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An assessment of status of small carnivore species and feeding ecology of large carnivores in Biligiri Rangaswamy Temple Wildlife Sanctuary

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Karnataka Forest Department
Government of Karnataka

Sálim Ali Centre for Ornithology and Natural History

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Submitted to Karnataka Forest Department

Chamarajanagara

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Executive summary

Small carnivore species: Among 10 small carnivore species known from BRT WLS, we recorded nine species during this study *viz.* Jungle cat *Felis chaus*, Rusty spotted cat *Prionalilurus rubiginosus*, Leopard cat *Prionalilurus bengalensis*, Small Indian civet *Viverricula indica*, Asian palm civet *Paradoxurus hermophroditus*, Striped-necked mongoose *Herpestes vitticollis*, Ruddy mongoose *H. smithii*, Common mongoose *H. edwardsi* and Smooth coated otter *Lutra perspicillata*. The only species that was not recorded was Malabar civet *Viverra civettina*. Jungle cat and rusty spotted cat were recorded in drier forests including dry deciduous and scrub forests of the foothills, whereas the leopard cat was recorded only in moist deciduous forests. Among the three species of civets, Malabar civet was earlier reported from the high elevated areas of the hills with evergreen forests. In the present study we were unable to get any information on this species; however, we suggest a proper exploration for the species in the estates and surrounding areas of the hills. Other two species were generalist species found in all the altitude and forests types, however, the Asian palm civet was recorded in association with good forest cover. Smooth coated otter was recorded from all the reservoirs around the sanctuary, often it was sighted at back waters of Suvarnavathi reservoir in small groups of two to three individuals. Among the three mongoose species found in the sanctuary, the stripe-necked mongoose was recorded from dry deciduous forests to shola forests, but predominantly in high elevation rather than low elevation forests, whereas common mongoose was more common in scrub, deciduous and moist deciduous forests of the sanctuary. But, surprisingly ruddy mongoose was recorded mostly from mid elevation and moist deciduous and evergreen forests. Habitat type and openness in each habitat type have highly influenced the presence and abundance of each species of small carnivores in the sanctuary. Among all the species, Asian palm civet was more abundant which was followed by small Indian civet. Compared to many other forests or regions in India, the sight record of rusty spotted cat was relatively good here. During our entire study we had 13 detections which may be due to the extensive sampling effort.

Ecology of large carnivores: Out of total scats of tiger (n=41), 59% of the scats had only one species and 36% species had two species and only 5% of the scats had more than two species. The major prey species include gaur, sambar, chital, wild pig, muntjac, four horned antelope,

Indian hare and domestic cattle, and also some other small mammals and birds. The tiger has preyed on various body sized prey species, analysis shows that there is a high preference for large body sized prey species over the small body size prey species. The wild prey species constituted 90.02% and remaining 9.98% was livestock especially domestic cattle. Of the wild prey species, sambar constituted 36.66% followed by gaur (23.33%), chital (15.00%), wild pig (10.00%), cattle (8.33%), muntjac (3.33%) and 1.66% each four horned antelope and hare. Gaur and sambar were observed to be the principal prey species for tigers in BRT WLS as reflected by the percentage occurrence of prey remains in scats. Gaur and sambar also contributed to the highest biomass of prey consumed by the tiger. On the other hand, the relative occurrence of chital in tiger scat was very low in BRT WLS when compared to Kanha, Bandipur and Nagarahole. This is probably due to very low density of chital in the BRT WLS. Though the density of Gaur and sambar remained almost same as in Bandipur and Nagarahole, the tiger might be more dependent on these two species where there is low density of chital.

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Chapter 1

Introduction, objectives and methods

Introduction

The Biligiri Rangaswamy Temple Wildlife Sanctuary (BRT WLS) lies between 11˚ 40´-12˚ 09´ N and 77˚ 05´-77˚ 15´ E, with an area of 540 sq. km (Fig.1.1). Presently the sanctuary is a part of the newly framed Chamarajanagara district of Karnataka. Biogeographically, the sanctuary is located at the easternmost edge of the Western Ghats, and between 11˚ and 12˚ N, its North-South running chain meet the hills of the Eastern Ghats at 78˚ E. Hence, the sanctuary has been considered as a living bridge between the Eastern and the Western Ghats (Ganeshaiah and Uma Shankar, 1998). The altitude varies from 600 m to 1800 m AMSL. The wide range of climatic conditions also contribute to heterogeneous assemblage of habitats such as scrub, deciduous, riparian, evergreen, sholas, and grasslands.

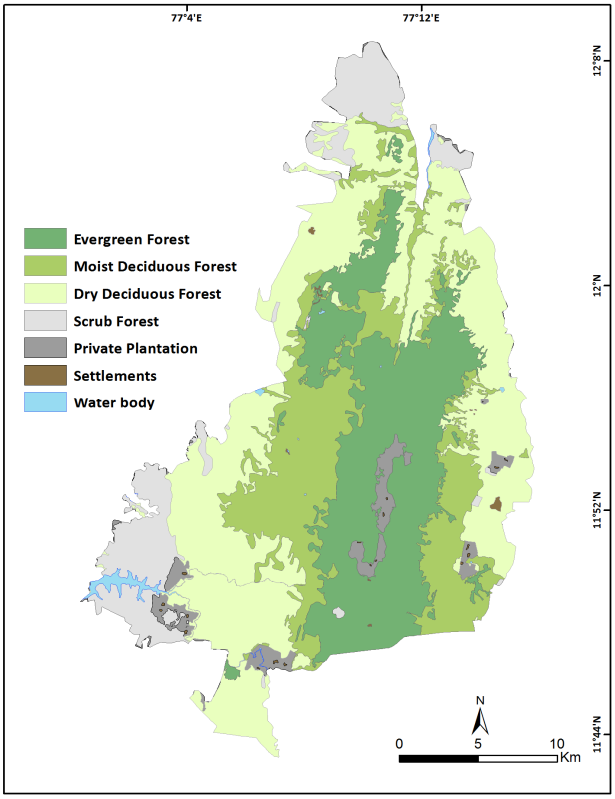

Figure 1.1 Vegetation map of the BRT WLS

The sanctuary is rich in flora and fauna due to high variation of altitude and consequently wide array of vegetation types available. Most of the studies in the sanctuary have been focused on flora, forest structure and forest-people interactions (Ramesh, 1989; Hegde et al, 1996; Shankar et al, 1996; Murali et al, 1996, 1998; Uma Shankar et al, 1998, 2004; Ganeshaiah et al 1998; Bawa et al, 1999; Murali and Setty, 2001; Setty et al, 2001;Ganesan and Setty, 2004), at the taxa level, only couple of sight records of birds and importance of the birds in the sanctuary are attempted (Karthikeyan, et al, 1995; Aravind et al, 2001; Islam and Rahmani, 2004; Srinivasan and Prashanth, 2005, 2006). Recently Zoological Survey of India, Kolkata came up with the documentation of fauna of all the major taxa for the sanctuary (Editor-Director, 2006), however, the information was restricted to checklist level for most of the taxa. From the body of available literature it appears that the scientific knowledge on taxa like amphibians, reptiles, birds and mammals are inadequately documented in the sanctuary.

Paucity of baseline data on higher taxa in the sanctuary has led to initiation of a series of scientific studies. As a first phase of this, the distribution and abundance of large mammals, density of large prey species and density of elephants were established. The study highlighted availability of large prey base (especially gaur and sambar) in the sanctuary. Though the complex of Nagarahole, Bandipur, Mudumalai, BRT WLS and Satyamangala forests are one of the largest stretches of contiguous forests holding largest population of tiger in the wild, the estimate for tiger and its ecology is not available for BRT WLS. Not only the tiger but even the status and ecology of other predators and small carnivores had not been studied. During initial phase of this study, we encountered many lesser known small carnivore species, which has made us to believe that the sanctuary holds many of such species. This prompted us to propose a study on small carnivores in the sanctuary. Accordingly, the project titles "**An assessment of status of small carnivore species and feeding ecology of large carnivores in Biligiri Rangaswamy Temple Wildlife Sanctuary**" was taken up with assistance from the forest department.

Objectives

The major focus of the study was to understand the types of small carnivore species present and to check for their habitat preferences. The second objective was to study the prey composition of the large carnivore species in the sanctuary. Further, in addition to this, our aim was to carry out

capacity building at local management level, typically for the frontline staff so that they could learn the skill of using camera traps.

Methods

Day surveys:

Number of transects was decided based on the vegetation types available in the sanctuary using GIS based administrative boundaries and vegetation maps. A total of 33 random line transects were laid, which represented all the forest types, altitudinal gradients and administrative units of the sanctuary. The length of transects were kept between 2 to 4 km totaling 93 km and each of them was walked a minimum of five times and maximum of eleven times between 06.00 to 10.00 hrs and 16.30 to 18.30 hrs. Transects were walked during a period of seven months from October 2009. The total kilometers walked on transect lines was 795.5 km.

During the transect walks, for every sighting of the animal, data related to name of the species, number of individuals, animal to observer distance and angle of the detection from main bearing were collected. Observer to animal distance was measured using OPTI-LOGIC 1000 XL and OSPREY rangefinder and the angle of the detection from the line was collected using a compass. The coordinates were recorded for each sighting using GARMIN eTrex H and GARMIN 72 GPS units. Species identification was made using Prater (1971).

Night surveys:

Some of the species which are strictly nocturnal by nature, and hence could not be assessed during the day transect walks; hence we conducted night surveys to find the abundance (relative encounter rate –animals per km) of such species in the sanctuary. We selected existing motorable roads in the sanctuary and each road was traveled consecutively for two days between 19.00 to 24.00 hrs. During this exercise the jeep was driven at a speed of 10 km/hr, and an observer sitting atop on the jeep used a flash light connected to the jeep to sight the nocturnal animals. Once the animal was spotted by an eye shine, it was differentiated based on the colour of the reflection from eyes, distance between the eyes and size; if the animal was far from the observer then a binocular was used to identify the species. The distance covered was documented using the vehicle odometer or known distance of each route. The abundance of nocturnal animals was

presented as encounter rate (animals/km). A total of 462 km of sampling was done during the night.

Further, the minimum administrative unit of the sanctuary is a beat. We considered this as the smallest unit for the study and explorations. In each beat a walk was made both during the day and night, to ensure the detection of both diurnal and nocturnal species. During this exercise, presence information on all the lesser small carnivore species was recorded. In addition to this habitat type and terrain were also recorded.

Since the detection rates of some of the species were less; the camera traps were deployed to enhance our detection of a species. The digital map of the park was taken in the GIS software, and 2 sq km grids were overlaid on the sanctuary. Since the mid-section of the sanctuary is highly elevated, and all-around there is a slope and foothills with scrub or dry deciduous forests, a stretch of grids from west to east representing all types of the forests in the sanctuary were selected for the sampling. In each grid, 9 to 10 camera traps were deployed at a regular interval at the rate of one trap per 20 ha. We used digital camera traps, with a battery backup for ten days and 4GB memory card. Location of the traps was fixed based on the recent usage of the area which was decided based on the animal trail or tracks showing recent movement of animals, near old scats or den sites. Camera traps were left for three days in each site with a dry fish baits to lure the animals towards camera traps to increase the detection rate. Each trap was checked every day and images were downloaded in a folder with identity of the grids and geo-coordinates. Habitat covariates such as tree DBH, number of fallen logs, tree stumps, presence of cattle dung and general habitat type were also collected for each site and also at the level of grid. A total of 41 grids were covered and the total camera trap nights were 328.

We adopted non-invasive methods to study feeding ecology of large carnivore species. Systematic search was made to collect the scats in each beat, once the scat was noticed, a small quantity of scat was collected and stored in clean plastic containers, and also other variables were recorded like coordinates, location characteristics, species name, and other evidences for the species identification. The diet of carnivores was assessed using the hair remains of the animals in the scat, by referring to Mukherjee et al. (1994).

Organization of report

Chapter 1 has provided the background for the study, objectives of the study and brief methods that we have followed to address the proposed objectives. We have discussed and introduced the small carnivore species found in the sanctuary in Chapter 2. The abundance of the small carnivore species and the factors influenced the abundance in the sanctuary are discussed in the Chapter 3. Chapter 4 discusses the feeding ecology of tiger in the sanctuary.

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Chapter 2

Small carnivores of Biligiri Rangaswamy Temple Wildlife Sanctuary

Mammals of the families Felidae, Viverridae, Herpestidae, Mustelidae and Procyonidae are generally called as small carnivores. This category excludes Family Canidae. About 37 species of small carnivores are reported from India. They belong to the families Felidae (cats), Viverridae (civets, linsangs and binturong), Herpestidae (mongooses), Procyonidae (Red Panda) and Mustelidae (otters, martens, weasels, and badgers).

Karnataka state may have 16 to17 species of small carnivores, being a highly diverse group of mammals. Small carnivores occupy a variety of habitats ranging from dry plains, thick evergreen forests to coastal plains. They play an important role as pest controllers, prey base for many animals, seed dispersers and pollinators. Some of them are also known to kill domestic fowl, and hence they are considered as pests. Most species have similar food habits, feeding mostly on invertebrates, amphibians, reptiles, birds and small mammals. Although they are called carnivores, some of them also feed on fruits and seeds. Many of them are nocturnal in habit, solitary in nature, small in body size and occupy habitats with thick vegetation. Such cryptic nature of these animals made it difficult to study them, and as a result, we know little about them. There are no detailed studies from Karnataka on any aspect of small carnivores. This is true also for other regions of India, as well as other parts of the world. However, few studies have been initiated in recent years to document the ecological aspects of these species in peninsular India (Mukherjee 1989; Mudappa 2001; Rajamani et al. 2003; Mukherjee et al. 2004). Other than these studies, most of the information on these animals comes from anecdotes or sight records, which no doubt, have significantly contributed in understanding the distribution and comparative status of these species.

In the first phase of study of mammals in BRT WLS, we documented all sightings of small carnivores during the surveys which led to the second phase of the study with more focus on the small carnivore species. In the present chapter we introduce the small carnivores known from the study area and the species recorded throughout the study period.

Small carnivore species:

We prepared a list of small carnivore species might occur in the BRT WLS based on nominal distribution as projected by Prater (1971). Among 10 small carnivore species known from BRT WLS, we recorded nine species of them during this study *viz*. jungle cat *Felis chaus*, rusty spotted cat *Prionalilurus rubiginosus*, leopard cat *Prionalilurus bengalensis*, small Indian civet *Viverricula indica*, Asian palm civet *Paradoxurus hermophroditus*, striped-necked mongoose *Herpestes vitticollis*, ruddy mongoose *H. smithii*, common mongoose *H. edwardsi* and smooth coated otter *Lutra perspicillata*. The only species that was not recorded was Malabar civet *Viverra civettina*. Local people during our interaction revealed the presence of civet with a tail having less fur and peach coloured tip at coffee estate at higher altitude in the sanctuary. This is more a characteristic of brown palm civet, which is found in forests of Western Ghats. However, during the survey we were unable to sight it.

Table 1 Small carnivore species of the BRT WLS

Species	**IUCN status**	**Forest ranges**				
		K. Gudi	**Yelandur**	**Punjur**	**Bylore**	**Kollegal**
Jungle cat (*Felis chaus)*	LC	P (3)	P (1)	P (3)	P (1)	P (1)
Leopard cat (*Prionalilurus bengalensis)*	LC	P (3)	P (1)	P (3)	P (3)	P (1)
Rusty spotted cat (*Prionalilurus rubiginosus)*	VU	P (1)	P (1)	P(1)	N	N
Small Indian civet (*Viverricula indica)*	LC	P (1)	P (1)	P (1)	P (1)	P (1)
Asian palm civet (*Paradoxurus hermophroditus)*	LC	P (1)	P (1)	P (1)	P (1)	P (1)
Malabar civet (*Viverra civettina*)	CR	N	N	N	N	N
Stripe-necked mongoose *(Herpestes vitticollis)*	LC	P (1)	P (1)	P (1)	P (3)	P (3)
Common mongoose (*H. edwardsi)*	LC	P (1)	P (1)	P (1)	P (1)	P (1)
Ruddy mongoose (*H. smithii)*	LC	P (1)	P (1)	N	N	P (1)
Smooth coated otter (*Lutra perspicillata*)	VU	P (1)	N	P(1)	N	P

Jungle cat (*Felis chaus*)

Jungle cat is relatively larger in body sized animal when compared to the rusty spotted cat, with short tail, and is known to prefer open canopy forests with water bodies. This one of the most common species of small carnivores found to occur in the State. They occur at all altitudes ranging from the coast to high altitudes of the Western Ghats. Further, they occupy most of the habitat types varying from coastal habitat, evergreen forests of the Western Ghats to dry plains. Kumara and Singh (2007) reported one sighting from Pushpagiri Wildlife Sanctuary, twice in Nugu, five times in Tumkur, once in Kolara and once in the Chamundi hill near Mysore. They reported that most of the sightings were close to some water bodies or in the croplands. In BRT WLS all our records were at foot hills with open canopy forests.

Leopard cat (*Prionalilurus bengalensis*)

Leopard cat has been reported to occur in some reserves of Karnataka (Karanth 1986). Kumara and Singh (2007) reported a total of eleven sightings during their survey in Karnataka: five in Sharavathi Valley Wildlife Sanctuary, two each in Bandipur National Park and Talakavari Wildlife Sanctuary, and one each in Pushpagiri Wildlife Sanctuary and in a coffee estate in Virajpet adjacent to Brahmagiri Wildlife Sanctuary in Kodagu district. The animal in the coffee estate was seen among bushes, along the fence of the estate. Local information revealed that

leopard cats are quite common in Kodagu. The species is found to occur along the forests of the Western Ghats, and adjacent deciduous forests. No information was available from the drier plains of the state. It has also been sighted on the fringes of a coffee estate adjacent to Bhadra Wildlife Sanctuary in Chikmagalur. Leopard Cats have often been recorded in evergreen forests and adjacent croplands in the Kalakkad-Mundanthurai Tiger Reserve (Mudappa 2002) and Indira Gandhi Wildlife Sanctuary (Kumar et al. 2002). The present record in BRT WLS is first record for this region. The animal was sighted in moist deciduous forests of the sanctuary.

Rusty spotted cat (*Prionalilurus rubiginosus*)

Rusty spotted cat is one of the smallest cats in the world and the species is known to be arboreal and nocturnal (Nowell and Jackson 1996). Kumara and Singh (2007) reported three sightings from the state during their survey which includes one animal in Nugu, one in Bandipur National Park and one in Sira of Tumkur. The species also have been reported from Andhra Pradesh (Rao et al. 1999) and drier forests of Kalakkad-Mundanthurai Tiger Reserve in Tamil Nadu (Mudappa 2002). Mudappa (pers. comm.) also reported its occurrence in Indira Gandhi Wildlife Sanctuary in Tamil Nadu. Karanth (1986) considers southern plateau as a nominal distribution range of this species. Kumara and Singh (2007) reported the recovery of one skin from the outskirts of

Bangalore city. During the present survey the species was recorded from open scrub and dry forests of BRT WLS especially at foot hills of the sanctuary.

Small Indian civet (*Viverricula indica*)

The Small Indian Civet is highly terrestrial and is found to occur in various habitat types. The species is widely distributed in Karnataka (Kumara and Singh, 2007). The habitats range from coastal plains to wet evergreen forests, deciduous forests, dry scrub and rock dominated dry forests. They occur at altitudes ranging from <50 m to 1,400 m above msl. Kumara and Singh

(2007) reported sightings of 13 animals during their study in the state, one animal each in Brahmagiri-Makut, Bandipur National Park and Nugu Wildlife Sanctuary, five animals in Nagarahole National Park, three animals in Tumkur district and one each in Kolar and Chikmagalur districts. The sightings varied from crop fields in the drier plains to evergreen forests of the Western Ghats. During the present survey we have recorded the species from BRT WLS.

Asian palm civet (*Paradoxurus hermophroditus*)

Asian Palm Civet is found in most of the forest types including coast to dry plains, except in high altitude evergreen forests. It is capable of adapting to various habitats, forest types, including living in townships. They have often been observed to breed in house roofs in coastal plains and also in dry plains (such as Bidar district with little forest). However, they are very rare or absent in areas completely bare and without any vegetation. Kumara and Singh (2007) reported sightings 32 animals during their survey. They have recorded the species in variety of habitat types in Bandipur and Nagarahole. In the present study, the species has been recorded from the entire sanctuary including wet forests to dry scrub forests.

Malabar civet (*Viverra civettina*)

The species is extremely rare, and is listed under 'Schedule I' of the Indian Wildlife (Protection) Act and 'Critically endangered' in IUCN Red list. The only information available on this species is 'a possible sighting in Kudremukh (Karanth 1986). A later survey (Rai and Kumar 1993) also revealed a 'possibility of occurrence' along certain regions of the Western Ghats in Karnataka. The only evidence of its occurrence in its distributional range is the recovery of two skins from Nilambur in northern Kerala (Ashraf et al. 1993). According to Rai and Kumar (1993), Malabar Civets probably occur widely in Karnataka due to the presence of extensive lowland forests along the Western Ghats. There is also a record of possible occurrence of the species from the forests in high elevation areas of the sanctuary (Nandini and Muddapa, 2010). However, during our present survey we did not get any information on the species.

Stripe-necked mongoose (*Herpestes vitticollis*)

Stripe-necked Mongoose occurs in evergreen forests of the Western Ghats and adjacent dry deciduous forests in the State. Kumara and Singh (2007) reported the sighting 12 animals in Nagarahole, five in Bandipur, and four in Talakaveri Wildlife Sanctuary during their survey. They have been frequently sighted in Bhadra. All sightings reported were during the daytime, especially in the early mornings and late evenings. It appears that Stripe-necked Mongoose is more common than other mongoose species in deciduous forests like Nagarahole and Bhadra. In

the present study the species was recorded from lower elevation dry forests to higher altitude wet forests.

Common mongoose (*H. edwardsi*)

Common mongoose is one of the common animals in the open countryside in India. In Karnataka, they are found in coastal plains, disturbed evergreen forests and dry plains. However, they may be rare or even absent in high altitude rain forests. Kumara and Singh (2007) reported sightings of two animals each in Tumkur, Nugu and Chikmagalur, three in Bandipur National Park, four in Mysore, and one in Bangalore during their survey. They also report no sightings in-spite of the vigorous efforts in evergreen forests of the Western Ghats and deciduous forests of Nagarahole. The sightings of the species were very frequent at foot hills of the BRT WLS, especially at scrub and deciduous forests, however, animals were also recorded from moist deciduous forests of the sanctuary.

Ruddy mongoose (*H. smithii*)

Ruddy Mongoose was reported to occur in dry forests and forests with rocky outcrops, with scrub forests to moist deciduous forests, and are absent in completely barren areas and costal Karnataka (Kumara and Singh, 2007). They reported the sightings of five animals in Nagarahole, three in Bandipur National Park, one each in Hasanur forests in Chamarajnagar and Savandurga forests in Magadi of Bangalore district, and six in Daroji Bear Sanctuary in Bellary district. All sightings were in dry forests or rocky areas. Animals are also sighted frequently in Bhadra and Bandipur (Karanth 1986, 1988). The ruddy mongoose was also recorded from the sanctuary from scrub forests at foot hills to moist deciduous forests at mid elevation in the hills.

Smooth coated otter (*Lutra perspicillata*)

Among three species of otter found in southern India, smooth coated otter is one of the common species found in reservoirs, rivers and streams in the plains. Kumara and Singh (2007) reported the sightings of otters from Cauvery River near T. Narasipura (three animals) and at Sangama near Cauvery Wildlife Sanctuary (one animal). However, the otters are known to occur in Bheema, Krishna, Ghataprabha, Malaprabha, Tunga, Bhadra, Hemavathi, Kapila, Cauvery rivers and many reservoirs. However, the habitats of the species are little explored in the state. During the present study, we recorded the animals from Suvarnavathi and Gundal reservoirs.

Food of small carnivores:

All these small carnivore species usually feed on small sized prey species, however the preference vary between the species. Though all the cats feed on small mammals, birds, reptiles and amphibians, the high preference goes to mainly rodents, especially rats. Jungle cat also often feeds on domestic fowl and also fish, whereas the leopard cat is known to feed on insects. All the mongoose species are known to feed on rodents and other small mammals, birds, bird's eggs, reptiles, fish, insects and roots. Ruddy mongoose and stripe-necked mongoose are often seen feeding on carcasses whereas common mongoose is known to feed on fruits. Both Asian palm civet and small Indian civets are known to feed on rodents, lizards, insects and small birds, but Asian palm civets largely feed on various types of fruits than small Indian civet. Smooth coated otter is known to feed largely on fishes.

Other small mammals:

Apart from above mentioned small carnivore species, we also recorded many other small mammals from the sanctuary viz. slender loris, Bengal fox, white spotted chevrotain, large brown flying squirrel, Indian crested porcupine and Indian hare. Four individuals of Slender loris were recorded from Punjur and Bylore forest ranges. The Bengal fox was recorded from scrub forests around back waters of Suvarnavathi reservoir. Chevrotain and porcupine are abundant and recorded from almost all the forest ranges and vegetation types. More details of sight records and abundance are provided and already discussed in the earlier report (Kumara and Rathnakumar, 2010).

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Chapter 3

Abundance of small carnivores in BRT WLS: special reference to vegetation type and forest range

The data from night surveys, camera traps and day transect walks were used to address the abundance of small carnivore species in BRT WLS in relation to vegetation type. The same is also presented in respect to forest range, which will be useful for the local administrators for management of the forests. The data from night transects gave a estimate of abundance for small Indian civet, Asian palm civet, jungle cat, leopard cat and rusty spotted cat, whereas the data from day transects give an estimate for common mongoose, ruddy mongoose and stripe-necked mongoose. However, we did not sample for the otter for their abundance. Since many of the species are elusive, detection of them were very few, thus we could not estimate the abundance for some of the species. However, detections from all the methods were used to plot on the map (classified vegetation map), which gave an idea about in the type of habitat they commonly occur in. We computed the encounter rate for each species and represented them as number of sightings per km. ANOVA was used to compare the mean sightings per km between the forest ranges and forest types. Since the night survey was done according to the grids, the detection of animals was also plotted against to grids to understand the habitat factors influencing the occurrence of the species. Further, the data from camera traps were also analysed to see the capture rate, species and habitat association. The data from all the methods were plotted on the map to find a habitat where the species commonly occurred.

Results

During the night surveys, we sighted jungle cat, leopard cat, rusty spotted cat, small Indian civet and Asian palm civet, whereas during the day surveys common mongoose, stripe-necked mongoose and ruddy mongoose were sighted. Since many of them are elusive and shy, and all mongoose species are small in the body size to detect the animals during the day walk, the chances of detection gets reduced. Thus the rate of detection was less and hence the present findings should be considered as a relative index rather than absolute abundance though it throws some light on few aspects of some species for the further investigation and management.

The relative abundance of Asian palm civet, small Indian civet, jungle cat and rusty spotted cat was 0.12±0.02, 0.04±0.01, 0.04±0.01 and 0.02±0.01 respectively. Asian palm civet was more abundant than other three species. Among the three mongooses, ruddy mongoose (n=9, 0.011/km) was encountered more than common mongoose (n= 6, 0.007/km) and stripe-necked mongoose (n=7, 0.008/km). Since the number of detection of these animals was less, further relative abundance was not calculated for forest ranges and vegetation types. However, all the sightings of common mongoose were in dry forests i.e. three each sightings in dry deciduous forests and scrub forests. Where, ruddy mongoose was sighted more in evergreen forests (six sightings) than in other vegetation types (one each sightings in dry deciduous, moist deciduous and scrub forests). Stripe-necked mongoose was mostly sighted in moist deciduous forest (four sightings) and dry deciduous forests (three sightings).

Small Indian Civet

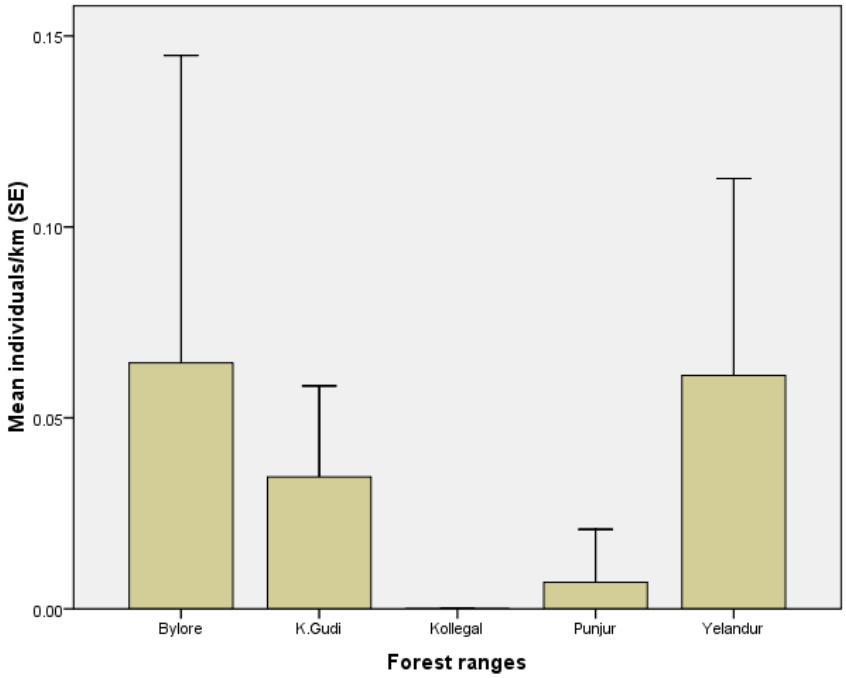
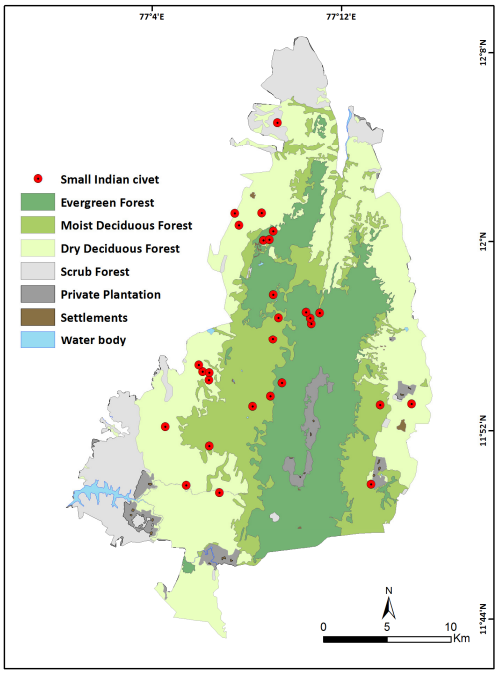
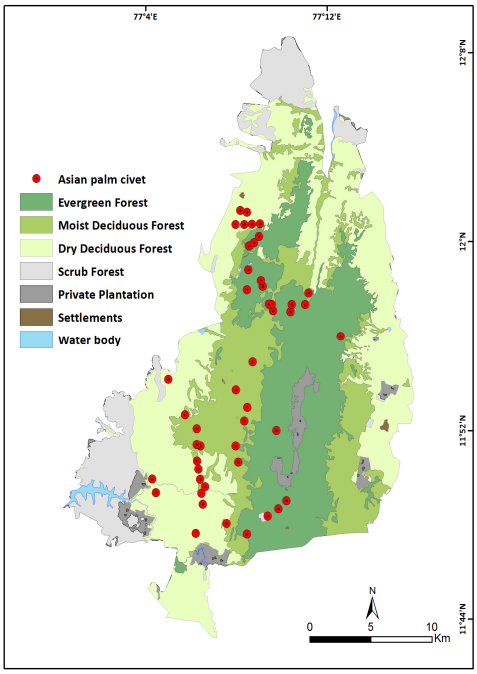


Figure 3.1 Relative abundance of small Indian civets in different forest ranges of BRT WLS





(a) (b)

Figure 3.2 Detection from all the types of field sampling

a. small Indian civet and b. Asian palm civet

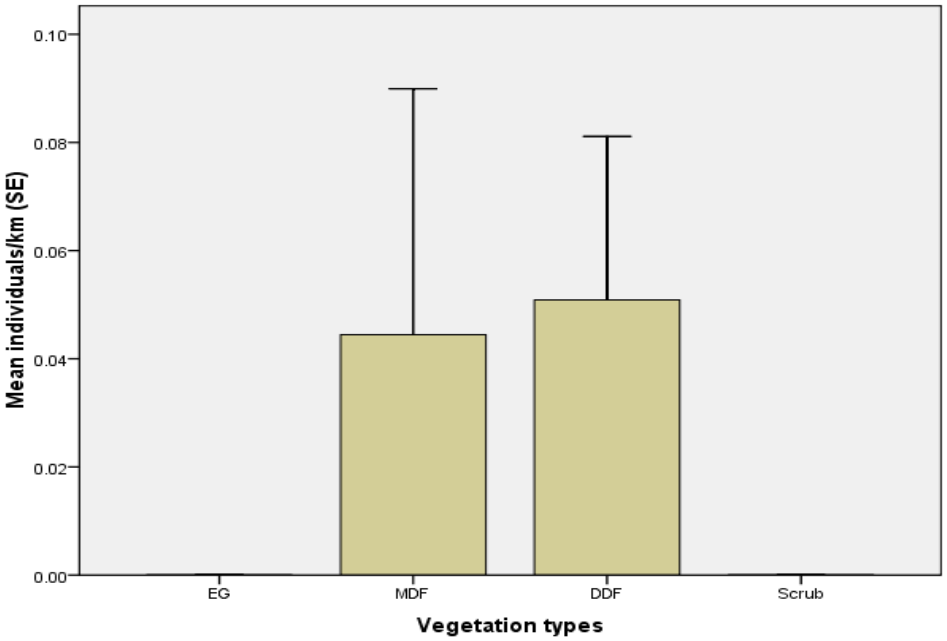


Figure 3.3 Relative abundance of small Indian civet in different vegetation types of BRT WLS

Small Indian civet was recorded from all the forest ranges except Kollegal (Fig. 3.2). The relative abundance was 0.06 in Bylore and Yelandur, 0.03 in K. Gudi and 0.01 in Punjur (Fig. 3.1). The relative abundance did not differ between the forest ranges ($F_{4,19}$ = 1.27, p >0.316). Small Indian civet was recorded from dry deciduous forests and moist deciduous forests, and the relative abundance was 0.05 and 0.04 respectively (Fig. 3.3). The relative abundance between the forest types was not significantly different ($F_{3,20}$ = 1.25, p >0.317).

Asian palm civet

Asian palm civet was recorded from all the forest ranges except Kollegal (Fig. 3.2). The relative abundance was highest in Yelandur (0.17), which was followed by K. Gudi (0.14), Punjur (0.12) and Bylore (0.03) (Fig. 3.4). The relative abundance did not differ between the forest ranges ($F_{4,19}$ = 1.672, p >0.198). Asian palm civet was recorded from dry deciduous forests, moist deciduous forests and evergreen forests except in scrub forests, and the relative abundance was 0.13,0.13 and 0.09 respectively (Fig. 3.5). The relative abundance between the forest types was not significantly different ($F_{3,20}$ = 0.765, p >0.527).

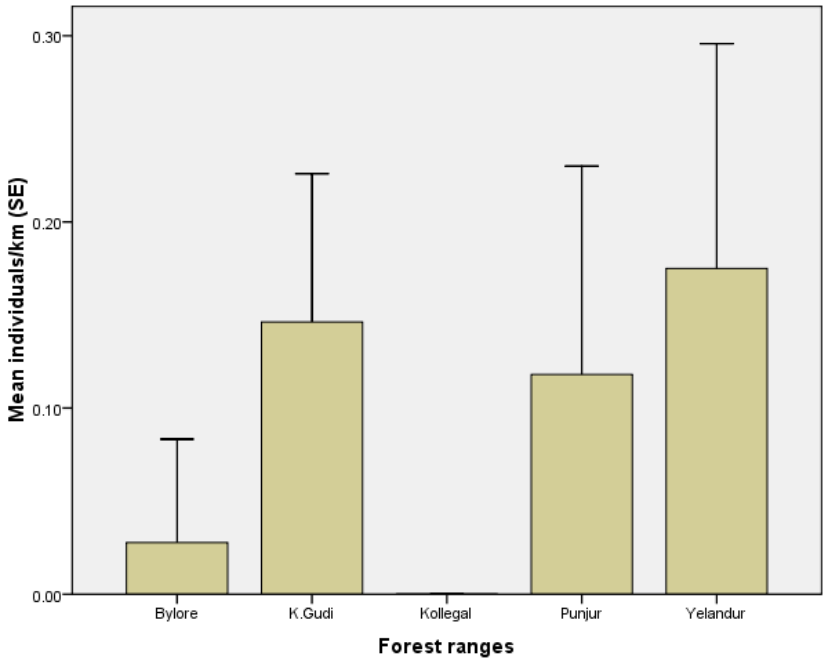


Figure 3.4 Relative abundance of Asian palm civet in different forest ranges in BRT WLS

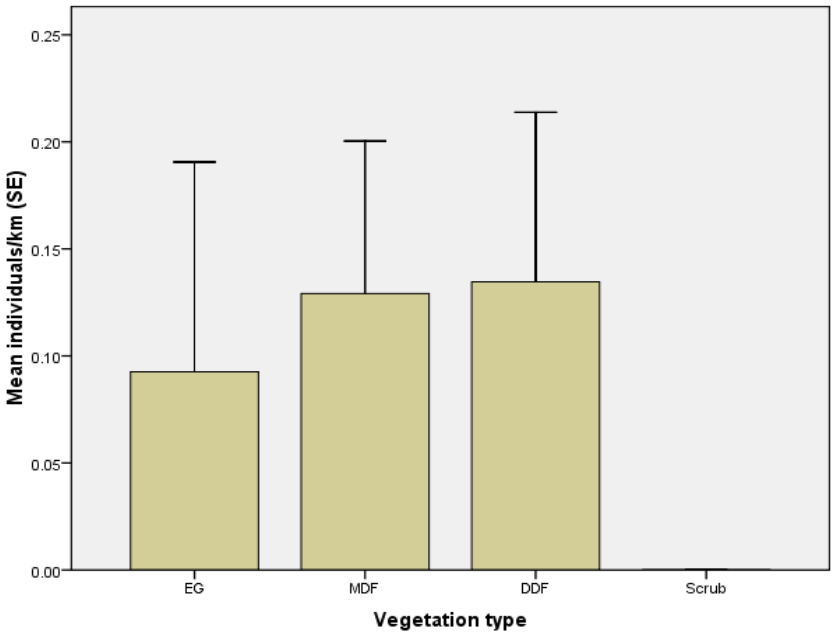


Figure 3.5 Relative abundance of Asian palm civet in different vegetation types of BRT WLS

Rusty spotted cat

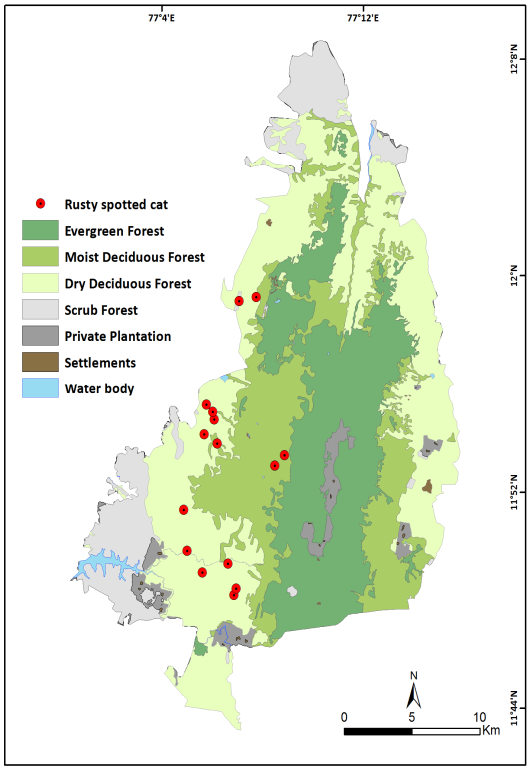


Figure 3.6 Detections of rusty spotted cat from all the types of field sampling

Rusty spotted cat was recorded from K.Gudi and Punjur ranges during the day transect, however, the animals were also sighted in Yelandur forest range (Fig. 3.6). The relative abundance was 0.04 in K. Gudi and 0.01 in Punjur range (Fig. 3.7). The relative abundance did not differ between the forest ranges ($F_{4,19}$ = 1.943, p >0.145). Though the rusty spotted cat was recorded from moist deciduous forests and dry deciduous forest during the study, during transect systematic survey the animal was recorded only from dry deciduous forests and the relative abundance was 0.03 (Fig. 3.8).

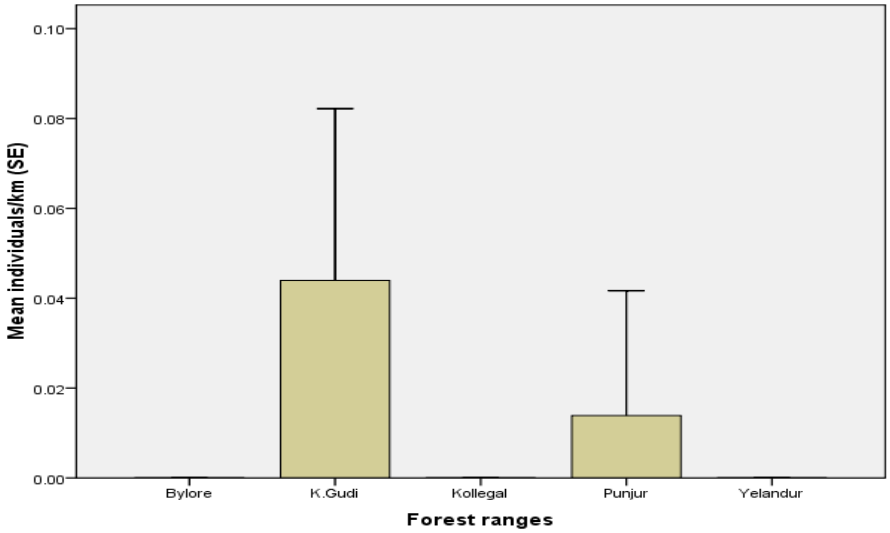


Figure 3.7 Relative abundance of rusty spotted cat in different forest ranges in BRT WLS

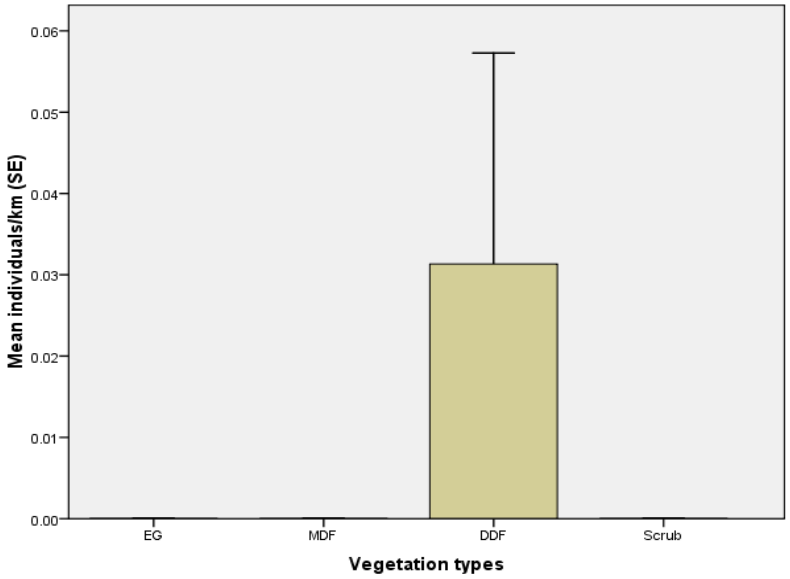


Figure 3.8 Relative abundance of rusty spotted cat in different vegetation types in BRT WLS

The detection of many of the small carnivore species was very less, thus, we could not provide animal abundance according to forest ranges and vegetation types. Capture rate of small carnivore species was very less in the camera trap survey. Total captures were only 13 (small Indian civet-2, Asian palm civet -3, rusty spotted cat-1, jungle cat -1, common mongoose-2, ruddy mongoose-1, stripe-necked mongoose-3) . Thus, any further analysis and developing the association with the habitat types or habitat covariates could not be achieved. However, we plotted all the sightings from day transects, night surveys and camera trap surveys to find out the probable habitat preference by the species. Nevertheless, this provided some understanding on occurrence of species in different vegetation types in BRT WLS (Table 3.1).

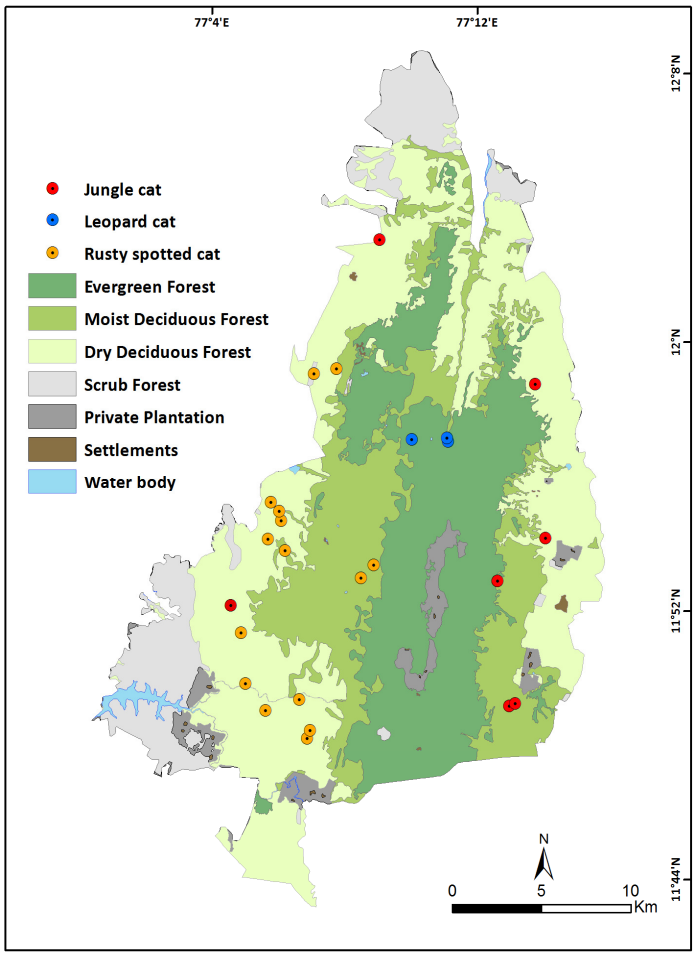


Figure 3.9a Detections of all the small cats in the BRT WLS from all the field sampling

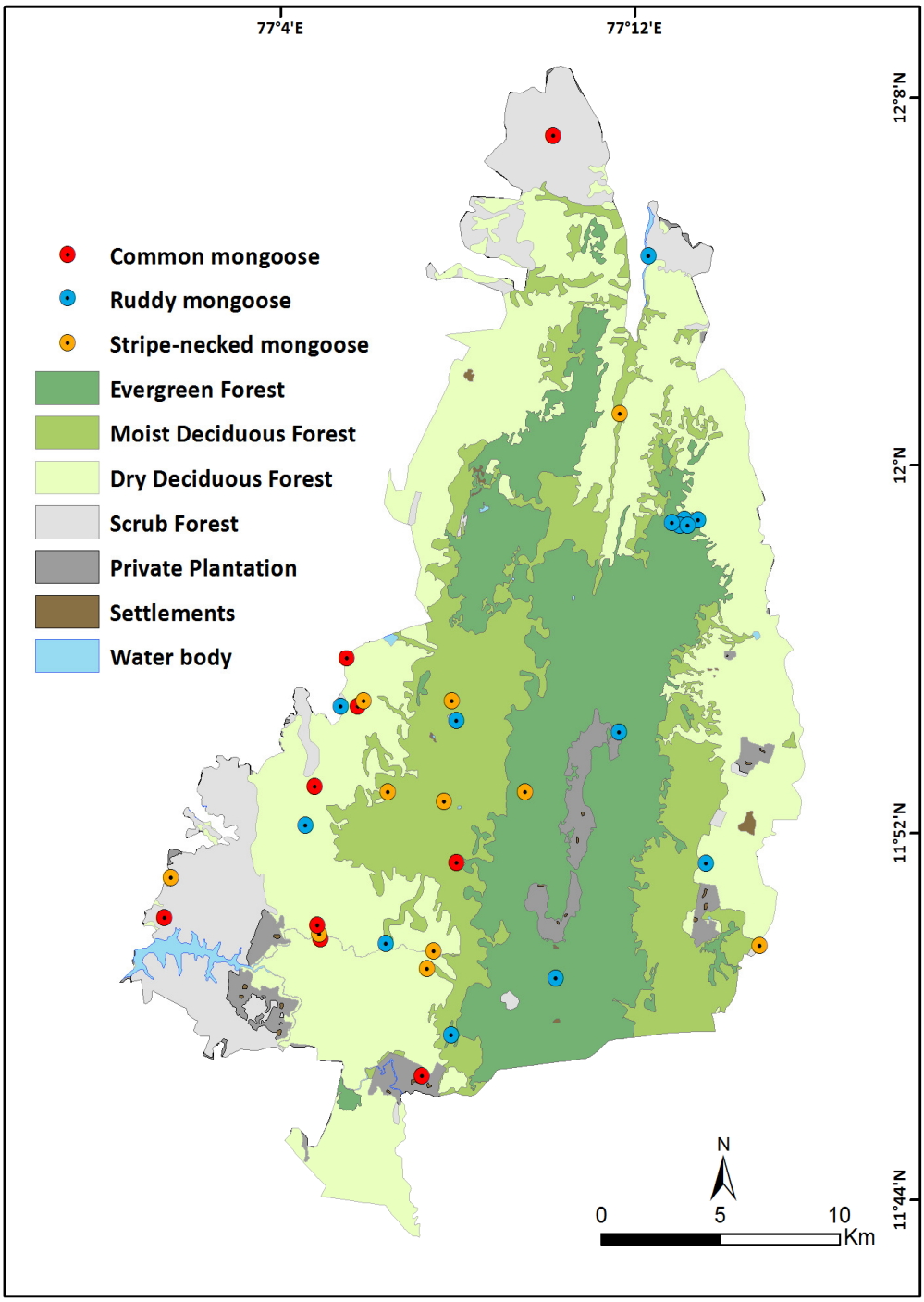


Figure 3.9b Detections of all the mongoose species in the BRT WLS from all the field sampling

Table 3.1 Number of sightings and their proportion of sighting in each vegetation type

Vegetation type	Jungle cat (%)	Leopard cat (%)	Rusty spotted cat (%)	Asian palm civet (%)	Small Indian civet (%)	Common mongoose (%)	Stripe necked mongoose (%)	Ruddy mongoose (%)	Total (%)
EG	0	3 (100.00)	0	16 (34.04)	7(25.00)	0	1(7.69)	7 (50.00)	34(25.37)
MDF	2 (33.33)	0	3 (23.08)	15(31.91)	8(28.57)	1(10.00)	5(38.46)	3(21.43)	37(27.61)
DDF	4(66.67)	0	10 (76.92)	15(31.91)	12(42.86)	5(50.00)	5(38.46)	3(21.43)	54(40.30)
Scrub	0	0	0	1(2.13)	1(3.57)	4(40.00)	2(15.38)	1(7.14)	9(6.72)
Total	6	3	13	47	28	10	13	14	134

EG: evergreen forest; MDF: moist deciduous forest; DDF: dry deciduous forest

Among the four major vegetation types, the sightings of small carnivore species was more in dry deciduous forests (40.30%), which is followed by moist deciduous forests (27.61%), evergreen forests (25.37%) and scrub forest (6.72%). The sightings were very relatively less in the scrub forests. However, some species did show restricted distribution pattern or high preference for certain vegetation types e.g. leopard cat was recorded only from evergreen forests whereas jungle cat and rusty spotted cats were recorded only from moist and deciduous forests. Though both the civets were recorded from all the vegetation types, Asian palm civets were almost equally recorded from all the vegetation types except in the scrub forests, whereas small Indian civet records were high for the dry deciduous forests than the other forest types. Among three mongooses, common mongoose was more sighted in dry forests than other two species. Surprisingly, ruddy mongoose was sighted more in wet forests than dry forests.

Discussion

The forest ranges in BRT WLS are very unique. The centre of the sanctuary is highy elevated area with wet forests, the bifurcation of the ranges is made in such a way that all the forest ranges have all the major vegetation types from evergreen forest at higher altitude to moist deciduous forests at mid altitude, deciduous forests at mid altitude to slopes up to foothills and scrub forests

at foothills. Though, some of the small carnivore species were not detected in some of the ranges, it may be due to access to all the vegetation types in the range, limited sampling effort, and also low abundance of the species might be some of the major reasons. However, the present findings provide a trend and understanding of the species and vegetation types they occur in at the BRT WLS.

The Malabar civet was reported by Nandini and Muddapa (2010) from BRT WLS based on possible sighting by other researchers in the area. However, this requires systematic investigation. On the other hand, smooth coated otter also occurs in all the riverine habitat and reservoirs in and around the sanctuary, which also requires separate field techniques to assess their status. The other habitat which requires proper exploration is that the wet forest with coffee plantations at higher altitude, which may be a habitat for Malabar civet and brown palm civet. Though, the presence of brown palm civet is not confirmed, still since the suitable habitat exists and also the description by the local people matches with the species, the occurrence of the species cannot be ruled out from the sanctuary. Therefore, a proper investigation is suggested in these habitats.

Though the Asian palm civet is known to occur in various habitat types varying from thick woody areas to urban habitat, since the species is mostly arboreal which requires wooded forests or elevated construction, the animal was mostly sighted in all the forest types except the scrub forests. Whereas, the small Indian civet is also habitat generalist and highly terrestrial, thus the animal was expected in all the forest types, however, the sightings in scrub forests was relatively less.

The highly preferred habitat of the jungle cat is open forests with water source. However, the species was recorded only from mid and low elevation highly disturbed forests or marginal forests with open canopy adjoining agriculture fields or villages. On the other hand, leopard cat is totally forest dwelling animal and recorded only from the thick wooded and relatively wet forests. Rusty spotted cat was recorded mostly in the mid and low elevation forests. Rusty spotted cat is known to inhabit variety of habitats varying from villages ‘human dominated habitat’, agriculture land and deciduous forests (Kumara and Singh, 2007). The sightings of the species in BRT WLS are more than the sightings reported from any other region. Probably, this may be due to the rate of exploration and sampling effort.

Compared to other species, the total detections of mongoose species was very less. Since they are diurnal, chances of sighting them is relatively less during the day transect walks as they are small sized animals.Thus the intensive camera trapping might give more reliable data than any other methods. The probable reason for more sightings of ruddy mongoose in evergreen forests and moist deciduous forest may be due to presence of more rocky areas at the transition of dry forests with wet forests on the slope which is otherwise the species is known to inhabit drier forests rather than the wet forests.

We consider BRT WLS as one of the potential areas to further study and understand the habitat preference and ecology of small carnivore species. Further exploration at high elevated forests is highly recommended. Rusty spotted cat is one of the lesser known small mammals, is commonly found in the BRT WLS, which adds conservation value to the area. This also gives an opportunity for the detailed study on the species. The management requires retaining all the forests types as such without much alteration, since each forest type is unique in its own way by inhabiting its species.

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Chapter 4
Ecology of large carnivore species in BRT WLS

BRT WLS is also a part of Nilgiri Biosphere Reserve, which includes major protected areas viz., Mudumalai Wildlife Sanctuary, Bandipur National Park, Nugu Wildlife Sanctuary, Nagarahole (Rajiv Gandhi National Park). BRT WLS is also a part of the forest complex which holds the largest population of tigers (Wikramanayake et al., 1988, 1999). The estimate of density for large herbivore species for few parks of the forest complex e.g. Mudumalai (Varman and Sukumar, 1995), Bandipur (Johnsingh, 1983; Karanth and Nichols, 2000) and Nagarahole (Karanath and Sunquist, 1992) shows that promising and relatively good prey base is available. Thus, WLS which is also equally well protected and has large extent of diverse forests is also expected to have similar prey base. The sanctuary has all the three major large predators of the region which includes tiger, leopard and dhole. The population density and biomass of large herbivore species have been used to compare the carrying capacity of different habitats (Eisenberg and Seidensticker, 1976; Eisenberg, 1980), and the same plays an important role in deciding the population density of large carnivores, since the large herbivores form a bulk of the prey base for them. Karanth and Stith (1999) have demonstrated that prey depletion can lead to drastic decline in the tiger population size, thus the population size of prey and predator is interdependent. Maintenance of the healthy population of herbivore species is indeed required for the survival and maintenance of viable population of large carnivore species (Karanth and Sunquist, 1995; Sunquist et al., 1999; Karanth and Stith, 1999; Biswas and Sankar, 2002; Bagchi et al., 2003). It is generally held that the direct positive correlations exist between habitat richness, prey base, diversity or biomass, and tiger density which emphasize the need for data on density and biomass of large herbivore species from every potential forests and parks in the habitat of large carnivores using standard census methodology (Karanth and Sunquist, 1992; Srikosamatara, 1993). This has been achieved for many parks in the country e.g. Bandipur, Pench, Kanha: Karanth and Nichols (2000), Nagarahole: Karanth and Sunquist (1992), Bhadra: Jathana et al. (2003), Mudumalai: Varman and Sukumar (1995), Gir: Khan et al. (1996), Ranthambore: Bagchi et al. (2003) and Pench: Biswas and Sankar (2002) and they have used statistically and biologically robust methods with the theoretical framework of distance sampling procedures (Burnham et al., 1980; Buckland et al., 1993, 2001). With this background, during first phase of the study, we estimated the density and biomass of large herbivore species with special emphasis on prey species in the

sanctuary. In the present report we looked at the prey selection by large carnivore species in BRT WLS.

During the first phase of the study, we collected scats of tiger, leopard and dhole. Carnivore scat in the field was identified as belonging to the tiger by the stool diameter (2.5 cm or above) and the size of the entire deposition (diameter > 6"). Leopard scat was identified, if the scat was in smaller size, and if we could identify the other secondary sings like pug marks. Usually, dholes deposit the droppings in an open area and in most of the cases it will be community defecation. The scats are usually relatively coiled and elongated. If the scats could not be confirmed for the identity of the species, they were not considered for the sampling. The scats were analysed following the methodology given by Mukherjee et al. (1994). Hairs in the scat were identified by gross morphological features (colour, texture and shape of the base) and medullary pattern following Koppikar and Sabnis (1976, 1981). We also compared the hair samples with the reference manual prepared by Wildlife Institute of India (Bahuguna et al. 2010). Due to various constraints, we were able to collect 41 scats of tiger, whereas only seven scats of leopard and 11 scats of dhole were collected. Since, the scat samples were not sufficient to understand the prey use for leopard and dhole, the analysis was done only for tiger.

Results

Out of total scats of tiger (n=41), 59% of the scats had only one species and 36% species had two species and only 5% of the scats had more than two species. The major prey species include gaur, sambar, chital, wild pig, muntjac, four horned antelope, Indian hare and domestic cattle, and also some other small mammals and birds. The tiger preyed on various body size prey species, analysis show the high preference for the large body size prey species over the small body size prey species. The wild prey species constituted 90.02% and remaining 9.98% was livestock especially domestic cattle. Of the wild prey species, sambar constituted 36.66% followed by gaur (23.33%), chital (15.00%), wild pig (10.00%), cattle (8.33%), muntjac (3.33%) and 1.66% each four horned antelope and hare. The biomass of the wild prey species contributed 90.12% of its diet where the remaining 9.88 % of the diet was domestic animals especially cattle. Gaur contributed 168.35 kg biomass to the diet of tiger followed by sambar (139.81 kg), cattle

(41.40 kg), chital (35.14 kg), wild pig (19.86 kg), muntjac (5.36 kg), four horned antelope (2.64 kg) and hare (2.05 kg) (Table 4.1).

Table 4.1 Prey species composition in tiger scats (n=41) and their relative biomass contribution in tiger diet in BRT WLS. Where x and y are related through the equation y = 1.980 = 0.035 x (Ackerman et al. 1984)

Prey species	Average body weight (X)	Prey species remains (F=60)	Relative occurrence (R) in %	No. of collectable scats produced/kill (Y)	Prey biomass consumed B=F*Y	% relative biomass of prey contribution (P=F*R in %)
Gaur	287	14	23.33	12.02	168.35	40.60
Sambar	125	22	36.66	6.35	139.81	33.72
Chital	55	9	15.00	3.90	35.14	8.47
Wild Pig	38	6	10.00	3.31	19.86	4.78
Muntjac	20	2	3.33	2.68	5.36	1.29
Four horned antelope	19	1	1.66	2.64	2.64	0.63
Hare	2	1	1.66	2.05	2.05	0.49
Domestic cattle	180	5	8.33	8.28	41.40	9.98
Total					414.62	

Discussion

During the first phase of the study, large herbivore density was estimated for the sanctuary. Estimate of large herbivore density when compared with those from the other parks in the country revealed that BRT WLS holds high density of muntjac, medium density of sambar and gaur, and very less density of Chital and Hanuman langur. Nevertheless, the density of sambar was on par or higher than the density in other parks of the same landscape (Bandipur: Johnsingh, 1983; Nagarahole: Karanth and Sunquist, 1995) and though the gaur density in BRT WLS was rather lower than in these parks, it shows a very promising density in the landscape. However, the density of large prey species is much better than the Bhadra Tiger Reserve (Jathanna et al. 2003). High degree of undulating terrain and dense lantana seems to decrease the grass availability for the grazers. The lower density of Hanuman langur may be due to hunting of the animal in the past. Blackbucks live in low abundance and are restricted to marginal areas and cropland in the periphery of the sanctuary and hence they were not sighted during the transect walk. The proportion of suitable habitat (open wooded forests like deciduous forests with opened canopy: Krishna et al., 2008) for four-horned antelope is much lesser in the sanctuary. Hence, the

number of detections was less and the estimate may be biased, nevertheless the present estimate for four-horned antelope (2.44 km^{-2}) shows presence of promising population in the sanctuary when compared to those estimates from Pench (0.7 km^{-2}) (Karanth and Nichols, 2000) and Gir (0.42 km^{-2}) (Khan et al., 1996).

Table 4.2 Biomass of prey species in BRT WLS (from the earlier report submitted to forest department)

Species	Weight in kg	Density (km^{-2})	Biomass (kg km^{-2})
Terrestrial large herbivores			
Gaur	450	5.08	2286.00
Sambar	134	6.01	805.34
Chital	47	13.96	656.12
Muntjac	21	3.70	77.70
Indian wild pig	32	5.33	170.56
Four-horned antelope	20	2.44	48.8
Total		36.52	4044.52
Arboreal large herbivores			
Hanuman langur	9	6.34	57.06
Bonnet macaque	4	6.56	26.24
Total		12.90	83.3
Overall		**49.42**	**4127.82**

Since elephants and rhino rarely contribute to the diet of large carnivore species (Sunquist, 1981; Johnsingh, 1983; Karanth and Sunquist, 1995), the estimates of them were removed while comparing the prey biomass density between the BRT WLS and other parks in the country. Biomass density varied from as low as 1277.25 kg km^{-2} in Bhadra to 7638 kg km^{-2} in Nagarahole. Seven parks in the country support more than 4000 kg $km^{-2}$of prey biomass viz. Nagarahole, Ranthambore, Pench, Bandipur, Kaziranga, BRT WLS and Kanha, which reveals that BRT WLS also supports one of the highest biomass rich areas in the country. The overall herbivore density in BRT WLS was lesser than the many protected areas. However since the density of large bodied species like gaur and sambar is very high in BRT WLS; it has contributed to high biomass density.

Table 4.3 Relative occurrence of major prey species tiger scats from different areas with gaur as one of the prey species

Species	Kanha	Bandipur	Nagarahole	BRTWLS
Gaur	8.3	5.5	17.4	23.3
Sambar	10.4	30.5	34.9	36.6
Chital	52.2	39.0	31.2	15.0
Barasingha	8.6			
Wild pig	0.8	5.5	9.4	10.0
Muntjac			6.1	3.3
Four horned antelope				1.6
Common langur	6.2		3.9	
Cattle	5.9	5.5		8.3
Others	6.1	14.0	7.1	1.6

Kanha-Schaller (1967); Bandipur-Johnsingh (1983);
Nagarahole-Karanth and Sunquist (1995)

Gaur and sambar were observed to be the principal prey species for tigers in BRT WLS as reflected by the percentage occurrence of prey remains in scats (Table 4.1). Gaur and sambar also contributed to the highest biomass of prey consumed by the tiger. Sambar remains in the tiger scat was high comparable to the frequency observed in Kanha, however, though it is higher than in Bandipur and Nagarahole (Table 4.3), but not too different. Conversely, gaur remained second highest, but the relative occurrence in scat was very high in BRT WLS compared to Kanha, Bandipur and Nagarahole. On the other hand, the relative occurrence of chital in the tiger scat was very low in BRT WLS compare to Kanha, Bandipur and Nagarahole. This is probably due to very low density of chital in the BRT WLS. Though the density of Gaur and sambar remained almost the same as in Bandipur and Nagarahole, the dependency of tiger on these two animals may be more than the chital. Further, it was apparent from the low density of langur that the langur remain were not observed in the scat. The sample size is not enough to address the complete prey selection and utilization by any of the large carnivore species. However, the present findings shed some light on ecology of tiger in the sanctuary, and we suggest further detailed study on ecology of all large carnivore species.

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