



Research Article

FEEDING ECOLOGY OF INDIAN LEOPARD (*PANTHERA PARDUSFUSCA*) IN THE HIREKALLUGUDDA SLOTH BEAR SANCTUARY (PROPOSED SANCTUARY) IN ARASIKERE, KARNATAKA, INDIA

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ABSTRACT

The feeding ecology of the Indian leopard (*Panthera pardusfusca*) was studied from February 2016 to September 2016 a total of 54 scat samples. These leopards feed on a variety of wild and domestic animals. Diet composition of the leopard will be primarily studied through scat analysis will be collected from well-defined sampling areas within the study period. A total of 12 prey species were successfully identified based on the microscopic hair analysis, percentage frequency of occurrence of prey hair, bones, or claws, in the scats and estimation of standard error using a regression equation and relative biomass consumed also recorded. However, the data regarding their diet composition is scanty and scat analysis revealed that the wild animals (45.00%) was their preferred diet, and domestic species including with dog and livestock were more frequently consumed (52.00%) while Sambar deer (23.70 %) and Goat (21.30 %) was most commonly used as diet during seasonal variations. Other species include porcupine, wild boar, hare, monkeys, peafowl, spurfowl, and mongoose some domestic species of sheep, cow, and some unknown species. Furthermore, the questioner's survey is recorded for human-leopard conflicts with investigations to cattle watchers also assessed.

Keywords: Arasikere, Leopard scat, Prey species, Livestock, Conflict.

INTRODUCTION

The Leopard (*Panthera pardusfusca*) has a wide range distribution from Africa to 1 parts of western and central Asia, in the Indian subcontinent to southeast and east Asia. The leopard is a large carnivore species listed as Vulnerable on the IUCN Red List because of human pressures and forest range fragmentations. It is reported that the leopard is found in almost every kind of habitat from the rain forest of the tropical forests, grassland plains to deserts and temperate region (Kitchener, 1991; Nowell & Jackson, 1996). In India, leopard is endangered with half of the estimated 14,000 leopards living outside protected areas. Given the threats the animals face today ranging from conflict with human and habitat destruction due to explosion for the human pressures, loss of wild prey, poaching for skins, bones, claw, and poisoning carcasses of livestock killed by leopards to places threats to the leopards (Kitchener, 1991). Therefore, the populations living nearby

of the human habitations are on the edge of extinction (Carter *et al.*, 2012). In India, where the border between jungle area and rural inhabitations could be a range, the leopards stay within the human habitat area. Such as very low density of wild prey, which has, as a result, required leopards depredate attack to humans and livestock, is that the ultimate cause of conflict with local villages and human habitat area (Schaller *et al.*, 1988). The animal moved one place to a different area according to the availability of livestock and wild prey and leopard's preferences and incidences of depredation (Knowlton *et al.*, 1999; Meriggi & Lovari, 1996). Leopards are considered as ecological generalists instead of specialists and reported feeding on large or small prey, they will be efficient scavengers and that they aren't averse to preying on domestic stock, a behavior that brings them into direct conflict with humans (Bailey, 1993). This is often mainly true in a country like India, where the human population is extremely high

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together with one in every of the highest density of livestock in the world (Robinson *et al.*, 2014). Availability of prey is one of the most critical cyclic of broad carnivore distribution, but wild prey may occur at very low densities in human-habitat (Karanth *et al.*, 2004; Khorozyan *et al.*, 2015). Livestock depredation by carnivores has become an essential hurdle in the conservation of predators at the top of the food chain. One of the critical aspects of the conservation of wild carnivores in human-dominated landscapes is the attitude of the affected people (Rahalkar, 2008; Thavarajah, 2008).

According to Lal, (1989), most of India's livestock depend on forests for its grazing requirements and when the leopards share their forest and non-forest area habitats with domestic livestock there is inevitably some leopard predation on livestock. In India leopard food habitats had been studied by Johnsingh (1983); Karanth, 1993; Kumaraguru, 2002; Schaller, 1967; Swaminathan *et al.*, 2002; Venkataraman *et al.*, 1995) the major prey species reported being chital, sambar and few percent of the livestock. Studies reports that leopard had more diverse diet ranging from lower size classes of animals to medium-sized wild species in Protected Areas of South Asia (Eisenberg & Lockhart, 1972; Rabinowitz, 1989; Seidensticker, 1990). Livestock predation is recorded in all the Project Tiger Reserves irrespective of adequate wild prey available in them (Sawarkar, 1986). Negi *et al.*, (1996) reported that 61 human beings were killed and injured by man-eating leopards whereas fifty leopards were killed in the Garhwal district of the U.P. between 1986 and 1996.

Recent studies on leopard attacks on humans and livestock have been conducted in Arasikere. The primary food for the leopard hunt the forest presently atherogenic presser increased near human settlements to predate on livestock and domestic animals in areas with abundant wild prey. These conflicts pose a major problem not only in Arasikere but also result to develop recommendations for control with conflict and mitigating human-leopard conflict in the Hassan district. Hirekallugudda sloth bear sanctuary (13° 22'N and 76° 17'E), Hassan District, Karnataka, with an expanse of ca. 15491.09 ha. state of the South-Western part of leopards at a large geographical scale, across Karnataka State in southern India (Athreya *et al.*, 2015). The Sanctuary (Figure. 1) is small isolated area, about Nagapuri-Hirekallugudda reserve forest surroundings 27 fringe villages along borders. The habitat is mainly rocky, with large boulders, dry deciduous scrub, and southern thorn forests.. The area has an elevation range between 510-1100 m above mean sea level. The vegetation in this region exists in a degraded state although a forestation program had ensured prominent plants in individual pockets. The study area has a semi-arid climate characterized by hot summers (24.2°– 42°C) during April– June and low rainfall (500-800 mm) from June to November. The rising conservation conflicts in the study area can be attributed to leopard evoked livestock injuries leading to more than 32 villages getting affected in the last four years in the region and also huge livestock loss in 22 villages affected in the previous 3 years protected area reserved for the conservation of wild animals and reduce human wildlife conflict based on scientific knowledge.

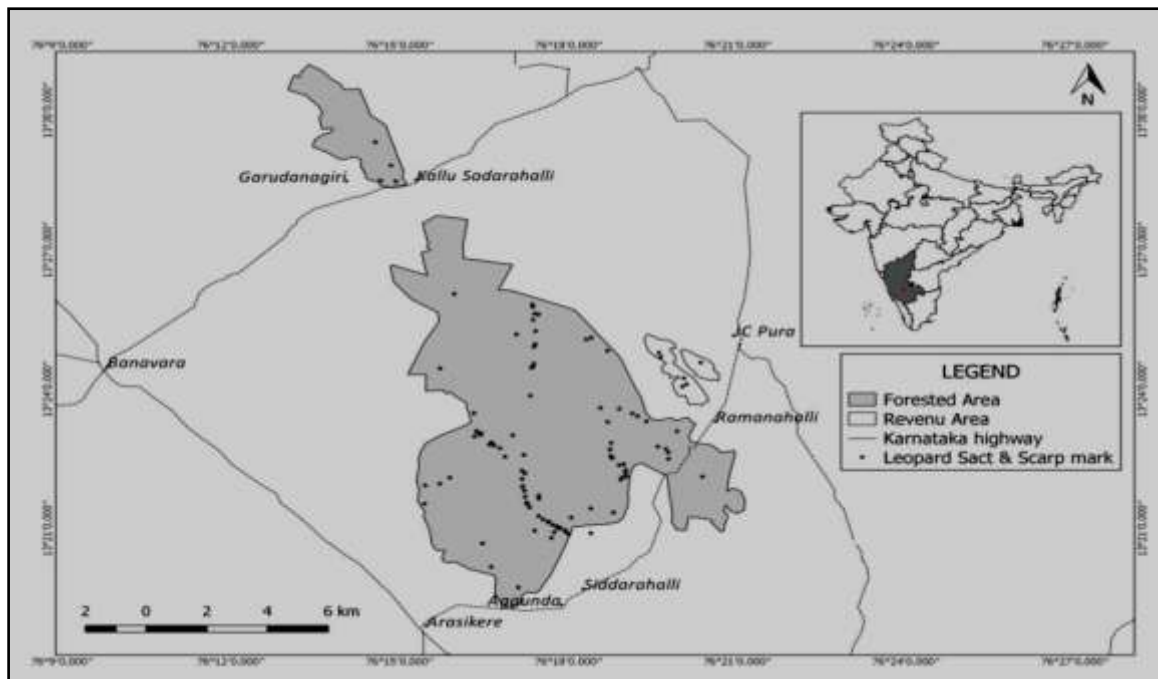


Figure 1. Map showing the location of the study area Hirekallugudda Sloth bear sanctuary (proposed sanctuary) in Arasikere, Hassan district, Karnataka.

MATERIALS AND METHODS

Leopard scat collection

Leopard scats were collected whenever encountered in the study area during from February 2016 to September 2016 the study period, interviews were conducted with the cattle watchers and village peoples to get preliminary information on the presence of leopard in the area followed by signs survey various flat livestock trails, or footpath terrains available within the field areas collection of the leopard scats. The scats were collected in paper bags and the date, locality, and Global Positioning System (GPS) locations were noted. Sampling sites would be selected based on different levels of human disturbance

Leopard Scat analysis

The diet composition of the leopard will be primarily studied through the scat analysis technique, as this is a non-invasive method that easily provides large samples (Johnsingh, 1983; Karanth & Sunquist, 1995). A total of 75 scat samples were collected in the field but a sample size of 54 Scat will be taken from well-defined sampling transect areas within the study period. Each scat was then triturated with water and then passed through a sieve. All the scat was weighed to observe the percentage of each part. Prey species were identified based on the component microscopic scat contents that were then teased apart with forceps, and undigested prey remains such as hair, bones, skin, claws, mandible, and other materials were separated for species identification. Unprocessed prey hair which remained in the scat after washing was used for the identification of prey species as described by Grobler & Wilson, (1972); Mukherjee *et al.*, (1994). The scat analysis method was chosen to estimate the proportion of different prey species consumed by a leopard (Link & Karanth, 1994; Schaller, 1967; Sunquist, 1981). The single scat taken with one bowl put the water washed then after used forceps five-time randomly take the sample further they were placed on the glass slides, hairs were randomly observed the percentage of each part that diet species. The prey composition of the predator scats was extrapolated in terms of the prey frequency of occurrence in the scat samples (FO), calculated by equation-E (Karanth & Sunquist, 1995; Mizutani, 1999; Pikonov & Korkishko, 1992; Ramakrishnan *et al.*, 1999). $FO = (ni/N) 100$ equation (E) Where ni is the number of scats where a given in the prey species residue occurs and N is the total number of all scat samples.

Relative Biomass Calculation

The relative biomass consumption was estimated by using the linear relationship developed by $Y = 1.98 + 0.035X$; where Y = weight of prey consumed per scat, and X = average weight of the prey species the applied in the form of a correction factor, to convert frequency of occurrence to relative biomass consumed. As the frequency of occurrence does not give the exact estimation relative biomass was recorded.

Human-Leopard Conflict

For analyzing, leopard-cattle conflicts, interviews of the attack viewers was conducted for cattle watchers using a standard questionnaire. Based on the village surveys, key findings to incidents of livestock depredation within forest, site visits at the time of cattle grazing about 1 km from the buffer area in Hirekallugudda-Arasikere. The information was collected under locations of livestock depredation that were visited and data on species, season, GPS location, etc. were recorded. Identification of predator was based on the direct sightings at cattle watching time, observations of villagers and collected information based on questioners.

RESULTS AND DISCUSSION

In the present study of feeding ecology Leopard 540 prey items (12 species) were identified in the study period. About 45% of the species devoured by leopards were of wild origin during study Most of the prey species were domestic livestock while domestic species constituted to be 52% of the leopard diet including dog and livestock animals (Figure. 2). About three percent of the leopard prey species were unidentifiable. Taghdisi *et al.*, (2013) also reported that wild ungulates including wild sheep, wild goats, and wild pig are amongst the most preferable food items of leopards accounting for 85.98% of their consumed biomass compared to 3.26% biomass consumed for livestock. Three species of domestic animals, i.e. goat, cow, and local domestic dog, were identified from the scat samples of Leopard, of which goat was the most preferred dietary species during the season Feb-Sept 2016.

During the present study, the dietary preference of the leopards was studied by the relative frequency percentage calculated based on leopard scat collected (n:54). The study exposed that there was a tremendous significant variation in the leopard scats processed comprising of a total of 12 prey items with their percent wise occurrence given in (Table. 1) the present study focused on the dietary preferences of a leopard during the period of Feb-Sept 2016. It was found that Sambar deer was the most preferred prey species (23.70%) of the leopard diet. Contradictory reports have been published by Mukherjee *et al.*, (1994). It was reported that leopards most frequently preyed on chital meat (64.7%). Ecosystems with cohabitation of humans and livestock include the highest density of domestic animals like a goat (21.30%) and Sheep (13.15 %) which may be another prey species level to leopard attacks. In the present study, one of the important prey occurrences of Domestic dog (12.59%) of the cattle watchers used the dog for guarding their cattle while grazing in the forest buffer zone since leopards can be easily hunted by domestic dogs, where leopard attacks were by far the dominant cause of death. The most abundant and readily available prey species was the Sambar deer followed by wild boar (7.78%) Black-naped hare (3.52%) and other prey species (Figure 3). Followed by native prey species, Porcupine, Un-identified, and Peafowl (2.96%) had a higher occurrence than mongoose and bonnet macaque (0.74 and 0.93%) in low occurrence leopard scats sampled. Besides

the above animals, it was also noted that Hare was one of the preferred prey items that had a 7.96% frequency of occurrence. Due to Porcupine and peafowl being confined, their rate in the leopard scats was limited however dog and peafowl had a similar appearance. Concerning livestock prey species, goat (21.30 percent) and cow (5.19 percent) were preferred species high occurrence of the scat. However, (Mukherjee *et al.*, 1994) reported an 18 percent occurrence of livestock in leopard scat comprising of

buffalo and cow with no presence of goat. Livestock depredation in form of calves of cow and buffalo and kids, and scavenging on kills of a cow made by a lion was noted in two instances. Spurfowl (2.22%) was a significantly less common prey species devoured by leopards. In conclusion, the prey selection nature of the leopard was found to be drastically variable and was based solely on the availability of the prey species ranging from fowl to sambar deer.

Figure 2. Percentage occurrence of prey species of Indian leopard in Hirekallugudda Sloth bear sanctuary (proposed sanctuary) Arasikere.

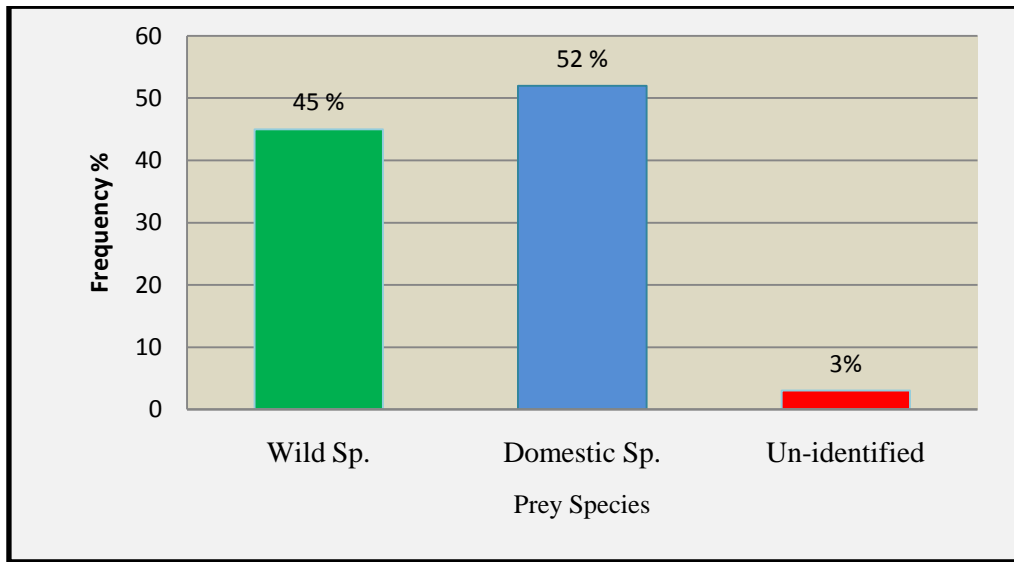


Table 1. Occurrences of Prey Frequency based on hair in Indian leopard scat (n=54) in Hirekallugudda Sloth bear sanctuary (proposed sanctuary) Arasikere.

S.No	Species	Frequency	Occurrence (%)	Mean	SE
1	Black-naped hare	19	3.52	2.11	0.21
2	Indian Porcupine	16	2.96	2.67	0.46
3	Sambar deer	128	23.7	8.53	0.45
4	Wild boar	42	7.78	5.25	0.8
5	Ruddy Mongoose	4	0.74	1.33	0.41
6	Bonnet Macaque	5	0.93	2.5	0.71
7	Spurfowl	12	2.22	1.71	0.31
8	Peafowl	68	2.96	2.67	1.01
9	Sheep	16	13.15	8.88	0.68
10	Goat	16	21.3	8.21	0.72
11	Cow	71	5.19	9.33	0.82
12	Domestic Dog	115	12.59	6.8	0.6
13	Un-identified	28	2.96	2.67	0.37
	Total	540			

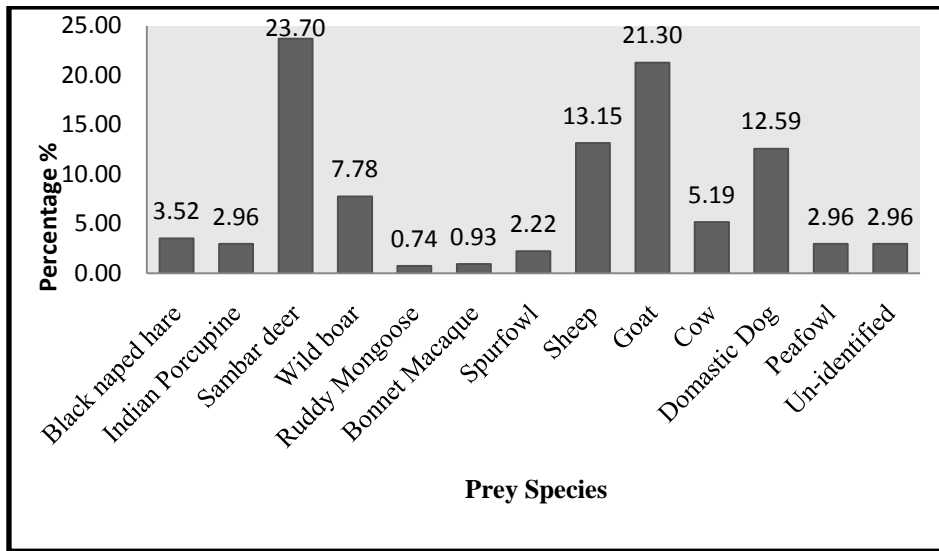


Figure 3. Percentage of prey species based on Indian leopard scat (n=54) in Hirekallugudda Sloth bear Sanctuary (proposed sanctuary) Arasikere.

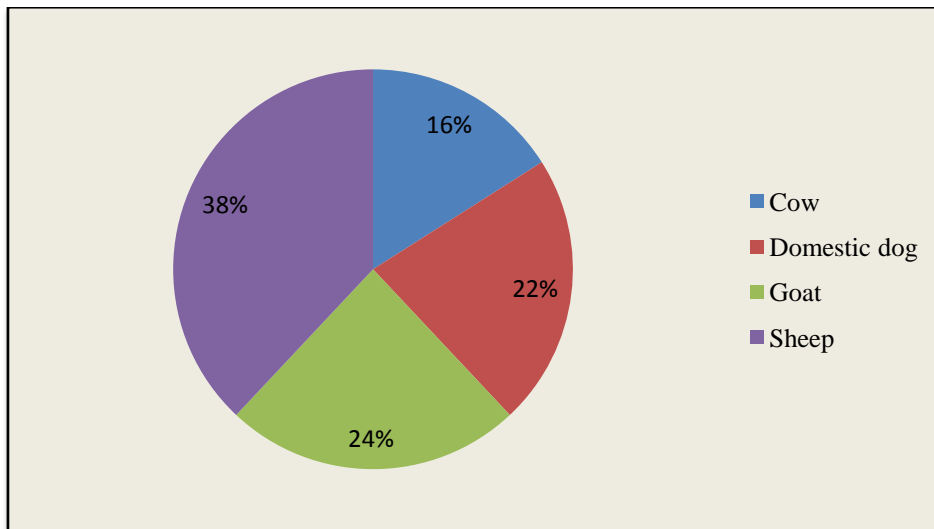


Figure 4. Pie charts display relative domestic of percentage four food categories by a Indian leopard in Hirekallugudda Sloth bear sanctuary (proposed sanctuary) Arasikere.

In terms of biomass consumed, livestock dominated by contributing 50.7% and followed by wild animals rearing part of the 49.3% half each percentage relative biomass. Sambar deer is the single most important prey species for leopards in the study area, making up 31.66% of the total biomass consumed (Table 2). Domestic animals for sheep, Goat and cow followed with percentages of 11.05, 19.57 and 10.7% respectively. Wild boar and Dog are also important, with 8.29 and 9.73% of relative biomass consumed (Table 2), Leopards preferred medium-sized prey but balance diet very small mammals for Black-naped

hare, Indian porcupine, ruddy mongoose and bonnet macaque also most important prey 2.32, 2.49, 0.50 and 0.66% of the biomass consumed (Table 2) and spurfowl and peafowl was the contributor among birds (Table 2). The study also evaluated 50 of the leopard attacks cases that occurred between 2012 and 2016. Interviews of the affected people in the village mostly included the cattle herders. The interviews revealed that leopard attacks on domestic animals were a frequent scenario for the past four years. It was revealed that the relaxed, laid-back attitude of the farmers while herding, grazing livestock in forest areas

was responsible for most of the attacks. Among the big cat species, leopards are more widely distributed in human habitat area owing to their feeding habit, highly adaptable hunting, and hermit-like nature. The five crucial essential prey species selected were taken from both superficial and deeper regions of the forest-based on the information received from the villagers. The study revealed that sheep (38 %), goat (24 %), domestic dogs (22 %), and cow (16 %) were the most commonly attacked by leopards (Figure 4). Most of the attacks (about 70%) took place while the livestock was grazing during broad daylight, and 30% of the animals were attacked outside the forest also. Livestock attacks by leopards were more likely if dogs were present in the household and if the livestock protection in that grazing times it is attacked more that area.

Based on the questionnaire, the results of the survey conducted among local villagers revealed that leopard attacks were seasonal. The main reason for the inside of

the forest February to August that time summer season middle of the not get food in outside villages so more cattle entry with forest and anther one rainy season for June to November heavy rain greens start in forest food availability high density cattle grazing resulting in increased human and animal conflicts. Leopard attacks on cattle were recorded throughout the year; however, more (45.0 %) occurred from May to August season high attacks, followed by January to February (30.0 %), winter (20.0 %), and November to December (5.0 %) agriculture harvesting time cattle low entry with in forest (Figure 5). Most attacks occurred around the forest and agricultural fields that occurred around forests and edges. The incidence of attacks was noted mostly around agricultural fields that were located around forest zones. More strikes occurred outside the protected area when people were working in agricultural fields and leading their livestock to graze within the territorial forest.

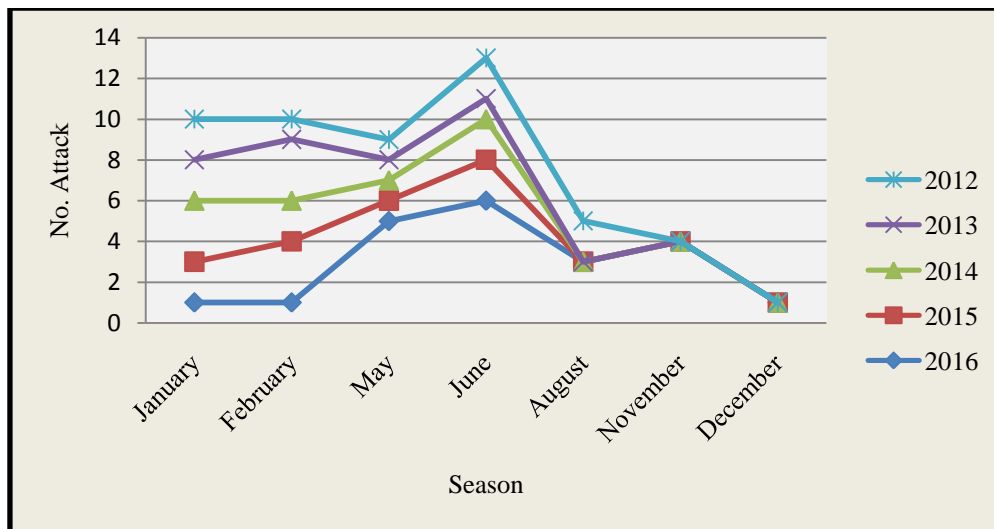


Figure 5. The charts display relative domestic animals of number of attack categories by a Indian leopard in Hirekallugudda Sloth bear sanctuary (proposed sanctuary) Arasikere.

The scats were found to be distributed mainly along the footpath or track, with very few scats located further inside the forest. The main buffer zone area was Aggund, Ramanahalli, and JC Pura which were working cattle entry points and therefore was prone to higher leopard attacks. The village small isolated area that kind of nearest village 1 < km as the bulk of the diet consists of abundantly found. The present study focuses on the diet of leopard, and it represents the overall diet range study period sambar deer has the highest frequency (23.70%) in the leopard diet. Contradictory reports have been published by they reported chital has the highest rate (64.7%) in leopard diet followed by sambar (20.2%), and other prey species. The study also revealed that the leopard's major food item in the area was sambar (*Rusaunicolor*) which is a large deer of distribution in Arasikere. Vegetation loss due to clearing by farmers, cutting by shepherds for fodder, and villagers for firewood

collection. It is reducing green cover and flora. This leads to multiple issues and adverse effects on the ecosystem. Revival of degraded habitats is one of our focus areas. Among the significant wild species preyed upon, the second most common animal was the wild boar (7.78 %) related to cow (5.19%). The other species of lagomorph found in Arasikere were remains of the relatively abundant black-naped hare (3.52 %) in scats representing the leopard diet. Mukherjee *et al.*, (1994); Sankar & Johnsingh, (2002) (personal communication) also found little hare to be preyed commonly by leopards. Karanth & Sunquist, (1995) estimated that only about 5 % of the leopard's prey in Nagarhole comprised of a hare. The present study noted that primates and small animals were not as important as a component of the leopard diet. Arboreal prey (Un-identified, spurfowl, peafowl, and macaque) represented 0.93 to 2.96 (Table 2) percent of prey taken. Peafowl

remains (in one case Mongoose 0.74 %) were found in scats, and were only a minor component of the leopard's diet. John Seidensticker, (1983) found that an abundant and diverse prey base in Chitawan resulted in the leopards taking macaques only occasionally, while (Schaller, 1967) found leopards to be killing langur frequently in Kanha Tiger Reserve. Livestock has been recorded as a significant component of the diet. Goats were the most commonly consumed species of domestic animals (Athreya *et al.*, 2015) reported 224 goats killed by leopards in the

five-year period, followed by the cow, sheep, and domestic dog, and, interestingly, the relative proportions were almost identical as reported losses among interviewed households. Around 87% of leopard diet in the human-dominated landscape supported by domestic animals where only few species of wild animals were recorded (Athreya *et al.*, 2016). Human use landscapes for a very longtime watching hunt to dog become important component of their diet (Athreya *et al.*, 2015).

Table 2. Calculation of biomass consumption (kg) Indian leopard in Hirekallugudda Sloth bears sanctuary (proposed sanctuary) Arasikere.

S No.	Species	Average body weight (kg)	Biomass per scat	Frequency of occurrence	Biomass consumed	Percentage (%) biomass consumption
1	Black-naped hare	2	2.05	3.52	7.21	2.32
2	Indian Porcupine	18	2.61	2.96	7.73	2.49
3	Sambar deer	62	4.15	23.70	98.37	31.66
4	Wild boar	38	3.31	7.78	25.74	8.29
5	Ruddy Mongoose	3	2.09	0.74	1.54	0.50
6	Bonnet Macaque	7	2.23	0.93	2.06	0.66
7	Spurfowl	2	2.05	2.22	4.56	1.47
8	Peafowl	2	2.05	2.96	6.07	1.96
9	Sheep	18	2.61	13.15	34.32	11.05
10	Goat	25	2.86	21.30	60.80	19.57
11	Cow	120	6.18	5.19	32.04	10.31
12	Domestic Dog	12	2.40	12.59	30.22	9.73

CONCLUSION

This study shows baseline data on the feeding ecology of leopards in Arasikere sanctuary (proposed sanctuary). It is supporting the prey base of the Leopard 12 species of wild and domestic recorded. The similarity of the two sources of data indicates that the scat analyses provided reliable results. Hence, the utilization of domestic animals seems to have increased over time. The cause of this increase is probably related to the fact that leopards are more frequently getting into contact with humans and their livestock and dog mostly found around human habitation area and cattle grazing time so simply attacked. Our data propose that making noise at cattle grazing time while moving through leopard habitat helps to avoid leopard encounters and attacks. The cattle entered the forest supporting for leopard but in results at the same time the economically lose of money in formers. Water sources in the localities of leopard den sites should be protected prey wild species or if lacking, could be provided. Restoration measures could include reducing the causes of degradation, facilitating regeneration of plants, and planting trees species including key food plants to augment cover and food for Sambar deer in those habitats. The domestic species control measures improve habitat quality and

indirectly conserve the leopards. The conservation of such habitat and prey species is important for area supported with leopard of population.

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