 scats, no new prey species was found in tiger's diet (figure 2C and 3C), that signifies our sample size was adequate to understand tiger's diet. It was found that 47.37% of tiger's diet was contributed by wild ungulates, 39.47% by livestock and 13.16% by common langur in terms of percentage frequency of occurrence (table 5). Livestock, however, contributed 47.33 % of the total biomass consumed by tiger in USTR (table 5). Ivlev's selection index expectedly indicated that tiger selected Chital and Wild Boar significantly ($p > 0.05$)

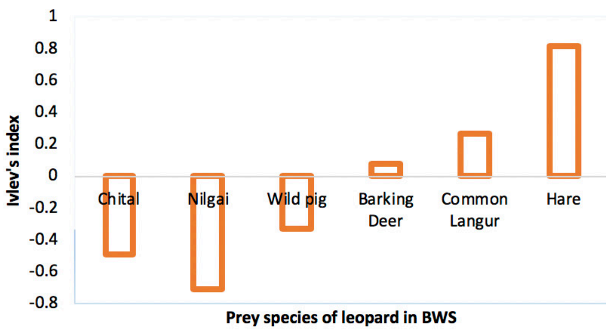

Figure 4. Prey selection of leopard as evidenced from Ivlev's Index in Bhoramdeo Wildlife Sanctuary, Chhattisgarh (2016–2017).

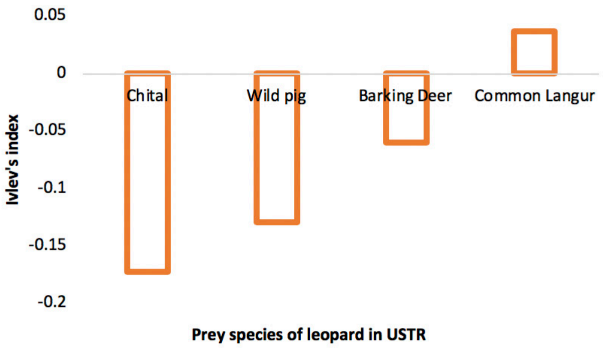

Figure 5. Prey selection of leopard as evidenced from Ivlev's Index in Udanti-Sitanadi Tiger Reserve, Chhattisgarh (2016–2017).

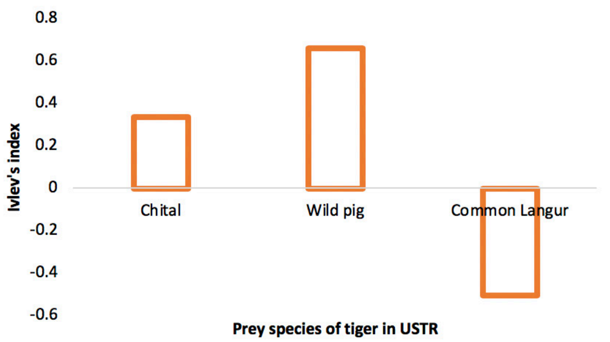

Figure 6. Prey selection of tiger as evidenced from Ivlev's Index in Udanti-Sitanadi Tiger Reserve, Chhattisgarh (2016–2017).

whereas langur was highly avoided by tiger during the study period (Figure 6). Sambar was found only two times in scat despite their low availability in the study area.

DISCUSSION

Population density of prey species, specifically ungulates were found significantly low in both the study areas BWS and USTR. Primates including Rhesus Macaque (24.03/km^2 and 22.94/km^2 in BWS and USTR, respectively) and Common Langur (21.82/km^2 and 35.06/km^2 in BWS and USTR, respectively) were found to be the most abundant prey speicies which evidently supported leopard population in the areas but were not preffered by tiger. Various studies on diet ecology of tiger indicated that they mostly prefer large to medium size prey species like Sambar, Chital and Wild Boar, whereas in Chhattisgarh large to medium size prey species have been found to be less as compared to other protected areas in central India (Table 6). Despite low abundance, however, tiger was found to prey mostly upon wild prey species including Chital and Wild Boar in USTR. Leopard was found to prefer mostly small to medium sized prey species including Barking Deer and Common Langur in both the study areas.

It can be assumed that low abundances of small to large sized wild ungulates in both the study areas have triggered livestock utilization by the large cats (Table 3-5). In USTR, livestock contributed 50% of overall biomass consumed by tiger and 15% in case of leopard. Similarly, in BWS livestock contributed more than 9% of overall biomass consumed by leopard. Less abundance of wild ungulates and higher utilization of livestock by tiger and leopard eventually have indicated that both the protected areas were not in a condition to sustain healthy large predator populations and the conditions appeared to be challenging for future large carnivore conservation efforts.

The study areas have resident populations of hunting human communities like Baiga, Kamar and Bhunjiya who still practice traditional hunting in these areas of Chhattisgarh. USTR even has pressures from external hunters who illegaly exploit the region as their hunting ground. These uncontrolled practices are serious threats to the wild ungulate populations and consequently affecting the food resources of carnivore populations in the study areas. Therefore, prey depletion by these illegal hunting practices compels large mammalian predators to prey upon livestock, which brings forward even bigger conservation threat, i.e., negative human-wildlife (tiger/leopard) interaction. Athreya et al. (2016) also supported the fact that in the situations where large prey availibility is less, chances of livestock predation is automatically elevated.

Both the study areas have villages inside the core

Table 3. Percentage frequency of occurrence, percentage biomass consumption of different prey species by leopard as shown by scat analysis in Bhoramdeo Wildlife Sanctuary, Chhattisgarh (2016–2017).

Prey Species	Presence in number of scats	% Frequency of occurrence	Average body weight	Prey consumed per field collectible scat (kg)	% Biomass (kg/per km²) consumed
Chital	11	8.73	45	1.92	13.26
Nilgai	3	2.38	147	1.98	3.73
Wild Boar	8	6.34	45	1.92	9.63
Barking Deer	15	11.9	25	1.73	16.27
Common Langur	55	43.65	10	1.25	43.00
Hare	9	7.14	2.7	0.74	4.20
Porcupine	2	1.58	-	-	-
Livestock	8	6.34	130	1.98	9.93
Rodents	15	11.9	-	-	-

Table 4. Percentage frequency of occurrence, percentage biomass consumption of different prey species by leopard as shown by scat analysis in Udanti-Sitanadi Tiger Reserve, Chhattisgarh (2016–2017).

Prey Species	Presence in number of scats	% Frequency of occurrence	Average body weight	Prey consumed per field collectible scat (kg)	% Biomass (kg/per km²) consumed
Chital	9	5.52	45	1.92	10.60
Sambar	2	1.23	130	1.98	2.44
Wild Boar	6	3.68	38	1.92	7.06
Barking Deer	5	3.07	24	1.72	5.31
Four-horned Antelope	4	2.45	19	1.59	3.90
Common Langur	83	50.92	14	1.25	63.42
Livestock	14	8.59	130	1.98	17.01
Rodents	36	22.09	-	-	-
Birds	4	2.45	-	-	-

Table 5. Percentage frequency of occurrence, percentage biomass consumption of different prey species by tiger as shown by scat analysis in Udanti-Sitanadi Tiger Reserve, Chhattisgarh (2016–2017).

Prey species	Presence in number of scats	% Frequency of occurrence	Average body weight	Prey consumed per field collectible scat (kg)	% Biomass (kg/per km²) consumed
Chital	6	15.79	45	4.32	14.63
Sambar	3	7.9	125	5.72	9.47
Wild Boar	9	23.68	45	4.05	21.94
Common Langur	5	13.16	10	2.43	6.63
Livestock	15	39.47	130	5.72	47.33

Table 6. Comparative account of prey densities from different protected areas of central India.

Area	Spotted deer		Sambar		Wild Boar		Barking Deer		Nilgai		Gaur		Chousingha	
	D	SE	D	SE	D	SE	D	SE	D	SE	D	SE	D	SE
Melghat[a]	NA	NA	10.5	3.5	NA	NA	2.7	0.3	NA	NA	5.8	1.7	NA	NA
Panna[b]	5	1.8	8.7	2.2	7.5	4	0	0	9.5	1.9	0	0	4.2	1.2
Phen[c]	0.96	0.53	6.09	2.08	20.05	5.88	2.97	0.6	0	0	2.49	1.33	0.59	0.59
Kanha[d]	26.3	3.3	8.2	0.9	4.9	0.4	2.5	0.2	0.5	0.2	4.5	1.1	NA	NA
Achanakmar[e]	10.33	2.68	NA	NA	12.72	4.31	0.97	0.35	NA	NA	8.59	3.38	NA	NA
Udanti-Sitanadi*	3.77	0.96	NA	NA	2.3	0.46	1.86	0.33	0.53	0.18	NA	NA	NA	NA
Bhoramdeo*	12.86	5.85	0.95	0.48	7.1	2.9	5.74	1.3	5.82	2.83	NA	NA	NA	NA

D—Density | SE—Standard Error | *—Study areas where the recent researches were conducted | ([a] Narasimmarajan et al. 2014, [b] Ramesh et al. 2013, [c] Jena et al. 2014, [d] Krishnamurthy et al. 2016, [e] Mandal et al. 2017).

areas and eventually have thousands of livestock which roam mostly unguarded within the protected areas and become easy prey to large predators. BWS has 29 villages inside the protected area boundary with approximately 4,000 domestic and feral cattle population, whereas, USTR has settlements of 99 villages with 26,689 livestock population. In the eight ranges of USTR, livestock density varied from 4.776–33.581/km^2 even overall density of livestock was 14.489/km^2 for the entire USTR which was found higher than the any wild ungulate population in this area. Consequently, cattle killing by both tiger and leopard has become common in these areas and may provoke severe negative human-carnivore interactions situations in both the protected areas in the near future.

The present study indicates the urgency of wild ungulate population recovery programs in both BWS and USTR and also supports to initiate the framework of the recovery plan by finding evident facts of low wild ungulate abundances and higher livestock utilization by large predators in these areas. Earlier studies showed that increasing availability of wider variety of ungulate prey species and checking grazing activities in a protected forest system may decrease the livestock predation by large predators in those areas and eventually decrease chances of negative human-large predator interactions (Basak et al. 2018; Sankar et al. 2009). Feasibility framework for recovery, however, is required by involving multi-step conservation friendly control measures. Village level mass sensitization to change their perception is vital to build up support for the ungulate recovery program and to maintain viable populations of large cats. Simultaneously strong protection framework is needed to safeguard the captive breeding and re-stalking of wild ungulate populations to increase sufficient prey-base for both tiger and leopard. Careful effort and strong scientific background behind the implementation of the ungulate augmentation plan can bring a fruitful result and can secure long term survival of large cats and other layer of carnivores in Bhoramdeo Wildlife Sanctuary and Udanti-Sitanadi Tiger Reserve in central India, Chhattisgarh.

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Hindi abstract: जंगलों में बड़े विडाल वंषी जीवों के लंबे समय तक बने रहने हेतु वहां के प्रे–बसे यानी षिकार की उपलब्धता एक अहम पैरामीटर होती है। इसी वजह से ऐसे क्षेत्रों में जहां जंगली षिकारी जीवों की कमी होती है पषुधन पर निर्भरता बढ़ जाती है और इससे बाघों जैसे जीव के संरक्षण में काफी दिक्कत होती है। इसीलिए ऐसे क्षेत्रों में जहां प्रे–बेस कम होता है वहां षिकारी जीवो के आहार पद्धति को समझना निष्चित तौर पर जरूरी हो जाता है। हमारा या अध्ययन मध्य भारत के कम षिकार की उपलब्धता वाले उदंती सीतानदी टाइगर रिजर्व एवं भोरमदेव अभ्यारण में किया गया जिससे वहां के षिकार और षिकारी जीवो के बीच के संबंध को समझा जा सके। हमने ट्रांजैक्ट लाइन सर्वे की मदद से अध्ययन क्षेत्र में पाए जाने वाले प्रे बेस की प्रचुरता का पता लगाया और पाया कि दोनों ही स्थानों में लंगूर (नॉर्थेर्न प्लेन्स लंगूर) और लाल मुँह वाला बन्दर (रीहस्स मेकाक) की संख्या अधिक है। मल के विष्लेशण से पता चला की कम षिकार की उपलब्धता होने के बावजूद बाघ चीतल, जंगली सूअर सहित अधिक मात्रा में पषुधन पर निर्भर रह रहे हैं (39%)। इसी प्रकार तेंदुआ के आहार में भी ज्यादातर लंगूर (43–50 %) और पषुधन (7–9 %) पाया गया है। दोनों ही अध्ययन क्षेत्रों में जंगली खुरधारी जीवो की कमी होना, बाघ और तेंदुए द्वारा लगातार पषुधन यानी मवेषी का षिकार करना इस बात की ओर से सूचित करता है कि ऐसे जंगलों में इनकी संख्या को बनाए रखना आने वाले कल में काफी मुष्किल होगा अथवा मध्य भारत में यदि बाघ और तेंदुए जैसे विडाल वंषी जीवो को बचाना है तो एक मजबूत कार्य योजना के साथ–साथ इनके रहवास और उसमें पाए जाने वाले षिकारी जीवों की संख्या को बढ़ाना अत्यंत आवष्यक है तभी हम इनके दूरगामी संरक्षण व संवर्धन को सुनिष्चित कर सकेंगे ।

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