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Food habits of leopard (*Panthera pardus*) in Tropical forest of Southern India.

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Abstract

Food habits of leopard (*Panthera pardus*) were studied in Nilgiri North Forest Division from December 2010 to March 2011. Data were collected on prey availability and food habits (undigested remains from scat) of leopard. In total, thirty one scats were collected from all the major habitats and across the altitudinal gradients (ranging from 300 to 2500 above MSL). Prey items were determined by using undigested matter isolated from the scats, and compared with a reference collection of hairs, bones and hooves from potential prey species. Ungulates are the most preferred prey of leopard in the study area. Among the ungulates, Sambar (32.26%) was the most preferred prey followed by Chital (19.35%), Muntjac (9.7%) and Wildboar (6.45%). Although Chital was the most abundant prey species in the study area, its distribution was restricted only in the lower plateau of the region. On the other hand, Sambar was distributed across the division and the leopard showed a high degree of preference for it in the study area. There was a marked difference (X^2 = 371.04, df= 8, P<0.05) between the prey abundance and prey preferred by leopard in the study area. We conclude that prey preference by leopard is largely dependent on the distribution of prey availability than the size of the prey.

Keywords: food habits, leopard, Nilgiris, *Panthera*, prey distribution

INTRODUCTION

The Leopard is a large cat distributed throughout Peninsular India. According to Nowell and Jackson (1996) it is the most widely distributed of all the wild cats. It is found in almost every kind of habitat from rain forests of the tropics to deserts and temperate areas (Kitchener 1991). In India, its principal habitat varies from tropical evergreen rain forest to open tropical dry thorn forest. It can also live outside the forest areas (Prater 1971) due to its ability to thrive on multitude of prey species ranging from Peafowl to Mongrels. Leopards hunt by stalking, taking their prey opportunistically and mostly at night, especially where people have persecuted it (Nowell and Jackson 1996; Schaller, 1967; Johnsingh, 1983; Karanth and Sunquist, 1995, 2000; Venkatraman *et al.*, 1995. Arivazhagan *et al* (2007) studied leopard food habits and reported that Chital (*Axis axis*), Sambar (*Cervus unicolor*), Barking deer (*Muntiacus muntjak*), Goral (*Nemorhaedus spp.*) and livestock were the major prey. In the Mundanthurai plateau of Tamil Nadu, Sathyakumar (1992) reported that leopards prey mainly on Sambar, Blacknaped Hare, Chital and livestock. In Bandipur, Johnsingh (1983) reported that 66% of Leopard kills were Chital. In Gir forests, Chellam (1993) found that 40% of Leopard scats had remains of Chital and 25% had Common Langur. In the tropical forest of Nagarhole, southern India, Karanth and Sunquist (1995) found that Chital constituted the major prey base of leopards.

According to Lal (1989) most of India's livestock depend on forests for its grazing requirements and when the leopards share their forest habitats with domestic livestock there is inevitably some leopard predation on livestock. A study on leopard food habits by Arivazhagan (1998) suggested that livestock were the most abundant animals in the tropical thorn forest in Nilgiris and concluded that livestock was the major prey consumed by leopard in both disturbed and undisturbed habitats. According to Sawarkar (1989) livestock predation is recorded in all the Project Tiger Reserves irrespective of adequate wild prey availability in the forest. Schaller (1967) reported that leopards on the periphery of Kanha Tiger Reserve subsisted almost entirely on livestock. One of the studies by Edgaonkar and Chellam (1998) reported that the major prey species of leopard was found to be domestic dog, domestic buffalos and rodents in Sanjay Gandhi National Park (SGNP), Maharashtra.

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Arivazhagan *et al* (2007) found that livestock was one of the major prey in human dominated landscape. However, the extent of damage varies according to the area as Norton *et al* (1986) observed only 2 out of 258 leopard scats contained sheep or goat remains, in African landscapes, while, Mizutami (1993) found in a ranch in Africa, that the leopard killed on an average about 14.4% sheep and 3.7% cattle annually. This paper reports the findings of study on the food habits of leopard in the Nilgiri North Forest Division with the following objectives.

1. To assess the prey abundance and the food habits of leopard in the Nilgiri North Forest Division, Tamil Nadu, South India.

2. To assess the human leopard conflicts especially cattle lifting problem in the landscape.

3. To suggest management recommendations to resolve and manage the problem of leopards in the landscape based on the study.

Study Area

The study was carried out in Nilgiri North Forest Division which spreads over an area of 854 sq.km and located between 11°23'- 11° 35' and 76° 31' – 76° 58' E (see Fig.1). This division is comprising of a mosaic of vegetation types from montane-shola grasslands, to dry deciduous forests and dry thorn forests. It shares its boundary with Mudumalai Tiger Reserve on the north-west, and Moyar gorge on the northern side, Udhagamandalam town on the Southern side, Nilgiri South forest division on the South western side, Coimbatore forest division on the eastern side and Gudalur Forest Division on the western boundary. This division has seven forest ranges namely Udhagai North, Kattabettu, Segur, Singara, Nilgiri Eastern slope, Coonoor and Kotagiri forest ranges.

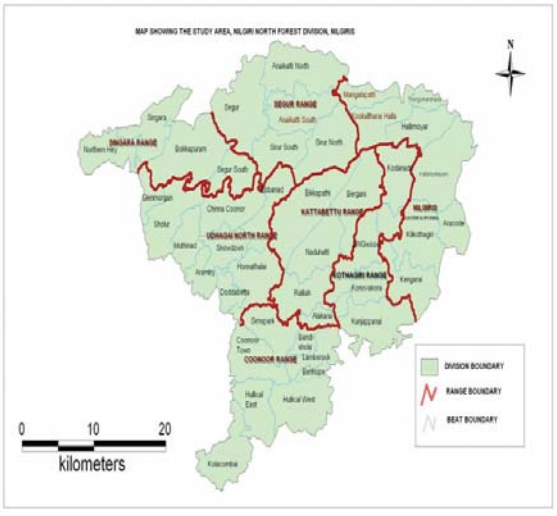

Figure 1. Map showing the study area of Nilgiri North Forest Division, The Nilgiris, Tamil Nadu, South India

The large mammalian fauna found in this division includes the Asian Elephant (*Elephas maximus*), Gaur (*Bos gaurus*), Sambar (*Cervus unicolor*), Chital (*Axis axis*), Blackbuck (*Antilope cervicapra*), Four-horned Antelope (*Tetracerus quadricornis*), Bonnet Macaque (*Macaca radiata*), Common Langur (*Semnopithecus entellus*), Indian Wild Boar (*Sus scrofa*) and Indian Porcupine (*Hystrix indica*). Mammalian predators of the present study area includes Leopard (*Panthera pardus*), Tiger (*Panthera tigris*), Asiatic Wild Dog (*Cuon alpinus*), Striped Hyena (*Hyaena hyaena*) and Jackal (*Canis aureus*). Other fauna of the study area include Blacknaped Hare (*Lepus nigricollis*), Common Palm Civet (*Paradoxurus hermaphroditus*), Jungle Cat (Felis chaus), Indian Peafowl (*Pavo cristatus*), Grey Jungle fowl (*Gallus sonneratii*), Python (*Python molurus*), Marsh Crocodile (*Crocodylus palustris*), Indian Star Tortoise (*Geochelone elegans*), Indian Black Turtle (*Melanochelys trijuga*),

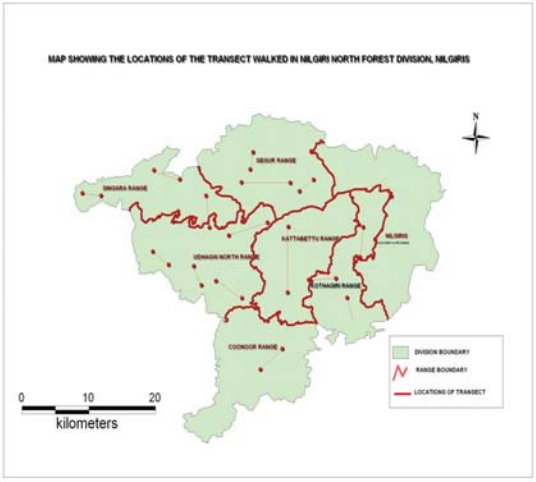

Figure 2. Map showing the distribution of transect walked for prey species assessment in the study area.

Leith's Softshell Turtle (*Aspideretes leithii*), Monitor Lizard (*Varanus bengalensis*) and endemic species such as Nilgiri Langur (*Semnopithecus johnii)* and Nilgiri Marten (*Martes gwatkinsii*).

MATERIALS AND METHODS

Prey Estimation

Prey abundance estimation was carried out by transect method followed by Arivazhagan 1997 (Encounter rate = Number of encounter of animal/ Total km walked). Third author of the paper and one Anti-poaching watcher (APW) had walked all the forest habitats during the study period (See Fig.2). Information such

as name of the species encountered, group size, No. of Km walked and GPS location of the each sighting of the animals were recorded while walking along the transect. The encounter rate of the prey base was assessed based on the data collected in each transect. Although the study site was larger in size, the study time was limited due to constraints in the project period. However data was collected in all the habitat types covering the seven ranges in the division.

Food Habits study

Food habit of leopard was examined by collection of leopard faeces (scat) to identify the prey items consumed by the predator. Intensive combing of the entire study area by foot by making use of the existing game roads, foot paths and cattle trails (Sunquist 1981 and Johnsing 1983, Venkatraman *et al.* 1995, Arivazhagan *et al.* 2007) was done for the collection of fresh scats. Intensive survey was made on daily basis in all the forest beats in the study area. Thirty one scats of leopard were collected from all the forest ranges of the division. The leopard scats were identified by its characteristic appearance and supplementary evidences in the form of track, scrapes and size of the scat (Karanth and Sunquist 1995). The leopard scats are usually smaller than the tiger's with characteristic constrictions and pointed tip.

The scats collected were air dried and kept in separate polythene bags with a label bearing information on date, place of collection, GPS location etc. All scats were soaked in water, washed and strained thoroughly to separate the prey remains like bones, hooves, hairs, quills, feathers etc. Samples of undigested hairs from the scats were washed in water; they were then dried and passed through Ether and Xylene (Koppiker and Sabnis, 1975). The hair remains of prey were used for species identification by following Mukherjee *et al.*(1994a,b). Those hair remains were then mounted on a slide in Xylene and examined under a binocular microscope for characteristic medullary patterns. The frequency occurrence of prey items was assessed randomly by a minimum of twenty hair samples from each scat (Mukherjee *et al.* 1994) to circumvent the possible biases (Karanth & Sunquist, 1995). A key given by Koppiker and Sabnis (1975) and Easa (1995) was also used for identification of prey species from the hairs found in the scats. The method described by Schaller (1967) was adopted to obtain the frequency of food items in the scats and their percentages were calculated.

The hair of prey species, which passes out undigested through the gut of predators, was the primary source of information for identifying the prey consumed (Sunquist,1981; Mukherjee, *et al.* 1994; Karanth and Sunquist, 1995). Prey species were identified based on microscopic features of the hair structure and remains of bones and teeth in comparison with reference collections at the Care Earth Field Station at Bhavanisagar. The identification was based on the general appearance of the hair, colour, relative length, relative width, texture, basal configuration, cortex pigmentation, medullary width and patterns as described by earlier workers (Putman, 1984; Karanth and Sunquist, 1995; Sujai, 2004, Arivazhagan *et al.* 2007).

Leopard – Human conflict

Leopard human conflict data were collected from the interviews of villagers. The secondary information such as, name of the village visited, location of the village, name of the person affected, species of domestic animals killed or injured by leopard, compensation claim, compensation paid, etc were collected from the forest department records. Apart from the above information, mortality of leopard, postmortem reports and conflict related information were also obtained from the forest department records.

RESULTS

Prey Estimation

In total, 37 transects of 207 km were walked in all the forest ranges of Nilgiri North Forest Division. During the transect walk, 10 species of mammalian fauna were encountered such as chital, sambar, gaur, balckbuck, blacknaped hare, common langur, nilgiri langur, bonnet macaque, malabar gaint squirrel and elephants. Among the prey species observed, bonnet macaque was frequently encountered (33%) followed by chital (21.6%), nilgiri langur (17.5%), gaur (8.6%), blackbuck (6.7%), sambar (5.4%) common langur (4.3%), blacknaped hare (0.9%) and malabar gaint squirrel (2.2%) (Table 1).

Prey abundance and biomass availability of prey were calculated from the occurrence of prey item in the scat samples and the live weight of the animal was calculated by adopting the Karanth and Sunquist (1995) method. This was used to arrive at the biomass of prey eaten by leopard (Table 2, Fig. 4). Among the biomass of

Table 1. Percent abundance of prey species encountered during the study period in the study area

Name of the Species	No. of Animals Encountered	Percent Abundance of Prey species	Mean Group Size	SD	SE	CV
Chital	116	21.6	5.8	3.2	72	55.8
Sambar	29	5.4	2.64	1.5	0.45	56.9
Blackbuck	35	6.5	7	6.5	2.9	93.1
Gaur	46	8.6	3.3	4	1.07	121.9
Bonnet Macaque	177	33.0	16.8	3.1	0.69	18.3
Common Langur	23	4.3	7.7	3.8	1.89	49.4
Nilgiri Langur	94	17.5	13.4	7.9	2.9	58.7
Indian Giant Squirrel	12	2.2	1.2	0.42	0.13	35
Blacknaped Hare	5	0.9	1.3	0.5	0.25	40

Table 2. Estimates of relative biomass of prey taken by leopard in the study area during the study period

Name of the Prey	Estimated (average) live weight[a] (Kg)	Relative frequency in scat	Relative Biomass[b] (Kg)
Sambar	62	32.26	2000
Chital	48	19.35	929.0
Barking Deer	22	9.68	212.9
Wild boar	38	6.45	245.2
Common Langur	8	3.23	25.8
Indian Porcupine	8	3.23	25.8
Blacknaped Hare	3	3.23	9.7
Domestic Dog	18	3.23	58.1

[a] – Approximate weights of prey species were calculated from Karanth and Sunquist (1995) except for domestic animals for which assumed weight of 18 kg is used.

[b]- Relative Biomass = Average weight X Relative frequency

prey consumed by leopard, sambar (2000kg) consisted the major diet of leopard followed by chital (929kg), barking deer (213kg), wild boar (245kg), common langur (26kg), porcupine (26kg) and blacknaped hare (10kg).

Scat study

Totally 31 scats were analyzed among which sambar (32.26%) was the most common prey of the leopard followed by chital (19.35%), barking deer (9.68%), wild boar (6.45%), common langur, porcupine, domestic dog constitute (3.23%) each and unidentified prey of 19.35% were recorded in the leopard diet (Table 3, Fig. 3). Though barking deer was not recorded or encountered during the prey estimation, still it constituted one of the preys of leopard especially in the upper part of the

Table 3. Frequency occurrence of different prey remains in the leopard scat

Name of the Prey	No. of scat	Frequency of occurrence
Sambar	10	32.26
Chital	6	19.35
Barking Deer	3	9.68
Wild Boar	2	6.45
Common Langur	1	3.23
Indian Porcupine	1	3.23
Blacknaped Hare	1	3.23
Domestic Dog	1	3.23
Unidentified	6	19.35

$$\text{Frequency occurrence} = \frac{\text{No.of scat in which prey items is found}}{\text{Total No. of scat examined}}$$

division. A significant test (Chi-squire test) showed that there is a significant difference between prey availability and prey consumed by leopard (X^2 = 371.04, df= 8, P<0.05).

Human – Leopard conflict

Data on leopard human conflict were collected from the forest department records from 2009 and 2010 (Fig. 5). There are about 11 incidents of cattle lifting by leopard during 2009 and 2010, of which 5 are cattle and 6 are goats in the division. During this period, Rs. 56,000/- was paid as compensation @ Rs.10,000/cattle and Rs.1000/goat. On the other hand, there are about ten incidents of leopard deaths recorded during 2009 and

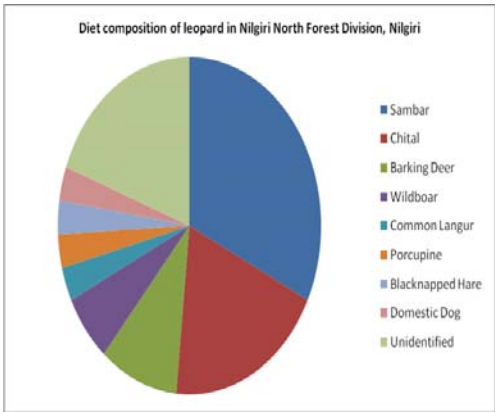

Figure 3. Diet composition of leopard in the study area during the study period (Values are present occurrences of different prey items in the scat).

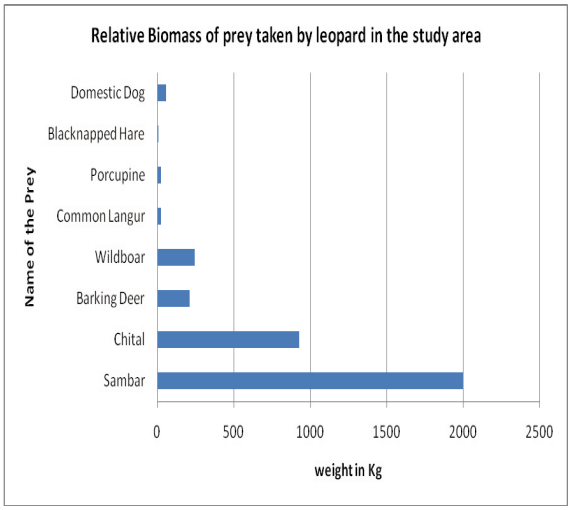

Figure 4. Relative Biomass of prey taken by leopard in the study area during the study period

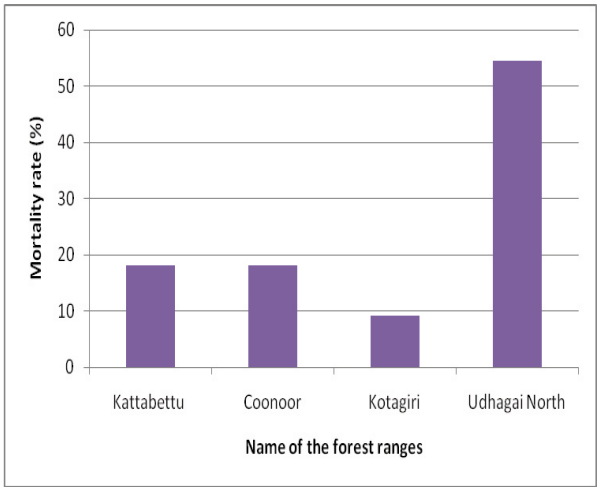

Figure 5. Percent livestock depredation by Leopard in the study area during 2009 and 2010

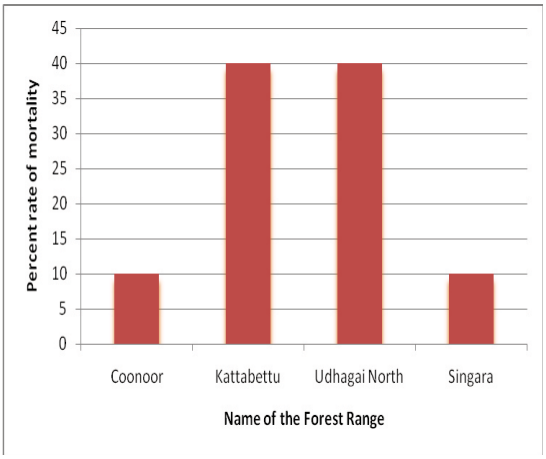

Figure 6. Percent mortality rate of leopards recorded across the forest range during 2009 and 2010

2010 across the division (Fig. 6). This clearly indicated the severity of leopard human conflict in the division

DISCUSSION

Prey Estimation and prey selection by leopard

Prey of leopard was estimated from the direct sighting of animals in the forest area of Nilgiri North Forest division. The prey base study indicated that bonnet macaque was encountered more (n=177), followed by chital (n= 119), nilgiri langur (n=94), gaur (n=46), blackbuck (n=35), sambar (n=29), common langur (n=23), malabar gaint squirrel (n=12) and blacknaped hare (n=5). Though arboreal mammals are found in more number, the dietary analysis showed that ungulates are the most preferred prey of leopard in the study area. Andheria *et al.* (2007) found that 88-97% of biomass consumed by the predator was ungulates. The finding of the present study further confirmed this as ungulates constituted a major portion of leopard diet in the study area.

Most of the studies concluded that leopard preying on chital was more (Johnsingh, 1983, Karanth and Sunquist, 1995, Arivazhagan *et al.* 2007, Andharia et al 2007). But the present study showed that sambar constituted the major prey (32.26%) followed by chital (19.35%). There is a reason to believe that chital was not found in all the habitats of the study area, as their distribution is restricted only to the low altitude area viz. Segur, Singara and Nilgiri Eastern Slope forest ranges, whereas, the leopard was found to be dependent on the sambar, barking deer and arboreal prey in the upper plateau. Similarly, Sathyakumar (1988) found that the sambar was major prey of leopard in the Mundanthurai plateau and attributed this to the fact that both the leopard and sambar are nocturnal animals and the leopard as stalker could easily kill sambar. Leopards are opportunists and are very flexible in their diet, and can thus survive in a region where the chital and other ungulates are completely absent or low in numbers. Arivazhagan (1998) in his study also observed amphibian and reptilian remains in the leopard scat, suggesting that leopards can survive on any type of prey. Johnsingh (1983) observed that leopards are able to feed on both small and large prey, and their ability to climb trees and scavenge may help them survive in a highly disturbed habitat where preys are scarce. Rice (1986) found that sambar was the most preferred prey of leopard followed by Nilgiri Tahr (*Nilgiritragus hylocrius*) in Eravikulam National Park, where Nilgiri Tahr was more abundant than sambar. Easa (1995) also confirmed the same, that leopards in Eravikulam National park are more dependent on sambar than Nilgiri Tahr though the Nilgiri Tahr was more abundant than sambar.

The result of the prey availability and prey consumed by leopard was compared using chi-squire test of significance. The test showed that there is a significant difference in the prey availability and prey eaten by leopard. The results of the present study suggested that leopards are very flexible in their diet; no matter what is available they feed upon for survival. To support that we have an evidence that domestic dog (3.5%) remains were found in one of the leopard scat. similarly Ramakrishnan *et al.* (1999) also found that (6.5%) of the leopard diet is domestic dogs. Apart from the above, other smaller prey like common langur, porcupine and blacknaped hare each constituted 3.5% of the leopard diet in the study area. Thus the preference of a prey by leopard is depends on the availability of prey in that area and chances of encountering them.

Human leopard conflict

The secondary Information on the leopard human conflicts shows that the leopard frequently preyed upon domestic livestock (4 cattle and one goat) in the division. But there is no incidence of human causality by leopard

in recent days. Arivazhagan (1998) recorded about six human deaths and injuries and twenty cattle killed by leopard during 1992-1998 in the lower plateau of the study area. Human animal conflict is an inevitable problem where humans are living close proximity to forest. As Sawarkar (1989) pointed out that when large cats live in proximity to humans, some amount of conflict at the border of the park is unavoidable and this usually takes the form of cattle killing by the predator. But the extent of cattle killing in the study area was somewhat extraordinary and seemed to be the outcome of human interference in the natural areas of leopards. Man-eating by leopards was also another cause of concern. Schaller (1967) mentioned that leopards eat man occasionally and humans on the whole did not contribute significantly to the leopard's diet as human causalities are expected to be rare and due to the result of accidental encounters.

Daniel (1996) pointed out when a leopard becomes a man-eater, it could be more dangerous than the tiger because of its boldness and cunning behaviour in entering villages to kill human prey. Corbett (1981) reported that the famous man-eating leopard of Rudraprayag claimed more than 125 victims from 1918 to 1925 before it was shot. According to Arivazhagan (1998) six incidents of human death and injuries by leopard is a direct evidence to altered behavior caused by villager's interferences into their natural habitats in the form of wood cutting , cattle grazing and hunting of wild prey illegally. This is one of the prime reasons for the leopard human conflicts in that area. But the present study suggested that fragmentation of habitat and stiff competition faced by the wild ungulates from the cattle for grazing inside the reserve forest resulted in the killing of livestock in the study area. Based on the present study following management recommendations are suggested.

1. Long-term study on prey and predator population in the division is needed, since the division is interspersed with large stretch of human dominated area. This will give a better understanding of prey-predator relationship and useful information for managing viable populations of wildlife in the landscape.

2. Anthropogenic pressure such as cattle grazing, wood cutting etc should be restricted.

3. Translocation of leopard (problematic animals) from one place to other place is not a permanent solution, which is nothing more than transferring problem from one place to another place. Because younger animals will occupy the vacuum created by the captured individual.

4. If translocation is the only choice, the proposed area should be thoroughly studied, especially on the existing leopards and tigers in that area. If that area already has a good number of leopards and tigers, translocation of newer leopard may lead to territorial fight.

5. It is important that the forest department's field staff, public and the media are made aware of the complexities of the conflict issue so that the spontaneous and often arbitrary demand for trapping of leopards may be reduced.

REFERENCE

Arivazhagan, C. 1998. A study on the food habits of leopard *Panthera pardus fusca* in the Sigur Reserve forest Nilgiri District and Thalamalai Reserve Forest, Erode District of Tamilnadu, southern India, with special reference to Human- Leopard conflicts. M.Phil thesis submitted to Bharadhidasan University, Trichy.

Arivazhagan,C, Arumugam, R., and Thiyagesan, K. 2007. Food habits of Leopard (*Panthera pardus fusca*), Dhole (*Cuon alpines*) and Striped Hyaena (*Hyaena hyaena*) in Tropical dry thorn forest of southern India. *J. Bombay Nat. Hist. Soc.*, 104: 178-187.

Andheria, A.P., Karanth, K.U and Kumar, N.S. 2007. Diet and prey profiles of three sympatric large carnivores in Bandipur Tiger Reserve, India. *J. Zool.*, 273: 169-175.

Bailey, T.N. 1993. *The African leopard. Ecology and Behaviour of a solitary felid*. Columbia University Press, New York. P. 429.

Bothman, J.DUP. and LE Riche, E.A.N. 1984. Aspects of the ecology and the behaviour of the leopard Panthera pardus in the Kalahari Desert. Koedoe Suppl. 27: 259-279.

Chellam, R 1993. Ecology of the Asiatic lion *Panthera leo persica*. Ph.D. thesis, Saurashtra University. P. 183.

Corbett, J. 1981. *The Man-eating leopard of Rudraprayag.* Oxford Unv. Press, New Delhi.

Daniel, J.C. 1996. *The leopard in India – A natural history.* Nataraj Publishers, Dehradun.

Easa, P.S. 1995. Prey predator studies in Eravikulam National Park, KFRI Research Report No.105, Peechi, Kerala.

Edgaonkar, A.J. and Chellam, R. 1998. A preliminary study on the Ecology of the leopard (*Panthera pardus fusca*) in the Sanjay Gandhi National Park, Maharashtra RR-98/002, August 1998, Wildlife Institute of India, Dehradun. P. 33.

Eisenberg, J.F. 1986. Life history strategies of the felidae: Variations on a common theme. *In:* S.D.Miller and D.D. Everett (eds), *Cats of the World: Biology, Conservation and Management*, National Wildlife Foundation, Washington, D.C.

Hoppe-Dominik, B. 1984. Etude du spectre des proies de la panther *Panthera pardus,* dans le Parc National de Tai e Côte d' Ivoire. *Mammalia,* 48: 477-87.

Hamilton, P.H. 1976. The movements of leopards in Tsvo National Park, Kenya, as determined by radio-tracking. M.Sc., thesis, University of Nairobi.

Johnsingh, A.J.T. 1983. Large mammalian predators in Bandipur. *J. Bombay Nat. Hist. Soc.*, 80: 1-57.

Kitchener, A. 1991. *The Natural History of the Wild Cats*. Christopher Helm, A & C Black, London. P. 279

Koppikar, B.R. and J.H. SABINS. 1975. Identification of Hairs of some Indian mammals, *J. Bombay Nat. Hist. Soc.*, 73:5-20.

Karanth, K.U. and Sunquist, M.E. 1995. Prey selection by tiger, leopard and dhole in tropical forest. *J. Anim. Ecol.*, 64:439-450.

Karanth, K.U. and Sunquist, M.E. 2000. Behavioural correlates of predation by tiger (*Panthera tigris*), leopard (*Panthera pardus*) and dhole (*Cuon alpinus*) in Nagarhole, India. *J. Zool. Lond.*, 250: 255-265.

Lal, J.B. 1989. *India's forests: myth and reality*. Nataraj Publishers. Dehradun.

Mizutami, F. 1993. Home range of leopards and their impact of livestock on Kenyan ranches, *Symp. Zool. Soc. Lond.*, 65:425-439.

Muckenhirn, N. and Eisenberg, J.F. 1973. Home ranges and predation in the Ceylon leopard. Pp. 142-175. In: (Ed: Eaton, R.L.) *The World's Cats. Vol. 1: Ecology and Conservation*. World Wildlife Safari, Winston, Oregon.

Mukherjee,S., Goyal., S.P. and Chellam, R. 1994a. Refined techniques for the analysis of Asiatic Lion *Panthera leo persica* scats. *Acta Theriol.*, 39: 425–430.

Nowell, K. and Jackson ,P. (EDS.) 1996. Wild Cats. Cat Specialist Group. IUCN/SSC Report, Geneva. P. 97-99.

Prater, S.H. 1971. *The Book of Indian Animals*. Oxford University Press, P. 324 Bombay.

Putman, R.J. 1984. Facts from faeces. *Mammal Rev.*, 14:79–97.

Rice,C.C.1986. Observations on predators and prey at Eravikulam National Park, Kerala. *J. Bombay. Nat. Hist. Soc.*, 83: 283-305.

Ramakrishnan, U., Richard,G. C. and Neil, W. P. 1999. Tiger decline caused by the reduction of large ungulate prey: evidence from a study of leopard diets in southern India. *Bio.Cons.*, 89: 113-120

Sathyakumar, S. 1992. Food habits of leopard (*Panthera pardus*) on Mundanthurai plateau, Tamil Nadu, India. *Tiger paper*, Vol. XIX: 8-9.

Schaller, G.B. 1967. *The Deer and the Tiger. A study of Wildlife in India*. University of Chicago Press. Illinois, P. 370.

Sunquist, M.E. 1981. The social organization of Tigers (*Panthera tigris)* in Royal Chitwan National Park. *Smithsonian Contrib. Zoo.*, 536:1-98.

Sujai, R. 2004. Diet profile of three large sympatric carnivores in Central India. MSc thesis. Bharathidasan University,Tamil Nadu, India. 858-866.

Sawarkar, V.B. 1989. Animal damage: predation on domestic livestock by large carnivores. *Indian Forester*, 112 : 85.

Venkatraman, A.B., Arumugam, R and Sukumar, R. 1995: The foraging ecology of dhole (*Cuon alpinus*) in Mudumalai Wildlife Sanctuary, Southern India. J. *Zoo. Lond.*, 237: 543-561.