SMALL CARNIVORES OF SELECTED PROTECTED AREAS OF KERALA

By

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(2016-27-001)

THESIS

Submitted in partial fulfilment of the requirement for the degree of

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DEPARTMENT OF WILDLIFE SCIENCE
COLLEGE OF FORESTRY
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KERALA, INDIA
2021

DECLARATION

I, hereby declare that this thesis entitled "**SMALL CARNIVORES OF SELECTED PROTECTED AREAS OF KERALA**" is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Place: Vellanikkara
Date: 21-1-2022

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CERTIFICATE

Certified that this thesis entitled " **SMALL CARNIVORES OF SELECTED PROTECTED AREAS OF KERALA"** is a record of research work done independently by Ms. Devika Sanghamithra under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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Devika Sanghamithra

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Introduction

INTRODUCTION

Small carnivores are the species coming under ten families of order Carnivora. There are 195 species of small carnivores in the world distributed to 10 families, they are Mustelidae, Herpestidae, Viverridae, Felidae, Procyonidae, Mephitidae, Eupleridae, Prionodontidae, Nandinidae, and Ailuridae (Wilson and Mittermeier, 2009; Mudappa, 2013; Nameer, 2015). Generally, small carnivores are defined as carnivores less than about five kg in body weight (Yoganand and Kumar, 1999). In India, we have 41 species of small carnivores (Menon, 2014) distributed among six families (Wilson and Mittermier, 2009; Mukherjee, 2013). This includes 15 species of mustelids, 10 species of Felidae (Small Cats), eight species of Viverridae, six species of Herpestidae, one species of Prionodontidae, one species of Ailuridae (Yonzon, 2013; Mudappa, 2013; Mukherjee, 2013; Anoop and Hussain, 2013).

Within the boundaries of Kerala, 13 species of small carnivores have been recorded (Nameer, 2015). These include the four herpestids (Indian Grey Mongoose *Herpestes edwardsii*, Brown Mongoose *H. fuscus*, Ruddy Mongoose *H.smithii,* and Stripe-necked Mongoose *H. vitticollis*), three felids (Jungle Cat *Felis chaus*, Leopard Cat *Prionailurus bengalensis*, and Rusty-spotted Cat *Prionailurus rubiginosus*), three viverrids (Brown Palm Civet *Paradoxurus jerdoni*, Common Palm Civet *P. hermaphrodites*, Small Indian Civet *Viverricula indica*) and three mustelids (Nilgiri Marten *Martes gwatkinsii*, Asian Small-clawed Otter *Aonyx cinereus*, Smooth-coated Otter *Lutrogale perspicillata*).

The small carnivores of Western Ghats exhibit a high amount of endemism. The species-level endemism in the Western Ghats is found among Brown Palm Civet and the Nilgiri Marten while sub-species level endemism is observed among Stripe-necked Mongoose and the Brown Mongoose. Among the various small carnivores of Western Ghats, the taxonomic status of Malabar Civet has been questioned by Nandini and Mudappa (2010) and Janardhanan *et* *al.* (2014) questioned the presence of Fishing Cat in Kerala. Since most of the small carnivores adapt well to the changing environments, the impact of climate change on this is erratic. For the species with a high level of endemism, the threats due to fragmented distribution will be high. It is expected that aquatic or semi-aquatic species would be affected more due to climate change.

The distribution of small carnivores is still studying and new reports come from various landscapes. A recent report of the Brown Palm Civet from the Satara district of Maharashtra is evidence for the extended species distribution further north of Goa. Earlier the distribution of the species was from Kalakkad Mundanthurai Tiger Reserve, Tamil Nadu to Bhagwan Mahaveer Wildlife Sanctuary in Goa (Bhosale *et al.*, 2013; Sayyed *et al.*, 2019). The northward distribution extension of Stripe-necked Mongoose has been reported from Maharashtra and Goa (Punjabi *et al.*, 2014). Recent records of Brown Mongoose from Bilgiri Rangaswamy Temple Tiger Reserve points towards the southeast extension of the distribution of the species from its known range (Suthar *et al.*, 2020). A recent report on Rusty-spotted Cat from Kerala had been made from Walayar Reserve Forest (Sanghamithra and Nameer, 2021). The reason for recent extensions in the distribution of small carnivores in the Western Ghats may be due to the range extension of the species to these areas or due to the recent scientific studies conducted in the area. If later is the case, it shows the lack of studies on the less known carnivores in the Western Ghats.

The distribution and habitat preferences of the species were influenced by various macro and microhabitat features and resource availabilities. Arboreal small carnivores like Common Palm Civet prefer tall and large trees with holes and vines for resting (Joshi *et al.*, 1995). Foraging storeys varied considerably among Small Indian Civet and Common Palm Civet. Small Indian Civet was a majorly ground-dwelling species whereas Common Palm Civet was generally foraging on the higher stories (Su and Sale, 2007). Eurasian Otter population has decreased considerably by 49.5% due to various factors like over human population, habitat destruction, hunting, reduction in prey base, and roadkills. Humans cause an immense threat to otters, both directly and indirectly (Ullah *et al.*, 2012). The distribution pattern of small carnivores had been predicted in response to environmental factors in Mudumalai Tiger Reserve, Western Ghats. It was found that the distribution of small carnivores was influenced by distance to villages, aspect of the land, land cover, rainfall for the period of coldest months, and precipitation during the warmest months (Kalle *et al.*, 2013a). The occurrence of a habitat specialist species would favor specific habitat types nevertheless of the food base availability (Petersen *et al.,* 2019). The niche of *Herpestes fuscus fuscus* was critically influenced by temperature, rainfall, and topography. The model predicted a decline in suitable habitat for the species in the future (Raman *et al.*, 2020). For facilitating the recovery and conservation of small carnivores in largely modifying habitats, the management plans and habitat restoration should consider the accessibility of appropriate denning sites.

An in-depth study of these small carnivore diel activities is required to recognize the details about their temporal overlap, coexistence, and avoidance of competition. The activity pattern is not only depending on the factors like limited resources and competition but also depends on seasonal fluctuations (Ikeda *et al.*, 2016), diurnal temperature variations (Fuller *et al.*, 2016), and prey-predator relations (Harmse *et al.*, 2011; Linkie and Ridout, 2011) and human interventions and human activity (Cruz *et al.*, 2018). It needs to be further investigated to understand how the sympatric species with overlapping diel activity perform the resource partitioning. Carnivores are generally grouped into two based on temporal activity such as nocturnal and diurnal. Small carnivores within the same temporal group have differences in the pattern so as to reduce the competition. Small carnivores within the same temporal group have differences in their spatial distribution also.

Small carnivores mostly share the same diversity of food that generally includes small mammals, birds, amphibians, reptiles, fishes, invertebrates, and fruits and seeds. The small carnivore population depends on the availability of a similarly big collection of prey species and food plants. Demographic and ecological dynamics of sympatric small carnivore's forms through interspecific competition. Coexistence mechanisms and niche partitioning are developed due to these competitive interactions.

Human-small carnivore conflict plays an important role in the conservation of these animals. It is one of the major problems faced by forest managers, conservationists, and people nowadays. Both people and the small carnivores are affected by these conflicts. The major conflict in the human-modified landscape is because of the animals trying to fulfill their basic necessities. The conflict between man and small carnivores occurs when activities of the animals lead to loss of crop or livestock or infrastructure and/or reduce the general wellbeing of the farmers. In a recovering or adapting small carnivore population, land use and landscape changes have immense pressure and alter the animal's behavior and population structure.

The IUCN status of small carnivores of Kerala is given in the table. Out of the 13 small carnivores, nine species are listed as least concern, three species are considered as vulnerable and one species is listed as near threatened (Table 1). The majority of the small carnivores are not a priority for conservation. According to IUCN red listing, the population is decreasing for around fifty percent of the small carnivores around the world, and they are not considered as threatened. The conservation of small carnivores needs a holistic approach. The species at risk are the major focus of the conservation programs but it is important to conserve the species that will become threatened in the future.

Table 1. IUCN Red List status of small carnivores of Western Ghats

Species	Scientific name	Family	IUCN threat category
Brown Palm civet	*Paradoxurus jerdoni*	Viverridae	LC
Common Palm Civet	*Paradoxurus hermaphroditus*	Viverridae	LC
Small Indian civet	*Viverricula indica*	Viverridae	LC
Indian Grey Mongoose	*Herpestes edwardsi*	Herpestidae	LC
Brown Mongoose	*Herpestes fuscus*	Herpestidae	LC
Ruddy Mongoose	*Herpestes smithii*	Herpestidae	LC
Stripe-necked Mongoose	*Herpestes vitticollis*	Herpestidae	LC
Jungle Cat	*Felis chaus*	Felidae	LC
Leopard Cat	*Prionailurus bengalensis*	Felidae	LC
Rusty-spotted Cat	*Prionailurus rubiginosus*	Felidae	NT
Smooth-coated Otter	*Lutrogale perspicillata*	Mustelidae	VU
Asian Small-clawed Otter	*Aonyx cinereus*	Mustelidae	VU
Nilgiri Marten	*Martes gwatkinsii*	Mustelidae	VU

Source: Nandini and Mudappa (2010); Janardhanan *et al.* (2014), and Nameer (2015)

The small carnivores occupy many substantial ecological roles in the ecosystem functioning of tropical forests. Losing these animals have serious impacts on the ecosystem. They are an integral part of the ecosystem and play an integral role in the functioning such as backing to energy flow and nutrient cycling and playing immensely significant roles as predators of small mammals and other small animals (Khan, 2004; Mukherjee *et al.*, 2013) and pollinators in tropical forests (Nandini and Karthik, 2007). Frugivorous small carnivores help in seed dispersal (Engel, 1992; Mudappa *et al.*, 2010; Jothish, 2011) and thereby in the vegetation dynamics of their habitat. They also form an important prey base for medium-sized carnivores and raptors (Mudappa *et al*., 2010; Athreya *et al*., 2014). In the absence of large carnivores, small carnivores act as the drivers of ecosystem community structure.

Due to their nocturnal and cryptic nature, many species are considered as rare or uncommon and knowledge about their ecology and their necessities are also limited. By the integration of modern technologies such as camera trapping to the traditional way of sampling, more records of these elusive species are being made and published.

About the studies on the small carnivores of Kerala part of the Westerns Ghats, most of them were primarily on the documentation of the small carnivores from various protected areas of Kerala. These include the diversity of small carnivores from Parmbikulam Tiger Reserve (PKTR) (Sreehari and Nameer 2016), Eravikulam National Park (Nikhil and Nameer 2017), Wayanad Wildlife Sanctuary (Sreekumar and Nameer 2018), and Silent Valley National Park (Sanghamithra and Nameer 2018). Additionally, there are reports of *Martes gwatkinsii* from Parambikulam Tiger Reserve (Sreehari and Nameer 2013), *Herpestes Smithii* from Parambikulam Tiger Reserve, and Chinnar Wildlife Sanctuary and *Herpestes fuscus* from PKTR and Eravikulam National Park (Sreehari *et al.*, 2013). The feeding, basking, and activity pattern of Nilgiri Marten was recorded from Pampadum Shola National Park (Anil *et al.*, 2018). An observation on the feeding of Stripe-necked Mongoose on invertebrates (beetles and grubs) from fresh elephant dung piles had been made from Periyar Tiger reserve (Syamili *et al.*, 2019).

The small carnivores use vast diversity of habitats for their continued reproduction. For guaranteeing the existence of the small carnivores and other wildlife for the future, landscape-level conservation of their natural habitats must be the uppermost priority. Understanding each species' geographical and ecological distributions and abundance is the foundation for the effective management and subsequent formulation of conservation strategies. Very little biological and ecological information is available on the lesser-known small carnivores such as felids (lesser cats), herpestids (mongooses), viverrids (civets), and mustelids (otters and martens). The attention given to these by the public and research community is less compared to the large mammals. The proposed study is expected to throw light into our perception of the small carnivores of the selected protected areas in the state, which in turn is expected to help us in the conservation planning of these less-known forms of mammals.

The objectives of the present study are to study the status of small carnivores such as felids (lesser cats), herpestids (mongooses), viverrids (civets), and mustelids (otters and martens) in selected protected areas and to study habitat preferences of small carnivores and their distribution in selected protected areas. It is proposed to study the temporal segregation between sympatric small carnivores. The feeding ecology of otters will also be studied. It is also proposed to study the feeding ecology of viverrids. In addition to the above, conservation challenges faced by the small carnivores in these selected study areas will also be studied.

Review of Literature

REVIEW OF LITERATURE

Small carnivores are the species coming under ten families of order Carnivora. There are 195 species of small carnivores in the world distributed to 10 families, they are Mustelidae, Herpestidae, Viverridae, Felidae, Procyonidae, Mephitidae, Eupleridae, Prionodontidae, Nandinidae, and Ailuridae (Wilson and Mittermeier, 2009; Mudappa, 2013; Nameer, 2015). Generally, small carnivores are carnivores less than about five kg in body weight (Yoganand and Kumar, 1999). In India, we have 41 species of small carnivores (Menon, 2014) distributed among six families (Wilson and Mittermier, 2009; Mukherjee, 2013). This includes 15 species of mustelids, 10 species of Felidae (Small Cats), eight species of Viverridae, six species of Herpestidae, one species of Prionodontidae, one species of Ailuridae (Hussain, 2013; Mudappa, 2013; Mukherjee, 2013; Yonzon, 2013). Small carnivores have an important part of our ecosystem. They help in pollination, seed dispersal, act as prey for large predators, and also helps in rodent pest suppression. Among the small carnivores, otters act as the top predator of an aquatic ecosystem.

The conservation priorities in our country are not in favor of small carnivores. The conservation and research activities are majorly stressed on the large and fascinating mammals. In the fast-growing world, the existence of small carnivores is at risk due to various reasons like habitat destruction, habitat degradation, habitat fragmentation, competition for resources, road accidents, and human-small carnivore conflicts. However, the small carnivores are less studied. The biological and ecological information on the small carnivores from the Western Ghats, southern India is far and in between. This may be due to their small size, low density, and nocturnality, which are obvious obstacles to conduct studies on these animals (mongooses, civets, otters, martens, and small cats). Understanding each species geographical and ecological distributions and abundance is the foundation for the effective management and subsequent formulation of long-term conservation strategies. The reviews of the literature suggest that the trend is changing in favor of these small cryptic animals.

2.1. SMALL CARNIVORES OF WESTERN GHATS

Kumara and Singh (2007) conducted an extensive survey and reported 11 species of small carnivores from Karnataka. More lately, Mudappa *et al.* (2007) studied the responses of small carnivores to rainforest fragmentation in the southern Western Ghats. The study found that limited endemic species are more affected by habitat fragmentation and disturbances. The disturbed habitats are susceptible to invasion by more widespread and common species at the cost of these endemic species. Alteration of the composition might also occur due to this. A very recent study was conducted by Pillay (2009) on small carnivores of southern Western Ghats and observed five species of small carnivores during the study.

Small carnivores of Western Ghats are studied from some of the protected areas. Martes gwatkinsii is reported from Parambikulam Tiger Reserve (PKTR) (Sreehari and Nameer, 2013). *Herpestes smithii* is reported from Parambikulam Tiger Reserve and Chinnar Wildlife Sanctuary and *Herpestes fuscus* is reported from PKTR and Eravikulam National Park (Sreehari *et al.*, 2013). Small carnivores of Mudumalai Tiger Reserve were studied using camera traps. Ten species were recorded from the reserve. Higher encounter rates of Small Indian Civet and Stripe-necked Mongoose was from Deciduous and semi-evergreen forests than thorn forests. Brown Palm Civet was documented only from semi-evergreen forests (Kalle *et al.*, 2013b).

Kumara *et al.* (2014) studied the status of small carnivores in Biligiri Rangaswamy Temple Tiger Reserve and reported nine species from BRT. In the reserve, the dry deciduous forest had higher sightings of small carnivores than other forest types. The small carnivores of Parambikulam Tiger Reserve are studied using camera traps, transect walks, and indirect evidence. Eleven species of small carnivores were recorded from the tiger reserve. The most common species recorded was Small Indian Civet followed by Common Palm Civet, Brown Palm Civet, and Stripe-necked Mongoose (Sreehari and Nameer, 2016). Nine species of small carnivores were reported from Eravikulam National Park, and the most abundant species was Jungle Cat followed by Leopard Cat and Stripe-necked Mongoose. The camera trap success rate from the national park was 2.1% (Nikhil and Nameer, 2017). In a camera trap study of small carnivores of Silent Valley National Park, seven species of small carnivores have been identified. Small Indian Civet was the most abundant species of the National Park followed by Brown Palm Civet, Stripe-necked Mongoose, and Brown Mongoose. The camera trap success rate was 10.90 % for the small carnivores. No significant niche partitioning was observed between the small carnivores in a discriminant analysis conducted for finding the relation between microhabitat variables and the species distribution (Sanghamithra and Nameer, 2018). During a camera trap study on the small carnivores of Wayanad Wildlife Sanctuary, nine species of small carnivores were recorded with Small Indian Civet is the most frequently spotted animal followed by Stripe-necked Mongoose and Common Palm Civet (Sreekumar and Nameer, 2018).

Anoop and Hussain (2004) have analysed the factors affecting habitat selection by *Lutrogale perspicillata*. The feeding ecology of *Lutrogale perspicillata* and their significance of fishes of Kerala have been studied in the Periyar Tiger reserve (Anoop and Hussain, 2005). The factors influencing the occurrence and habitat selection by *Aonyx cinereus* have been studied in Eravikulam National park (Perincherry *et al.*, 2011). The effect of climate change on the ecological niche of *Herpestes fuscus* in the Western Ghats had been predicted using Species Distribution Models (Raman *et al.*, 2020).

2.2.FAMILY MUSTELIDAE

2.2.1 Mustelidae studies in India and the Western Ghats

2.2.1.1.Honey Badger or Ratel *Mellivora capensis* Schreber, 1776

The Ratel or Honey Badger *Mellivora capensis* (Mustelidae) have a wide range of distribution spanning across Western Asia and the Indian peninsula, Africa, and the Arabian Peninsula. The knowledge of the species from the Indian subcontinent is very unreliable. Some recent records were made from southern India (Begg *et al.,* 2008), Gujarat (Joshi and Andavan, 2008), Karnataka (Gubbi *et al*., 2014, Krishna *et al.,* 2016). The major diet of the species included flesh and the diet is complemented by other vegetarian diets (Menon, 2014). Globally it is scheduled as Least Concern under *The IUCN Red List of Threatened Species*, (Begg *et al.,* 2008).

2.2.1.2.Nilgiri Marten *Martes gwatkinsii* Horsfield, 1851

Nilgiri Marten is an endemic mustelid to the Western Ghats. Some of the former records of the species are from Nilgiri biosphere Reserve (Yoganand and Kumar 1995), Eravikulam National Park (Madhusudhanan, 1995; Nikhil and Nameer, 2017), Peppara Wildlife Sanctuary (Christopher and Jayson, 1996; Raj, 2013), Periyar Tiger Reserve (Kurup and Joseph, 2001), Silent Valley National Park (Balakrishnan 2005; Sanghamithra and Nameer, 2018), Anamalai Tiger Reserve, Nelliyampathy Reserve Forest, Pampadum Shola National Park (Krishna and Karnad, 2010), Parambikulam Tiger Reserve (Sreehari and Nameer, 2016). The feeding, basking, and activity pattern of Nilgiri Marten was recorded from Pampadum Shola National Park. Forty-two independent sightings were recorded. The observed scats of the species contained hairs, nails, bones, and some seeds. And they also found that the species is most active during the daytime (Anil *et al.,* 2018). Nilgiri Marten is a Vulnerable as per IUCN red listing (Mudappa *et al.*,2015).

2.2.1.3.Smooth-coated Otter *Lutrogale perspicillata* Saint-Hilaire, 1826

A detailed study on the ecology of Smooth-coated Otter (*Lutrogale perspicillata*) in the National Chambal Sanctuary was conducted by Hussain (1993). The diet of Smooth-coated Otter mainly comprised of fish (more than 80%) (Hussain and Choudhury,1995, 1997, and 1998). The mean group size of the species in the Chambal Sanctuary was found to be 4.62 (±0.11) (Hussain, 1996 and 1998). Hussain and Choudhury (1997b) studied the distribution of the species in the National Chambal Sanctuary, and it identified that otters have a patchy distribution lengthwise the river. The otter preferred rocky banks followed by clayey parts, vegetated banks, and marshy and sandy banks. The species is heavily hunted in the Palani Hills, Tamil Nadu (Meena, 2002). During transect survey for tiger sites, Smooth-coated Otter sites were also recorded and the authors put forward the possibility of effects of changes in the fresh-water flow to the mangroves to the biodiversity in the region and to the Smooth-coated Otter population in the areas as they are the top predator of an aquatic ecosystem (Manjrekar and Prabu, 2014). From studying the past and present distribution of Smooth-coated Otters in Gujarat, it is found that the otter population is declining in the state and the species is having fragmented and isolated populations in the state (Suthar *et al.,* 2017). Smooth-coated Otters were camera trapped from Gavier Lake in Surat, Gujarat (Trivedi and Joshi, 2018). A single photograph of a solitary Smooth-coated Otter was recorded during a camera trap survey in Bandhavgarh Tiger Reserve, Madhya Pradesh (Rather *et al.,* 2019). This species is Vulnerable under *The IUCN Red List of Threatened Species* (de Silva *et al.,* 2015).

2.2.1.4.Eurasian Otter *Lutra lutra* Linnaeus, 1758

Eurasian Otters were usually observed in large streams of Sikkim (Ganguli-Lachungpa, 1989). Ramakantha in 1995, confirmed the first report on the occurrence of Eurasian Otter in Manipur. The species is unusual or infrequent in the regions of Ladakh (Shawl *et al.,* 2008). The species recorded from the Satpura Tiger Reserve, Madhya Pradesh based on the camera trap images. It is considered as the first photographic evidence of the species from central India (Joshi *et al.*, 2016). First photographic evidence of the species presence in Balaghat forest in Madhya Pradesh was reported by Jena *et al.* (2016). The very first photographic evidence and molecular evidence of the species was recorded from the Valparai plateau in 2016. It was roadkill of the species (Mudappa *et al.*, 2018). It is Near Threatened under *The IUCN Red List of Threatened Species* (Ross et al., 2015).

2.2.1.5.*Asian Small-clawed Otter Aonyx cinereus* Illiger, 1815

Asian Small-clawed Otters are sympatric with Eurasian Otter and Smooth-coated Otter in the majority of their distribution ranges (Hussain *et al.*, 2011). Altitude and stream order was found to be the two best predicting factors for the habitat occupancy of Asian Small-clawed Otter (Perinchery, 2011). The habitation and concentration of habitat use of Asian Small-clawed Otter in the Western Ghats were examined by Prakash *et al.* (2012). He discovered that the otters have a preference towards locations with burrows, boulders, and large fallen logs. Unaltered streams with fragments of forest patches and riparian vegetation enable the species to thrive in human-modified habitats. The northern extension of the distribution of the species in the Western Ghats is confirmed by the records from Maharashtra and Goa (Punjabi *et al.*, 2014). The occurrence of the species from various parts of Odisha has been recorded by Mohapatra *et al.* (2014) and this includes Karlapat WLS, Kotagarh WLS, Similipal Tiger Reserve, Muniguda, Gandahati, and Gadadi. They also observed that the species is distributed through perennial streams in the ecosystem. They are also moderately tolerant of human disturbances. This species is Vulnerable under *The IUCN Red List of Threatened Species* (Wright *et al.,* 2015).

2.3.FAMILY VIVERRIDAE

2.3.1. Viverridae studies in India and the Western Ghats

2.3.1.1.Malabar Civet *Viverra civettina* Blyth, 1862

Malabar Civet *Viverra civettina* is described by Blyth (1862) which was a large civet species in the Western Ghats (Pocock, 1933). The next available information about Malabar Civet was by Jerdon (1874). The species is reported that species was common all over the Malabar coast from Travancore. Most of the species reports are from coastal regions of the Kerala part of Western Ghats (Jerdon, 1874; Pocock, 1939; Prater, 1971). Other records of the species include Bhagavathy Valley, Karnataka (Karanth, 1986), Tiruvalla, Kerala (Kurup, 1989).

Even though a survey conducted in Kerala obtained a stuffed animal and skin (Ashraf *et al*., 1993), an extensive survey conducted in Nilambur and adjacent areas, a possible species habitat could not get any proof for the existence of the species in the area (Rai and Kumar, 1993). Many detailed surveys have been conducted in the Southern parts of the Western Ghats for getting direct evidence for the presence of the species. Unfortunately, all the results obtained were negative for the species occurrence (Jayson, 2007, Rao *et al.,* 2007, Ashraf *et al.,* 2009). A review on the previous reports of the species, and the museum collections, the authors reached two deductions. The first one suggests that the species was highly rare and might be extinct or nearly extinct in its habitats. The second conclusion was more of a possible one, where the species was a synthesized object and did not present at all. The reason behind this conclusion was the ambiguity in the data tagged along with the specimens of the species kept in the museums. They also suggest that the individuals reported might be misidentified individuals of Large-spotted Civet *Viverra megaspila* that might have escaped into the wild while the trade to India for the use in perfume industries. (Nandini and Mudappa, 2010).

2.3.1.2.Small Indian Civet *Viverricula indica* Saint-Hilaire, 1803

A study on the captive Small Indian Civet found that the majority of the individuals are collected from the wild. This will negatively affect the wild population of the species as no captive breeding programs were done (Balakrishnan and Sreedevi, 2007). The first record of Small Indian Civet from Kashmir Himalaya, India is stated by Charoo *et al* (2010). During the analysis of the diet of Leopard *(Panthera pardus),* remnants of Small Indian Civet were found frequently in the scats (Athreya *et al.*, 2014). A probable first incident of rabies in Small Indian Civet was reported from south India from Pilikula Biological Park, Mangalore. It is important to study the transmission of diseases in wildlife; otherwise, it may create higher risks to threatened species (Vaseem and Raghuram, 2017). Roadkill of the species was reported from Guwahati, Assam on the NH 37 which passes through a scrub forest in the area (Mahananda and Jelil, 2017). Under *The IUCN Red List of Threatened Species,* it is reported as Least Concerned (Choudhury *et al.,* 2015).

2.3.1.3.Common Palm Civet *Paradoxurus hermaphrodites* Pallas, 1777

Differences in the coats of individuals of Common Palm Civet found in northeastern India and South India were observed both in their summer and winter coats (Ramakantha, 1995). Fruit matter was found to be the major portion of the diet of the species in the semi-urban locations in Thiruvananthapuram, Kerala. The scats also contained animal matters like bones, hairs, and blood (Krishnakumar and Balakrishnan, 2003). Borah and Deka (2011) observed the mating behavior of the species from Assam. The pair were copulating on a tree branch during the daytime. The study reported that the Common Palm Civet feeds on 18 fruit species as a minimum. The study also reported the high germination rate of the seeds collected from the scat of Common Palm Civet. It was camera trapped during the camera trap survey as a component of a program to assess carnivore and prey species abundance in Namdapha National Park, Arunachal Pradesh (Datta *et al.*, 2008). The species was identified as a very good example of zoophily in the forest trees. The germination percentage of seeds from the feces of civet was found to be higher than usual (Jothish, 2011). A Common Palm Civet with a bird kill was photo captured from Valmiki Tiger Reserve, Bihar during a camera trap study for the Tiger in the Tiger reserve (Maurya *et al.*, 2017). Two incidents of color aberration in the coat of Common Palm Civet have been reported from Karnataka and Maharashtra. They also suggest further study on such individuals to identify polymorphism and the possibility of subspecies within Common Palm Civet (Chunekar *et al.*, 2018). Common Palm Civet was photographed for the first time from the mangroves of Godavari district of Andhra Pradesh (Malla *et al.*, 2019). It is reported to be Least Concerned in *The IUCN Red List of Threatened Species* (Duckworth *et al.*, 2016).

2.3.1.4.Brown Palm Civet *Paradoxurus jerdoni* Blanford, 1885

Brown Palm Civet is a high-altitude small carnivore species that is endemic to Western Ghats (Mudappa, 1998). Some of the published reports of Brown Palm Civet are from Coorg (Schreiber *et al.*, 1989) Silent Valley National Park (Ramachandran, 1990; Sanghamithra and Nameer, 2018), Kakachi Upper Kodayar (Ganesh, 1997), Anamalai hills (Mudappa, 2001), Parambikulam Tiger Reserve (Sreehari and Nameer, 2016), Eravikulam National Park (Nikhil and Nameer, 2017), and Wayanad Wildlife Sanctuary (Sreekumar and Nameer, 2018). It is believed that Brown palm Civet has distribution ranges from Kalakkad Mundanthurai Tiger reserve, Tamil Nadu in the Southern tip of

Western Ghats to Bhagwan Mahaveer Wildlife Sanctuary in Goa. The species was reported from the Satara district of Maharashtra and suggested the extension of distribution to the north of Goa. An albino individual of the species was documented from Amboli hill station, Maharashtra. It was the foremost event of pelage anomaly reported on Brown Palm Civet (Chunekar, 2014). Brown Palm Civet was recorded from the Satara district of Maharashtra, and the authors believe that the reports will fill up the gap in the prevailing areas south of the known north record of the species (Sayyed *et al.*, 2019). It is reported to be Least Concerned in *The IUCN Red List of Threatened Species* (Duckworth *et al.*, 2016).

2.4.FAMILY HERPESTIDAE

2.4.1. Herpestidae studies in India and Western Ghats

2.4.1.1.Indian Grey Mongoose *Herpestes edwardsii* Saint-Hilaire, 1818

The Indian Grey Mongoose is found throughout India except in the high Himalayas (Menon, 2014; Mudappa, 2013). Predatory behavior of Indian Grey Mongoose on Gharial eggs had observed (Choudhary, 1981). The species is highly hunted for furr in making brushes and also live captured and traded as pets. This might be due to the fact that they are present near to human habitations (Shekhar, 2003). It is considered as Least Concerned in *The IUCN Red List of Threatened Species* (Choudhury *et al.*, 2013).

2.4.1.2.Ruddy Mongoose *Herpestes smithii* Gray, 1837

Ruddy Mongoose could climb trees and they often hunt animals from trees and sometimes carries their prey to trees for feeding (Shekhar, 2003). It was observed that the species forage on forest floors, around the tree trunks, and under rocks (Shekhar, 2008). The occurrence of the species was reported from

Parambikulam Tiger Reserve and Chinnar Wildlife Sanctuary, Kerala (Sreehari *et al.*, 2013). The north-western extension from its known distribution was confirmed by a photo captured from Eserna hill range, in the western part of the Aravalli Hills (Dookia, 2013). It is considered as Least Concerned in *The IUCN Red List of Threatened Species* (Mudappa and Choudhury, 2016).

2.4.1.3.Brown Mongoose *Herpestes fuscus* Waterhouse, 1838

Brown Mongoose have been reported from various parts of the Western Ghats like Kalakkad Mundanthurai Tiger Reserve, Kerala (Mudappa, 2002), Anamalai Tiger Reserve (Mudappa *et al.,* 2007), Valaparai, Tamil Nadu (Mudappa *et al.,* 2007, Navya *et al.,* 2014), Peerumedu, Kerala (Mudappa *et al.,* 2008), Parambikulam Tiger Reserve, Kerala (Sreehari *et al.,* 2013) and Eravikulam National Park, Kerala (Sreehari *et al.,* 2013, Nikhil and Nameer, 2017, Sreehari *et al.,* 2020), High Wavy Mountains, Tamil Nadu (Sreenivas *et al.,* 2013), Silent Valley National Park, Kerala (Sanghamithra and Nameer, 2018), Pambanar; Periyar Tiger Reserve; Shendurney Wildlife Sanctuary; Peppara Wildlife Sanctuary (Raman *et al.,* 2020). It is Vulnerable as per *The IUCN Red List of Threatened Species* (Mudappa and Jathanna, 2015).

2.4.1.4.Stripe-necked Mongoose *Herpestes vitticollis* Bennett, 1835

The reviewed status, distribution, food, and feeding habits of Stripe-necked Mongoose were studied (Rompaey and Jayakumar, 2003). They also reviewed the reproduction and threats of the species. The distribution of the species was only known from the southern Western Ghats of India and Sri Lanka. Camera trap images and direct observations on the species in the states of -Maharashtra and Goa confirmed the northern extension of distribution of the species (Punjabi *et al.*, 2014). A camera trap photograph was obtained from Papikonda National Park, Andhra Pradesh, Eastern Ghats (Balaji and Satyanarayana, 2013). The species recorded from Similipal Tiger Reserve, Odisha confirmed its existence in Eastern India. And the study also suggests further systematic research in the Eastern Ghats and adjacent areas (Nayak *et al.*, 2014). It is Least Concerned as per *The IUCN Red List of Threatened Species* (Mudappa *et al.*, 2016).

2.5.FAMILY FELIDAE

2.5.1. Felidae studies in India and Western Ghats

2.5.1.1.Jungle Cat *Felis chaus* Schreber, 1777

Chavan (1987) studied the status of lesser cats in Gujarat. Some studies on the melanism in Jungle Cat *Felis chaus* were carried out by Chakraborty *et al*. (1988). Gogate (1997) surveyed the lesser cats of Maharashtra and listed five species of lesser cats including Jungle Cat. Jha (2000) reported the species from Sikkim. Gupta (2000) reported the illegal trade of Jungle Cat for meat in the Nilgiri Biosphere Reserve. Duckworth *et al*. (2005) studied the population status of Jungle Cat on the Indo-China border. They reported that Jungle Cats have a threatened population over there. They also found out that the Jungle Cat is a widespread and adaptable species. Mukherjee and Groves (2007) studied the geographic variations in Jungle Cat. Patel (2011) recorded three species of small cats, includes Jungle Cat *Felis chaus,* Rusty-spotted Cat *Prionailurus rubiginosus,* and Asiatic Wild Cat *Felis silvestris* from eastern Gujarat. He also recorded the major diet of the three small cats. Mukherjee *et al*. (2004) studied the significance of rodents in the diet of Caracal *Caracal caracal* and Jungle Cat *Felis chaus*. They found that the rodents provide up to 70% of the daily metabolizable energy in lesser cats. The study shows that the conversion to agriculture destroys the natural cover of the area which is essential for the hunting of felids. This cover should be protected in order to conserve our lesser cats as they play a very important role in controlling rodent pests. It is reported as Least Concern in *the IUCN Red List of Threatened Species* (Gray *et al.*, 2016).

2.5.1.2.Rusty-spotted Cat *Prionailurus rubiginosus* Saint-Hilaire, 1831

The majority of the published literature on Rusty-spotted Cat *Prionailurus rubiginosus* were occurrence reports. Very little knowledge was existing on the ecology and habitat of the species (Jackson, 1998; Mukherjee, 1998). Most of the literature on Rusty-spotted Cat were incidental reports. Very little information is available on the ecology and habitat of the species (Digveerendrasinh, 1995; Jackson, 1998; Mukherjee, 1998). The Rusty-spotted Cat has been reported from Jammu and Kashmir (Chakraborty, 1978), Gujarat (Chavan *et al*., 1991; Patel, 2011; Vyas *et al*., 2018), Rajasthan (Tehsin, 1994; Nayak *et al.,* 2017), Madhya Pradesh (Digveerendrasinh, 1995), Tamil Nadu (Jayson and Christopher, 1996; Pillay, 2009; Mukherjee and Koprade, 2014; Guptha and Ramanujam, 2017), Orissa (Acharjyo *et al.,* 1997), Maharashtra (Dubey, 1999; Karnat, 1999) and Andhra Pradesh (Rao *et al.,* 1999; Manikandan and Sivakumar, 2006; Mali and Srinivasulu, 2015; Aditya and Ganesh, 2016). There are only a few published reports of this species from Kerala part of the Western Ghats. The earlier reports of the Rusty-spotted Cat from Kerala, includes camera trap images from Periyar Tiger Reserve and Parambikulam Tiger Reserve, direct sighting from Wayanad Wildlife Sanctuary, roadkill of the species from Chinnar Wildlife Sanctuary (Shameer *et al*., 2019), and a captive animal from Pushpagiri hospital, Thiruvalla in Kottayam district (Easa *et al*., 2001). In a 20 year long observations both opportunistic and planned surveys on Rusty-spotted Cat, a total of 51 records have been made. Among the 51 records 41.18% were direct sightings, 39.22% were camera trap images, 11.76% were rescued and 7.84% were roadkills (Sharma and Dhakad, 2020). It is a Near Threatened species, as per the *IUCN Red List of Threatened Species* (Mukherjee *et al.,* 2016).

2.5.1.3. Leopard Cat *Prionailurus bengalensis* Kerr, 1792

Leopard Cats have a widespread distribution in India through various habitats including rain forests to coasts and to high altitudes to dry coniferous forests (Sunquist and Sunquist, 2009). In the Western Ghats it is reported from Peppara Wildlife Sanctuary (Jayson and Christopher, 1996), Kalakkad Mundanthurai Tiger Reserve (Mudappa, 2002), Bilgiri Rangaswamy Temple tiger reserve (Kumara *et al.*, 2014), Parambikulam Tiger Reserve (Sreehari and Nameer, 2016), Eravikulam National park (Nikhil and Nameer, 2017), Wayanad Wildlife Sanctuary (Sreekumar and Nameer, 2018) and Silent Valley national park (Sanghamithra and Nameer, 2018). They also reported that the sighting of nocturnal mammals has become rare in the Western Ghats. The species was reported from various parts of India, they were from Sikkim (Jha, 2000; Kathiawar and Srivastava, 2014), Namdapha National Park Pradesh (Datta *et al.*, 2008), Khangchendzonga Biosphere Reserve (Sathyakumar *et al.*, 2011). The diet of the species was analyzed from the Sundarbans. It was found that rodents were the preferred prey of Leopard Cat and other food items include insects, birds, plant parts, crabs, and agamids (Khan, 2004). It is reported as Least Concern in *the IUCN Red List of Threatened Species* (Ross *et al.*, 2015).

2.5.1.4. Fishing Cat *Prionailurus viverrinus* Bennett, 1833

The distribution of Fishing Cats in West Bengal was restricted to Sundarbans due to habitat destruction and (Bhattacharya, 1989). The feeding habits of the Fishing Cat were reported from Keoladeo National Park (Nayerul and Vijayan, 1993). Scavenging habits of the species were observed from Rajasthan (Haque and Nayerul, 1998). The species was reported from Sikkim (Jha, 2000), Terai region, Himalaya, and from northeastern India (Choudhury, 2003). The coastal areas and potential Fishing Cat habitats in Kerala were extensively surveyed and no evidence for existence was found. They concluded that the species might be locally extinct from the area or the species might never be present in the location (Janardhanan *et al.,* 2014). Molecular analysis was done on the small carnivore scats collected from various fishing habitats of the country. The presence of the species was found from Sundarbans, Hoogly, Howrah of West Bengal; Dudhwa and Katarniaghat Tiger Reserve, Uttar Pradesh; Keoladeo Ghana National Park, Rajasthan; Mangajodi, Odisha and Coringa mangroves, Andhra Pradesh (Mukherjee *et al.,* 2012). From a detailed biodiversity inventory of the species in Odisha. The distribution of the species was confined to mangroves, coastal belts, and swamps near paddy fields (Palei *et al.,* 2018). It is reported as Endangered in *the IUCN Red List of Threatened Species* (Mukherjee *et al.,* 2010)

2.6.OTHER SMALL CARNIVORE STUDIES IN INDIA

The distribution and ecology of viverrids and mustelids of Manipur were studied (Ramakantha, 1995). One of the pioneering studies on small carnivores of Western Ghats was from Nilgiri Biosphere Reserve (Yoganand and Kumar, 1995). A small carnivore study in Arunachal Pradesh and Assam reported 23 species (Choudhury, 1997a, 1997b, 2002). Camera traps were used to survey small carnivores of Darjeeling, giving preference to the Red Panda *Ailurus fulgens* (Bahuguna, 1998).). Twenty-two species of small carnivores were reported from Bengal (Choudhury, 1999). Nineteen small carnivore species were recorded from Nagaland during a study (Choudhury, 2000).

The major diet of Red Panda includes leaves of the bamboos *Actinidia maling* and *A. aistata.* The species also consume bamboos shoots and fruits or berries. In Sinpatterns National Park, West Bengal, free-roaming cattle communities found around the forest impose a threat to Red Panda and its habitats (Sunita *et al*., 2001). The small carnivore status of the state Assam was given by Choudhury (2004). Conservation status and presence of small carnivores in two different protected areas of Arunachal Pradesh were studied and 18 small carnivores along with all the three otters found in the country were reported (Datta *et al.*, 2008). The threats to Red Panda were analyzed during a study in species habitats in West Bengal. They also suggested various activities needed for the conservation of the species (Mallick, 2010). Asiatic Golden Cat was photographed for the first time from Buxa Tiger Reserve, West Bengal. Polymorphic individuals of the species were recorded during the study (Ghose *et al.*, 2019).

2.7. ACTIVITY PATTERNS OF SMALL CARNIVORES

Common Palm Civet and Small Indian Civet showed nocturnal activity in a study analyzing the niche partitioning of sympatric small carnivores, where Small Indian Civet showed less activity just after sunset and activity peaks during 1900hrs-2200hrs and 0030hrs-0300hrs (Su and Sale, 2007). Small Indian Civet showed a variation in activity peaks in nocturnal activity between the two study areas. One location had a peak towards dusk and another with peak during midnight hours (Gerber *et al.*, 2012). Diel activity pattern of Giant Otters (*Pteronura brasiliensis*) in Brazil have been studied using radio telemetry and camera traps. They found that the Giant otters are mostly diurnal and crepuscular *(*Leuchtenberger *et al.*, 2013*)*. Camera trap images were used to study the activity pattern of the Leopard Cat in Khangchendzonga Biosphere Reserve. It is found that they are nocturnal with an activity peak between 0200-0300 hrs. This activity pattern was contradicting with sympatric carnivores and coincided with that of Murids which is Leopard Cats' primary food source (Bashir *et al.*, 2014). Other than food availability, the temperature and human disturbances affect the activity pattern of Smooth-coated Otters of North Luangwa Valley, Zambia. Activity patterns of the species varied between winter and summer. They were more active during the daytime in winter than in summer. Considering the behavior of the animal, most of the time Smooth-coated Otters are observed to be traveling followed by grooming (White, 2013).

Nine small carnivore species were camera trapped from Wayanad Wildlife Sanctuary. All the three civets recorded from the sanctuary showed pre-midnight activity patterns with varying peak activity between the species. Small Indian Civet showed more activity towards early morning hours and Common Palm Civet showed multiple activity peaks after the midnight hours. Whereas Brown Palm Civet had activity peaks towards pre midnight hours. By analyzing the activity pattern of Stripe-necked Mongoose and Ruddy Mongoose it is found that both of the species have a diurnal dial activity pattern. The Stripe-necked Mongoose had an activity peak towards the morning hours (Sreekumar and Nameer, 2018). The activity pattern of seven small carnivores of the oil palm landscape of Sumatra is studied using camera traps. Yellow-throated Marten showed a diurnal activity pattern. And all other six viverrids (Banded Palm Civet *Hemigalus derbyanus,* Binturong *Arctictis binturong,* Common Palm Civet *Paradoxurus hermaphrodites*, Malay Civet *Viverra tangalunga,* Masked Palm Civet *Paguma larvata*, Small-toothed Palm Civet *Arctogalidia trivirgata*) detected showed nocturnal activity pattern with varying activity peaks (Solina *et al.*, 2018). Activity pattern of Nilgiri Marten is observed from Pampadum Shola National Park and it is found that the species is active during day hours and shows peak activity during 0900 hours-1100 hours and 1500 hours -1700 hours (Anil *et al.*, 2018).

Small Indian Civet and Indian Grey Mongoose showed a diurnal activity pattern in the tropical dry evergreen forests of Villupuram district, Tamil Nadu. Common Palm Civet was nocturnal in the region. Both Golden Jackal and Jungle Cat in the area had cathemeral activity patterns. From the diel activity overlap studies, it was observed that Golden Jackal and Jungle Cat have the highest (78%) overlap in the activity followed by Common Palm Civet and Jungle Cat (77%) (Selvan *et al.*, 2019). In northeast India, Asiatic Golden Cat and Marbled Cats were active during the daytime hours, while Clouded Leopard was active during crepuscular hours and Leopard Cat was primarily nocturnal. Marbled Cat and Asiatic Golden Cat had the highest overlap in the activity pattern (82%), Leopard cat and Clouded Leopard had 79% overlap (Mukherjee *et al.,* 2019).

Resource availability influences the diel activity of small carnivores. The activity pattern of Leopard Cat, varied between seasons with high prey base and low prey base. The Leopard Cat showed a crepuscular pattern when the food was abundant and showed cathemeral activity when the food was scarce. Common Palm Civet was strictly nocturnal without showing much variation between times of low and high food availability. Small Indian Civet was also nocturnal with a peak between 0300-0600hours. Small Asian Mongoose showed a strict diurnal activity irrespective of the food availability (Petersen *et al.,* 2019). Leopard Cat of Ziwuling National Nature Reserve and Qiaoshan Provincial Nature Reserve, China was more active during night hours than the day hours. Asain Badger and Masked Palm Civet showed nocturnal activity pattern. The Yellow-throated Marten was a diurnal species with some activity in crepuscular hours. Siberian Weasel had diurnal activity (Zhao *et al.*, 2019). Activity pattern of mammals of Manas National Park were assessed from camera trap images and it is found that, *Felis Chaus, Melogale moschata* and *Manis pentadactyla* were nocturnal species and *Prionailurus bengalensis*, *Viverra zibetha* and *Viverricula indica* were mostly nocturnal. Whereas, *Herpestes auropunctatus, Herpestes edwardsii, Herpestes urva*, and *Martes flavigola* were diurnal species and *Lutrogale perspicillata* was mostly diurnal. *Paradoxurus hermaphrodites* showed a cathemeral activity pattern (Bhatt *et al.,* 2020).

2.8. HABITAT PREFERENCES OF SMALL CARNIVORES

In study done on Common Palm Civets of Nepal, it was reported that Common Palm Civets chose tallest and largest trees preferably with vines or holes for resting (Joshi *et al.*, 1995). Anoop and Hussain (2004) have studied the factors affecting habitat selection by Smooth-coated Otters in Kerala. A segregation of areas selected by otters was observed in regions characterized by low water depth and width, where the area has a gentle slope and less rockiness and where a greater number of streams join the lake. It is found that the Smooth-coated Otters preferred river banks with loose sand as otter sites and they try to avoid areas with human disturbances (Shenoy *et al.*, 2006). Niche differentiation among the Small Indian Civet and Common Palm Civet was studied in Myanmar and it is found that their foraging storeys varied considerably. Small Indian Civet was majorly ground dwelling species whereas Common Palm Civet was generally foraging on the higher stories (Su and Sale, 2007).

The Presence of Small Indian Civet in Taiwan was positively influenced by humidity, gradual slopes, elevations, and number of woody species. The Masked-palm Civet was positively affected by steeper slopes, lower elevations, and canopy cover. The distribution of the species is negatively affected by moisture availability. (Chen *et al.*, 2009). In the Swat and Dir district, Pakistan, Eurasian Otter population has decreased considerably by 49.5% due to various factors like over human population, habitat destruction, hunting, reduction in prey base, and roadkills. In a survey conducted among the people it reported that otters were killed for pelts (47%), hunted due to competition for fish (13%), and for consuming (11%). Humans cause immense threat to otters, both directly and indirectly (Ullah *et al.*, 2012).

Distribution pattern of small carnivores have been predicted in response to environmental factors in Mudumalai Tiger Reserve, Western Ghats. It was found that the distribution of *Felis chaus*, *Paradoxurus hermaphroditus*, and *Herpestes smithii* were influenced by distance to villages and precipitation during the warmest months Whereas, *Viverricula indica* was inclined by distance to villages and aspect. Distance to village and rainfall for the period of coldest months were significant for *Herpests vitticollis*. Distance to villages, precipitation during warmest months and land cover were substantial for *Herpestes edwardsii* (Kalle *et al.*, 2013a). Ecological Niche Factor Analysis (ENFA) was used to predict the habitat suitability model for Leopard Cats of

Khangchendzonga Biosphere Reserve. The best predictors for the presence Leopard Cat in the area were the altitude, prey abundance and tree cover. The cats preferred a lower elevation (Below 2750 m AMSL) in the Eastern Himalayas (Bashir *et al*., 2013). For the day beds Common Palm Civet chose oil palm trees with more leaves and thick fern density. Regarding the home range of the species, home ranges were overlapped between and within the sexes and they vary with season. It is found that food availability plays an important role in the space use of the species (Nakashima *et al*., 2013).

Habitat preferences of small carnivores were studied in Sumatra. The number of species recorded and several macro and micro habitat variables were related and found significant positive relationship between canopy closure and greater distance from the forest. The number of species detection was more in fragmented landscapes which might be due to the edge effect (Solina *et al,* 2018). Small Asian Mongoose had a strong association with dry dipterocarp forests of Sakaerat Biosphere Reserve, Thailand, irrespective of prey base availability. The authors also predict that the occurrence of a habitat specialist species would favor specific habitat types nevertheless of the food base availability (Petersen *et al.,* 2019). Newly, the effect of climate change on the ecological niche of *Herpestes fuscus* in Western Ghats was studied and it identified that the niche of *Herpestes fuscus fuscus* was critically influenced by temperature, rainfall, and topography. The model estimates the currently suitable habitats were mostly towards the south of the Palghat Gap. The model predicted a decline in suitable habitat for the species in the future (Raman *et al*., 2020).

2.9. FOOD AND FEEDING HABITS OF SMALL CARNIVORES

Feeding of two Stripe-necked Mongoose on two days old tiger kill of a sambar was observed during day time, whereas the tiger was feeding on the kill during night time (Ramachandran, 1985). The feeding ecology of Smooth-coated Otters was studied in Periyar Tiger Reserve, Kerala. The diet analysis of the species revealed that fishes comprised of the major prey item followed by amphibians, birds, and invertebrates (Anoop and Hussain, 2004). The authors observed an incident of Yellow-throated Marten feeding on flowers in Balpakram National Park in Meghalaya (Nandini and Karthik, 2007). Generally, the fecal deposition sited of carnivores are often rocky, dry, nutrient-poor locations and hence seed dispersed by carnivores may have higher mortality chances (Nakashima *et al.*, 2010). Brown Palm Civet was found to be a frugivorous species. Ninety-seven percent of the scats sampled contained fruits followed by invertebrates (11%), vertebrates (3%), and flowers (1.48%) (Mudappa *et* al., 2010). In a majority of the small carnivores of India, feeding ecology is studied poorly (Kalle *et al.*, 2012).

Mongoose are omnivorous species that prey upon a variety of resources. The major diet includes invertebrates (48%), small mammals (18%), fruits (16%), reptiles (7%), birds (4%), other plant parts (3%), and carrion and fishes (1% each) (Kalle *et al.*, 2012). Leopard Cat majorly preyed on small mammals (82%) were 89.2% of the scats comprised of Murids followed by 21.62% of Pikas and 10.81% of birds (Bashir *et al.*, 2013). Common Palm Civet showed a frugivorous diet both in oil palm plantations and in secondary forests. Oil palm fruits in the feces consisted of 44% and it was the major component in the diet in the plantations and figs and other fruits consisted of 45% (Nakashima *et al.*, 2013). Fish was the most frequent prey item of Neotropical Otter *Lontra longicaudis* with 57.8% of all food followed by rodents, birds, amphibians, and snakes. They also show a change in diet composition between the seasons however fish were the primary food choice. Rodents were also consumed in all the seasons. Birds were consumed in the majority of the seasons studied and half of the studied seasons included snakes (Souza *et al.*, 2013).

Delibes-Mateos *et al.* (2014) has done a survey on the feeding habits of Eurasian Otter and it showed that fishes were the major food of otters in Portugal. They also found out that at the estuaries the otters feed on larger fishes compared to other areas. A study on the indigenous knowledge of people of the Cauvery deltaic Region in Tamil Nadu about the Common Palm Civet showed the diet of the species includes both tender and ripened Coconut, palm fruits, vegetables, mangoes and insects, rats, and herons. The data was obtained by interviewing the local people (Paramanandham and Pradhap, 2016). The diet composition of Eurasian Otter in different freshwater habitats of Europe has primarily included fishes followed by amphibians, birds, mammals, and insects. The otters in still water fed greatly on fishes compared to the otters in flowing water and the percentage of fish in the food were more in water bodies with vegetation on the bank compared to other land uses (Krawczyk *et al.,* 2016).

Scats of Nilgiri Marten were observed during a study, and they found probable remains of small mammals and some seeds. They also recorded an incident of the species chasing and killing a *Moschiola indica* from Pampadum Shola National Park (Anil *et al.,* 2018). Food habits of Common Palm Civet were studied during the winter season in Patna Bird Sanctuary, Uttar Pradesh. It was observed that the species is omnivorous species mostly foraging on fruits (39.28%). Other food items documented were insects (29.46%), carnivores (21.42%), and others (9.82%). A carnivorous portion from the roadkill of Jackal scavenged by Common Palm Civet. Plastic content was also identified from the scats (Khan *et al.,* 2019). Feeding of Stripe-necked Mongoose on invertebrates from the fresh Asian Elephants dung piles was directly observed on two occasions from the Periyar Tiger Reserve, Kerala (Syamili *et al.,* 2019).

2.10. THREATS TO SMALL CARNIVORES

Small carnivores are threatened in many ways. Mongooses were severely hunted for bushmeat and their hair for making brushes and charms (Hanfee and Ahmed., 1999). The major threats faced by the Small Indian Civets *Viverricula indica* are the illegitimate hunting for meat and civetone, habitat destruction, along other anthropogenic causes (Gupta, 2000). The Brown Palm Civets were threatened by illegal hunting and the conversion of rainforest into tea and coffee plantations (Nandini *et al.*, 2002). The skin of the Small Indian Civets was also used for the preparation of Ayurvedic medicines against epilepsy (Gupta, 2004). Smooth-coated Otters of south Indian river systems were found to be threatened by habitat destruction due to developmental projects reclamation of wetlands for settlements and agriculture, reduction in pry biomass, poaching, and contamination of waterways (Shenoy *et al., 2006)*. Civets were seen as a threat to the orchards and poultry and were often killed on sight or captured. Among the civets in the pet trade young individuals are frequently observed in the markets than adult individuals (Shephered, 2008).

Asian Small-clawed Otters are traded for their meat, as pets and to use in some traditional medicines. 36.9% of the respondents said that otters were poached mainly out of curiosity. Many of them were killed as pests. Pet trade is also huge as they are cute and tamable animals. The lack of knowledge regarding the significance of the species in the ecosystems increases the threat to their survival (Gonzalez, 2010). Lyngdoh *et al.* (2011) observed that the Spotted Linsang is extensively hunted in Arunachal Pradesh for its fur and meat and thus the species is uncommon. Common Palm Civet is traded extremely for the production of the most expensive coffee, Kopi Luwak or Civet coffee. The demand for the animal and the impact of trade on the species is not studied in detail (Enam, 2012). In 2013, abandoned baggage carrying 11 live otters was seized. Since there were no tags attached no arrest was made (Shephered and Tansom, 2013). The number of otter roadkills is increasing due to the expanding road networks in the otter habitats. Sometimes the road accidents of the species would not cause the death of the individual, but it increases the chance of the animal getting hit by another vehicle or getting caught by a predator. The study also shows that adult male otters are more affected by road accidents. This tendency might be due to the reason that they have a larger home range than females and young males (Grogan *et al.*, 2013).

The Asian Small-clawed Otter has been hunted for its meat and pelts. It is a major threat to the species. In a study conducted in Odisha about the Asian Small-clawed Otter, it is found that the species are hunted and they are also threatened by heavy fishing and hunting crabs. The reduction in the food base has a direct influence on the survival of the species in the area. Sometimes the water body is poisoned for fishing and it would affect the otter directly or indirectly (Mohapatra *et al.*, 2014). In s survey conducted in the wildlife market of Myanmar, otter parts and carcasses were there for sale. Unidentified otter skins, full otter skeletons, and otter carcasses have been identified from the retail shop of the market. It shows how the animals are exploited in the country and it leads to the importance of protecting the animals from hunting and illegal trade (Shephered and Nijman, 2014). Otter trapping and hunting date back to historical times in the marshlands of Iraq. In a recent survey done by the authors among the anglers and fishermen of the area, it found that Eurasian Otter and Smooth-coated Otter are frequently trapped and hunted to keep as pets and for fur. Otters are killed due to the competition for the fish. They sometimes get entangled in the net spread for fishing and when they could not escape from the net by themselves, they get drown and die. In recent times electrofishing was more frequent due to its easiness, which in turn results in the electrocution of the otters (Al-Sheikhly *et al.*, 2014). Hunting of small carnivores was reported from the Namdapha National Park, Arunachal Pradesh. Some are exploited commercially but majorly the hunting was carried out as a result of Human-wildlife conflict (Sethy *et al.*, 2014).

Illegal Wildlife trade has a direct impact on the four species of Otters in Asia, they are Eurasian Otter, Hairy-nosed Otter *Lutra sumatrana*, Asian Small-clawed Otter, and Smooth-coated Otter. In a review of otter trades between 1980-2015, it was found that India had the most number of seizure reports with 51.6% of the total seizure reports. This also suggests the increased otter trade in India and relatively efficient law enforcement in India against the illegal trade in wildlife. Trade of Otter fur was 98.7% of the total seizure individuals. Live animal was only 0.9% and other body parts and carcasses include 0.2% (Gomez *et al.,* 2016). The road kills of small carnivores are often and it is important to study the implications of roads and railway lines passing through unprotected forest lands on the wildlife of the area. The study on the impact of increasing traffic on wildlife is studied majorly in Protected Areas (Mahananda and Jelil, 2017). Road Kill of Eurasian Otter was reported from the Valparai Plateau, Tamil Nadu. The kill was found near the tea plantation. The area included many fragmented rainforest patches and some swamps (Mudappa *et al.,* 2018). A poaching incident on the Common Palm Civet was reported from Nadangiri Reserved Forest, Assam. Two foresters encountered the poachers with a dead Common Palm Civet which was hunted. This hunting may cause reduction in the local population of the species (Jelil *et al.,* 2018).

2.11. HUMAN-SMALL CARNIVORE CONFLICT

Yellow-throated Marten in Barsey Rhododendron Sanctuary was notorious for poultry raids in the villages near to the forest leading to human wildlife conflicts in villages (Ghose *et al.*, 2014). In a study conducted on the human-otter conflict in Thrissur, Kerala, three independent attacks of otters on humans were reported during a three-year period. In one incident the person lost his life. Compensation was given by Kerala Forest Department to the affected persons and family. It is concluded as territorial intrusion by humans might be the reason for triggering the attack by otters (Govind and Jayson, 2018). The attitude and perception of people towards two threatened small carnivores of Chile was studied using semi structured interviews. The attack of carnivores on farm animals creates conflict between humans and small carnivores and it will negatively affect the long-term conservation of the species. In the study area, construction of confinement to the farm is identified as an effective method to reduce the predation of small carnivores on farm animals (Sacristan *et al.,* 2018). Attitude of local people towards Leopard Cat conservation is studied in Taiwan using questionnaire survey. Majority of the interviewed people was positive towards the conservation. Negative attitude towards the conservation of the species was more among the farmers mainly due to the predation of species on poultry (Best and Pei, 2019).

Materials and methods

MATERIAL AND METHODS

In a forest, natural occurrence of any vegetation type is influenced greatly by the collective effects of the habitat factors. In a given habitat these factors have an important role in the presence and survival of different species in the habitat. The factors of habitat are physical features and physiographic features, geology, soil, climate, and biotic factors. The forest types are identified based on these factors. The state Kerala comes under the Tropical zone with the exception of the regions above 1500m Above Mean Sea Level such as Montane subtropical and Montane temperate. The forests in Kerala are broadly classified as Tropical Evergreen Forests, Moist Deciduous Forests, Dry Deciduous Forests, and Montane Forests.

A forest type is a blend of closely similar communities of vegetation, in all of which the alike arboreal species are prevailing and each of which is homogenous regarding the composition of primary layers of vegetation, the complex of site factors, the relations amongst plants and environment, the course of reproduction and changing aspects of succession.

3.1 STUDY AREAS

Forests of Kerala is classified created on the background of Champion's classification. According to this the forests of Kerala is mainly categorized into four groups, Tropical Wet Evergreen Forests, Tropical Moist Deciduous Forests, Tropical Dry Deciduous Forests, and Montane Subtropical Forests. The above said classification is adopted in this study. The study areas selected are given in the Figure 1.

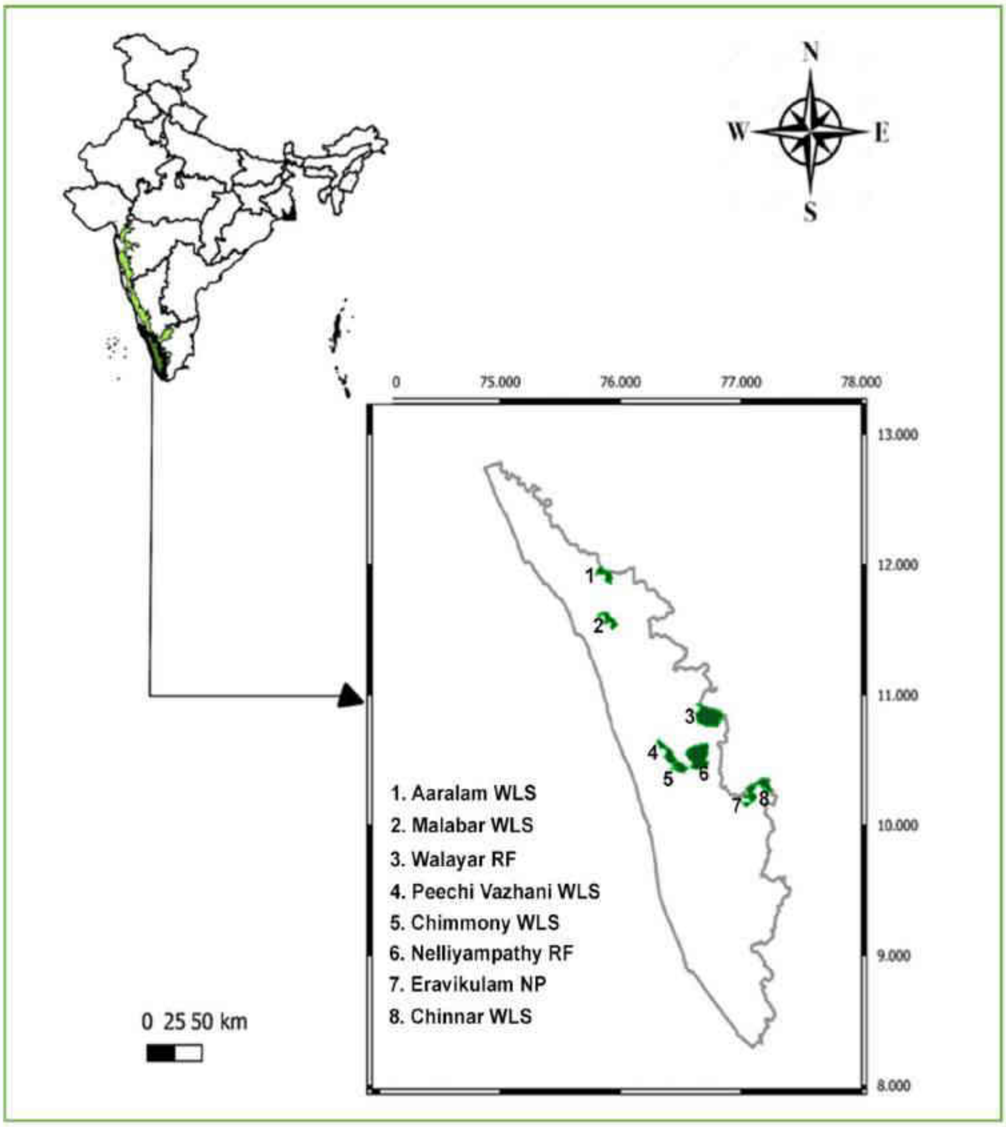

Figure 1. Map showing the study locations

3.1.1. TROPICAL WET EVERGREEN FORESTS

Tropical Wet Evergreen Forests are described as evergreen, hydrophilic plants, trees with at least 30m high, and rich with lianas and epiphytes.

Buttressed roots and cauliflowery are characteristics in evergreen forests. The mean annual temperature is about 26^0 Celsius. The warmest period is from February to May. In the evergreen forests, the Mean annual rainfall is around 3175mm to 7620 mm. considering the rocks and soils present in evergreen forests, rocks are mostly crystalline and metamorphic. Soil differs substantially across the sites. Soil depth is generally low and the humus layer is not very thick. Even though the evergreen forests are present in lower altitudes like 250m, the best form of these forests are present between the altitudes of 610m AMSL to 1057m AMSL. Typical genera of flora present in tropical evergreen forests are Palaquium, Hopea, Vateria, Calophyllum, Mesua, Cullenia, Artocarpus, and Kingiodenddron. According to these characteristics, two protected areas were selected, and they are Nelliampathy Reserve Forest and Malabar Wildlife Sanctuary.

3.1.1.1. Nelliyampathy Reserve Forest

The study was conducted at Nelliyampathy Reserve Forests (NRF), which is part of the Anamalai Hills, southern Western Ghats, India. The Nelliampathy reserve forest lies between 10 42' and 10 62' North and between 76 53' and 76.73' East in the Western Ghats. The total area covered by NRF is 206 sq. km., and the altitude varies from 40m above MSL to 1530m above MSL. The major vegetation type here is West Coast Tropical Evergreen Forest. and the dominant trees are *Cinnamomum malabatrum, Drypetes roxburghii, Holigarna arnottiana, Mesua ferrea, Palaquim ellipticum, Schleichera oleosa, Syzygium cumini,* and *Vateria indica*. The average height of the trees was 28m, the density of trees was 110 trees/ha., and canopy density was 80%. The average temperature varies between 21 °C to 41 °C during summer and the temperature can be as low as 10 °C during the winter in the upper reaches of the Nelliampathies. The mean annual rainfall is 2500 mm (Varghese 2015).

3.1.1.2. Malabar Wildlife Sanctuary

Malabar Wildlife Sanctuary falls in Nilgiri Biosphere Reserve and Wayanad Elephant Reserve. The altitude of the sanctuary ranges between 40m-1506m AMSL. The sanctuary is situated between 11^0 75' and 11^0 76' North latitudes and between 76^0 20' and 75^0 38' East longitudes. Kuttiyadi River is the major drainage in the sanctuary along with many perennial and ephemeral streams. The Tropical Evergreen Forest of the Sanctuary falls between the altitude of 240m AMSL to 1100m AMSL. The mean annual rainfall is 4800mm. The temperature ranges from 16^0 C to 38^0 C. The hottest months are April and May and the coolest months are from December to February.

3.1.2. TROPICAL MOIST DECIDUOUS FOREST

The Tropical Moist Deciduous Forests contains a large number of commercial timber species like teak, rosewood, etc. Under encouraging environments, the crown of the trees is rounded. The fluting of the stem and thick fibrous bark with fissures are characteristics of the trees in this forest. The average temperature varies from 24^0 C to 27^0 C and the average maximum is between 35^0 C to 38^0 C. Mean annual rainfall is between 1651mm to 1778mm. In most parts of the forest, the rock is metamorphic like granite, gneiss, and schist. They are present in a wide range of altitudes. *Tectona grandis* is the most characteristic species of the forest. Other principal species are *Terminalia bellarica, T. paniculata, T. tomentosa, Lagerstroemia lanceaolata, Pterocarpus marsupium, Grewia tilifolia,* and *Adina cordifolia*. According to these characteristics three protected areas were selected, and they are Aralam Wildlife Sanctuary, Chimmony Wildlife Sanctuary, and Peechi-Vazhani Wildlife Sanctuary.

3.1.2.1. Aralam Wildlife Sanctuary

Aralam Wildlife Sanctuary is contiguous with the Wayanad-Brahmagiri hills and Wayanad Northern slopes. The sanctuary is located between 11^0 54' N to 11^0 59' N latitudes and 75^0 47' E and 75^0 57' E longitudes. The sanctuary spans over an area of 55 km^2 and the elevation ranges from 60m AMSL to 1589m AMSL. Cheenkanni River and Urutti River serve as the major drainage in the area. The mean annual rainfall varies from 2800mm to 4700mm with maximum rainfall going up to 6000mm during the southwest monsoon. The average temperature varies flanked by 11^0 C to 40^0 C.

3.1.2.2. Chimmony Wildlife Sanctuary and Peechi-Vazhani Wildlife Sanctuary

Chimmony Wildlife Sanctuary lies between 10^0 22' and 10^0 26' North latitudes and 76^0 31' and 76^0 37' East longitudes. The total area of the sanctuary is 85.067 sq. km. The sanctuary contains Watersheds of Kurumali River and Mupliam Rivers. The altitudes vary from 40m to 1110m AMSL. The annual average rainfall in the sanctuary is 2900mm. The minimum temperature in the area is 15^0 C and the maximum temperature is 36^0 C with the hottest months from March-April.

Peechi Wildlife Sanctuary spans over 125 sq. km. and falls between 10^0 28' and 10^0 38' North latitudes and 76^0 18' and 76^0 28' East longitude. The average rainfall of the area is 3000mm and the temperature varies between 15^0C to 38^0 C. The sanctuary drains into three rivers, Kurumali River, Manali River, and Wadakkanchery River.

3.1.3. TROPICAL DRY DECIDUOUS FORESTS

Tropical Dry Deciduous Forests are found in the rain shadow areas of the state. As their name implies, they are described by low moisture availability and the absence of perennial streams. Temperature varies between 18^0 C to 37^0 C. Dry season in these are not long as that of other dry parts of India due to a good portion of rain received from North East Monsoon. Mean annual rainfall ranges from 880mm to 1150mm. The rocks and soil vary considerably. Major characteristic species of this forest are *Tectona grandis, Anogeissus latifolia* and Terminalia spp. Bestowing to these characteristics two protected areas were selected, and they are Chinnar Wildlife Sanctuary and Walayar Reserve Forest both lies on the leeward side of the Western Ghats.

3.1.3.1. Chinnar Wildlife Sanctuary

Chinnar Wildlife Sanctuary is situated in the eastern parts of the High ranges of the Western Ghats in Kerala. The Chinnar lies between the latitudes of 10^0 15'N to 10^0 21'N and longitudes 77^0 05'E to 77^0 16'E. The total area covered by the sanctuary is 90.44km^2. The altitude varies from 400m AMSL to 2372m AMSL. Two perennial rivers Chinnar and Pambar drain the sanctuary and the valley is deeply eroded by these rivers and their tributaries. The area has a prolonged dry season and very low rainy days as the sanctuary is located in the rain shadow regions of Western Ghats. The annual rainfall ranges from 300mm to 500mm from a very limited number of rainy days ranging between 30 to 40 days. The region has six to seven months of the dry period during the year. Dry Deciduous forest followed by scrub forest is the dominant vegetation in the sanctuary. Dry deciduous forest covers around 30% of the sanctuary. The major species in this forest type are *Anogeissus latifolia, Hardwickia binate, Boswellia serrata, Santalum album, Casia fistula, Sterculia urens,* and *Garuga floribunda.*

3.1.3.2. Walayar Reserve Forest

The Walayar Reserve Forest extends over 125.65km^2 and lies between 76^0 34' to 76^0 55' East longitudes and 10^0 42' to 10^0 59' North Latitudes. The major tree species in this dry deciduous patch include *Anogeissus latifolia,*

Plate 1. Image showing an evergreen habitat of Nelliyampathy Reserve Forest, Kerala

Plate 2. Image showing moist deciduous habitat of Aaralam Wildlife Sanctuary, Kerala

Plate 3. Image showing dry deciduous habitat of Walayar Reserve Forest, Kerala

Plate 4. Image showing grassland habitat of Eravikulam National Park, Kerala

Plate 5. A & B- Camera trap set in the field; C- Fixing camera trap In the field

Alangium salvifolium, Careya arborea, Tectona grandis, Buchanania axillaris, Garuga pinnata, Cassia fistula, Strebulus asper, Holarhena pubescens, and *Clerodendrum infortunatum.* The Walayar River and Malampuzha are the two major drainages of the reserve forest. The minimum temperature is 20^0C and the maximum temperature is 40^0C. The average annual rainfall is 586mm.

3.1.4. MONTANE SUBTROPICAL FORESTS

Montane subtropical forests are distributed in the higher altitudes of the Western Ghats between 1000m AMSL to 2500m AMSL. The mean annual temperature varies from 18^0 C to 24^0 C. The rainfall range lies between 1800mm to 8000mm. Rock types vary considerably from place to place. The soil is between tropical red earth and temperate brown earth. *Syzygium* spp. Are characteristic of this forest and lauraceeals are also generally present. Giving to these characteristics two grasslands have been selected in two protected areas, and they are Eravikulam National Park and Malabar Wildlife Sanctuary.

3.1.4.1. Eravikulam National Park

The Eravikulam National Park is part of the high range mountains of southern Western Ghats. The National Park has located between 10^0 05'N to 10^0 20'N Latitudes and 77^0 00' E to 77^0 10'E longitudes. The national park has an extend of $97km^2$ and the elevation varies from 1500m AMSL to 2695m AMSL. The tropical montane climate is a specialty of the National park. The mean annual rainfall is 4500mm and the park gets major precipitation from June to August. The average day temperature varies between 23-25^0 C during winter. The minimum monthly mean recorded in January is 6.25^0 C and the mean maximum was recorded in February, 24.29^0 C. Winter nights in the park are characterized by frost. The major forest type in the park is Southern Montane Wet Temperate Forest.

3.2. METHODS

3.2.1. Period of observation

The research was conducted from August 2018 to February 2020. We spent at least 30 days in each location.

3.2.2. Site selection

A reconnaissance survey was done in each location for the identification of potential sites of small carnivores. Evidence like scats, spraints, pugmarks, scratches, etc. were taken into concern.

3.2.3. Camera Trap Survey

Camera trapping is one of the finest techniques to study secretive and shy small carnivores. The study used digital scout cameras with passive infra-red sensors for heat and motion detection (Cuddeback attack model C1) camera traps to study the small carnivores of Kerala. The study was carried out from August 2018 to August 2019. Camera trapping stations were identified from the occurrence of scats, pugmarks, and scratches of the small carnivores. The camera traps were kept at a height of 30 cm from the ground and with a separation of at least 250 m from each other (Mudappa *et al.*, 2007; Sreehari and Nameer, 2016; Nikhil and Nameer, 2017; Sanghamithra and Nameer, 2018; Sreekumar and Nameer; 2018). The cameras were set up in default settings. The time delay between the pictures during the day was set as fast as possible, and during the night it was set with a time delay of 5 seconds (Plate 5). Garmin GPS etrex 30 was used to mark the camera trap stations. At each trapping station, each camera was opened for 25 days. Thus, at least 750 camera trap days were carried out in each habitat. And a total of 7,925 camera-trap days with 1,90,200 trapping hours were carried out in the selected protected areas.

3.2.4. Day transects for direct evidence

For direct sightings of small carnivores like otters, mongooses, etc. day transects were walked starting from 06.00hrs and sightings were recorded. Two hundred and nineteen transects of length two kilometer each were walked in the study locations. Each transect was tracked using the GPS. All transects were walked at least once and direct sightings of small carnivores were recorded.

3.2.5. Day transects for indirect evidence

In presence-absence studies, where target species are either detected or undetected at specified locations, utilization of indirect signs is common (Perinchery *et al.,* 2011). Difficulty in direct observation and crepuscular or nocturnal habit of otters has led to the development of the "Standard Otter Surveys" which consist of the search for spraint in transects along the banks of water bodies (Mason and Macdonald, 1986). A total of 219 transects of each two km were covered. Indirect evidence like animal tracks, pug marks, spraints and scats were recorded and quantified for assessing the presence of small carnivores (Yoganand and Kumar, 1995; Shijo *et al.,* 2007).

3.2.6. Miro-habitat parameters for otters

Micro-habitat parameters those are crucial for the survival of otters such as substrate type – rock or soil or grass, canopy cover, ground cover, litter depth, depth of the water body near to the bank, the slope of the bank, stream order, presence or absence of holts, if holts present substrate type, distance from the edge of the water body, and height from the water surface from the study location were recorded.

3.2.7. Collection of spraint and spraint analysis

Collection of spraints was done from the entrance of dens, communal sprainting sites adjacent to dens, and feeding areas. Banks of the streams and the lakes will be intensively investigated within 10m distance from the water body for otter spraints. Spraints of Smooth-coated Otters were identified based on the presence of fish remains since *Lutrogale perspicillata* is known to feed extensively on them (Anoop and Hussain, 2005). Spraints of Asian Small-clawed Otters were identified based on the presence of crustacean remains because *Aonyx cinereus* feeds extensively on them (Foster-Turley, 1992). GPS location of each spraint sample and habitat parameters of that location were collected for doing habitat analysis. For this study, one spraint was defined as the collection of all the fecal matter of an otter group deposited in one spraint site at one communal sprainting site. The spraints were collected in polythene bags soaked overnight in detergent. After that, the samples were rinsed using tap water and sieved through an iron mesh of size one mm. The samples were then stored in polythene zip-lock covers for analysis after drying in the shade and weighed individually.

3.2.7.1. Spraint analysis

The cleaned spraints were uniformly spread over a whiteboard and observed using a 10X convex magnifying lens. The remains were separated into various groups like scales, bones, crustaceans, and insect remains, using forceps and needles each will be weighed and packed separately. Specific prey items were identified mostly up to the family level (Anoop and Hussain, 2005). Food items identified were verified through comparison with samples collected from the field.

3.2.7.1.1. Score Bulk Estimate

Proportions of different prey categories were estimated using score bulk estimate. This was done visually. Each prey category represented was given a score from one to ten. This score was then multiplied with the dry weight of the spraint and the resulting figure was expressed as a percentage.

3.2.7.1.2. Frequency of occurrence

The frequency of occurrence is the number of prey categories expressed as a proportion of the total number of occurrences of all prey categories in a sample.

3.2.8. Collection of scat and scat analysis

Food habits of the Brown Palm Civet were studied using scat analysis, a technique widely used to study small carnivore diet. As the Brown Palm Civet is strictly nocturnal and inhabits rainforest with a dense canopy cover and understory, direct observations of feeding or camera trapping were not feasible. Scats of the Brown Palm Civet were identified based on their shape, size, and location. Brown Palm Civet scats are straight, cylindrical ($\leq$2 cm in diameter), rounded at both ends, and usually defecated as a single bolus on prominent places like fallen logs and rocks. This defecation behavior is typical of Brown Palm Civets. Unlike felid scats, Brown Palm Civet scats lacked a pungent odor (Mudappa and Kumar, 2010). Scats of Brown Palm Civet are collected from study areas.

3.2.8.1. Scat analysis

Collected scats were dried and segregated into different components (seeds, fruit remains, and animal parts). The contribution of each species to the diet (fruits, invertebrates, vertebrates, etc.) was calculated as (i) the frequency of occurrence and (ii) percentage volume. The importance of a dietary species was assessed based on its frequency of occurrence in the diet (Mudappa *et al.*, 2010).

3.2.8.1.1. Frequency of occurrence of a food item

The frequency of occurrence of a food item is expressed as a ratio between the number of scats with a food item to the total number of scats. The frequency of occurrence was considered for the overall diet as it creates the data comparable with results of most other studies.

3.2.8.1.2. Percentage volume of food item

Proportions of different prey categories were estimated using percentage volume. This was done visually.

3.2.9. Micro-habitat parameters for small carnivores

Micro-habitat parameters were documented at each of the study sites. Micro-habitat parameters are crucial for the survival of the small carnivores such as canopy height (visual estimation), canopy cover (visual estimation), the height of shrubs (stems < 10 cm girth at breast height), and ground vegetation (herbaceous plants < 50 cm in height, measured with tape), litter depth (average of four measurements taken around the trap using calibrated probe), and basal area of trees > 30 cm girth. densities of shrubs (within 5 m radius), trees, climbers, buttresses, and canes, and distance to the nearest large tree (measured with a tape to a tree > 60 cm girth), frequency of natural hollow in the trees, etc., in the study locations were studied. Apart from these the gross habitat features such as vegetation type, the GPS location, and the weather parameters of the study site, etc also documented and the relationships between the presence or absence of small carnivores with these parameters were worked out (Sanghamithra, 2016).

3.2.10. Questionnaire survey

A detailed structured interview schedule was prepared and conducted among three categories (Local people, Tribal people, and Kerala Forest Department staff) to gather data regarding the human-small carnivore conflict, attitude, and perception of the individuals towards the small carnivores. The interview schedule was designed under five sections, consist of 21 titles. Each of the sections was designed to detail various aspects concerned to the individuals which include personal information, knowledge about small carnivores, human-small carnivore conflict, knowledge on threats faced by small carnivores, attitude, and perception towards small carnivore conservation. The purposive sampling consists of 40 individuals from each category.

3.3. DATA ANALYSIS

The diversity of a species can be expressed by various indices. In the present study, the species richness, species diversity, and relative abundance were studied. Habitat selection of small carnivores will be analyzed using presence-only models from the variables collected on the ground. The activity pattern of the small carnivores was studied using camera trap data. From the GIS data collected distribution map of the small carnivores will be produced (QGIS). The details are detailed below.

3.3.1. Margalef Species Richness Index

Margalef index is calculated by the formula given below,

$$\mathbf{DMg} = \frac{\mathbf{S\text{-}1}}{\mathbf{ln\ N}}$$

Where, 'S' is the total number of species recorded and 'N' is the total number of individuals summed overall 'S' species (Magurran, 1988).

3.3.2. Diversity Indices

3.3.2.1. Simpson's Index, λ

Simpson (1949) proposed the first diversity index used in ecology as

$$\lambda = \Sigma\, p_i^2$$

where 'pi' is the proportional abundance of the 'i'th species given by

$$p_i = \frac{n_i}{N}$$

Where, 'i' = 1, 2, 3, 4, ...S, 'n'$_i$ is the number of individuals of the 'ith' species, and 'N' is the total known individuals for all S species in the population. Simpson's index, which varies from 0-1, gives the probability that two individuals drawn at random from a population belong to the same species. Simply stated, if the probability is high that both individuals belong to the species, then the diversity of the community sample is low (Ludwig and Reynolds., 1988).

3.3.2.2. Shannon-Wiener Index, H

The Shannon-Wiener index (Shannon and Wiener, 1963) is a measure of the average degree of "uncertainty" in predicting to what species an individual is chosen at random from a collection of 'S' species and 'N' individuals will belong. This average uncertainty increases and as the distribution of individuals among the species becomes even. Thus H' has two properties that have made it a popular measure of species diversity: (1) H'=0 if and only if there is only one species in the sample, (2) H' is maximum only when all 'S' species are represented by the same number of individuals, that is, a perfectly even distribution of abundance (Ludwig and Reynolds, 1988).

The equation of the Shannon function, which uses natural logarithm (ln), is

$$\mathbf{H' = \Sigma\ (p_i.\ ln\ p_i)}$$

Where 'H'' is the average uncertainty per species in the infinite community made up of 'S' species with known proportional abundance p_1, p_2, p_3,..........p_s.

3.3.3. Analysis of diel activity

For every camera trap image, we have identified species, date, time, and location. To ensure the independence of the capture, we have defined successive images of the same species at the same camera trap station within a recess of ≤30 minutes as a single event (Linkie and Ridout, 2011; Mukherjee *et al.*, 2019; Selvan *et al.*, 2019). However, if more than one individual of similar or different species were captured in a single image, each individual was considered as a discrete incident (Mukherjee *et al.*, 2019).

The timings of dawn and dusk in the study area were recorded during the study period. Sunrise and sunset were about at 0640 hrs. and 1815 hrs., local time (GMT+5), correspondingly. On the basis of dawn and dusk, the day was divided into three periods, 0740-1715 as a day, 17.15-0540 as night, and 0540-

0740 (dawn) and 1715-1915 (dusk) as crepuscular (Gerber *et al.*, 2012, Selvan *et al.*, 2019).

The diel activity of species was categorized as diurnal (<10% of records at night), nocturnal (>90%of records at night), mostly diurnal (10-29% of records at night), mostly nocturnal (70-89% of records at night) or cathemeral (30-69% of records at night) (Gomez *et al.*, 2005; Azvedo *et al.*, 2018; Selvan *et al.*, 2019).

The diel activity pattern and coefficient of activity overlapping were determined using a non-parametric circular Kernal density method. We used the 'Overlap' R package (Meredith and Ridout, 2018) to analyze the activity pattern of specific species and the coefficient of overlap between two species. To obtain a bias-corrected percentile, we estimated the 95% confidence interval of Δ with 1000 bootstrap.

3.3.4. Habitat use analysis

The data analysis was primarily done using statistical packages such as the XL STAT (XLSTAT 2020.5.1.1041).

3.3.4.1. Prediction of presence or absence of species using habitat parameters

Logistic regression measures the relationship between a categorical dependent variable and one or more independent variables, which are usually (but not necessarily) continuous, by using probability scores as the predicted values of the dependent variable. Here it is used to check whether the prediction of presence or absence of the small carnivore using habitat parameters is possible. Eleven micro-habitat parameters were used in this regression analysis.

3.3.4.2. Discriminant analysis

Differential preferences of the species for the studied habitat variables are examined using discriminant analysis. It shows whether there is any niche partitioning between and among the species with respect to the studied habitat variables.

3.3.5. Interview schedule analysis

A total of 120 respondents were interviewed using questionnaire. Each question in the questionnaire was assumed to be a category and the sub-questions were taken as sub-categories. Separately tabulated responses were used for various statistical analyses such as correlation studies and association studies using R software. Frequency of a response and its frequency, chi-square test, Kruskal test, and Mann-Whitney U test were done in the R-studio.

One of the main non-parametric tests, the chi-square test was used to test the significance. P-values were used in hypothesis testing and the value varies, between zero and one. It helps to figure out the significance of the results. Kruskal test was used for the comparison of three independent samples. It was used to know whether the sample means are equal or not.

Results

RESULTS

4.1. SPECIES COMPOSITION OF SMALL CARNIVORES OF KERALA

The present study of small carnivores of selected protected areas of Kerala recorded all thirteen species from the Kerala part of Western Ghats. The small carnivores were distributed among four families such as Viverridae, Herpestidae, Mustelidae, and Felidae (small cats). This comprises four species each of herpestids, three species of viverrids mustelids, and felids (Table 2). All of these species were camera trapped during the present study.

Table 2. List of small carnivores and evidence showing their presence from Kerala

Common Name	**Scientific Name**	**Family**	**Detection of the species**		
			Camera trap	**Direct sighting**	**Indirect evidences**
Brown mongoose	*Herpestes fuscus*	Herpestidae	*		
Stripe-necked mongoose	*Herpestes vitticollis*	Herpestidae	*	*	
Ruddy Mongoose	*Herpestes smithii*	Herpestidae	*		
Grey Mongoose	*Herpestes edwardsi*	Herpestidae	*		
Small Indian Civet	*Viverricula indica*	Viverridae	*		
Brown Palm Civet	*Paradoxurus jerdoni*	Viverridae	*	*	*

Common Palm Civet	*Paradoxurus hermaphroditus*	Viverridae	*		
Jungle Cat	*Felis chaus*	Felidae	*	*	
Leopard Cat	*Prionailurus bengalensis*	Felidae	*		*
Rusty-spotted Cat	*Prionailurus rubigenosus*	Felidae	*		
Nilgiri Marten	*Martes gwatkinsi*	Mustelidae	*		
Asian Small-clawed Otter	*Aonyx cinereus*	Mustelidae	*		*
Smooth-coated Otter	*Lutrogale perspicillata*	Mustelidae	*		*

All the species were camera trapped at least for one time (Plate 6-9). The Stripe-necked Mongoose, Brown Palm Civet, and Jungle Cat was sighted directly during transect walks. Indirect evidence of Brown Palm Civet, Smooth-coated Otter, Asian Small-clawed Otter, and small cats were identified from various habitats. The details of habitat-wise species details are given below.

4.2. CAMERA TRAPPING ON SMALL CARNIVORES OF KERALA

A total of 255 camera trap locations were identified from various forest habitats of Kerala. An effective total of 7925 days was sample using camera traps, monitoring 1,90,200 hours. The details of habitat-wise trapping effort were given in Table 3.

Table 3. Habitat wise and total camera tap efforts during the study

Location	Camera trap effort	
	Days	**Hours**
Evergreen habitat (South) (EG_S)	840	20160
Evergreen habitat (North) (EG_N)	1275	30600
Grassland shola habitat (South) (GLS_S)	915	21960
Grassland shola habitat (North) (GLS_N)	950	22800
Moist deciduous habitat (South) (MDF_S)	825	19800
Moist deciduous habitat (North) (MDF_N)	840	20160
Dry deciduous habitat (South) (DDF_S)	1140	27360
Dry deciduous habitat (North) (DDF_N)	1140	27360
Total effort	**7925**	**190,200**

Order carnivore accounted for 16.79% (909) of the total photographed mammal species (5411 images). Out of these carnivores, small carnivore images were 52.8% (480 images) recording all the listed small carnivores from Kerala. The most frequently reported small carnivore was Stripe-necked Mongoose (22.3%; 107 images), followed by Brown Palm Civet (20.6%; 99 images), Small Indian Civet (17.9%; 86 images), and Jungle Cat (8.3%; 40 images). Indian Grey Mongoose, Rusty-spotted Cat, and Smooth-coated Otter were photo captured only once (0.21%) during the camera trap study period.

Table 4. Habitat wise details of small carnivores' camera trapped

Common Name	EG_S	EG_N	GL_S	GL_N	MDF_S	MDF_N	DDF_S	DDF_N
Brown mongoose	26	4	4	0	0	2	0	0
Stripe necked mongoose	41	4	23	6	5	1	0	27
Ruddy Mongoose	0	0	0	0	0	7	2	6
Grey Mongoose	0	0	0	0	0	0	1	0
Small Indian Civet	25	0	2	10	23	4	4	18
Brown Palm Civet	86	5	4	1	3	0	0	0
Common Palm Civet	0	0	0	0	8	0	14	13
Jungle Cat	0	0	40	0	0	0	0	0
Leopard Cat	3	0	10	0	0	0	0	2
Rusty-spotted Cat	0	0	0	0	0	0	0	1
Nilgiri Marten	5	0	7	0	0	0	0	0
Asian Small-clawed Otter	0	5	0	0	0	0	0	0
Smooth-coated Otter	0	0	0	0	1	0	0	0

Stripe-necked Mongoose and Small Indian Civet were reported from all the four habitat types of Kerala. During the study, no Stripe-necked Mongoose image was obtained from dry deciduous forest (south). Ruddy Mongoose and Common Palm Civet was only reported from camera traps from dry deciduous habitats and moist deciduous habitats. Brown Mongoose and Brown Palm Civet was photographed from three habitats, Evergreen forests (both south and north), grassland shola, and moist deciduous forests. Leopard Cat was reported from evergreen habitat, grassland, and dry deciduous habitat. Nilgiri Marten was photo captured only from the southern part of the Western Ghats (evergreen and grassland habitat). Jungle Cat was only reported from the grassland habitat of Eravikulam National Park. Asian Small-clawed Otters were photographed from evergreen forests. Indian Grey Mongoose, Rusty-spotted Cat and Smooth-coated Otter was only once during the whole study period. Camera trap images of small carnivores were given in Plate 6-9. The details of number of photographs obtained from each habitat is given in the Table 4. And the proportion of detection of individuals from different habitats is given in Table 5.

Table 5. The proportion of detections in different habitats in Kerala

	Habitat type								Total	
	Dry deciduous		Moist deciduous		Grassland		Evergreen			
Species	No. of detection	% of detection	No. of detection	% of detection	No. of detection	% of detection	No. of detection	%of detection	No. of detection	%of detection
SNM	27	25.23	6	5.61	29	27.10	45	42.06	107	23.62
BPC	0	0	3	3.03	5	5.05	91	91.92	99	21.85
SIC	22	25.58	27	31.40	12	13.95	25	29.07	86	19.77
JC	0	0	0	0	40	100	0	0	40	8.83
BM	0	0	2	5.56	4	11.11	30	83.33	36	7.94
CPC	27	77.14	8	22.86	0	0	0	0	35	7.72
RM	8	53.33	7	46.67	0	0	0	0	15	3.31
LC	2	13.33	0	0	10	66.67	3	20	15	3.31

NM	0	0	0	0	7	58.33	5	41.67	12	2.64
ASCO	0	0	0	0	0	0	5	100	5	1.10
IGM	1	100	0	0	0	0	0	0	1	0.22
SCO	0	0	1	100	0	0	0	0	1	0.22
RSC	1	100	0	0	0	0	0	0	1	0.22
TOTAL	88	19.43	54	11.92	107	23.62	204	45.03	453	

SNM-Stripe-necked Mongoose, BM-Brown Mongoose, IGM-Indian Grey Mongoose, RM-Ruddy Mongoose, BPC-Brown Palm Civet, CPC-Common Palm Civet, SIC-Small Indian Civet, JC-Jungle Cat, LC Leopard Cat, RSC-Rusty-spotted Cat, NM- Nilgiri Marten, ASCO-Asian Small-clawed Otter, and SCO-Smooth-coated Otter.

Habitat wise comparison of small carnivore species present in more than one habitat is made by t-test and the details are given. The mean values of species in each habitat are used for the comparison and the values are given in Table 6.

Table 6. Mean values of species in different habitats which are used for the t-test

	Mean						
Habitat	**SIC**	**BPC**	**CPC**	**SNM**	**BM**	**LC**	**NM**
Evergreen_south	0.83	2.83	0	1.73	0.87	0.1	0.17
Moist Deciduous_south	0.79	0.16	0.27	0.2	0	0	0
Dry Deciduous_south	0.13	0	0.47	0	0	0	0
Grassland Shola_south	0.07	0.13	0	0.83	0.13	0.33	0.27

Plate 6. Images showing civets of Kerala

Plate 7. Images showing small cats of Kerala

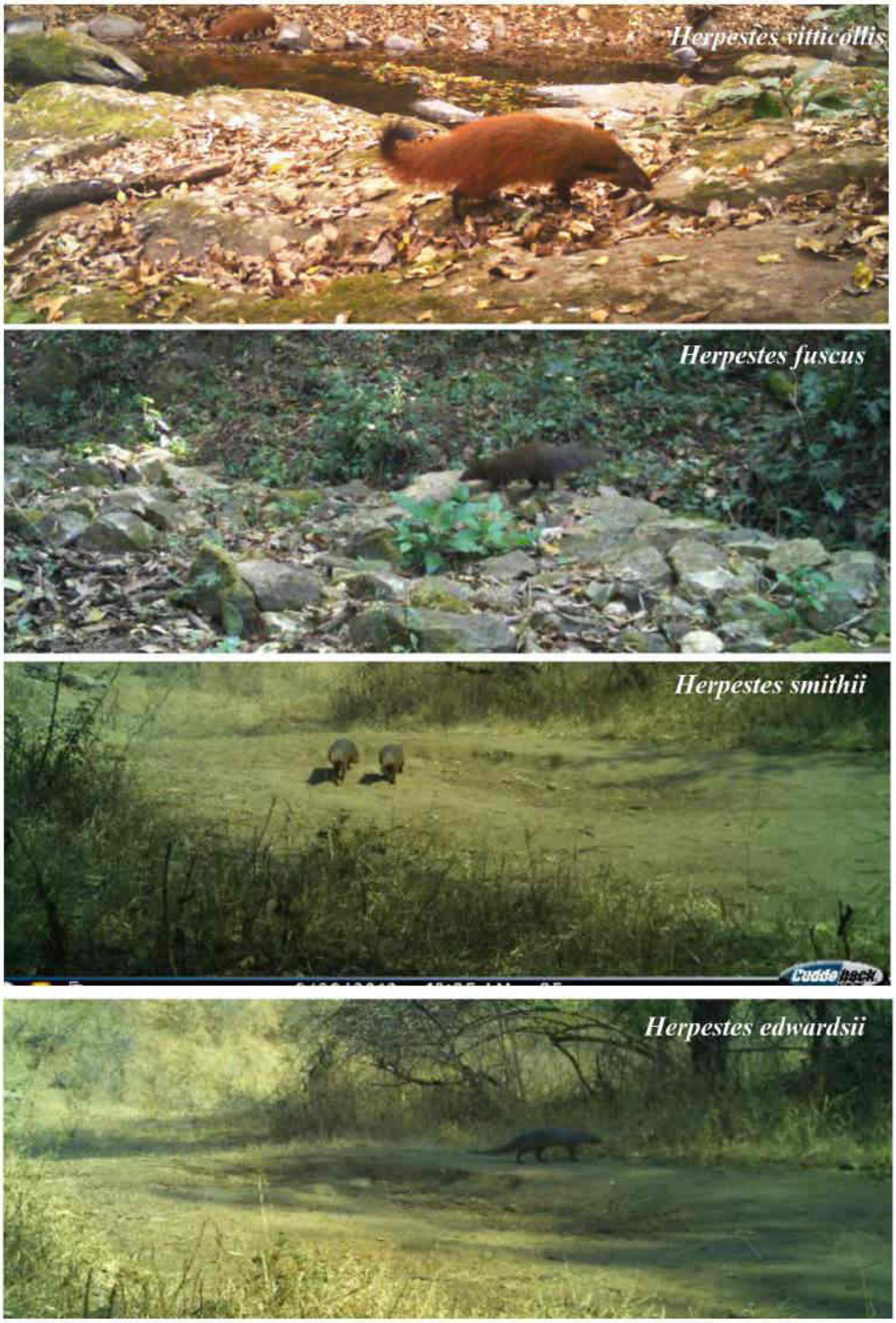

Plate 8. Images showing mongooses of Kerala

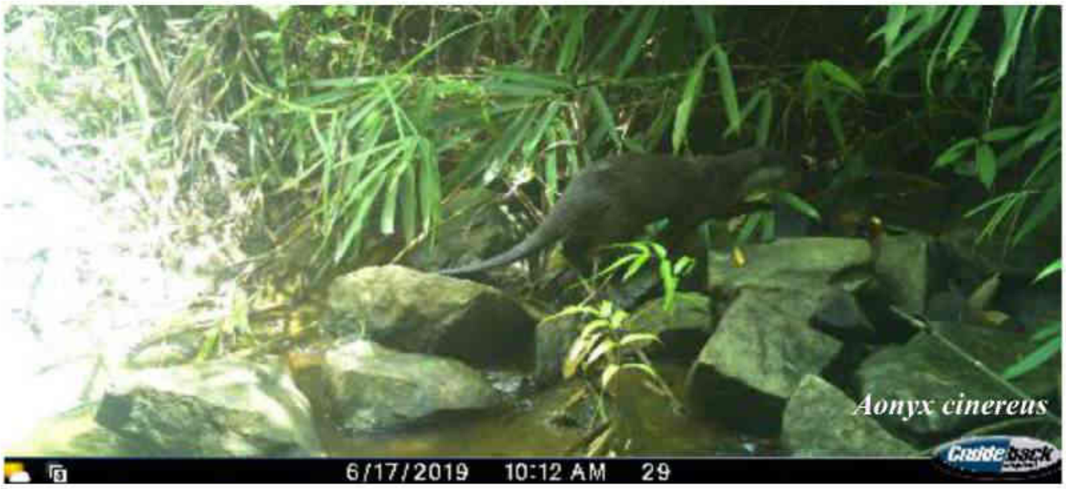

Plate 9. Images showing otters and marten of Kerala

Table 7. Comparison of small carnivores in different habitats situated south of Palghat gap

Habitat combination	SIC	BPC	CPC	SNM	BM	LC	NM
EG and GLS	0.013*	0.020*	0	0.248^{ns}	0.037*	0.314^{ns}	0.580^{ns}
EG and MDF	0.011*	0.018*	0	0	0	0	0
EG and DDF	0.024*	0	0	0	0	0	0
GLS and MDF	0.021*	0.759^{ns}	0	0.047*	0	0	0
GLS and DDF	0.522^{ns}	0	0	0	0	0	0
MDF and DDF	0.038*	0	0.530^{ns}	0	0	0	0

Details of comparison of small carnivores in different habitats studied south of the Palghat gap are given in Table 7. While comparing the species distribution between two habitats south of the Palghat Gap, significant difference was observed for some species. Small Indian Civet distribution was significantly different between evergreen habitat and grassland habitat, evergreen habitat and moist deciduous habitat, evergreen habitat and dry deciduous habitat, grassland habitat and moist deciduous habitat and moist deciduous habitat and dry deciduous habitat. The distribution of Brown Palm Civet significantly varied between evergreen habitat and grassland habitat and evergreen habitat and moist deciduous habitat. The distribution of Stripe-necked Mongoose and Brown Mongoose varied significantly in grassland and moist deciduous habitat and evergreen and grassland habitat respectively.

The mean values of species in each habitat are used for the comparison and the values are given in Table 8.

Table 8. Mean values of species in different habitats situated north of the Palghat gap which is used for the t-test

	Mean				
Habitat	**SIC**	**BPC**	**SNM**	**BM**	**RM**
Evergreen north	0	0.17	0.13	0.13	0
Moist Deciduous north	0.13	0	0.03	0.07	0.23
Dry Deciduous north	0.6	0	1	0	0.23
Grassland Shola north	0.33	0.03	0.2	0	0

Table 9. Comparison of small carnivores in different habitats situated north of Palghat gap

Habitat combination	**SIC**	**BPC**	**SNM**	**BM**	**RM**
EG and GLS	0	0.149^{ns}	0.664^{ns}	0	0
EG and MDF	0	0	0.168^{ns}	0.562^{ns}	0
EG and DDF	0	0	0.045*	0	0
GLS and MDF	0.479^{ns}	0	0.252^{ns}	0	0
GLS and DDF	0.447^{ns}	0	0.073^{ns}	0	0
MDF and DDF	0.045*	0	0.025*	0	1^{ns}

Details of comparison of small carnivores in different habitats studied north of the Palghat gap are given in Table 9. While comparing the four habitats situated north of the habitat, a significant difference in species distribution was identified among some habitats. The Small Indian Civet distribution was significantly different between moist deciduous habitat and dry deciduous habitat. In the case of Stripe-necked Mongoose, a significant difference was identified between evergreen habitat and dry deciduous habitat and between moist deciduous habitat and dry deciduous habitat.

Table 10. Comparison of small carnivores in different habitats situated north and south of the Palghat gap

Habitat combination	SIC	BPC	CPC	BM	SNM	RM
EG_south and north	0	0.020*	0	0.040*	0.032*	0
MDF_south and north	0.036*	0	0	0	0.160^{ns}	0
DDF_south and north	0.051^{ns}	0	0.927^{ns}	0	0	0
GL_south and north	0.349^{ns}	0.251^{ns}	0	0	0.054^{ns}	0.313^{ns}

The distribution of species between habitats situated north and south of the Palghat gap was tested using the t-test (Table 10). The distribution of Small Indian Civet was significantly different between moist deciduous habitat situated south and north of the Palghat gap. There was a significant difference between evergreen habitats situated south and north of the Palghat gap for three species like Brown Palm Civet, Brown Mongoose, and Stripe-necked Mongoose.

4.3. RELATIVE ABUNDANCE OF SMALL CARNIVORES

A total of 4369 photographs were obtained during the study. Out of theses, carnivores accounted for 909 (16.03%), among that 52% were small carnivores in 13 species (Figure 2). The most abundant small carnivore species recorded was Stripe-necked Mongoose (25.83%; 124 images) followed by Brown Palm Civet (20.62%; 99 images), and Small Indian Civet (17.91%; 86 images) (Figure 3). The least abundant species recorded were Smooth-coated Otter and Rusty-spotted Cat (0.20%; 1 image each).

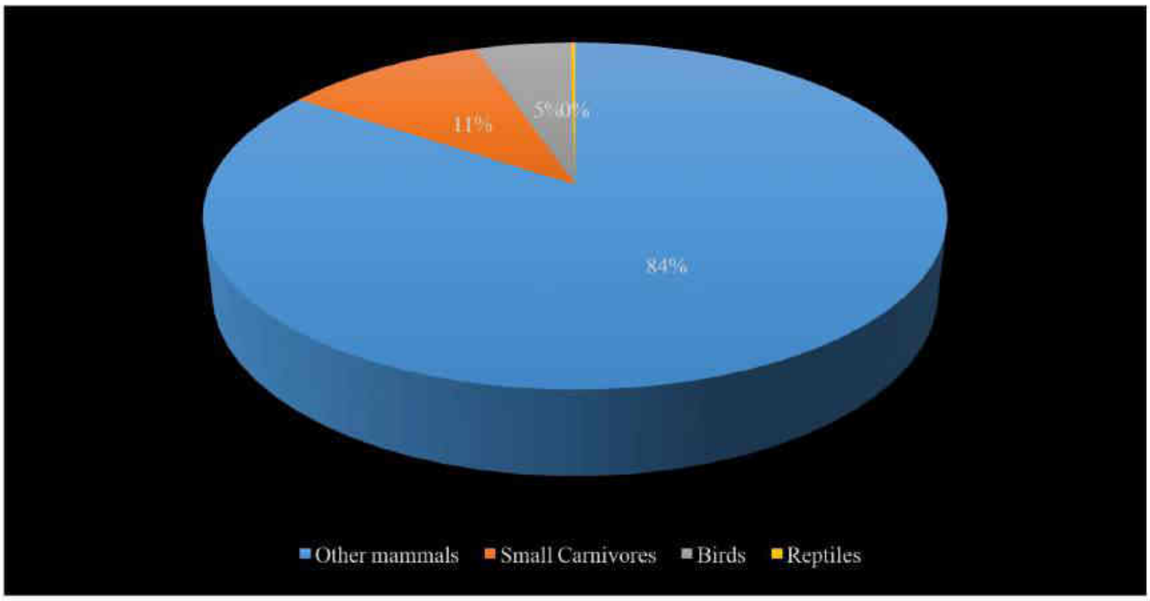

Figure 2. Relative abundance of animals during the present research

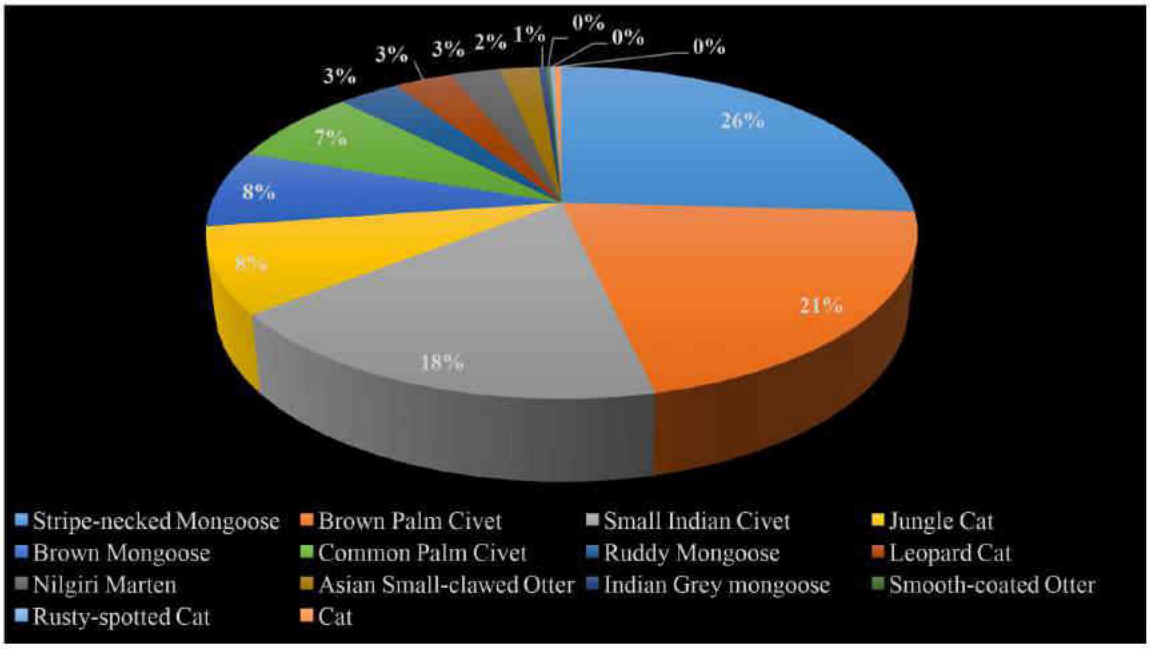

Figure 3. Species wise relative abundance of small carnivores of Kerala

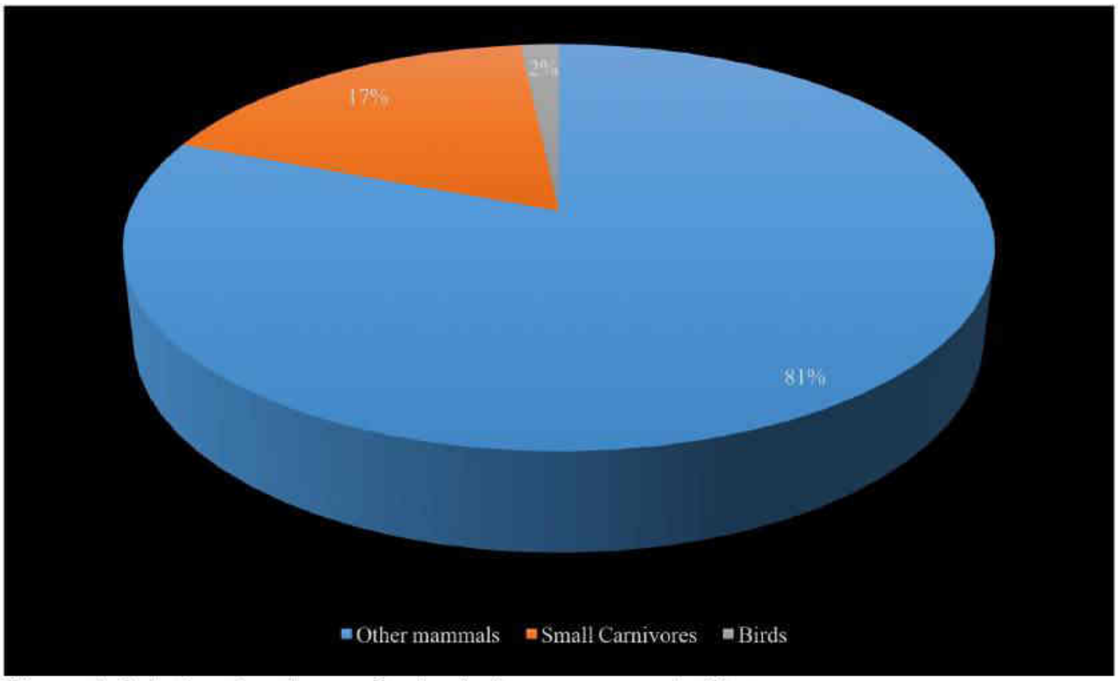

Figure 4. Relative abundance of animals from evergreen habitat

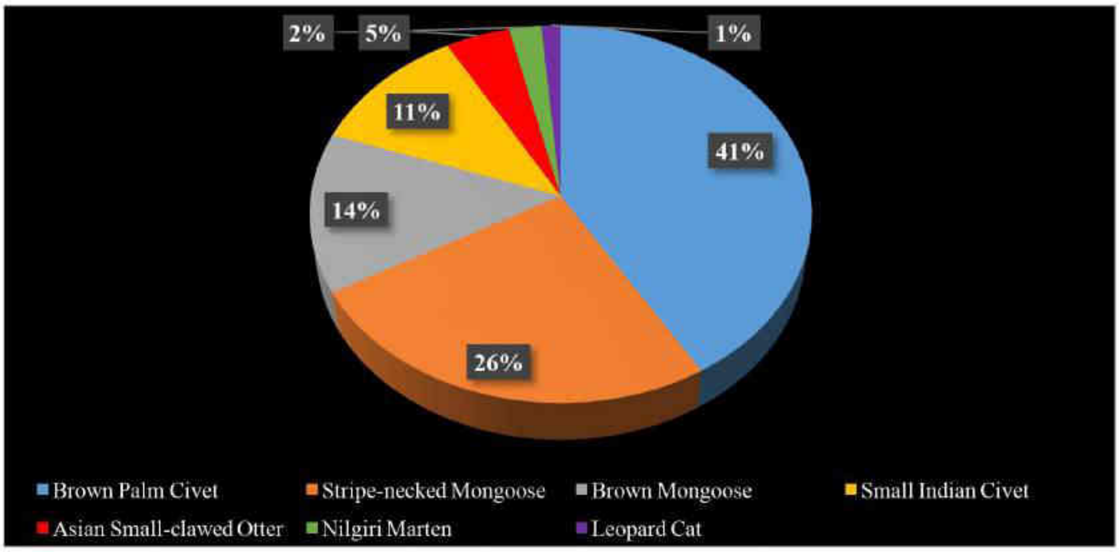

Figure 5. Relative abundance small carnivores of evergreen habitat

In the evergreen habitat studied a total of 1257 individuals were photographed and out of that 80.82% were other mammals. Small carnivores' abundance in the evergreen habitat was 17.50% and other carnivores' abundance was 4.37% (Figure 4).

Relative abundance small carnivores of evergreen habitat are given in Figure 5. Among the small carnivores of evergreen habitat Brown Palm Civet (41%) was the most abundant species followed by Stripe-necked Mongoose (26%) and Brown Mongoose (14%) (Fig). Among the two evergreen habitats surveyed, evergreen habitat situated south of Palghat gap had a relative abundance of 25.42% for small carnivores (Figure 6 and 8). Relative abundance of other mammals was 75%. Amongst the small carnivores, Brown palm Civet (43.65%) was the most abundant species followed by Stripe-necked Mongoose (26.39%) and Brown Mongoose (13.19%) (Figure 7). Whereas, Asian Small-clawed Otter (43.47%) was the most abundant species and recorded only from the evergreen forest north of Palghat gap followed by Brown Palm Civet (21.73%) and Stripe-necked Mongoose and Brown Mongoose (17.39% each) (Figure 9). Nilgiri Marten (2.54%) and Leopard Cat were only reported from evergreen south of the Palghat gap.

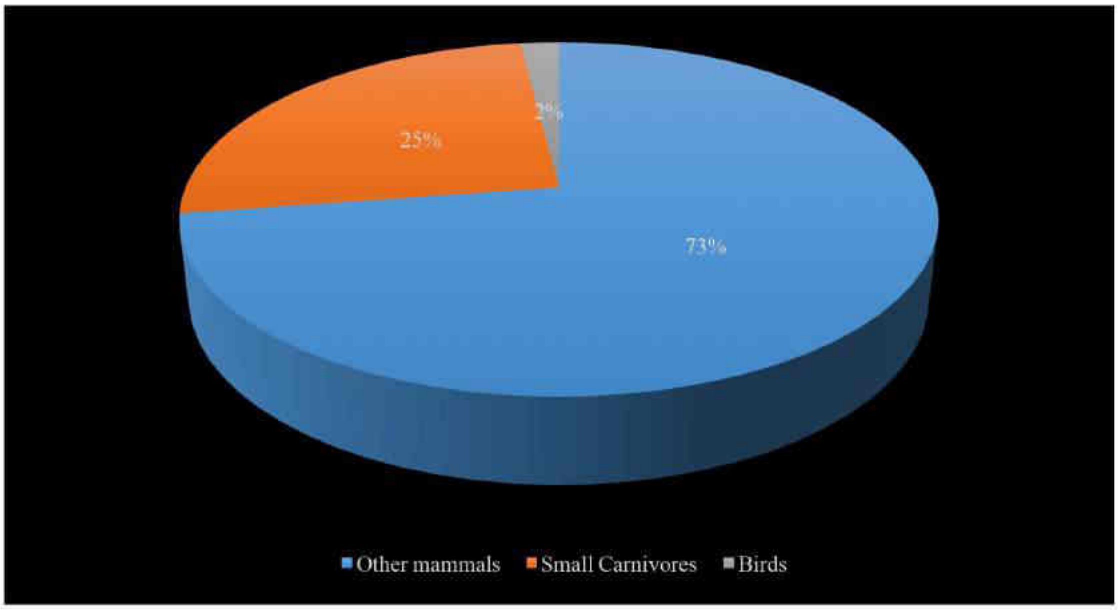

Figure 6. Relative abundance of animals from evergreen habitat, south of the Palghat gap

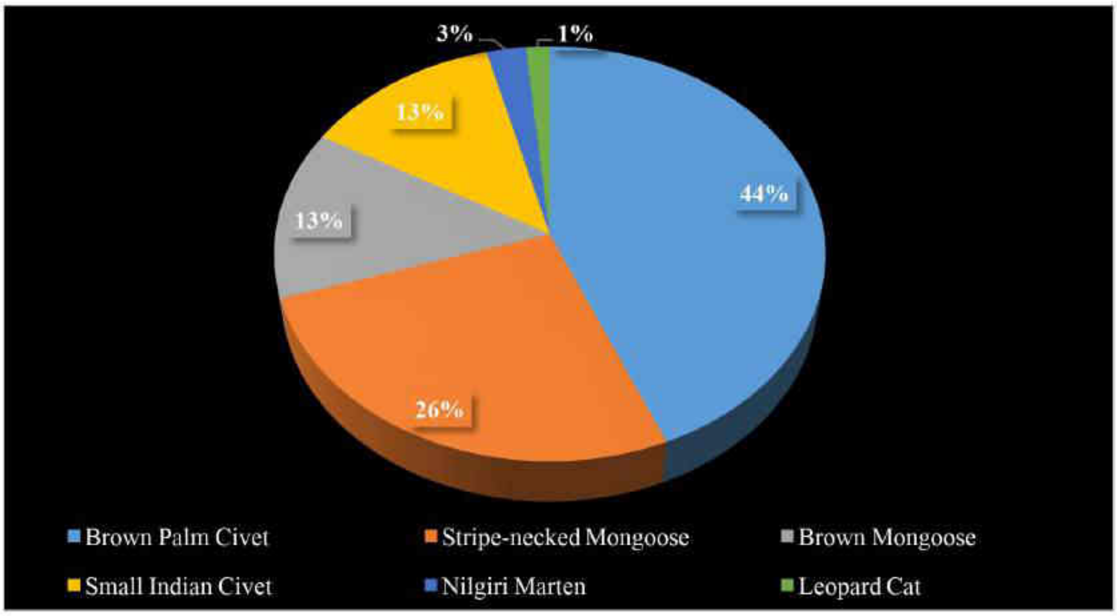

Figure 7. Relative abundance of small carnivores from evergreen habitat, south of the Palghat gap

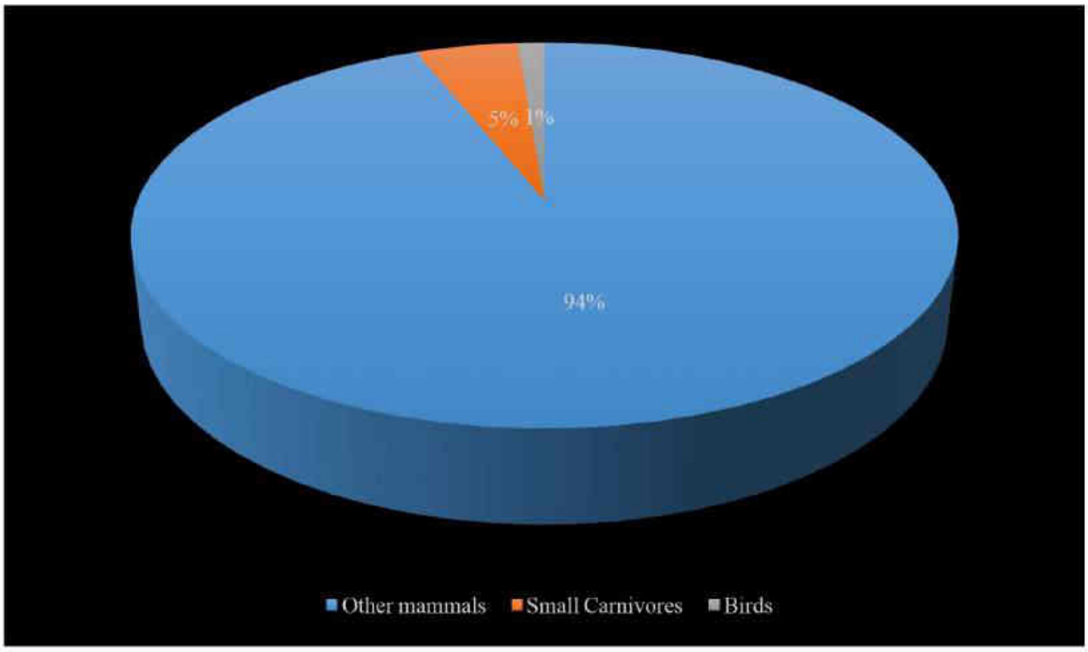

Figure 8. Relative abundance of animals from evergreen habitat, north of Palghat gap

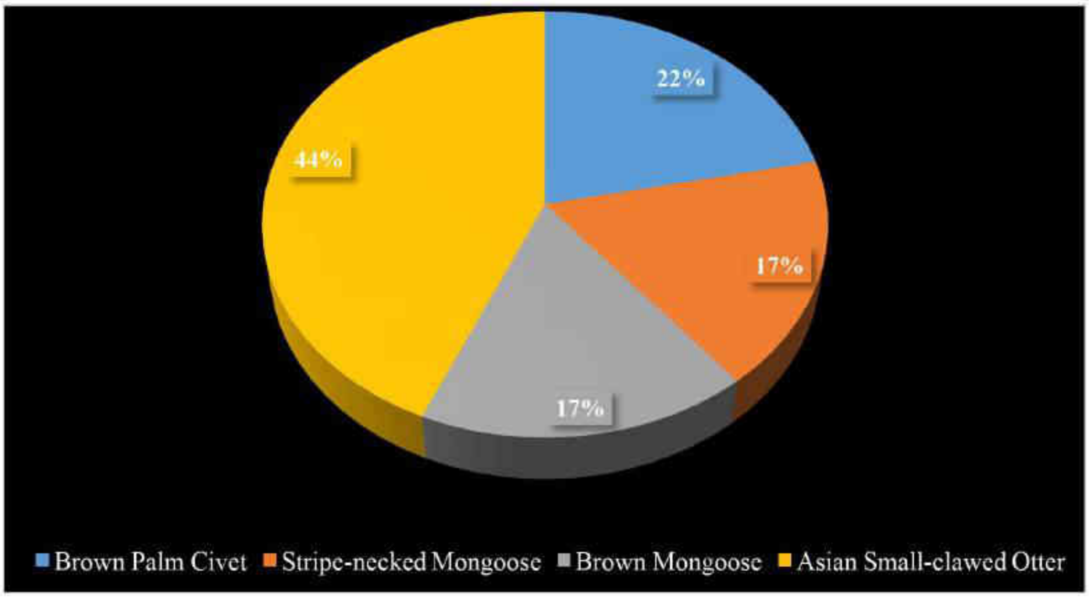

Figure 9. Relative abundance of small carnivores from evergreen habitat, north of the Palghat gap

In the moist deciduous habitat studied a total of 1394 individuals were photographed and out of that 92.04% were other mammals. Small carnivores' abundance in the moist deciduous habitat was 3.95% and (Figure 10). Among the small carnivores of moist deciduous habitat, Small Indian Civet (49.09%) was the most abundant species followed by Common Palm Civet (14.54%) and Stripe-necked Mongoose (12.72%) (Figure 11). Moist deciduous habitat situated south of the Palghat gap had a relative abundance of 6.69% for small carnivores. The relative abundance of other mammals was 85% % (Figure 12). Amongst the small carnivores, Small Indian Civet (56.09%) was the most abundant species followed by Common Palm Civet (19.51%) and Stripe-necked Mongoose (14.63%) (Figure 13). Moist deciduous habitat situated north of the Palghat gap had a relative abundance of 1.79% for small carnivores. The relative abundance of other mammals was 91% and other carnivores were (5.61%) (Figure 14). Ruddy Mongoose (50%) was the most abundant species of the moist deciduous forest north of the Palghat gap followed by Small Indian Civet (28.57%) Brown Mongoose (14.29%) (Figure 15).

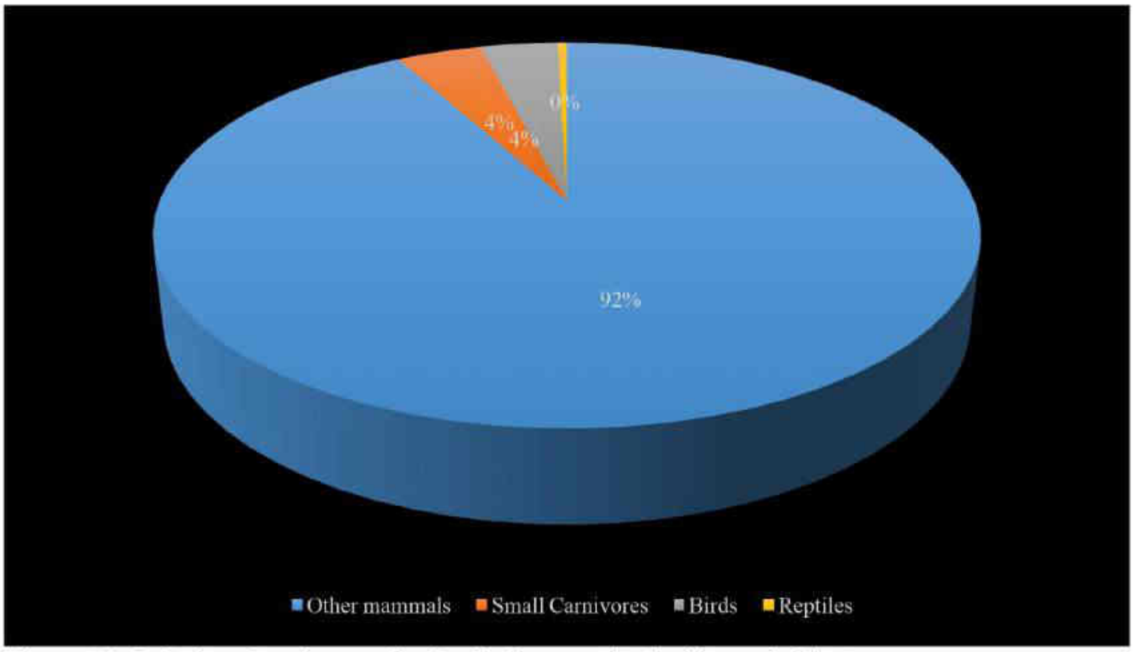

Figure 10. Relative abundance of animals from moist deciduous habitat

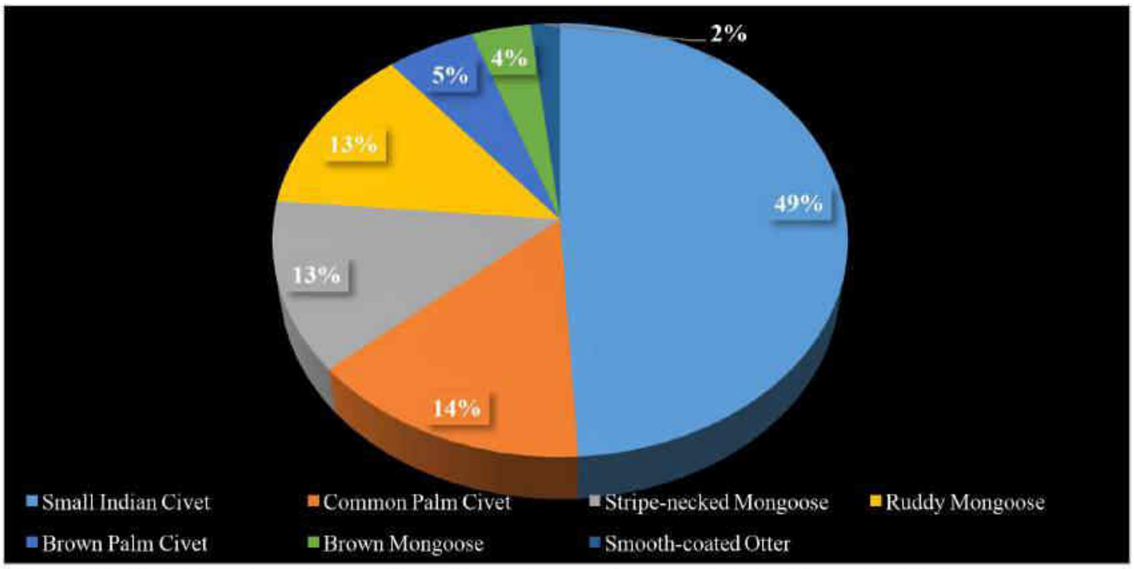

Figure 11. Relative abundance of small carnivores from moist deciduous habitat

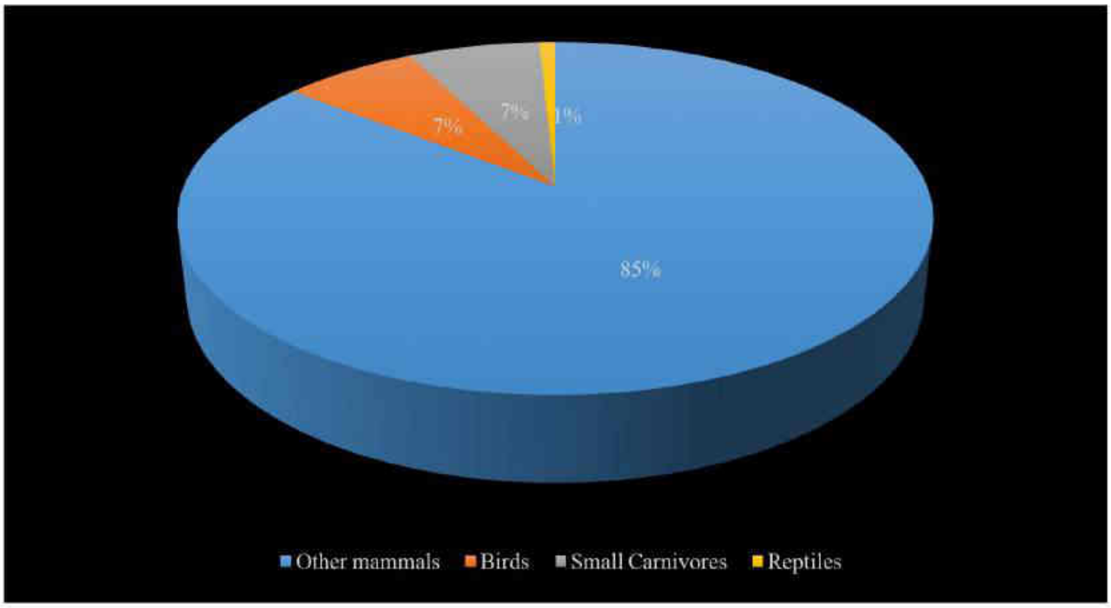

Figure 12. Relative abundance of animals from moist deciduous habitat, south of Palghat gap

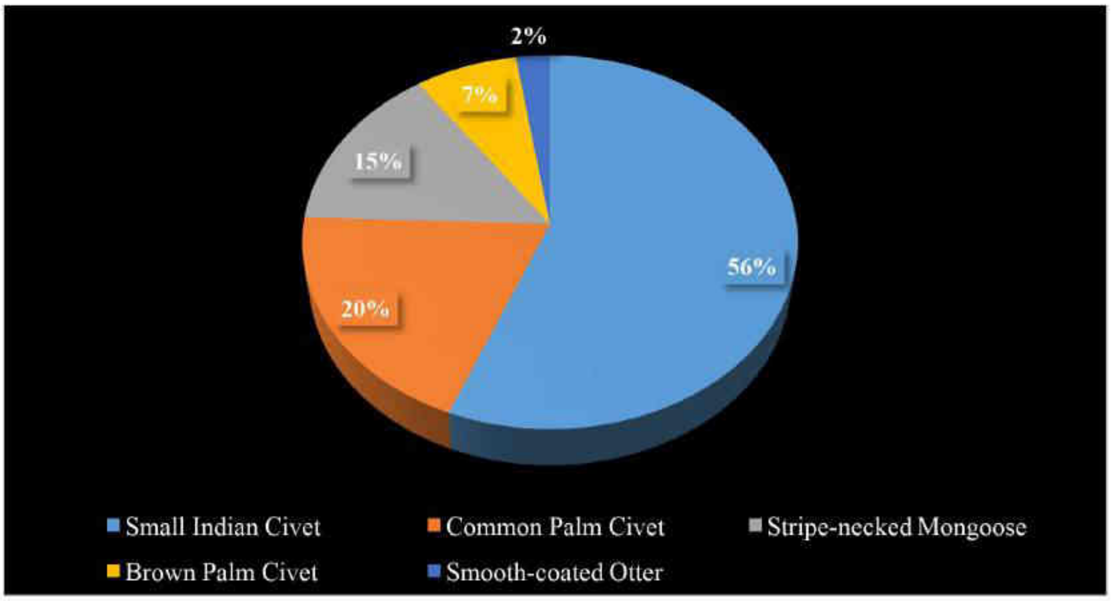

Figure 13. Relative abundance of small carnivores of moist deciduous habitat, south of Palghat gap

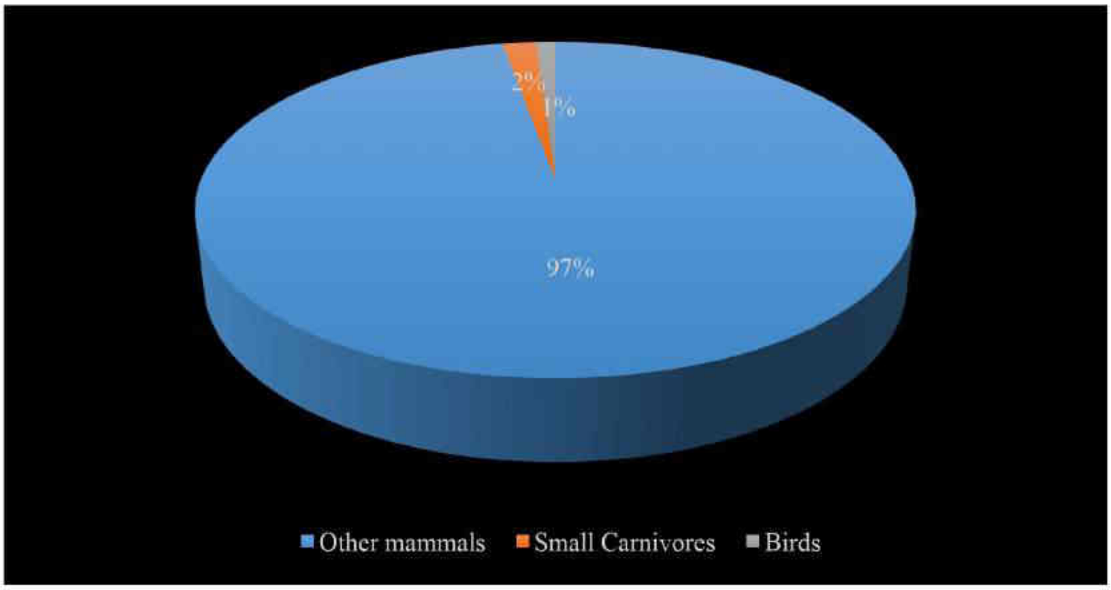

Figure 14. Relative abundance of animals from moist deciduous habitat, north of Palghat gap

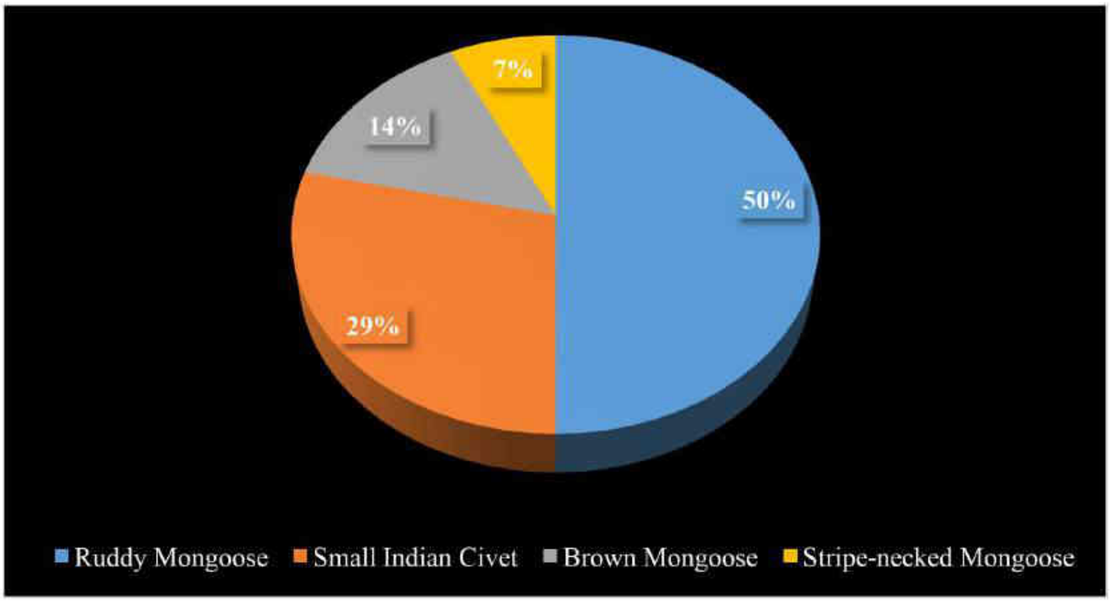

Figure 15. Relative abundance of small carnivores of moist deciduous habitat, north of Palghat gap

In the dry deciduous habitat studied a total of 2226 individuals were photographed and out of that 91.55% were other mammals. Small carnivores' abundance in the dry deciduous habitat was 4.27% (Figure 16). Among the small carnivores of dry deciduous habitat Stripe-necked Mongoose (32%) was the most abundant species followed by Common Palm Civet (27%) and Small Indian Civet (24%) (Figure 17). The dry deciduous habitat situated south of the Palghat gap had a relative abundance of 2.19% for small carnivores(Figure 18). Amongst the small carnivores, Common Palm Civet (63.63%) was the most abundant species followed by Small Indian Civet (18.18%) and Ruddy Mongoose and Grey Mongoose (9.09% each) (Figure 19). Dry deciduous habitat situated north of the Palghat gap had a relative abundance of 5.98% for small carnivores. The relative abundance of other mammals was 81% and other carnivores were (8.19%) (Figure 20). Stripe-necked Mongoose (41.09%) was the most abundant species here, followed by Small Indian Civet (24.66%) and Common Palm Civet (17.81%) (Figure 21).

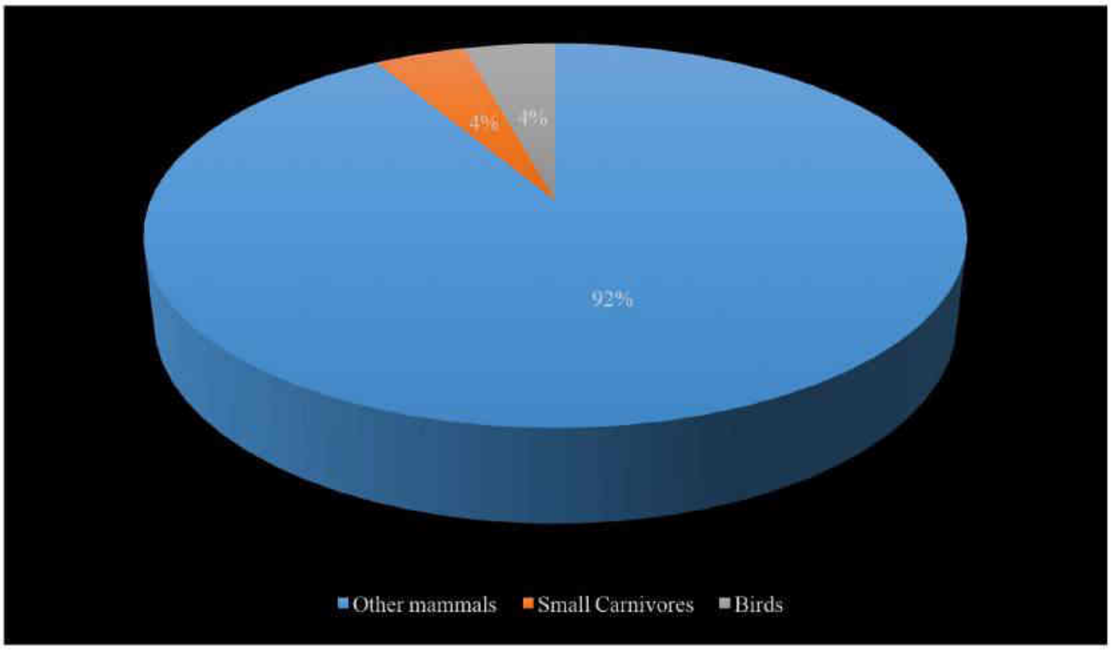

Figure 16. Relative abundance of animals from dry deciduous habitat

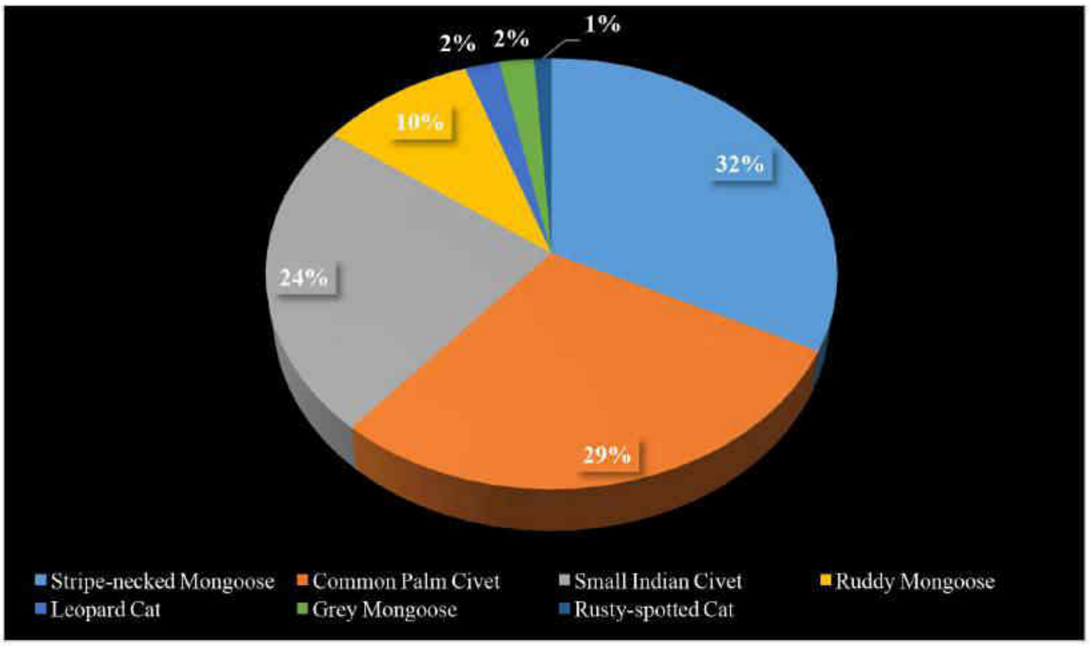

Figure 17. Relative abundance of small carnivores of dry deciduous habitat

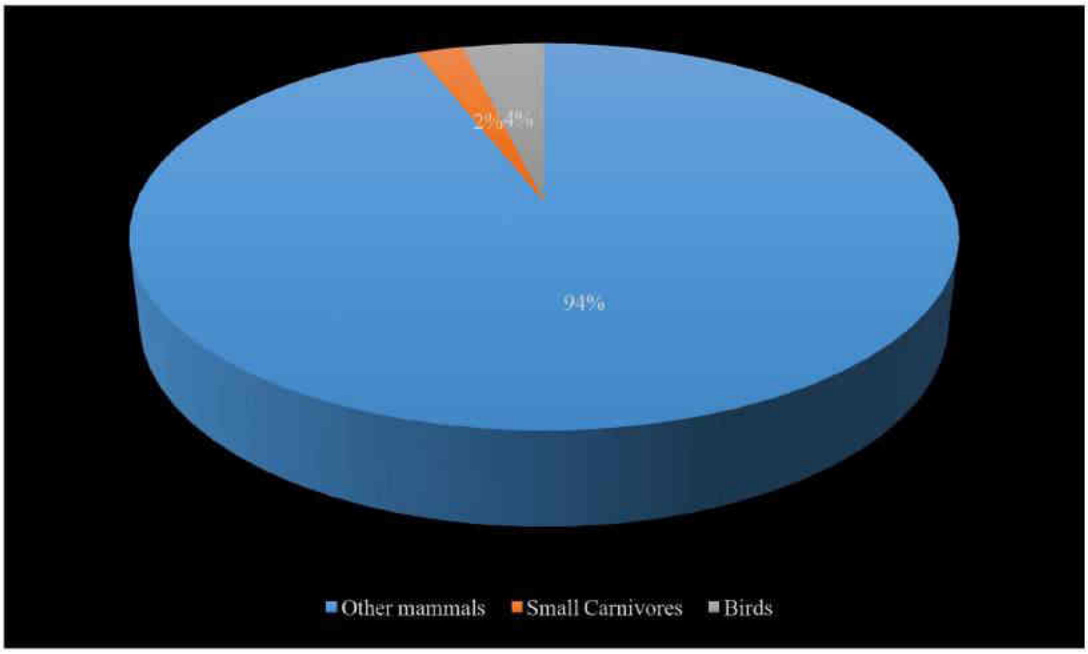

Figure 18. Relative abundance of animals from dry deciduous habitat, south of Palghat gap

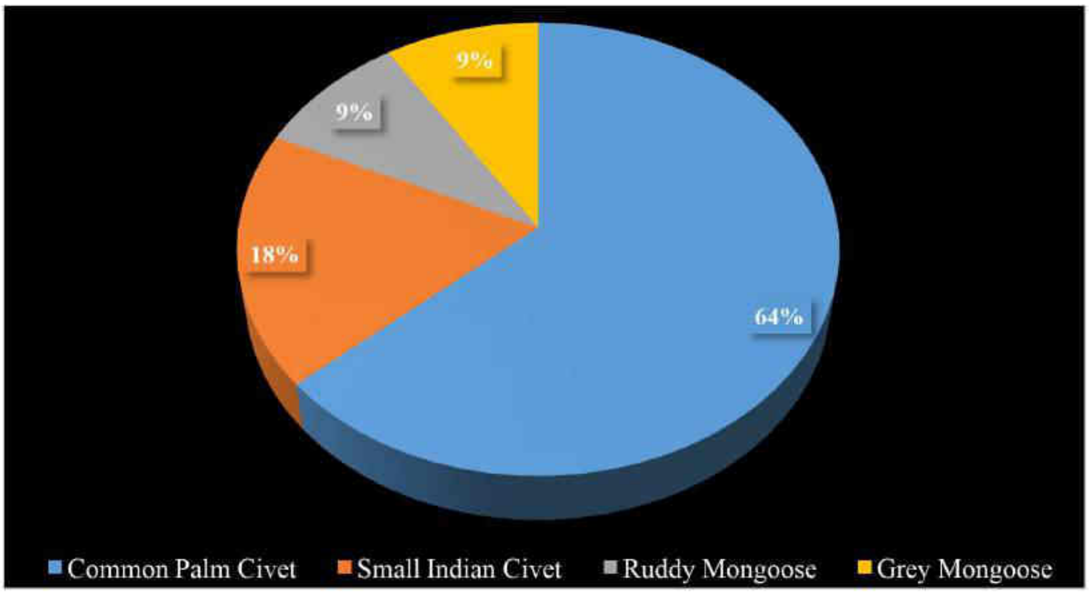

Figure 19. Relative abundance of small carnivores of dry deciduous habitat, south of Palghat gap

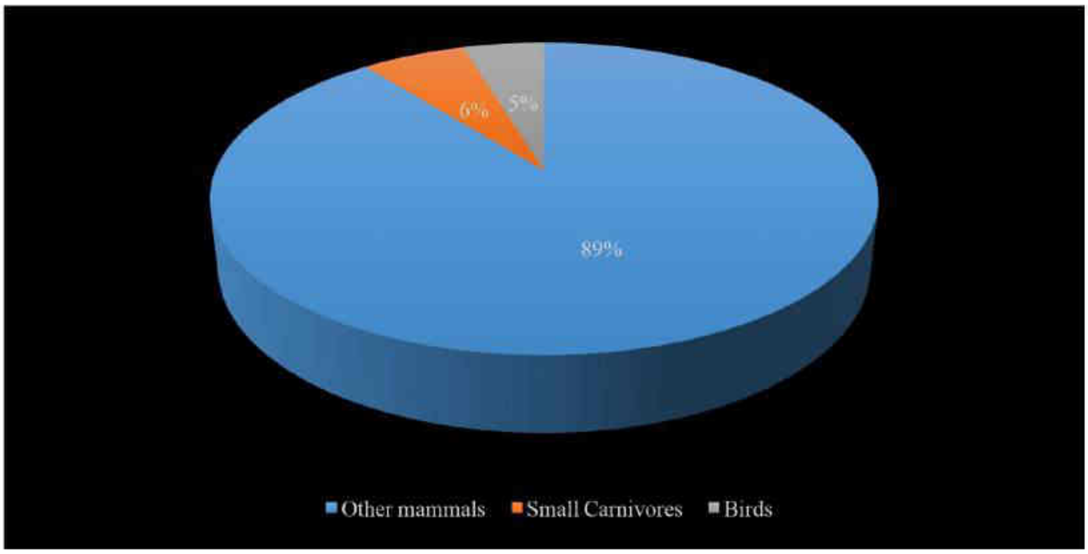

Figure 20. Relative abundance of animals from dry deciduous habitat, north of Palghat gap

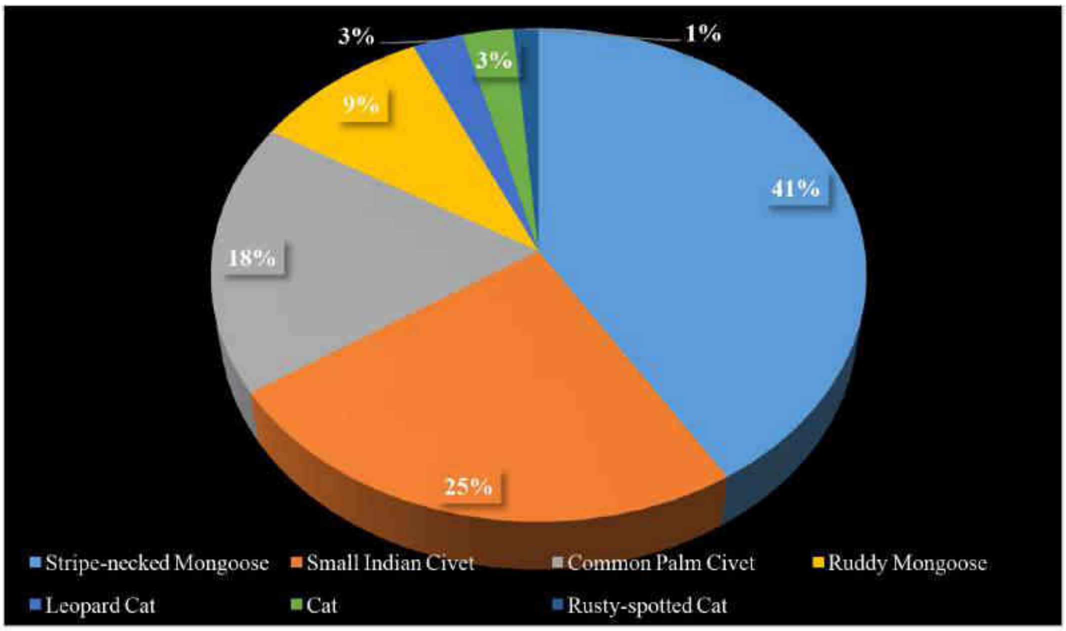

Figure 21. Relative abundance of small carnivores of dry deciduous habitat, north of Palghat gap

In the grassland habitat studied, a total of 795 individuals were photographed and small carnivores' abundance in the grassland habitat was 13.84% (Figure 22). Among the small carnivores of grassland habitat Jungle Cat (32%) was the most abundant species followed by Stripe-necked Mongoose (28.18%) and Small Indian Civet (10.90%) (Figure 23). The grassland habitat situated south of the Palghat gap had a relative abundance of 17.98% for small carnivores (Figure 24). Amongst the small carnivores, Jungle Cat (43.01%) was the most abundant species followed by Stripe-necked Mongoose (26.88%) and Leopard Cat (10.75%) (Figure 25). Jungle Cat was only observed from this study area. Grassland habitat situated north of the Palghat gap had a relative abundance of 6.11% for small carnivores. The relative abundance of other mammals was 89.21% and other carnivores were (2.16%) (Figure 26). Small Indian Civet (58.82%) was the most abundant species in grassland habitat followed by Stripe-necked Mongoose (35.29%) and Brown Palm Civet (5.88%) (Figure 27).

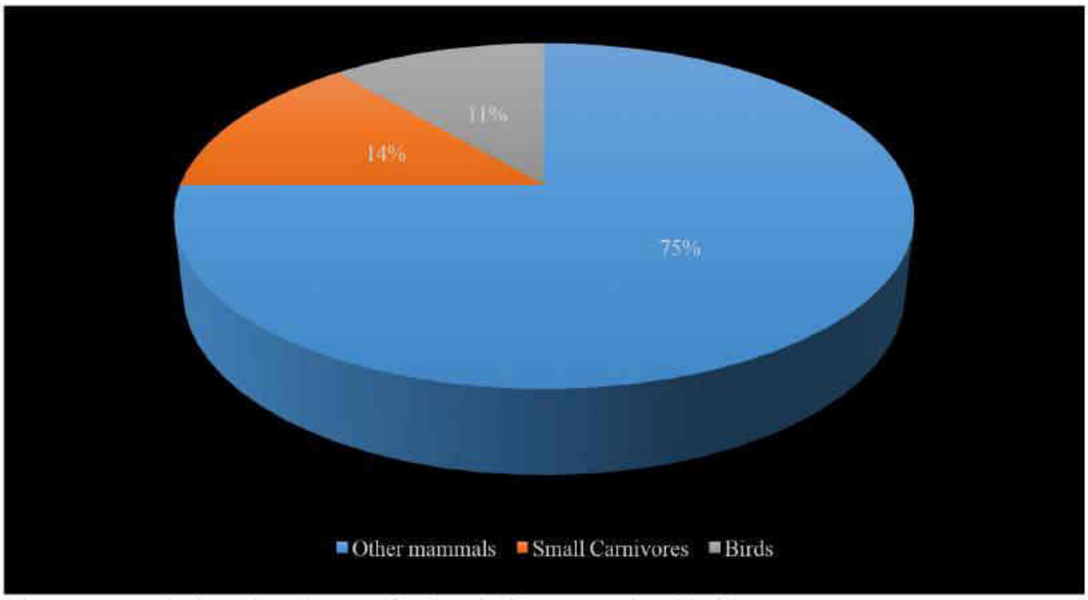

Figure 22. Relative abundance of animals from grassland habitat

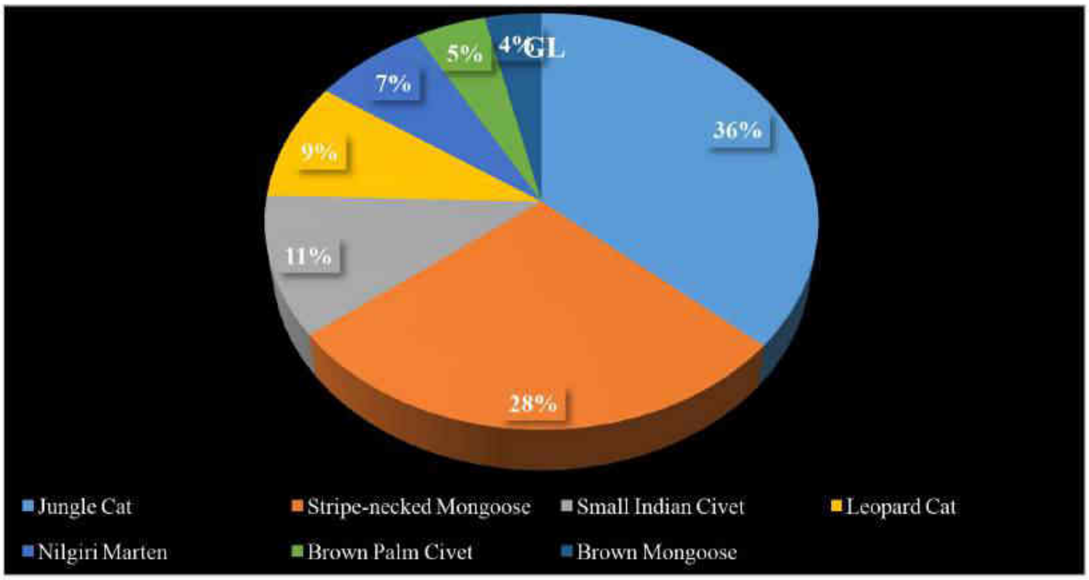

Figure 23. Relative abundance of small carnivores of grassland habitat

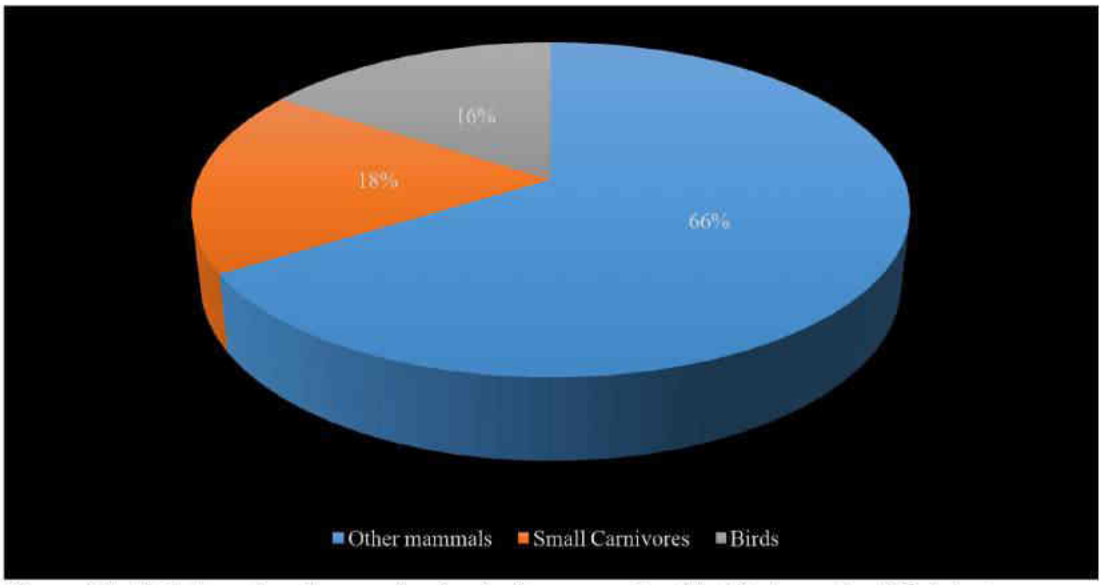

Figure 24. Relative abundance of animals from grassland habitat, south of Palghat gap

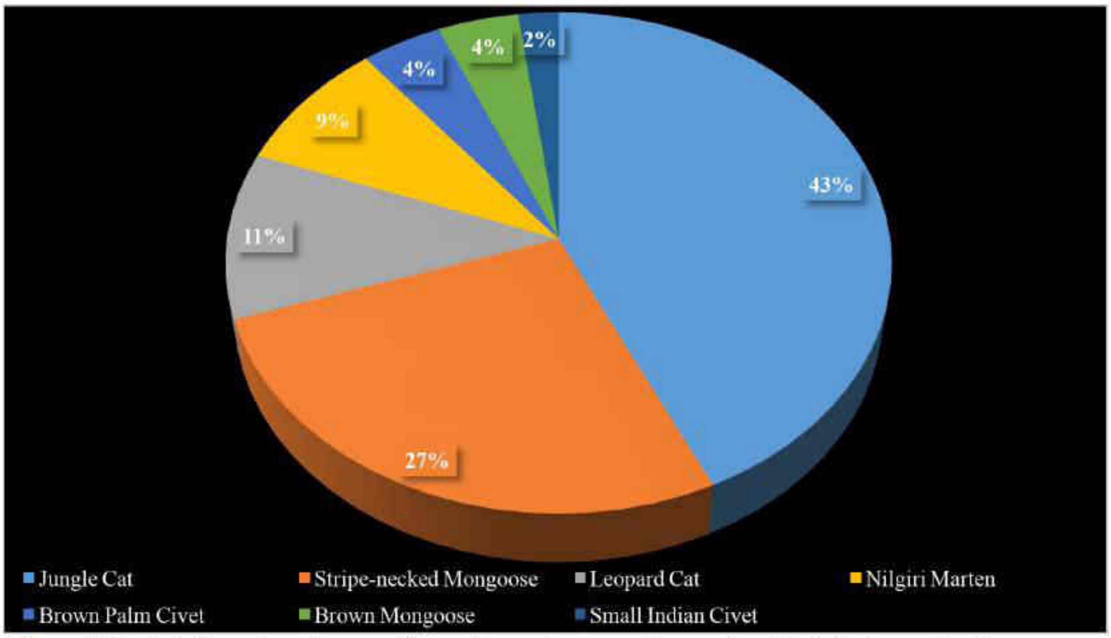

Figure 25. Relative abundance of small carnivores of grassland habitat, south of Palghat gap

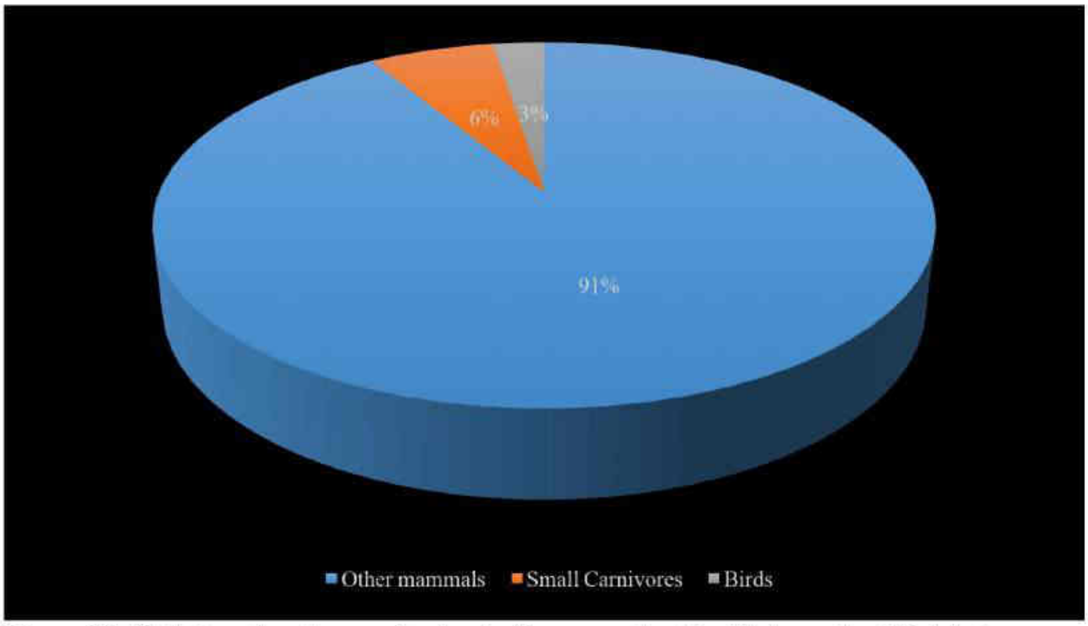

Figure 26. Relative abundance of animals from grassland habitat, north of Palghat gap

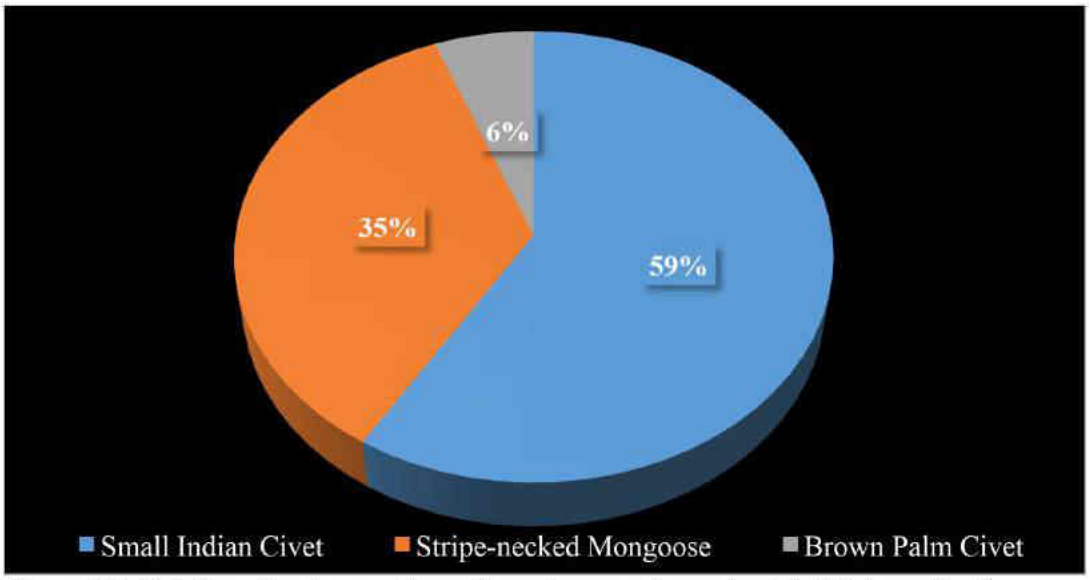

Figure 27. Relative abundance of small carnivores of grassland habitat, north of Palghat gap

4.4. SUCCESS RATE OF CAMERA TRAPS IN VARIOUS HABITATS

The total camera trap effort in days was 7925 camera trap days and the total photographs obtained of small carnivores was 455 images. The total small carnivore success rate from all the studied habitats was 5.74 per 100 trap nights (Table 11). while comparing the success rates from each habitat, evergreen habitat of south of the Palghat gap showed the highest success rate, 22.14 per 100 trap nights, and the least rate of camera trap success was shown by evergreen habitat, north of the Palghat gap. The second-highest success rate was obtained from grassland habitat, south of the Palghat gap followed by dry deciduous habitat north of Palghat gap and moist deciduous habitat, south of Palghat gap (Figure 28).

Table 11. Camera trap success of small carnivore detection in selected habitats of Kerala

Location	**Camera trap days**	**No. images**	**Success rate**
Evergreen_south	840	186	22.14
Grassland_south	915	90	9.84
Dry deciduous foreset_north	1140	69	6.05
Moist deciduous forest_south	825	40	4.85
Dry deciduous forest_south	1140	21	1.84
Grassland_north	950	17	1.79
Moist deciduous forest_north	840	14	1.67
Evergreen_north	1275	18	1.41
Total effort	**7925**	**455**	**5.74**

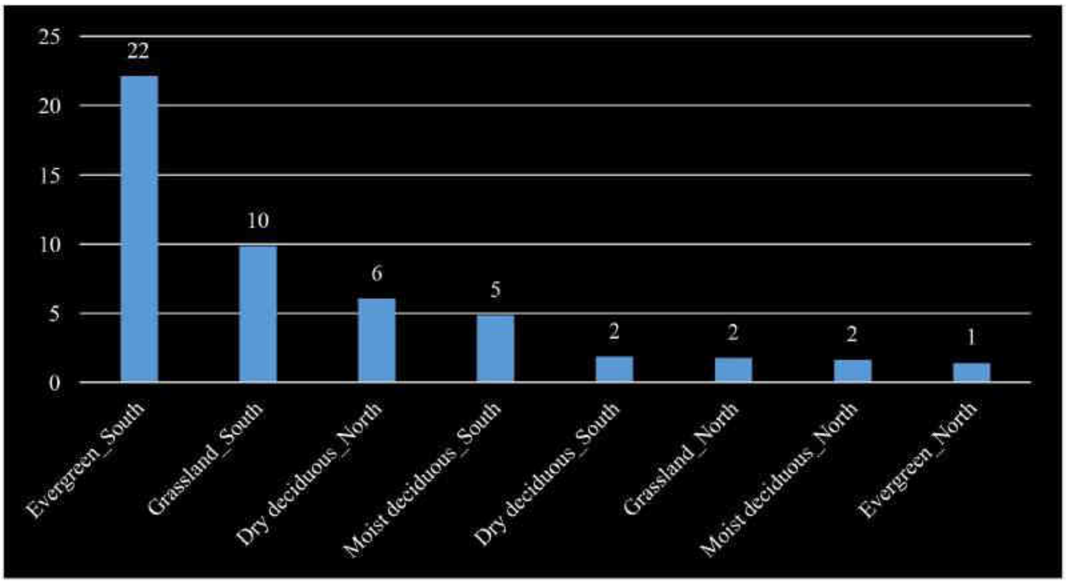

Figure 28. Camera trap success rate of small carnivores from various habitats

Among the small carnivore species, Strip-necked Mongoose (1.35 per 100 trap nights) was the most photo captured species followed by Brown Palm Civet (1.24 per 100 trap nights) and Small Indian Civet (1.08 per 100 trap nights). Indian Grey Mongoose, Rusty-spotted Cat, and Smooth-coated Otter were the least detected species with 0.012 per 100 trap nights (Table 12).

Table 12. Species wise camera trap success rate of small carnivores

Common Name	Camera trap days	No. images	Success rate (per 100 trap nights)
Stripe necked mongoose	7925	107	1.35
Brown Palm Civet	7925	99	1.25
Small Indian Civet	7925	86	1.08
Jungle Cat	7925	40	0.50
Brown mongoose	7925	36	0.45
Common Palm Civet	7925	35	0.44
Ruddy Mongoose	7925	15	0.19
Leopard Cat	7925	15	0.19
Nilgiri Marten	7925	12	0.15
Asian Small-clawed Otter	7925	5	0.06
Grey Mongoose	7925	1	0.01
Rusty-spotted Cat	7925	1	0.01
Smooth-coated Otter	7925	1	0.01
Unidentified Cat	7925	2	0.02

4.5. SPECIES RICHNESS AND DIVERSITY OF THE SMALL CARNIVORES OF KERALA

The various diversity indices and species richness parameters such as the number of taxa (S), number of individuals (n), Dominances, Shannon-Weiner index (H), Simpson's index (1-D), Berger Parker index, and Margalef index (M) were calculated for each habitat (Table 13).

Table 13. Species richness and diversity indices for the small carnivores of Kerala

Indices	**MDF**	**EG**	**GL**	**DDF**
Taxa_S	7	7	7	7
Individuals	55	219	102	93
Dominance_D	0.29	0.27	0.23	0.25
Simpson_1-D	0.70	0.73	0.77	0.74
Shannon_H	1.50	1.52	1.68	1.50
Margalef	1.49	1.11	1.29	1.32
Berger-Parker	0.49	0.41	0.33	0.32

Diversity index Shannon-Weiner index was compared using a t-test. T-values for comparing the indices between habitats were found to be non-significant at 0.05 levels (Table 14).

Table 14. Comparison of Shannon diversity indices in the different habitats in Kerala

	Evergreen	**Moist deciduous**	**Dry deciduous**	**Grassland**
Evergreen	NA	-0.10 ns	0.17 ns	-1.80 ns
Moist deciduous	-0.10 ns	NA	0.01 ns	-1.22 ns
Dry deciduous	0.17 ns	0.01 ns	NA	1.70 ns
Grassland	-1.80 ns	-1.22 ns	1.70 ns	NA

Dominance index, Simpson index of different habitats of Kerala were compared using the student t-test. T-values for comparing the indices between habitats were found to be non-significant at 0.05 levels (Table 15).

Table 15. Comparison of Simpson indices in the different habitats in Kerala

	Evergreen	Moist deciduous	Dry deciduous	Grassland
Evergreen	NA	0.54 ns	0.54 ns	1.48 ns
Moist deciduous	0.54 ns	NA	0.80 ns	1.29 ns
Dry deciduous	0.54 ns	0.80 ns	NA	0.99 ns
Grassland	1.48 ns	1.29 ns	0.99 ns	NA

The various diversity indices and species richness parameters such as the number of taxa (S), number of individuals (n), Dominances, Shannon-Weiner index (H), Simpson's index (1-D), Berger Parker index, and Margalef index (M) were calculated for each habitat (Table 16).

Table 16. Species richness and diversity indices for the small carnivores of habitats in the north of Palghat gap of Kerala

	MDF_N	EG_N	GL_N	DDF_N
Taxa_S	4	4	3	6
Individuals	14	22	17	71
Dominance_D	0.35	0.31	0.47	0.28
Simpson_1-D	0.64	0.69	0.52	0.71
Shannon_H	1.17	1.28	0.84	1.41
Margalef	1.13	0.97	0.71	1.17
Berger-Parker	0.5	0.45	0.58	0.42

Diversity index Shannon-Weiner index was compared using a t-test. When comparing the Shannon diversity indices for habitats north of the Palghat gap using t-test, a significant difference was observed between evergreen habitat and grassland habitat at 0.05 level and dry deciduous habitat and grassland habitat at 0.01 level (Table 17)

Table 17. Comparison of Shannon diversity indices in the different habitats situated north of the Palghat gap in Kerala

	Evergreen	**Moist deciduous**	**Dry deciduous**	**Grassland**
Evergreen	NA	-0.55 ns	-0.88 ns	2.39 *
Moist deciduous	-0.55 ns	NA	-1.20 ns	1.39 ns
Dry deciduous	-0.88 ns	-1.20 ns	NA	-3.35 **
Grassland	2.39 *	1.39 ns	-3.35 **	NA

Dominance index, Simpson index of different habitats of Kerala were compared using the student t-test. T-values for comparing the indices between dry deciduous habitat and grassland habitats were found to be significant at 0.05 levels. All other habitats compared were non-significant at 0.05 level (Table 18).

Table 18. Comparison of Simpson indices in the different habitats situated north of the Palghat gap in Kerala

	Evergreen	**Moist deciduous**	**Dry deciduous**	**Grassland**
Evergreen	NA	0.45^{ns}	0.26^{ns}	1.60^{ns}
Moist deciduous	0.45^{ns}	NA	0.70^{ns}	0.93^{ns}
Dry deciduous	0.26^{ns}	0.70^{ns}	NA	2.10 *
Grassland	1.60^{ns}	0.93^{ns}	2.10 *	NA

The various diversity indices and species richness parameters such as the number of taxa (S), number of individuals (n), Dominances, Shannon-Weiner index (H), Simpson's index (1-D), Berger Parker index, and Margalef index (M) were calculated for each habitat (Table 19).

Table 19. Species richness and diversity indices for the small carnivores of habitats in south of Palghat gap of Kerala

	MDF_S	EG_S	GL_S	DDF_S
Taxa_S	5	6	7	4
Individuals	41	197	85	22
Dominance_D	0.38	0.29	0.26	0.45
Simpson_1-D	0.62	0.70	0.73	0.54
Shannon_H	1.20	1.4	1.57	1.03
Margalef	1.07	0.94	1.35	0.97
Berger-Parker	0.56	0.43	0.4	0.63

A diversity t-test was carried out to compare the Shannon diversity indices for habitats south of the Palghat gap and it was found to be significant at 0.05 level between moist deciduous habitat and grassland habitat and dry deciduous habitat and grassland habitat (Table 20).

Table 20. Comparison of Shannon diversity indices in the different habitats situated south of the Palghat gap in Kerala

	Evergreen	Moist deciduous	Dry deciduous	Grassland
Evergreen	NA	-1.39^{ns}	1.97^{ns}	-1.69^{ns}
Moist deciduous	-1.39^{ns}	NA	0.78^{ns}	-2.34 *
Dry deciduous	1.97^{ns}	0.78^{ns}	NA	2.69 *
Grassland	-1.69^{ns}	-2.34 *	2.69 *	NA

Dominance index, Simpson index of different habitats of Kerala were compared using the student t-test. T-values for comparing the indices between habitats were found to be non-significant at 0.05 levels (Table 21).

Table 21. Comparison of Simpson indices in the different habitats situated south of the Palghat gap in Kerala

	Evergreen	**Moist deciduous**	**Dry deciduous**	**Grassland**
Evergreen	NA	1.23 ^{ns}	1.48 ^{ns}	0.93 ^{ns}
Moist deciduous	1.23 ^{ns}	NA	0.59 ^{ns}	1.64 ^{ns}
Dry deciduous	1.48 ^{ns}	0.59 ^{ns}	NA	1.75 ^{ns}
Grassland	0.93 ^{ns}	1.64 ^{ns}	1.75 ^{ns}	NA

4.6. PREDICTION OF PRESENCE OR ABSENCE OF SPECIES USING HABITAT PARAMETERS

Binary logistic regression is used to predict the relationship between a categorical dependent variable and values of independent variables, which are usually continuous. The presence or absence of small carnivores in habitat was predicted using the continuous habitat parameters. Eleven micro-habitat parameters were used for the regression analysis they were Distance to the waterbody, width of the waterbody, GBH (cm), Slope of the land (in degrees), Canopy height (m), Canopy cover (percentage), Litter depth (cm), shrub density (shrubs/area), tree density (trees/area), climber density (climbers/area), and altitude (m AMSL). The result of logistic regression analysis done for each species is given below in detail.

4.6.1 Prediction of presence or absence of Stripe-necked Mongoose of dry deciduous habitat (North of Palghat Gap)

Eleven microhabitat parameters have been used to do the analysis Binary logistic regression analysis was done for predicting the presence of Stripe-necked Mongoose species. It was found that only two variables have a significant influence on the presence or absence of the species. They are the width of waterbody and altitude (Table 22). Akaike information criterion (AIC) score was 27.97 and the model was selected.

Table 22. Habitat parameters influencing the presence of Stripe-necked Mongoose in dry deciduous habitat

Variable	Coefficient	Chi-square value	P value
Width of the Waterbody	0.5349	5.1808	0.05
Altitude	0.0145	4.6526	0.05

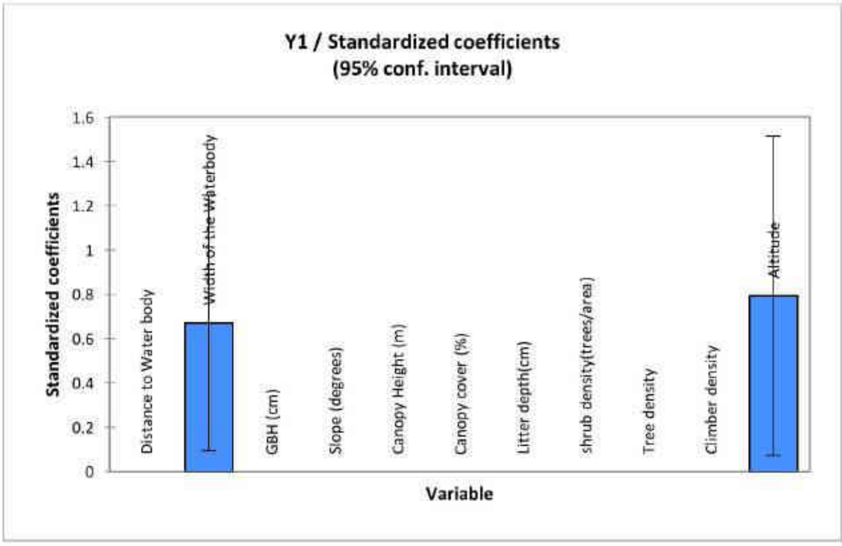

Figure 29. Influence of habitat parameters on the occurrence of Stripe-necked Mongoose

The regression coefficient is the estimated increase in the logged odds of the outcome per unit increase in the value of the independent variable. In Figure 29. Positive variables indicate that increase in these variables leads to higher presence. Here both the significant independent variables have a positive influence over the species occurrence. If the height of the blue bar is more, then these variables are

Pred (Stripe-necked Mongoose) = 1 / (1 + exp (-(-7.40131+0.53487* width of waterbody +0.01451* altitude)))

more important. The binary logistic regression model is given below.

The classification table of observed and predicted response of the fitted logistic regression model for predicting the presence of Stripe-necked Mongoose in terms of different habitat parameters is given in Table 23.

Table 23. Evaluation of logistic regression model for Stripe-necked Mongoose

from \ to	**0**	**1**	**Total**	**% correct**
0	22	2	24	91.67%
1	3	4	7	57.14%
Total	25	6	31	83.87%

The percentage of correct predictions is 83.87 percent. The higher the overall percentage of correct predictions, the better is the model.

4.6.2 Prediction of presence or absence of Small Indian Civet of dry deciduous habitat (North of Palghat Gap)

Binary logistic regression analysis was done for predicting the presence of Small Indian Civet. It was found that only two variables have influence on the presence or absence of the species. They are distance to waterbody and altitude (Table 24). Akaike information criterion (AIC) score was 34.88 and the model was selected.

Table 24. Habitat parameters influencing the presence of Small Indian Civet in dry deciduous habitat

Variable	Coefficient	Chi-square value	P value
Distance to Water body	-0.2014	1.5113	0.22
Altitude	0.0158	7.1770	0.01

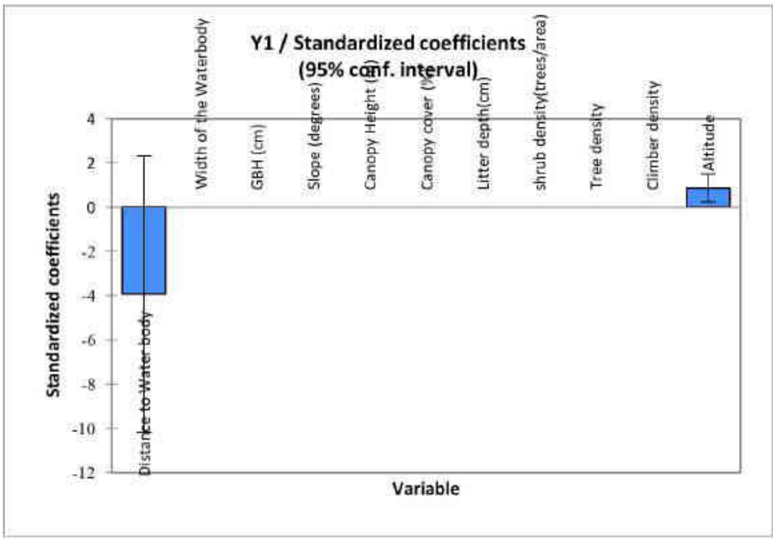

Figure 30. Influence of habitat parameters on the occurrence of Small Indian Civet

In Figure 30. variables that are positive indicate that an increase in these variables leads to a higher presence. Variables that are negative indicate that a decrease in these variables leads to an increase in the presence of Small Indian Civet. Here distance to waterbody has a negative relation where altitude has a positive influence over the species occurrence. If the height of the blue bar is more, then these variables are more important. The binary logistic regression model is given below.

Pred (Small Indian Civet) = 1 / (1 + exp(-(-6.02781-0.20136*Distance to Water body+0.01577*altitude)))

Classification table of observed and predicted response of the fitted logistic regression model for predicting the presence of Small Indian Civet in terms of different habitat parameters is given in Table 25.

Table 25. Evaluation of logistic regression model for Small Indian Civet

from \ to	0	1	Total	% correct
0	20	2	22	90.91%
1	4	5	9	55.56%
Total	24	7	31	80.65%

The percentage of correct predictions is 80.65 percent. The higher the overall percentage of correct predictions, the better is the model.

4.6.3 Prediction of presence or absence of Small Indian Civet of evergreen habitat (South of Palghat Gap)

Binary logistic regression analysis was done for predicting the presence of Small Indian Civet. It was found that only two variables have an influence on the presence or absence of the species. They are shrub density and tree density (Table 26). Akaike information criterion (AIC) score was 32.16 and the model was selected.

Table 26. Habitat parameters influencing the presence of Small Indian Civet in evergreen habitat

Variable	Coefficient	Chi-square value	P value
Shrub density	-0.3735	1.2539	0.27
Tree density	-0.7732	4.1483	0.05

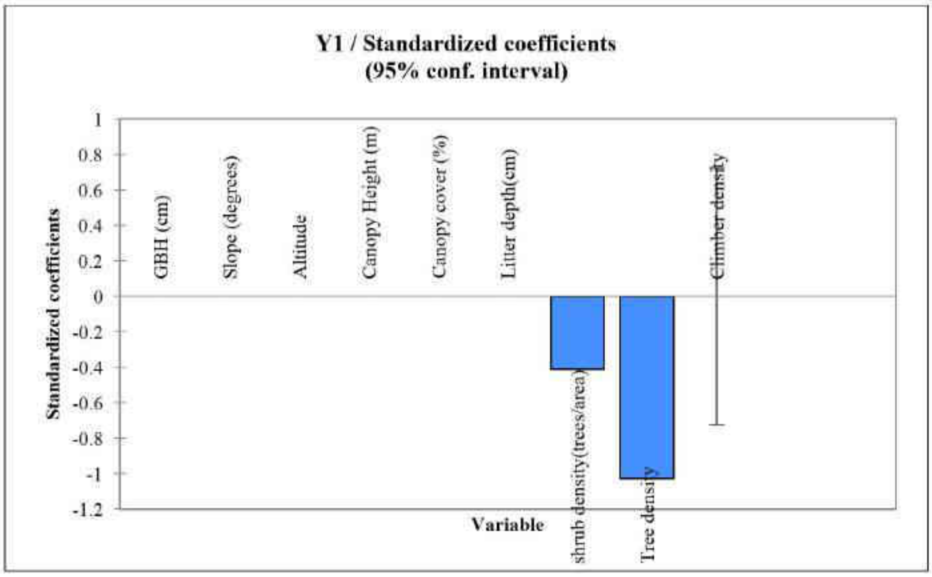

Figure 31. Influence of habitat parameters on the occurrence of Small Indian Civet

In Figure 31. Variables that are negative indicate that a decrease in these variables leads to a higher presence of Small Indian Civet. Here both shrub and tree density have a negative influence over the Small Indian Civet occurrence. If the height of the blue bar is more, then these variables are more important. The binary logistic regression model is given below.

Pred (Small Indian Civet) = 1 / (1 + exp (-(6.18971-0.37354*Shrub density-0.77320*Tree density)))

Classification table of observed and predicted response of the fitted logistic regression model for predicting the presence of Small Indian Civet in terms of different habitat parameters is given in Table 27.

Table 27. Evaluation of logistic regression model for Small Indian Civet

from \ to	0	1	Total	% correct
0	19	2	21	90.48%
1	4	3	7	42.86%
Total	23	5	28	78.57%

The percentage of correct predictions is 78.57 percent. The higher the overall percentage of correct predictions, the better is the model.

4.6.4 Prediction of presence or absence of Brown Palm Civet of evergreen habitat (South of Palghat Gap)

Binary logistic regression analysis was done for predicting the presence of Brown Palm Civet. It was found that only two variables have a significant influence on the presence or absence of the species. They are slope and tree density (Table 28). Akaike information criterion (AIC) score was 41.43 and the model was selected.

Table 28. Habitat parameters influencing the presence of Brown Palm Civet in evergreen habitat

Variable	Coefficient	Chi-square value	P value
Slope	0.0526	3.9101	0.05
Tree density	-0.3496	3.1706	0.08

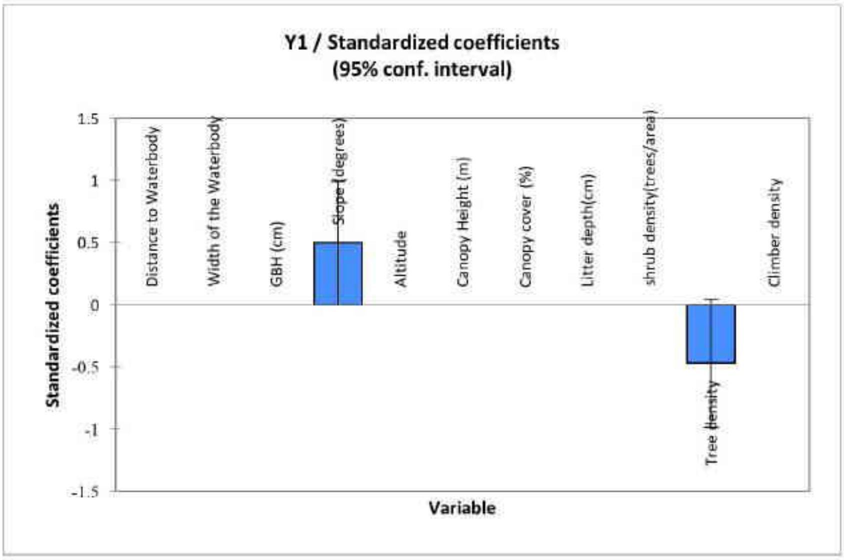

Figure 32. Influence of habitat parameters on the occurrence of Brown Palm Civet

In Figure 32. Positive variable indicates that an increase in these variables leads to higher presence. Negative variables indicate that a decrease in these variables leads to increased presence of Brown Palm Civet. Here slope of the land has a positive relation and tree density have a negative influence over the Brown Palm Civet occurrence. If the height of the blue bar is more, then these variables are more important. The binary logistic regression model is given below.

Pred (Brown Palm Civet) = 1 / (1 + exp (-(1.02779+0.05260*Slope-0.34959*Tree density)))

Classification table of observed and predicted response of the fitted logistic regression model for predicting the presence of Brown Palm Civet in terms of different habitat parameters is given in Table 29.

Table 29. Evaluation of logistic regression model for Brown Palm Civet

from \ to	0	1	Total	% correct
0	13	3	16	81.25%
1	5	8	13	61.54%
Total	18	11	29	72.41%

The percentage of correct predictions is 72.41 percent. The higher the overall percentage of correct predictions, the better is the model.

4.6.5 Prediction of presence or absence of Brown Mongoose of evergreen habitat (South of Palghat Gap)

Binary logistic regression analysis was done for predicting the presence of Brown Mongoose. It was found that only two variables have a significant influence on the presence or absence of the species. They are slope and width of the waterbody (Table 30). Akaike information criterion (AIC) score was 35.19 and the model was selected.

Table 30. Habitat parameters influencing the presence of Brown Mongoose in evergreen habitat

Variable	Coefficient	Chi-square value	P value
Width of the Waterbody	0.4449	2.7830	0.10
Slope	0.0361	1.2287	0.27

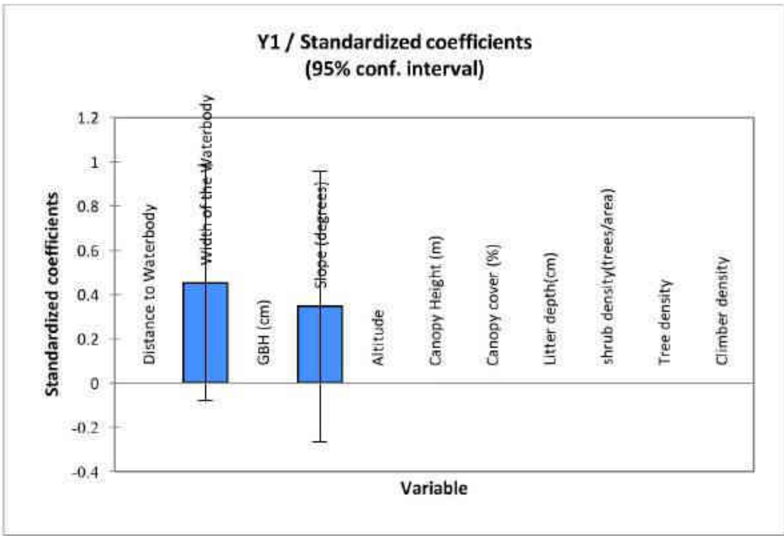

Figure 33. Influence of habitat parameters on the occurrence of Brown Mongoose

In Figure 33. variables that are positive indicate that an increase in these variables leads to higher presence. Here both slope of the land and width of the nearby waterbody have a positive relation with Brown Mongoose occurrence. If the height of the blue bar is more, then these variables are more important. The binary logistic regression model is given below.

Pred (Brown Mongoose) = 1 / (1 + exp(-(-2.88030+0.44492*Width of waterbody +0.03608*Slope)))

Classification table of observed and predicted response of the fitted logistic regression model for predicting the presence of Brown Mongoose in terms of different habitat parameters is given in Table 31.

Table 31. Evaluation of logistic regression model for Brown Mongoose

from \ to	0	1	Total	% correct
0	18	2	20	90.00%
1	4	4	8	50.00%
Total	22	6	28	78.57%

The percentage of correct predictions is 78.57 percent. The higher the overall percentage of correct predictions, the better is the model.

4.6.6 Prediction of presence or absence of Stripe-Necked Mongoose of evergreen habitat (South of Palghat Gap)

Binary logistic regression analysis was done for predicting the presence of Stripe-necked Mongoose. It was found that only two variables have a significant influence on the presence or absence of the species. They are shrub density and tree density (Table 32). Akaike information criterion (AIC) score was 35.10 and the model was selected.

Table 32. Habitat parameters influencing the presence of Stripe-necked Mongoose in evergreen habitat

Variable	Coefficient	Chi-square value	P value
Shrub density	-0.7409	5.9769	0.05
Tree density	-0.4668	2.8988	0.09

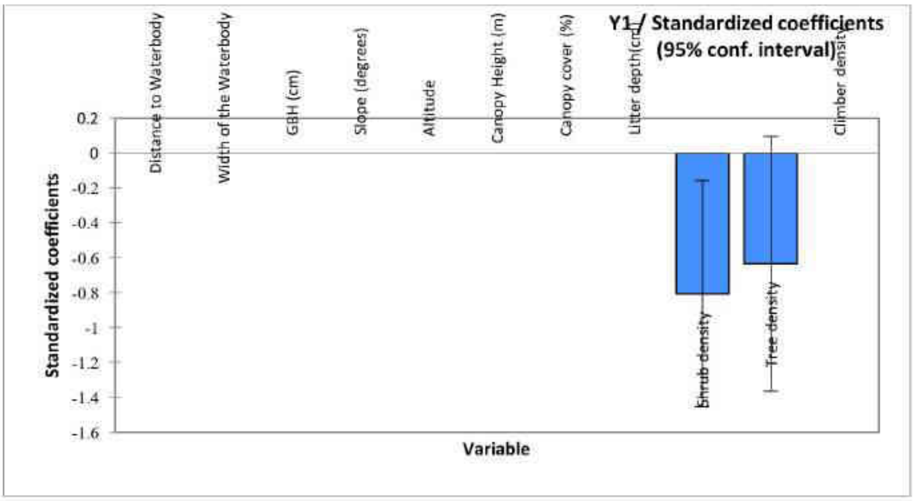

Figure 34. Influence of habitat parameters on the occurrence of Stripe-necked Mongoose

In Figure 34. Variables that are negative indicate that a decrease in these variables leads to an insrease in presence of Stripe-necked Mongoose. Here both shrub density and tree density have a negative impact on Stripe-necked Mongoose occurrence. If the height of the blue bar is more, then these variables are more important. The binary logistic regression model is given below.

Pred (Stripe-necked Mongoose) = 1 / (1 + exp(-(6.50593-0.74095*Shrub density - 0.46682*Tree density)))

Classification table of observed and predicted response of the fitted logistic regression model for predicting the presence of Stripe-necked Mongoose in terms of different habitat parameters is given in Table 33.

Table 33. Evaluation of logistic regression model for Stripe-necked Mongoose

from \ to	0	1	Total	% correct
0	17	3	20	85.00%
1	4	5	9	55.56%
Total	21	8	29	75.86%

The percentage of correct predictions is 78.57 percent. The higher the overall percentage of correct predictions, the better is the model.

4.6.7 Prediction of presence or absence of Stripe-necked Mongoose of grassland habitat (South of Palghat Gap)

Binary logistic regression analysis was done for predicting the presence of Stripe-necked Mongoose. It was found that only two variables have a significant influence on the presence or absence of the species. They are altitude and tree density (Table 34). Akaike information criterion (AIC) score was 37.45 and the model was selected.

Table 34. Habitat parameters influencing the presence of Stripe-necked Mongoose in grassland habitat

Variable	Coefficient	Chi-square value	P value
Tree density	0.1935	1.6225	0.21
Tree density	-0.0090	4.6920	0.05

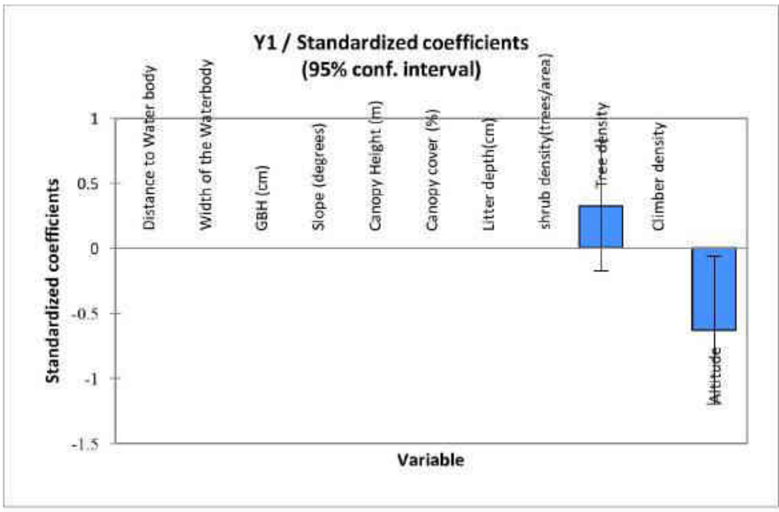

Figure 35. Influence of habitat parameters on the occurrence of Stripe-necked Mongoose

In Figure 35. Positive variables indicate an increase in these variables leads to higher presence. Variables that are negative indicate that decrease in these variables leads to a higher presence of Stripe-necked Mongoose. Here tree density has positive impact on Stripe-necked Mongoose occurrence whereas altitude has a negative impact. If the height of the blue bar is more, then these variables are more important. The binary logistic regression model is given below.

Pred (Stripe-necked Mongoose) = 1 / (1 + exp(-(17.15959+0.19351*tree density-0.00897*Altitude)))

Classification table of observed and predicted response of the fitted logistic regression model for predicting the presence of Stripe-necked Mongoose in terms of different habitat parameters is given as Table 35.

Table 35. Evaluation of logistic regression model for Stripe-necked Mongoose

from \ to	0	1	Total	% correct
0	13	4	17	76.47%
1	3	8	11	72.73%
Total	16	12	28	75.00%

The percentage of correct predictions is 75.00 percent. The higher the overall percentage of correct predictions, the better is the model.

4.6.8 Prediction of presence or absence of Jungle Cat of grassland habitat (South of Palghat Gap)

Binary logistic regression analysis was done for predicting the presence of Jungle Cat. It was found that only two variables have a significant influence on the presence or absence of the species. They are distance to waterbody and litter depth (Table 36). Akaike information criterion (AIC) score was 38.33 and the model was selected.

Table 36. Habitat parameters influencing the presence of Jungle Cat in grassland habitat

Variable	Coefficient	Chi-square value	P value
Distance to Water body	0.0672	1.6144	0.21
Litter depth	-0.5069	3.0095	0.09

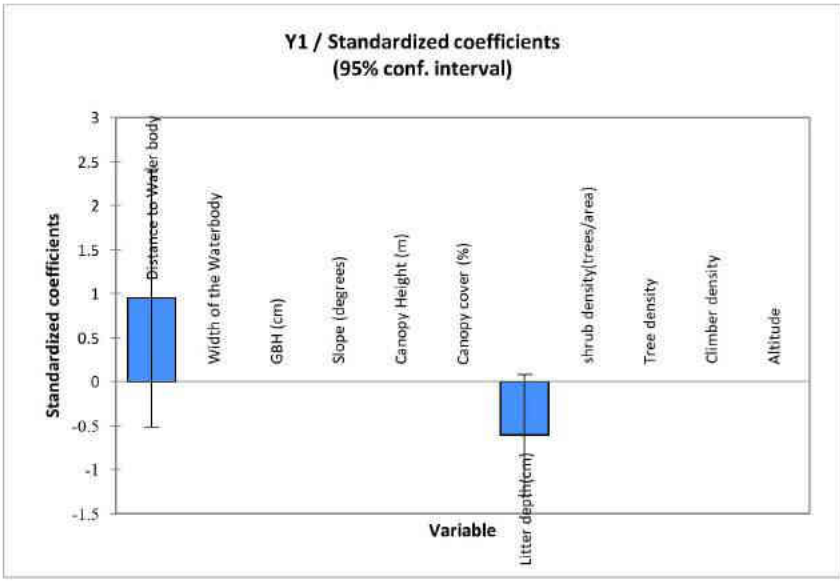

Figure 36. Influence of habitat parameters on the occurrence of Jungle Cat

In Figure 36. variables that are positive indicate an increase in these variables leads to higher presence. Negative variables indicate a decrease in these variables increase presence of Jungle Cat. Here distance to waterbody has positive impact on Jungle Cat occurrence whereas litter depth has a negative impact. If the height of the blue bar is more, then these variables are more important. The binary logistic regression model is given below.

Pred (Jungle Cat) = 1 / (1 + exp(-(-0.01361+0.06720*Distance to waterbody-0.50690*Litter depth)))

Classification table of observed and predicted response of the fitted logistic regression model for predicting the presence of Jungle Cat in terms of different habitat parameters is given as Table 37.

Table 37. Evaluation of logistic regression model for Jungle Cat

from \ to	0	1	Total	% correct
0	17	0	17	100.00%
1	9	2	11	18.18%
Total	26	2	28	67.86%

The percentage of correct predictions is 67.86 percent. The higher the overall percentage of correct predictions, the better is the model.

4.6.9 Prediction of Presence or Absence of Small Indian Civet of Moist Deciduous Habitat (South of Palghat Gap)

Binary logistic regression analysis was done for predicting the presence of Small Indian Civet. It was found that only two variables have a significant influence on the presence or absence of the species. They slope and tree density (Table 38). Akaike information criterion (AIC) score was 41.07 and the model was selected.

Table 38. Habitat parameters influencing the presence of Small Indian Civet in moist deciduous habitat

Variable	Coefficient	Chi-square value	P value
Slope	-0.0659	1.6639	0.20
Tree density	0.2315	1.2389	0.27

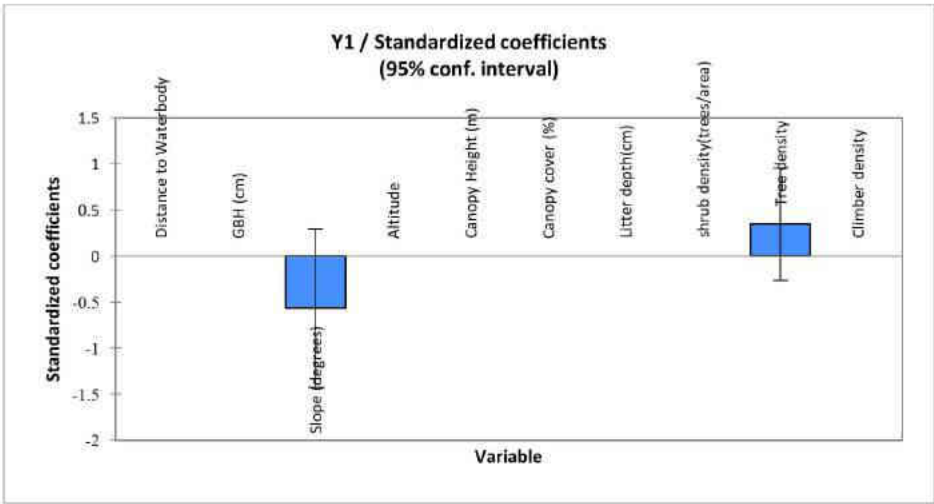

Figure 37. Influence of habitat parameters on the occurrence of Small Indian Civet

In Figure 37. variables that are positive indicate that increase in these variables leads to higher presence. Variables that are negative indicate that decrease in these variables leads to higher presence of Small Indian Civet. Here tree density has positive impact on Small Indian Civet occurrence whereas slope of land has a negative impact. If the height of the blue bar is more, then these variables are more important. The binary logistic regression model is given below.

Pred (Small Indian Civet) = 1 / (1 + exp(-(-1.29705-0.06587*Slope+0.23153*Tree density)))

Classification table of observed and predicted response of the fitted logistic regression model for predicting the presence of Small Indian Civet in terms of different habitat parameters is given in Table 39.

Table 39. Evaluation of logistic regression model for Small Indian Civet

from \ to	0	1	Total	% correct
0	18	2	20	90.00%
1	8	1	9	11.11%
Total	26	3	29	65.52%

The percentage of correct predictions is 67.86 percent. The higher the overall percentage of correct predictions, the better is the model.

4.7 DIFFERENTIAL PREFERENCES OF SMALL CARNIVORES FOR HABITAT VARIABLES

Differential preferences of the species for the studied habitat variables are examined using discriminant analysis. It shows whether there is any niche partitioning between and among the species concerning to the studied habitat variables.

Table 40 below shows the pair-wise Fisher's distances (blue cells) and associated P values (green cells). There is no significant difference in the clusters indicating that the species show no significant niche partitioning in evergreen habitat (South of Palghat gap) in Nelliyampathy Reserve Forest (Figure 37).

Table 40. Fisher's distance matrix

	Brown Mongoose	**Brown Palm Civet**	**Small Indian Civet**	**Stripe-necked Mongoose**
Brown Mongoose	0	0.4686	0.5544	0.3331
Brown Palm Civet	0.9047	0	0.4663	0.5533
Small Indian Civet	0.8458	0.9061	0	0.4871
Stripe-necked Mongoose	0.9694	0.8466	0.8930	0

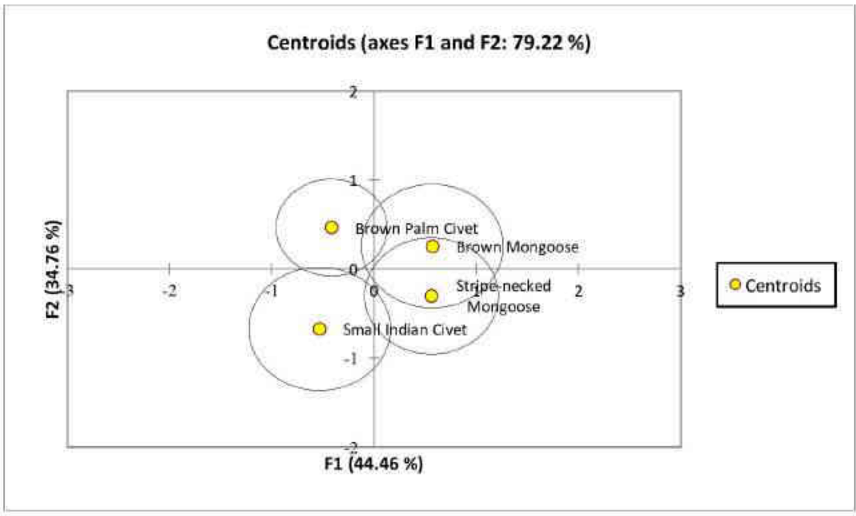

Figure 38. Niche overlapping of small carnivores of evergreen habitat (South of Palghat gap)

Table 41 below shows the pair-wise Fisher's distances (blue cells) and associated P values (green cells). There is no significant difference in the clusters indicating that the species show no significant niche partitioning in grassland shola habitat (South of Palghat gap) (Figure 38).

Table 41. Fisher's distance matrix

	Brown Mongoose	Brown Palm Civet	Jungle Cat	Leopard Cat	Nilgiri Marten	Stripe-necked Mongoose
Brown Mongoose	0.000	0.000	0.633	0.320	0.285	0.466
Brown Palm Civet	1.000	0.000	0.633	0.320	0.285	0.466
Jungle Cat	0.781	0.781	0.000	0.405	0.693	0.359
Leopard Cat	0.972	0.972	0.937	0.000	0.240	0.300
Nilgiri Marten	0.982	0.982	0.731	0.991	0.000	0.348
Stripe-necked Mongoose	0.903	0.903	0.958	0.978	0.962	0.000

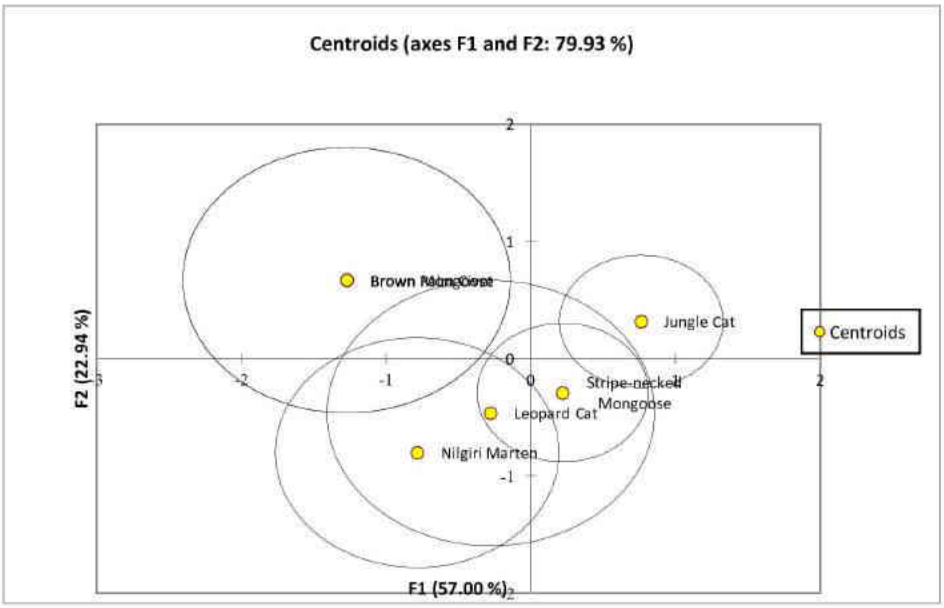

Figure 39. Niche overlapping of small carnivores of grassland shola habitat (South of Palghat gap)

Table 42 below shows the pair-wise Fisher's distances (blue cells) and associated P values (green cells). There is no significant difference in the clusters indicating that the species Stripe-necked Mongoose, Small Indian Civet, and Common Palm Civet show no significant niche partitioning in dry deciduous habitat (North of Palghat gap) of Walayar Reserve Forest (Figure 39). However, Ruddy Mongoose showed significant niche partition from all the other three species in the habitat.

Table 42. Fisher's distance matrix

	Common Palm Civet	**Ruddy Mongoose**	**Small Indian Civet**	**Stripe-necked Mongoose**
Common Palm Civet	0	6.9392	0.3543	2.0590
Ruddy Mongoose	0.0055	0	6.1945	9.8330
Small Indian Civet	0.7062	0.0085	0	2.1423
Stripe-necked Mongoose	0.1551	0.0012	0.1449	0

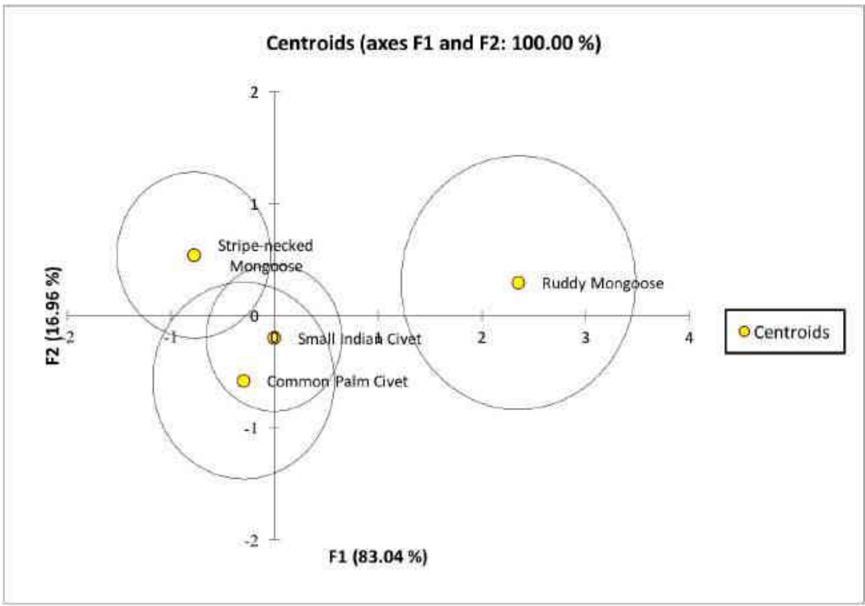

Figure 40. Niche overlapping of small carnivores of Dry deciduous habitat (North of Palghat gap)

4.8 DIEL ACTIVITY PATTERN OF SMALL CARNIVORES

From the camera trap images obtained diel activity patterns of ten small carnivores were studied. Species Asian Small-clawed Otter (Figure 41), Brown Mongoose (Figure 42), and Jungle Cat (Figure 43) are showing a cathemeral activity pattern. The activity peak of Asian Small-clawed Otter is from 1800hrs to 2000hrs. Diel activity peak of Brown Mongoose is during midnight hours (2300hrs -2400hrs). The species also showed some activity during the daytime. The Jungle Cat showed the activity peak during 0200hrs to 0300 hrs. Some crepuscular hour activity is also observed for the animal.

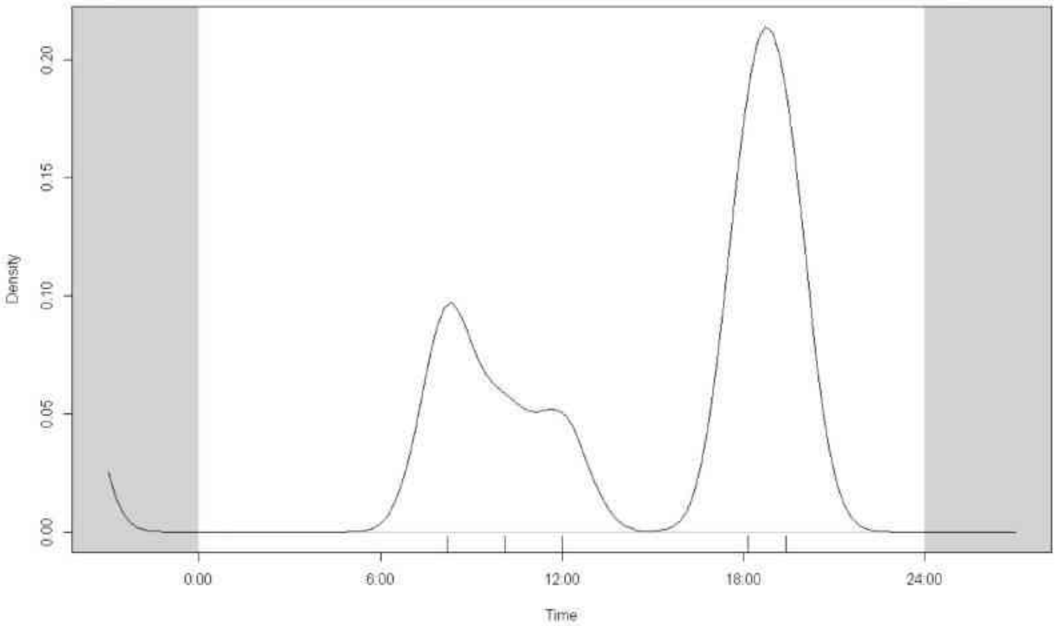

Figure 41. Activity pattern of Asian Small-clawed Otter of Kerala

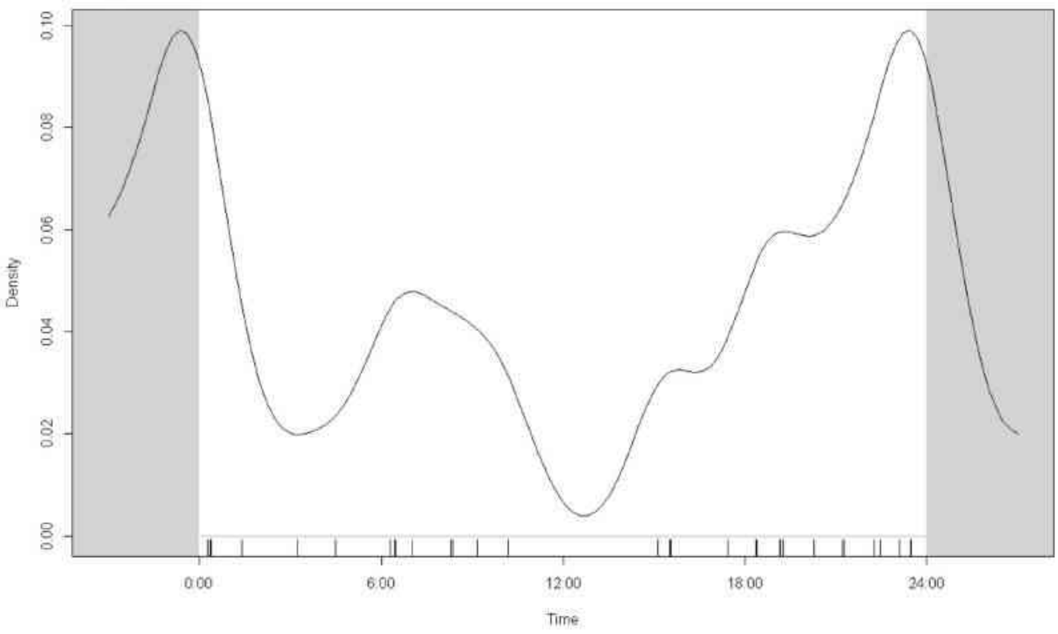

Figure 42. Activity pattern of Brown Mongoose of Kerala

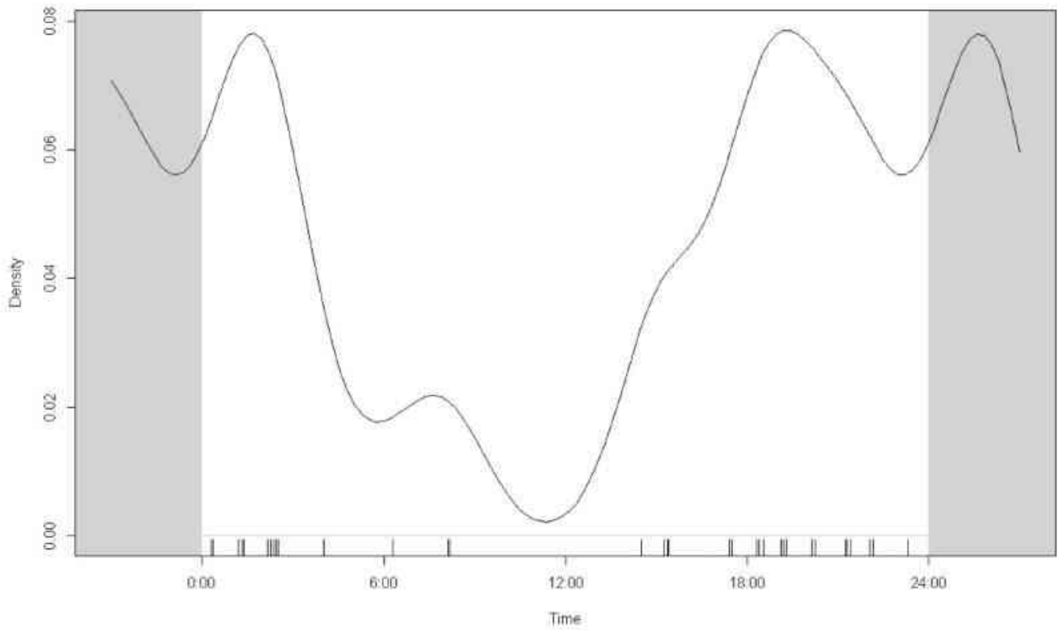

Figure 43. Activity pattern of Jungle Cat of Kerala

The activity pattern Brown Palm Civet (Figure 44), Common Palm Civet (Figure 45), and Leopard Cat (Figure 46) showed mostly nocturnal activity patterns. The maximum activity of Brown Palm Civet is observed during the night (1900hrs to 2100hrs) and in the early morning hours (0300hrs to 0500hrs). the species showed very little activity during the daytime. The Common Palm Civet was almost active throughout the night hours. Even though it showed more activity during 2100hrs to 2200hrs and 2300hrs to 2400hrs. Leopard Cat was mostly nocturnal with more activity during 2300hrs to 0200hrs, and it also showed some activity during crepuscular hours.

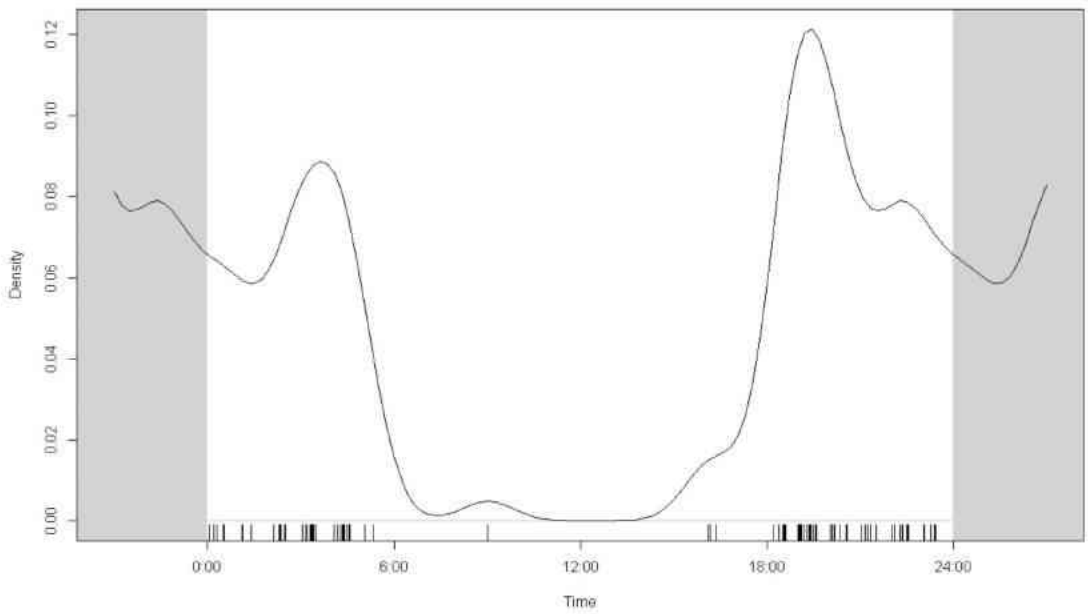

Figure 44. Activity pattern of Brown Palm Civet of Kerala

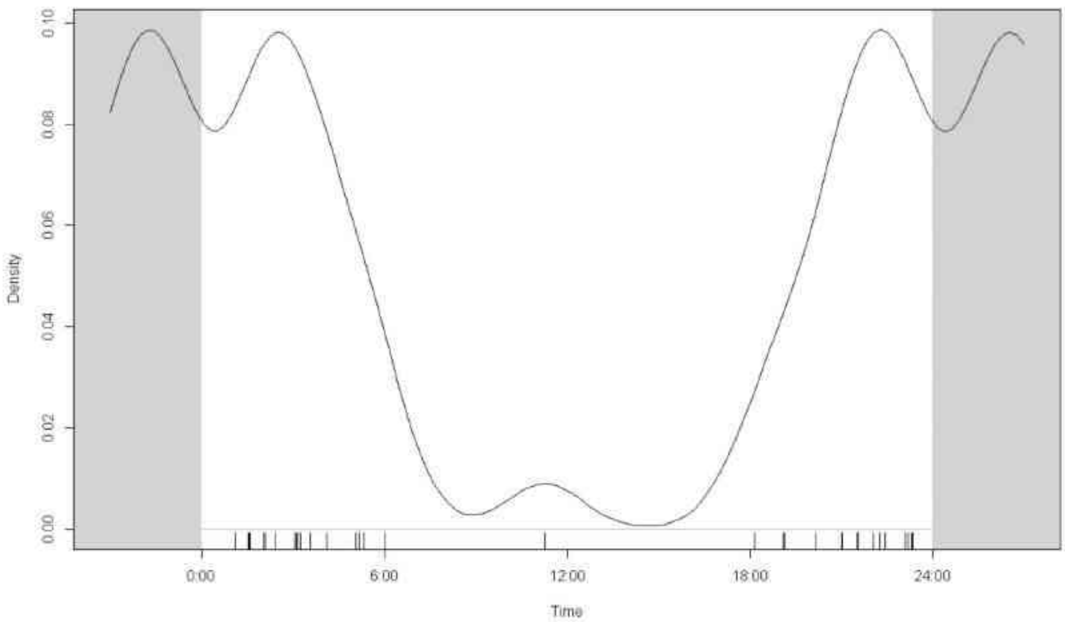

Figure 45. Activity pattern of Common Palm Civet of Kerala

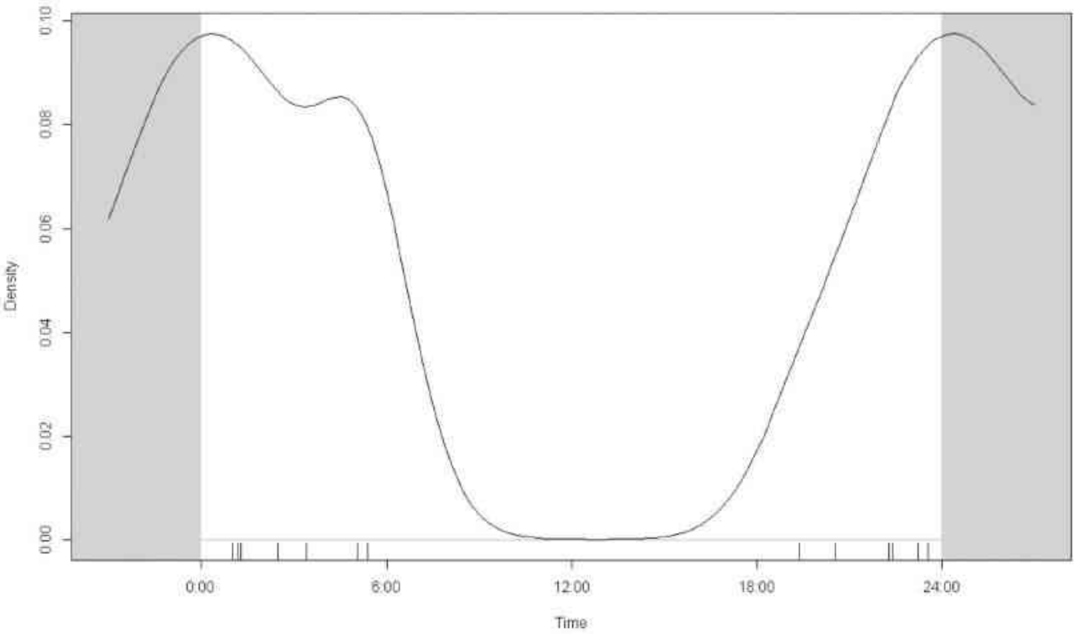

Figure 46. Activity pattern of Leopard Cat of Kerala

Small Indian Civet was the only small carnivore that showed a complete nocturnal activity pattern (Figure 47). The activity peaks of Small Indian Civet are 2000hrs to 2200hrs and 0000hrs to 0200hrs.

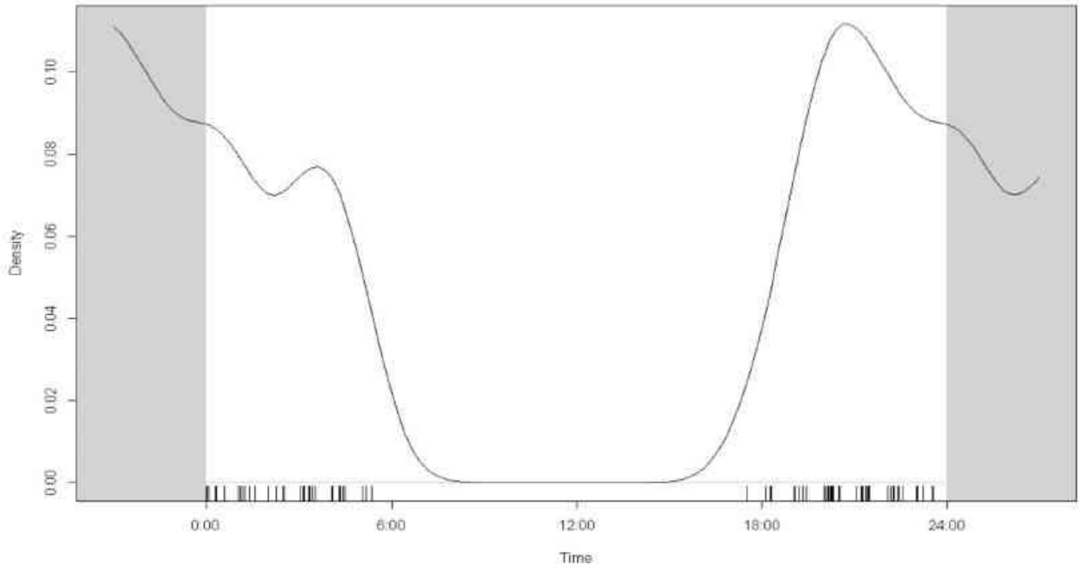

Figure 47. Activity pattern of Small Indian Civet of Kerala

Stripe-necked Mongoose, Ruddy Mongoose, and Nilgiri Marten had a complete diurnal activity pattern. Stripe-necked Mongoose even showed some activity during crepuscular hours and its activity peak during 0700hrs to 0900hrs, 1000hrs to 1200hrs, and 1500hrs to 1700hrs (Figure 50). Ruddy Mongoose showed very little activity during crepuscular hours and the activity peaks are during 0800hrs-1000hrs (Figure 49). Nilgiri Marten had activity peaks during 0800hrs to 1000hrs and it also showed little activity during dawn (Figure 48).

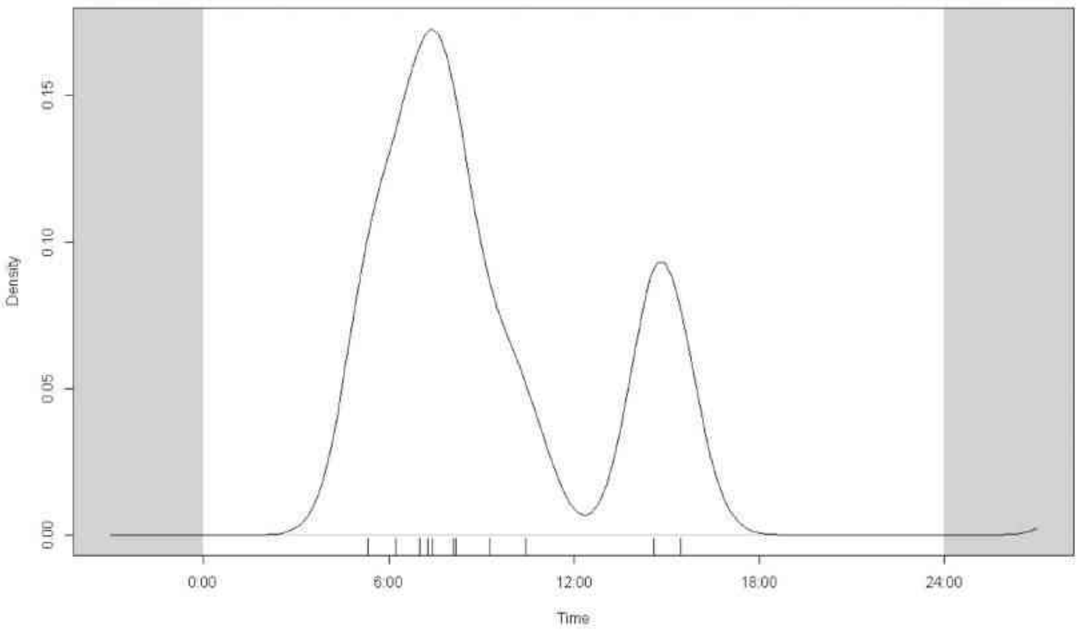

Figure 48. Activity pattern of Nilgiri Marten of Kerala

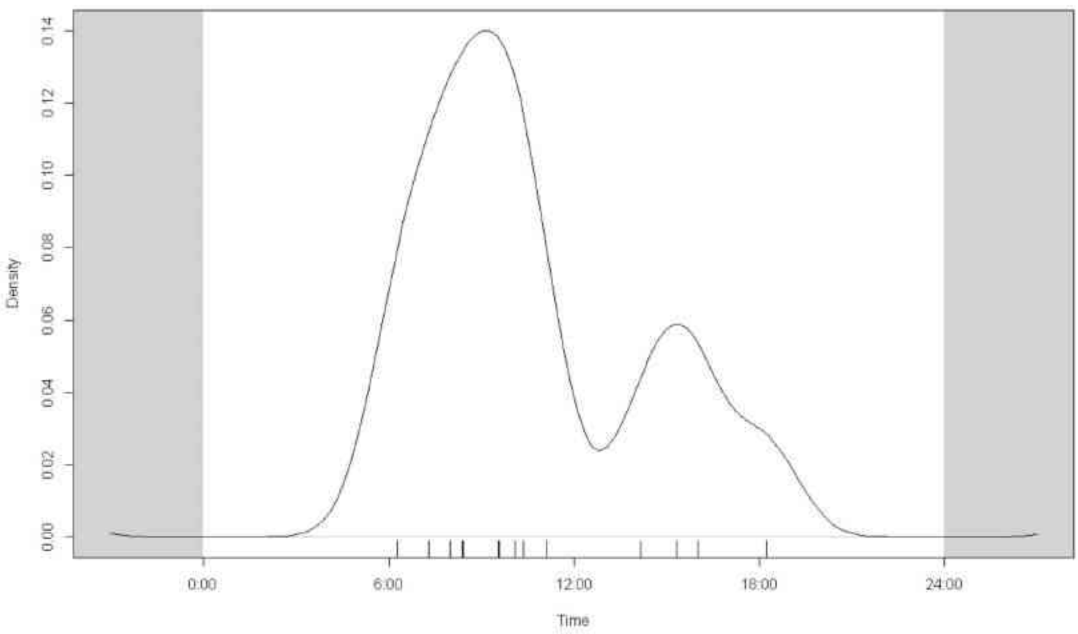

Figure 49. Activity pattern of Ruddy Mongoose of Kerala

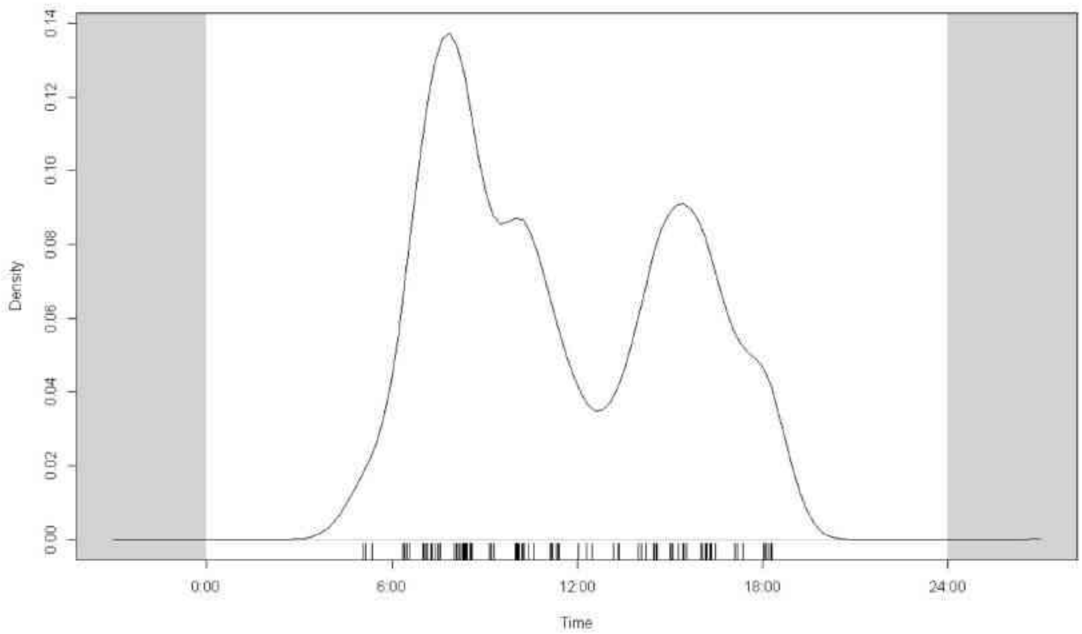

Figure 50. Activity Pattern of Stripe-necked Mongoose of Kerala

4.8.1 Diel activity pattern overlap

Diel activity overlap of sympatric small carnivores was analyzed and it was found that Small Indian Civet and Brown Palm Civet have the most overlap between their activity pattern (87%; 0.77-0.95) (Figure 51a). The next pair of small carnivores with more overlap was Common Palm Civet and Leopard Cat (86%; 0.69-1.00) (Figure 51b) and Common Palm Civet and Small Indian Civet (86%; 0.76-0.96) (Figure 51c). The former two pairs were nocturnal in their activity whereas the latter pair had a diurnal activity pattern. The least activity overlap was observed between Stripe-necked Mongoose and Small Indian Civet (9%; 0.06-0.018) (Figure 56c) and Small Indian Civet and Nilgiri Marten (10%; 0.01-0.21) (Figure 56b). More than 50% overlap in activity have been shown by sympatric small carnivores like Brown Mongoose and Small Indian Civet (66%; 0.52-0.78) (Figure 53a), Brown Mongoose and Brown Palm Civet (65%; 0.51-0.78) (Figure 53c), Brown Mongoose and Leopard Cat (67%; 0.50-0.84) (Figure 52f), Brown Mongoose and Jungle Cat (74%; 0.58-0.87) (Figure 52b), Stripe-necked Mongoose and Nilgiri Marten (72%; 0.52-0.88) (Figure 52e), Stripe-necked Mongoose and Asian Small-clawed Otter (50%; 0.235-0.73)(Figure 53d) (Table 22).

Table 43. Activity overlaps of small carnivores of Kerala

Species	Overlap (%)	Confidence interval	Figure No.
Brown Palm Civet and Small Indian Civet	87	0.77-0.95	50a
Common Palm Civet and Leopard Cat	86	0.69-1.01	50b
Common Palm Civet and Small Indian Civet	86	0.73-0.96	50c
Ruddy Mongoose and Stripe-necked Mongoose	84	0.68-0.96	50d
Brown Palm Civet and Common Palm Civet	79	0.66-0.89	50e
Leopard Cat and Small Indian Civet	79	0.61-0.94	50f
Brown Palm Civet and Jungle Cat	75	0.62-0.86	51a
Brown Mongoose and Jungle Cat	74	0.58-0.87	51b
Brown Palm Civet and Leopard Cat	74	0.56-0.84	51c
Jungle Cat and Small Indian Civet	72	0.57-0.84	51d
Nilgiri Marten and Stripe-necked Mongoose	72	0.52-0.88	51e
Brown Mongoose and Leopard Cat	67	0.50-0.84	51f
Brown Mongoose and Small Indian Civet	66	0.52-0.78	52a
Jungle Cat and Leopard Cat	66	0.46-0.82	52b
Brown Mongoose and Brown Palm Civet	65	0.51-0.71	52c
Asian Small-clawed Otter and Stripe-necked Mongoose	50	0.23-0.73	52d
Brown Mongoose and Ruddy Mongoose	43	0.25-0.61	52e
Brown Mongoose and Stripe-necked Mongoose	42	0..29-0.57	52f
Brown Mongoose and Nilgiri Marten	36	0.21-0.53	53a
Jungle Cat and Stripe-necked Mongoose	34	0.20-0.47	53b
Jungle Cat and Nilgiri Marten	24	0.09-0.41	53c
Leopard Cat and Nilgiri Marten	23	0.07-0..41	53d
Leopard Cat and Ruddy Mongoose	19	0.03-0.37	54a
Common Palm Civet and Ruddy Mongoose	18	0.04-0.33	54b
Common Palm Civet and Stripe-necked Mongoose	16	0.06-0.26	54c
Leopard Cat and Stripe-necked Mongoose	15	0.03-0.29	54d
Brown Palm Civet and Stripe-necked Mongoose	13	0.05-0.20	54e
Brown Palm Civet and Nilgiri Marten	12	0.21-0.25	54f
Ruddy Mongoose and Small Indian Civet	12	0.01-0.25	55a
Nilgiri Marten and Small Indian Civet	10	0.01-0.21	55b
Small Indian Civet and Stripe-necked Mongoose	9	0.06-0.18	55c

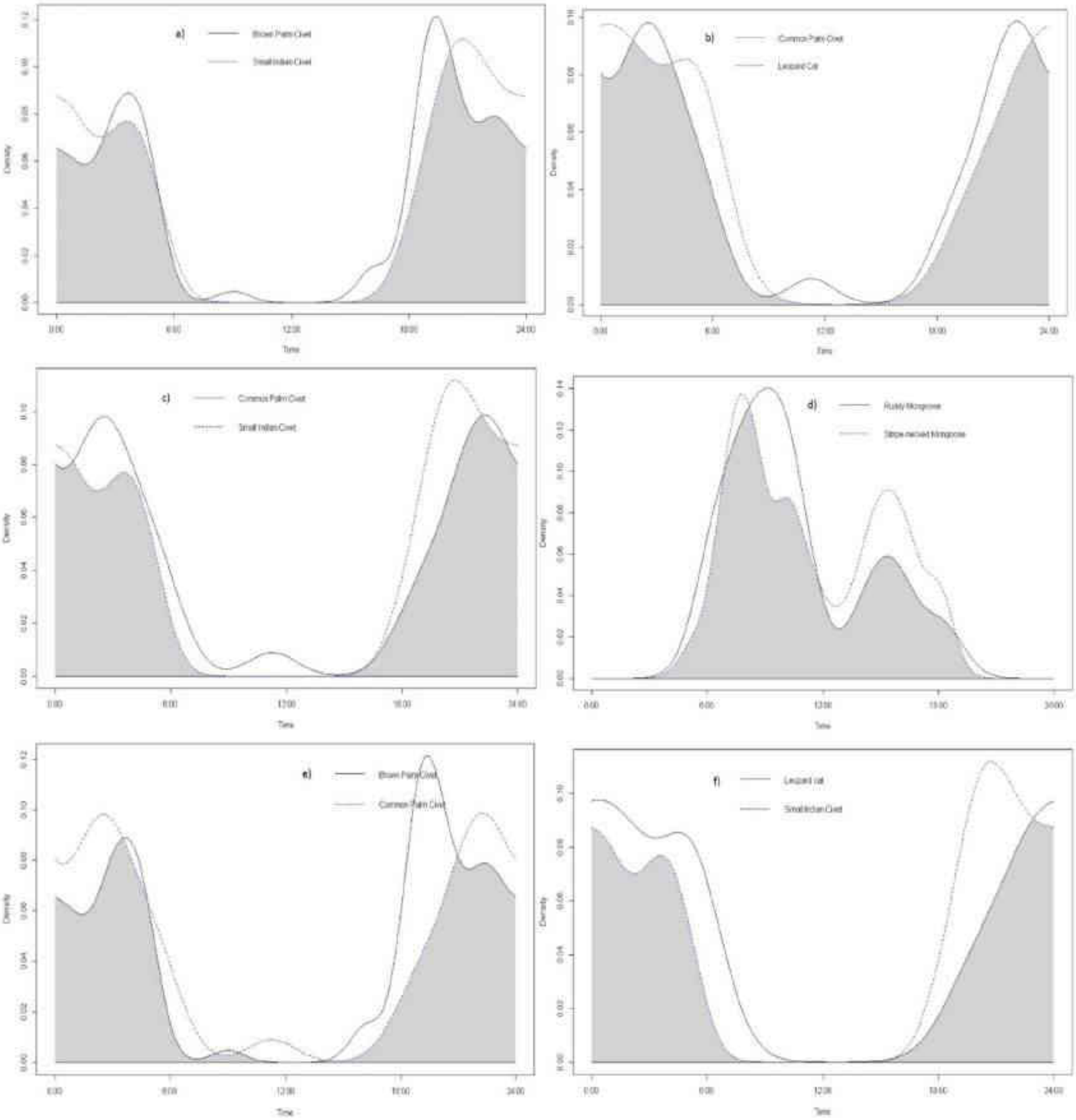

Figure 51. Diel activity overlaps of selected small carnivores in Kerala

a) Brown Palm Civet and Small Indian Civet, b) Common Palm Civet and Leopard Cat, c) Common Palm Civet and Small Indian Civet, d) Ruddy Mongoose and Stripe-necked Mongoose, e) Brown Palm Civet and Common Palm Civet, and f) Leopard Cat and Small Indian Civet

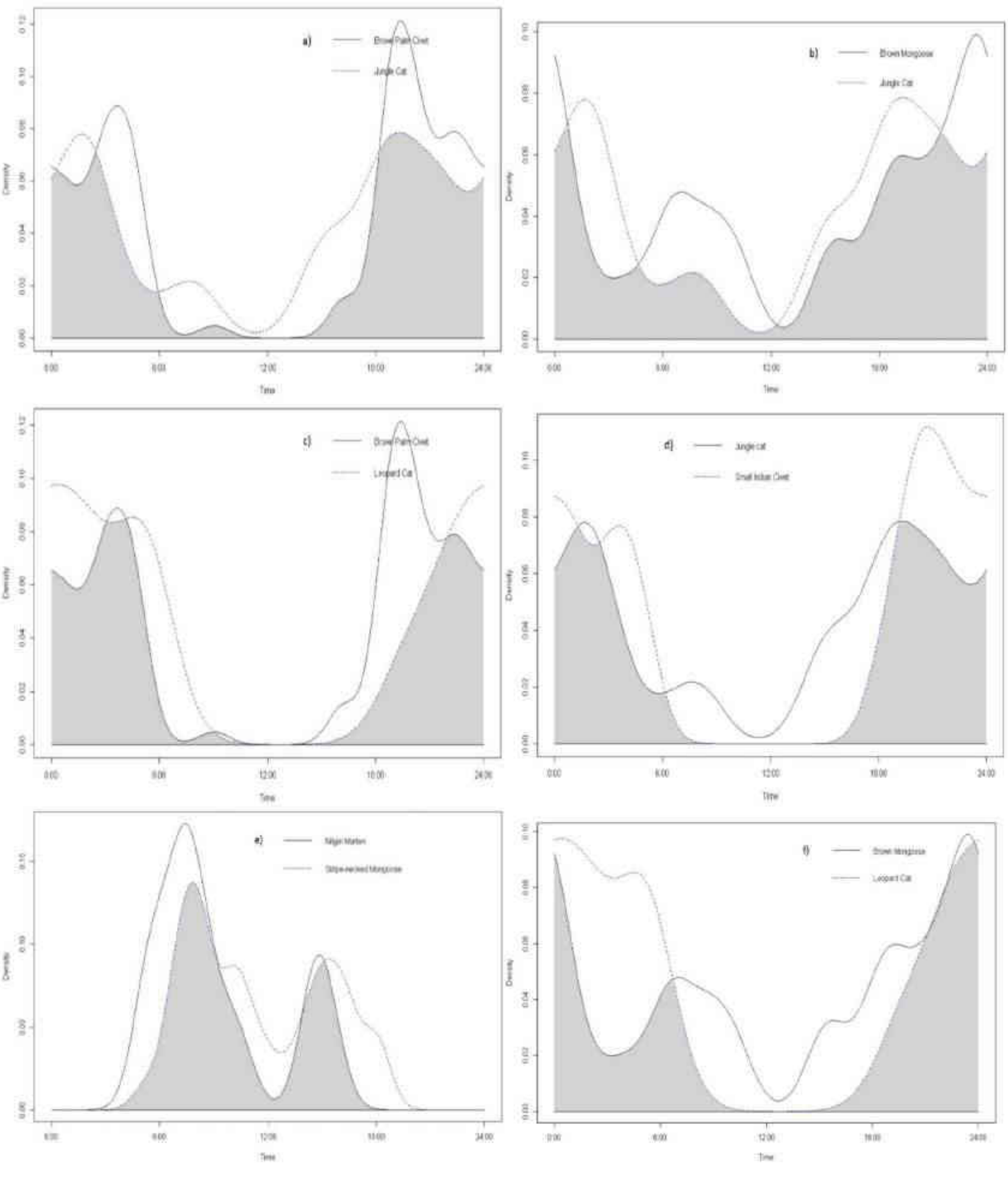

Figure 52. Diel activity overlaps of selected small carnivores in Kerala

a) Brown Palm Civet and Jungle Cat, b) Brown Mongoose and Jungle Cat, c) Brown Palm Civet and Leopard Cat, d) Jungle Cat and Small Indian Civet, e) Nilgiri Marten and Stripe-necked Mongoose, and f) Brown Mongoose and Leopard Cat

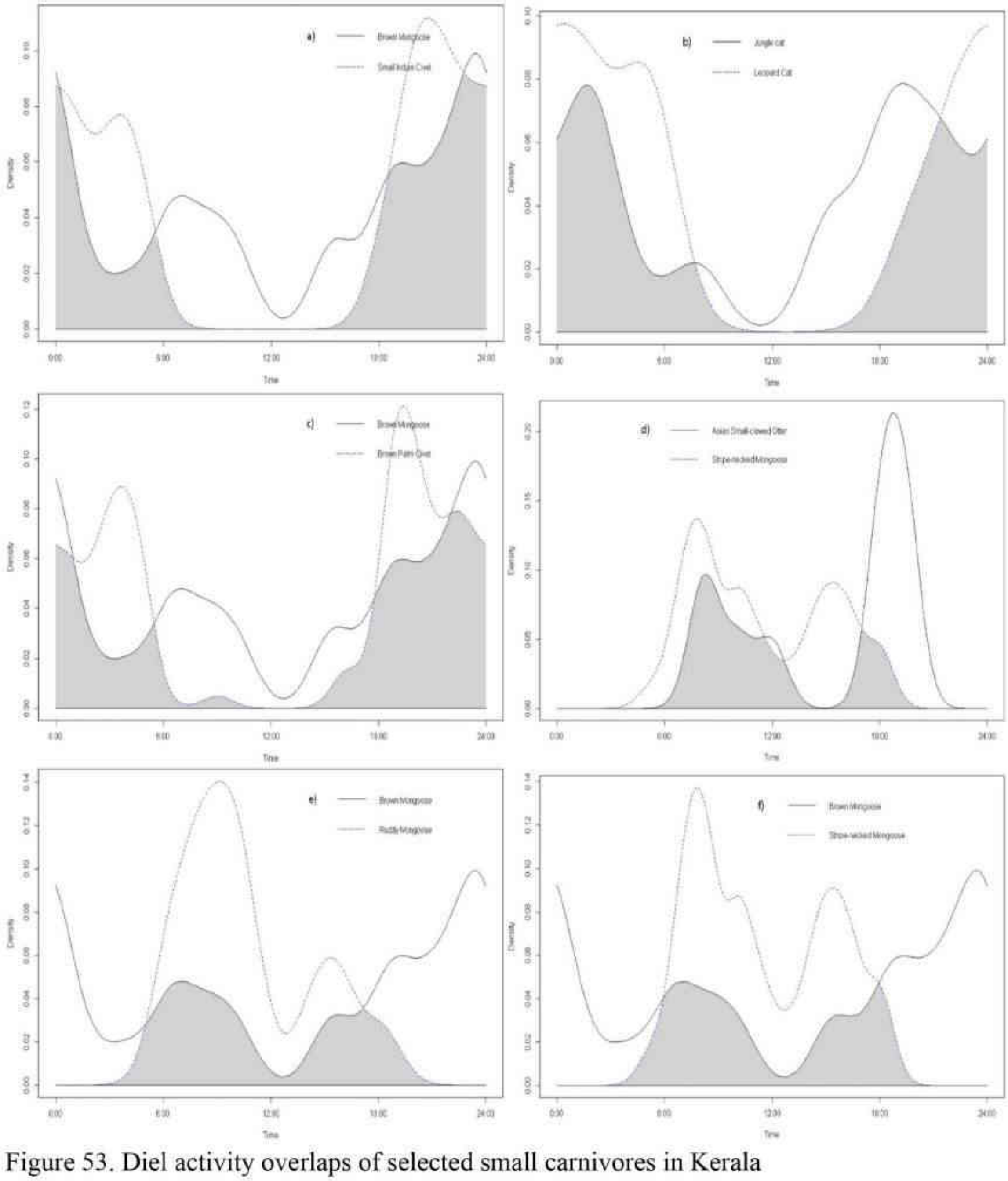

Figure 53. Diel activity overlaps of selected small carnivores in Kerala

a) Brown Mongoose and Small Indian Civet, b) Jungle Cat and Leopard Cat, c) Brown Mongoose and Brown Palm Civet, d) Asian Small-clawed Otter and Stripe-necked Mongoose, e) Brown Mongoose and Ruddy Mongoose, and f) Brown Mongoose and Stripe-necked Mongoose

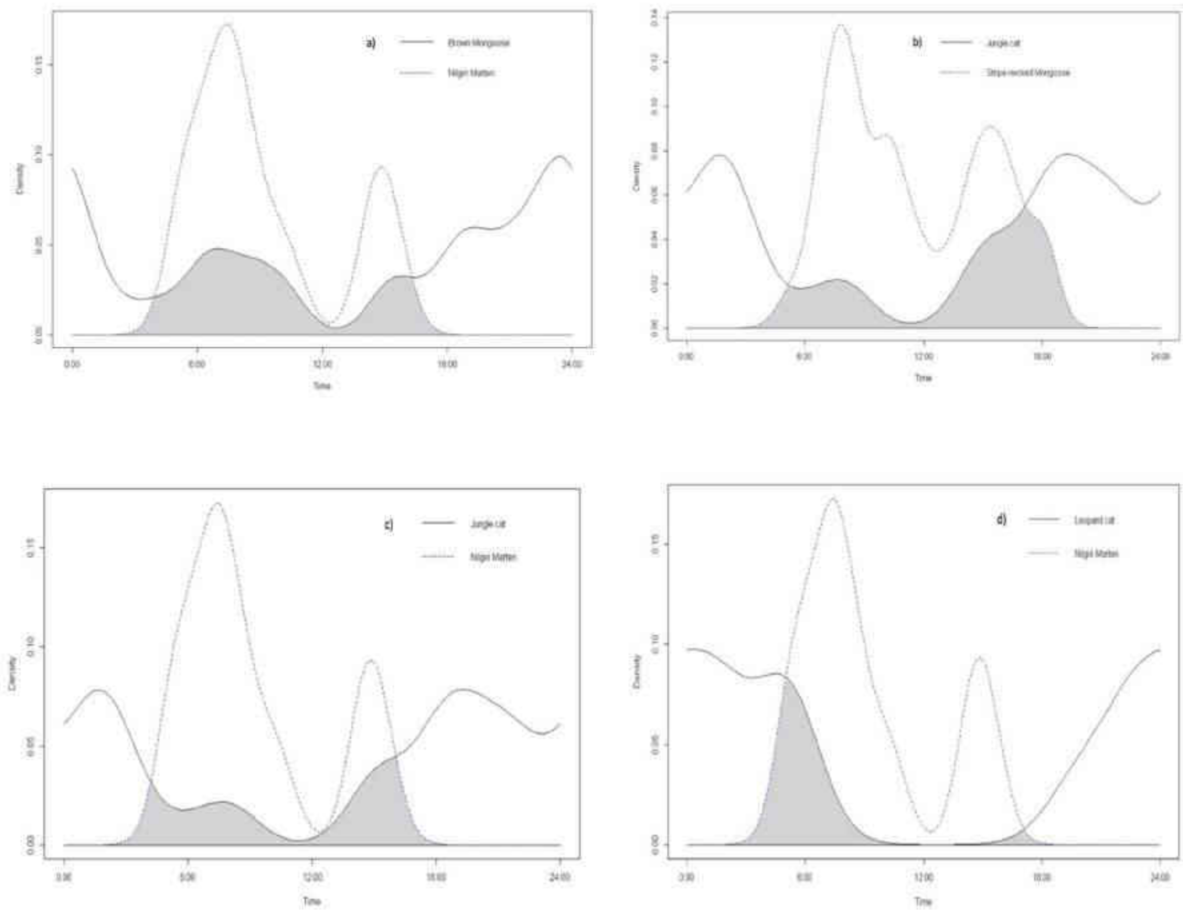

Figure 54. Diel activity overlaps of selected small carnivores in Kerala

a) Brown Mongoose and Nilgiri Marten, b) Jungle Cat and Stripe-necked Mongoose, c) Jungle Cat and Nilgiri Marten, and d) Leopard Cat and Nilgiri Marten

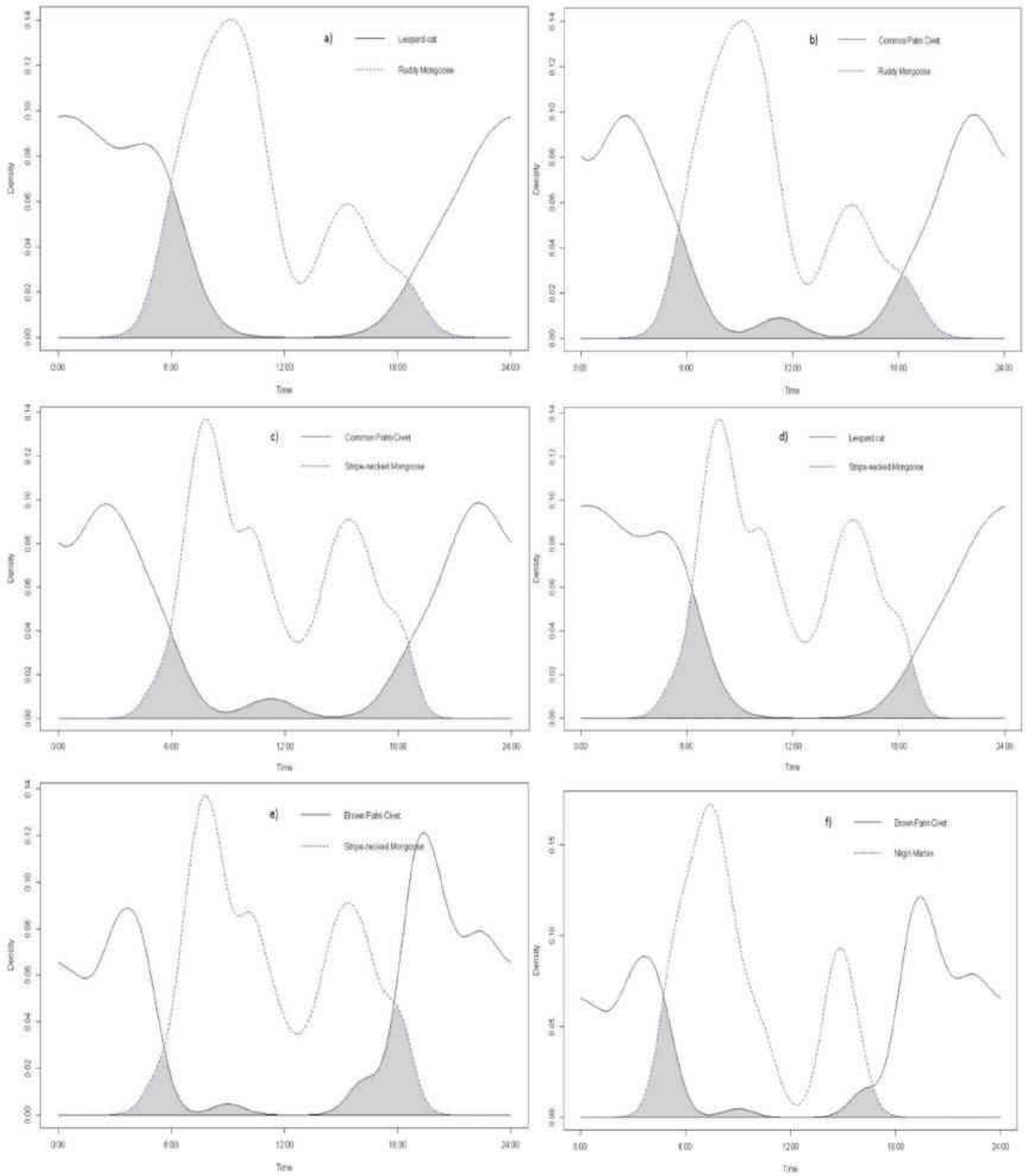

Figure 55. Diel activity overlaps of selected small carnivores in Kerala
a) Leopard Cat and Ruddy Mongoose, b) Common Palm Civet and Ruddy Mongoose, c) Common Palm Civet and Stripe-necked Mongoose, d) Leopard Cat and Stripe-necked Mongoose, e) Brown Palm Civet and Stripe-necked Mongoose, and f) Brown Palm Civet and Nilgiri Marten

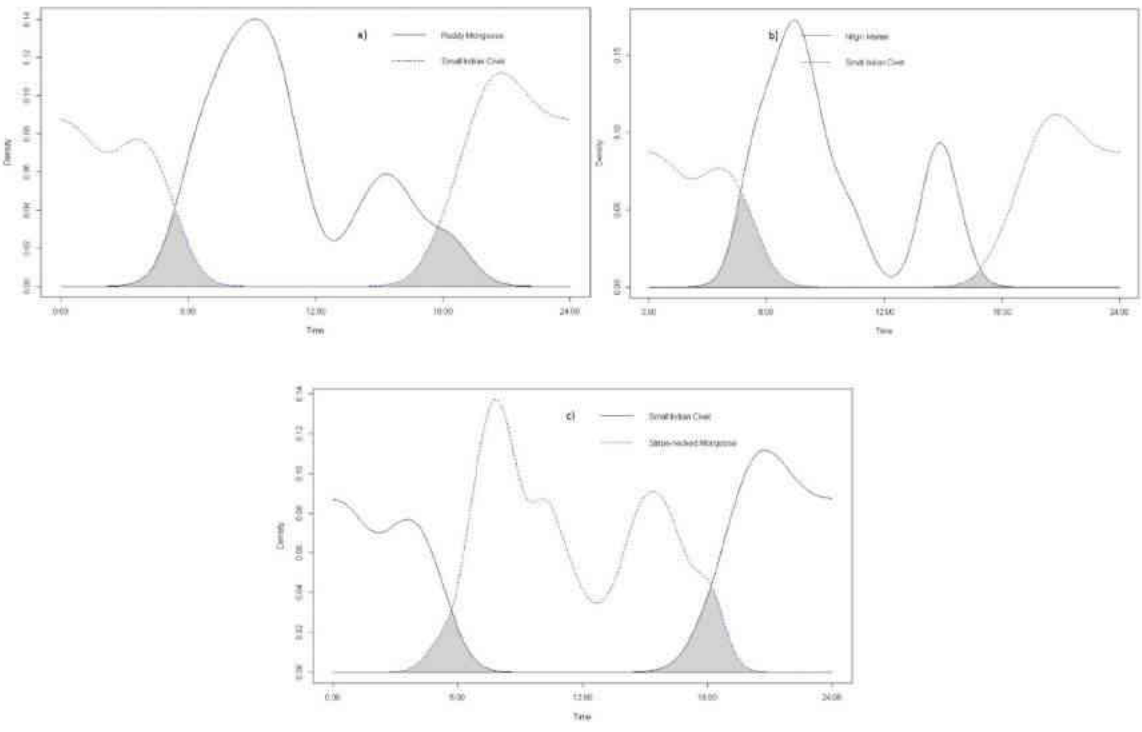

Figure 56. Diel activity overlaps of selected small carnivores in Kerala
a) Ruddy Mongoose and Small Indian Civet, b) Nilgiri Marten and Ruddy Mongoose, and c) Small Indian Civet and Stripe-necked Mongoose

4.9. ABUNDANCE OF SMALL CARNIVORES OF KERALA USING INDIRECT EVIDENCES

The day transects were done on the existing trails, forest roads, and streams, searching for indirect evidence of small carnivores in various habitats. A total of 438 km was walked through the various trails in search of indirect evidence. One hundred and five indirect evidences including 85 scats and 20 tracks pertaining to small carnivores were identified from the study locations. The otter trails were collected from the stream beds. Pugmarks of other carnivores were also located from the study locations which included Tiger *Panthera tigris,* Leopard *Panthera pardus,* Sloth Bear *Melurus ursinus,* and Wild Dog *Cuon alpinus*.

Among the 105 indirect evidences, 43 were of Brown Palm Civet (40.95%), 29 of Asian Small-clawed Otter (27.62%), 26 of cat species (24.76%), Smooth-coated Otter (4.76%) and Mongoose/civet (1.90%).

4.10. ABUNDANCE OF SMALL CARNIVORES OF KERALA USING INDIRECT BASED ON DIRECT SIGHTINGS

During the day transects walked, there were only four direct sightings of small carnivores during the study. They were the two sightings of Stripe-necked Mongoose, one sighting of the Brown Palm Civet, and one sighting of Jungle Cat all from Kerala

4.11. DIET OF ASIAN SMALL-CLAWED OTTER

Diet of Asian Small-clawed Otter was studied by analyzing 19 spraints collected from various study locations. Two methods were used to estimate the proportions of different prey categories consumed. They were score bulk estimate (SB) and frequency of occurrence (FO). Only three types of prey items were observed during the spraint analysis. They were crabs, fishes, and insects. The crab was the major prey item of the species. The most frequently occurred food item was crabs (100%) followed by fishes (36.84%) and insects (21.05%) (Table 44 and Figure). The percentage volume of each prey category was 75.32% for crabs, followed by fishes (21.04%) and insects (3.63%).

Table 44. Proportions of various prey items in spraints of Asian Small-clawed Otter in Kerala

Prey	Score bulk estimate (%)	Frequency of occurrence (%)
Crabs	75.32	100
Fish	21.04	36.84
Insects	3.63	21.05

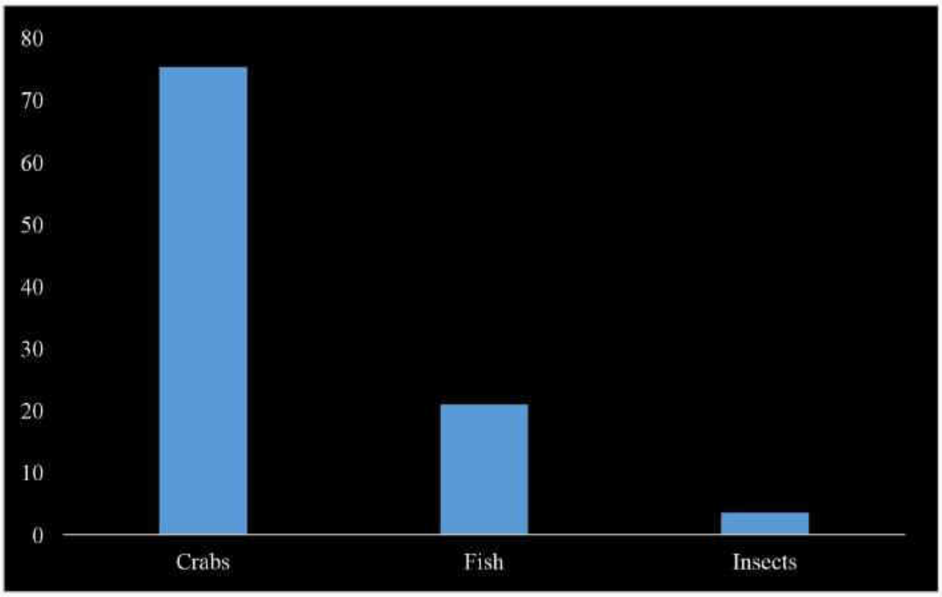

Figure 57. Percentage frequency composition of diet of Asian Small-clawed Otter in Kerala

4.12. DIET OF SMOOTH-COATED OTTER IN KERALA

Diet of Smooth-coated Otter was studied by analyzing 51 spraints collected from Kole wetlands in Thrissur. References collected during the project were also used to identify the prey items. Two methods were used to estimate the proportions of different prey categories consumed. They were score bulk estimate (SB) and frequency of occurrence (FO). Only three types of prey items were observed during the spraint analysis. Fish was the major prey with 100% frequency of occurrence followed by insects (35.29%) in the diet of Smooth-coated Otter followed by crabs (11.76%) (Table 45 and Figure 58). Whereas based on the percentage volume, fishes were 97.92%, crab (1.225) was the next major food of Smooth-coated Otter followed by insects (0.85%).

Table 45. Proportions of various prey items in spraints of Smooth-coated Otter in Kerala

Prey	**Frequency of occurrence (%)**	**Score bulk estimate (%)**
Fishes	100	97.92
Crabs	11.76	1.22
Insects	35.29	0.85

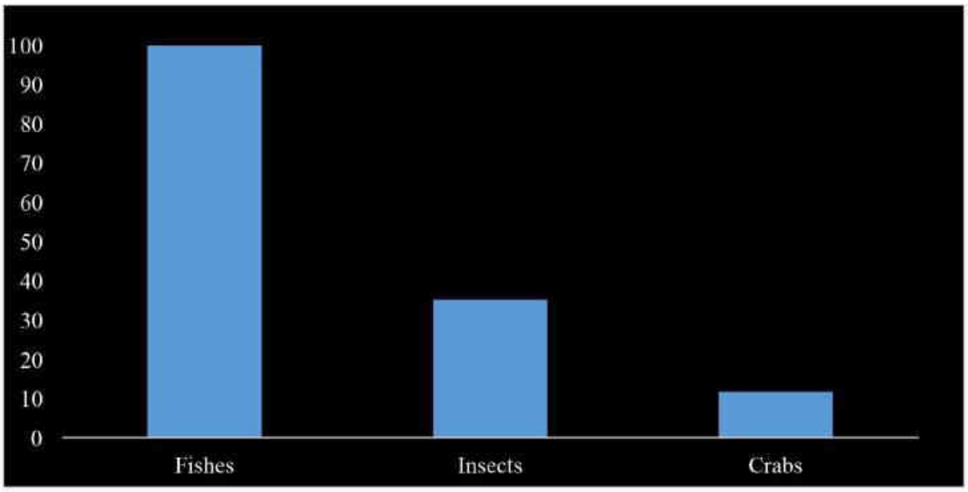

Figure 58. Percentage frequency composition of diet of Smooth-coated Otter in Kerala

Species level identification of fishes was made for five species and one species of fish was identified up to genus level. The fishes identified were *Anabus testudineus, Dawkinsia filamentosa, Pseudetroplus maculatus, Rasbora dandia, Xenetodon cancila* and *Channa sp.* Relative proportion of individual prey species in the diet of Smooth-coated Otter is given in Table 46. The percentage frequency composition of the individual prey items in the diet of Smooth-coated Otter is illustrated in Figure 59. *Pseudetroplus maculatuswas*

(96%) *the most frequently consumed species followed by Channa sp* (94.12%)%) and *Anabus testudineus* (52.94%). In the diet of Smooth-coated Otter Channa sp. ranked first in terms of percentage volume (57.05%) followed by *Pseudetroplus maculatus was* (29.38%) and *Anabus testudineus* (9.74%).

Table 46. Relative proportion of individual prey species in the diet of Smooth-coated Otter in Kerala

Prey category	**Frequency of occurrence (%)**	**Score bulk estimate (%)**
Pseudetroplus maculatus	96.08	29.38
Channa sps	94.12	57.05
Anabas testudineus	52.94	9.74
Rasbora dandia	13.73	0.43
Dawkinsia filamentosa	7.84	0.13
Xenetodon cancila	27.45	1.19
Crabs	11.76	1.22
Insects	35.29	0.85

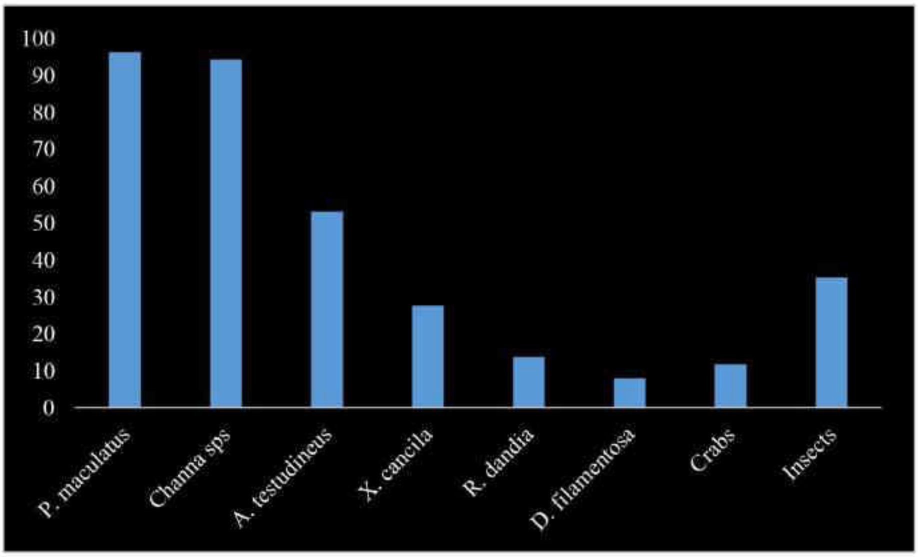

Figure 59. Percentage frequency composition of individual prey item in diet of Smooth-coated Otter in Kerala

4.13. DIET OF BROWN PALM CIVET IN KERALA

Diet of Brown Palm Civet was studied by analyzing 43 scats collected from various study locations. Two methods were used to estimate the proportions of different prey categories consumed. They were Percentage volume (PV) and frequency of occurrence (FO). Ten prey categories were observed during the scat analysis. They were Coffea sp., *Drypetes rouxburgi*, Ficus sp., Elaeocarpus sp., Syzigium sp., and three unidentified plants and hair of a mammal. From the scats analyzed, Coffea sp. (48.84%) was found to be the most frequent food item, followed by *Drypetes rouxburgi* (18.60%) and Syzygium sp. (18.60%) (Table 47 and Figure 60). Coffea sp. had highest percentage volume among the scats analyzed, followed by *Drypetes rouxburgi* (16.42%).

Table 47. Proportions of various food items in scats of Brown Palm Civet

Prey item	**Frequency of occurrence (%)**	**Percentage Volume (%)**
Coffea sps	48.84	39.78
Drypetes rouxburgi	18.60	15.77
Ficus sps	11.63	2.87
Elaeocarpus sps	4.65	3.94
Psidium Guajava	16.28	5.38
Syzigium sps	18.60	7.17
Unidentified plant 1	16.28	9.32
Unidentified plant 2	11.63	4.66
Unidentified species 3	6.98	7.53
Hair	13.95	3.58

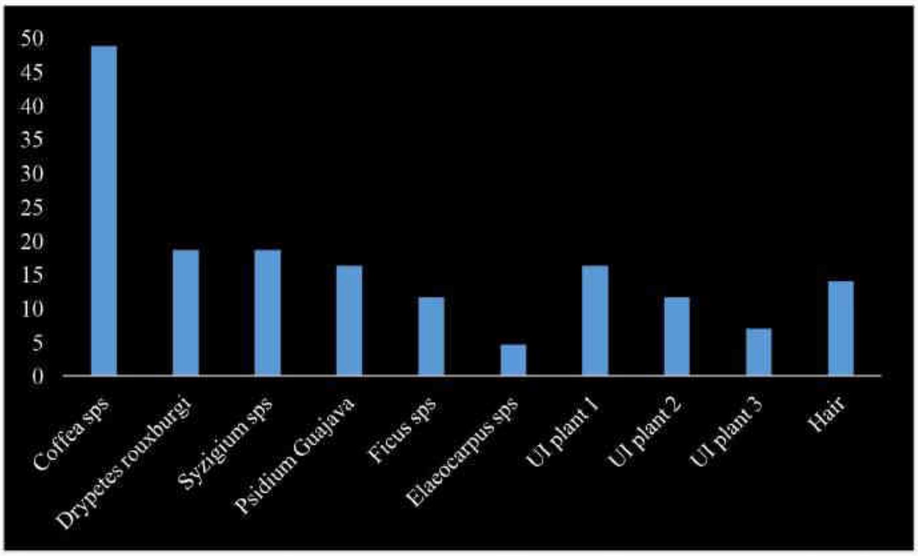

Figure 60. Percentage frequency composition of diet of Brown Palm Civet

4.14. DISTRIBUTION OF SMALL CARNIVORES IN SELECTED LOCATIONS IN KERALA

The distribution of small carnivores in various habitats of Kerala is illustrated in Figures 61-68. Figure 61 shows the distribution of Brown Mongoose. The species was recorded from three habitats except from dry deciduous habitat and moist deciduous habitat (south of Palghat gap). Figure 62 illustrates the distribution of Stripe-necked Mongoose. The species was camera trapped from all the habitat type. No photograph of the species was obtained from dry deciduous habitat (South of Palghat gap). The distribution of Brown Palm Civet was shown in the Figure 63. The species was present from three habitats except dry deciduous habitat and moist deciduous habitat (north of Palghat gap). The distribution of Common Palm Civets was shown in the Figure 64. The species was present from two habitats, dry deciduous habitats and moist deciduous habitat (South of Palghat gap). Small Indian Civet distribution is given in the Figure 65. The species was reported from all the four habitats studied. Leopard Cat's distribution was shown in the Figure 66 and the species was found from three habitats. The species was not recorded from moist deciduous habitats. The distribution of Ruddy Mongoose and Nilgiri Marten is given in the Figure 67. The Ruddy Mongoose was recorded from dry deciduous habitats and grassland habitat (North of Palghat gap). The presence of Nilgiri Marten was recorded from grassland habitat (south of Palghat gap) and evergreen habitat (South of Palghat gap). The distribution of Asian Small-clawed Otter, Smooth-coated Otter, Jungle Cat, Rusty-spotted Cat, and Indian Grey Mongoose was illustrated in the Figure 68. Each species was reported from only one habitat during this study.

Rasbora dandia

Pseudetroplus maculatus

Dawkinsia filamentosa

Channa sps

Xenetodon cancila

Anabas testudineus

Insects

Crabs

a) Diet constituents of Smooth-coated Otter

Crabs

Fishes

Insects

b) Diet constituents of Smooth-coated Otter

Plate 10. Diet constituents of Smooth-coated Otter and Small-clawed otter

Syzigium sps

Psidium sps

Ficus sps

Drypetes rouxburgi

Unidentified

Unidentified

Coffea sps

Unidentified

Plate 11. Diet constituents of Brown Palm Civet

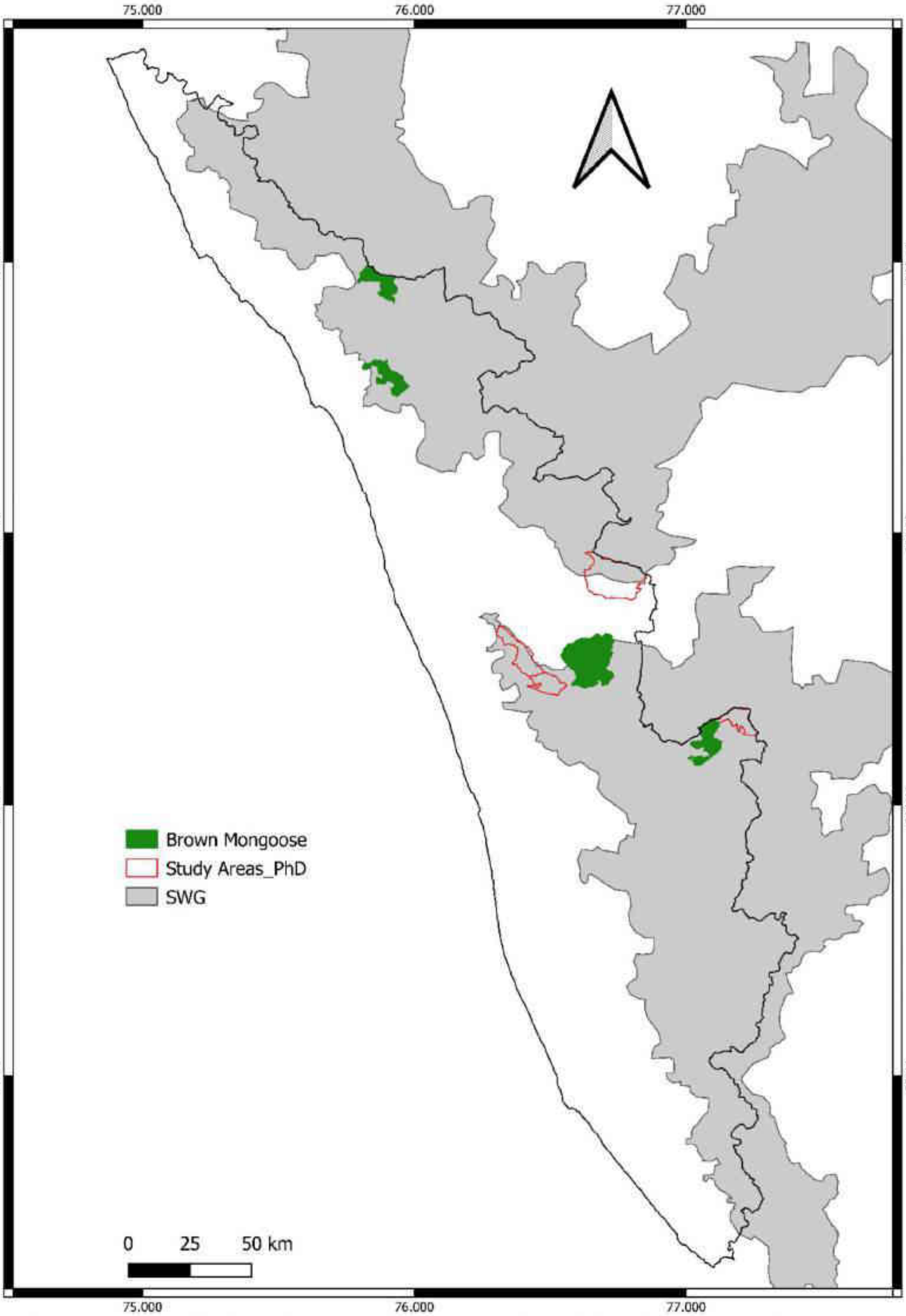

Figure 61. Distribution of Brown Mongoose selected locations in Kerala

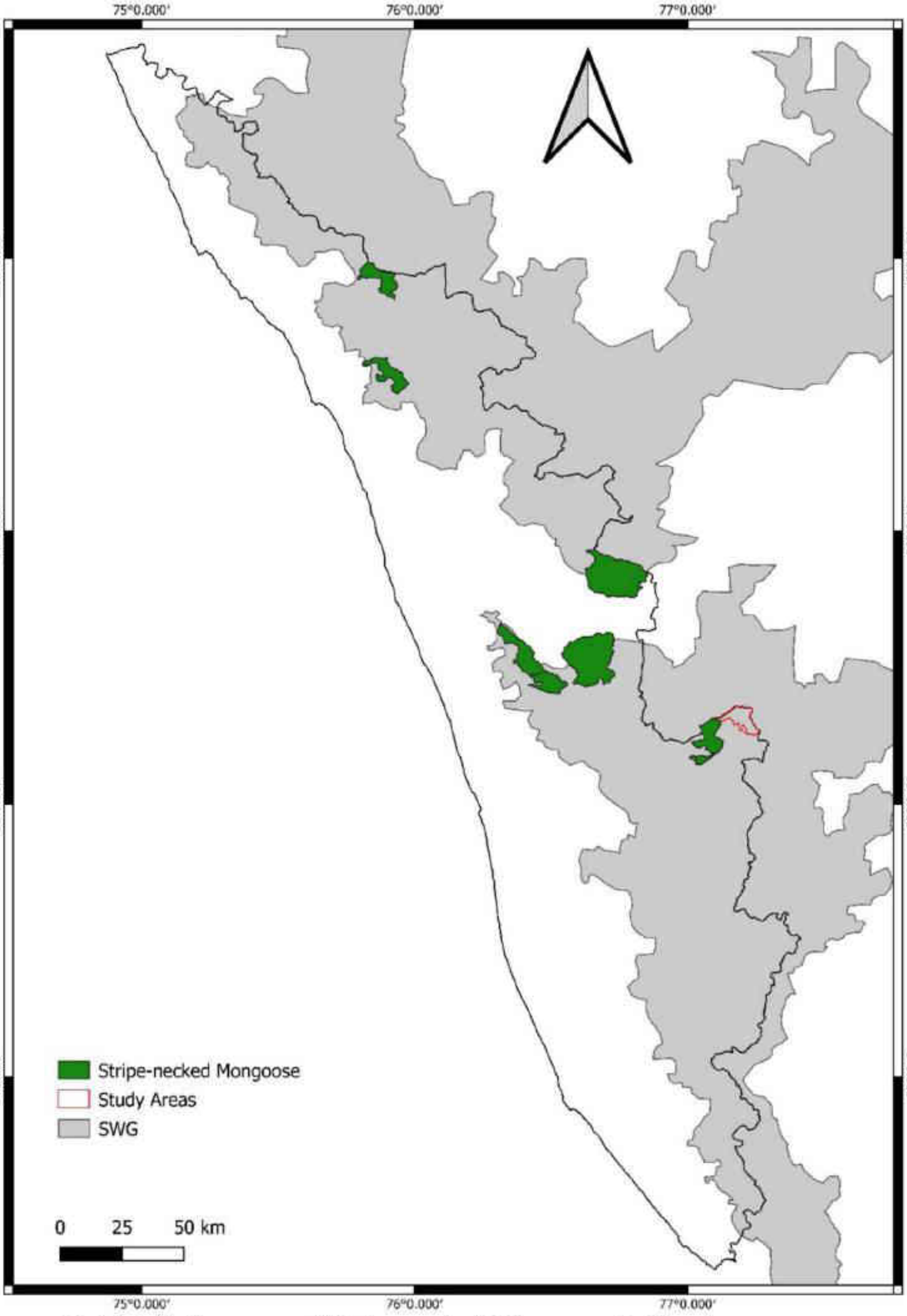

Figure 62. Distribution map of Stripe-necked Mongoose in Kerala

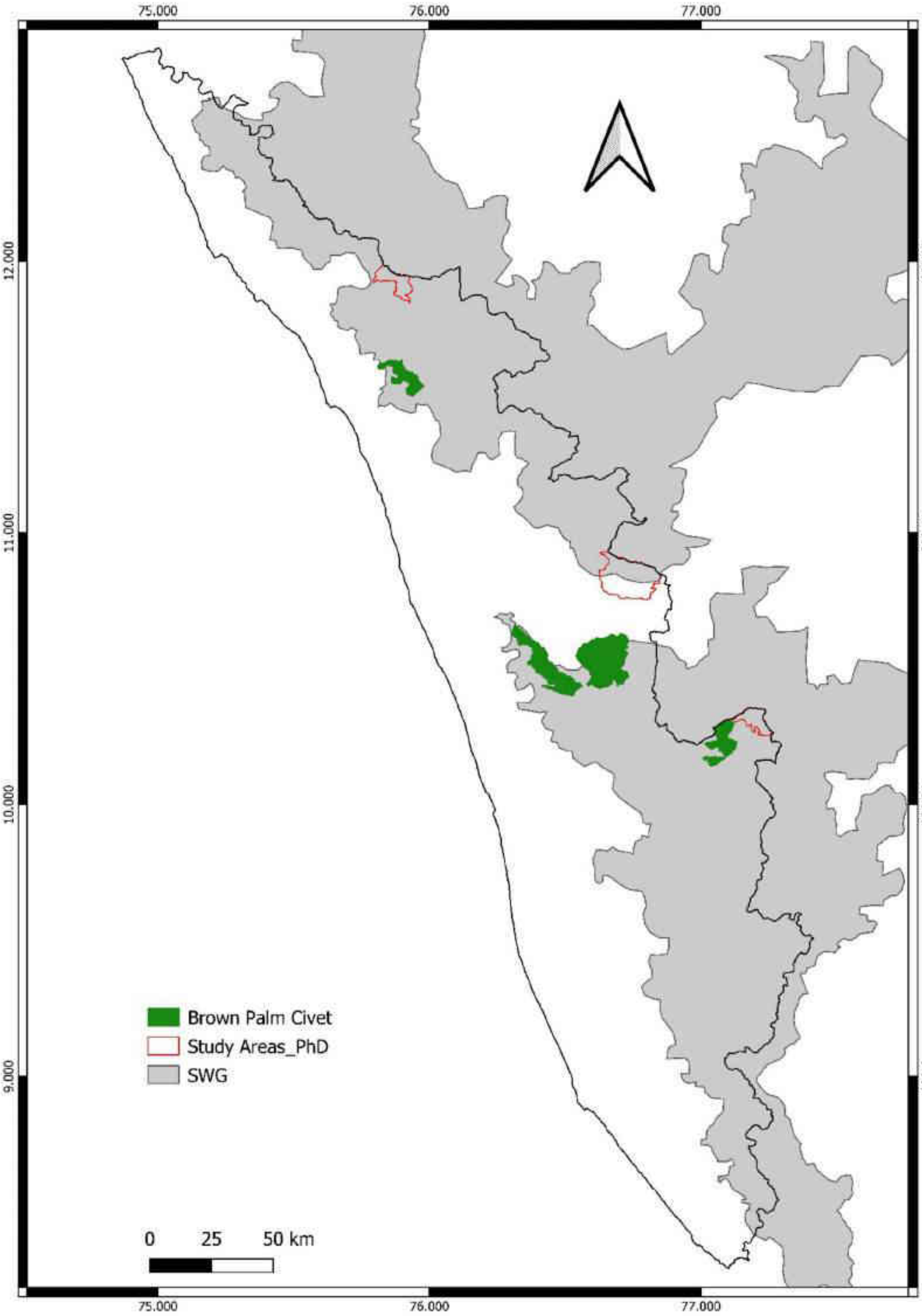

Figure 63. Distribution map of Brown Palm Civet in Kerala

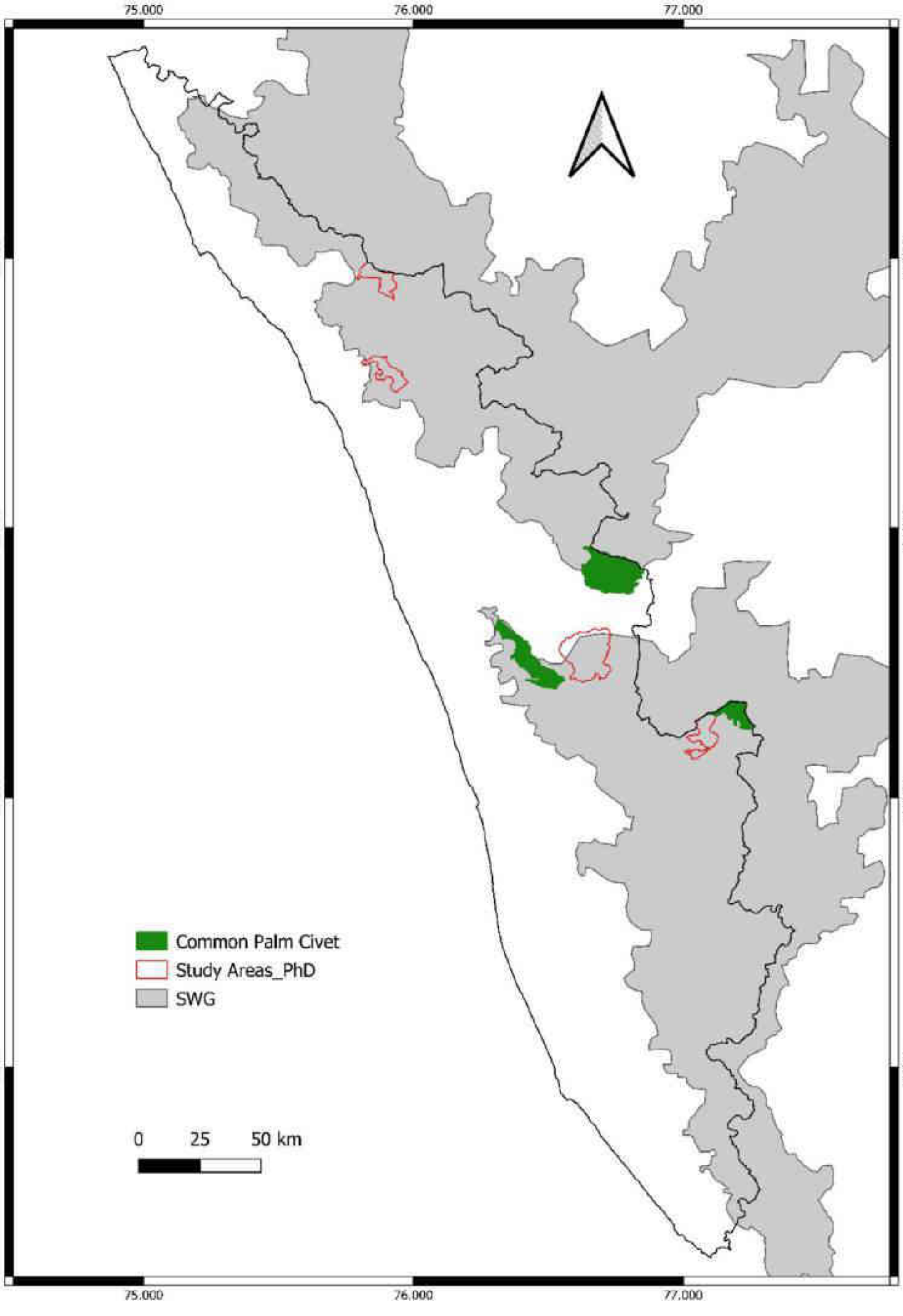

Figure 64. Distribution map of Common Palm Civet in Kerala

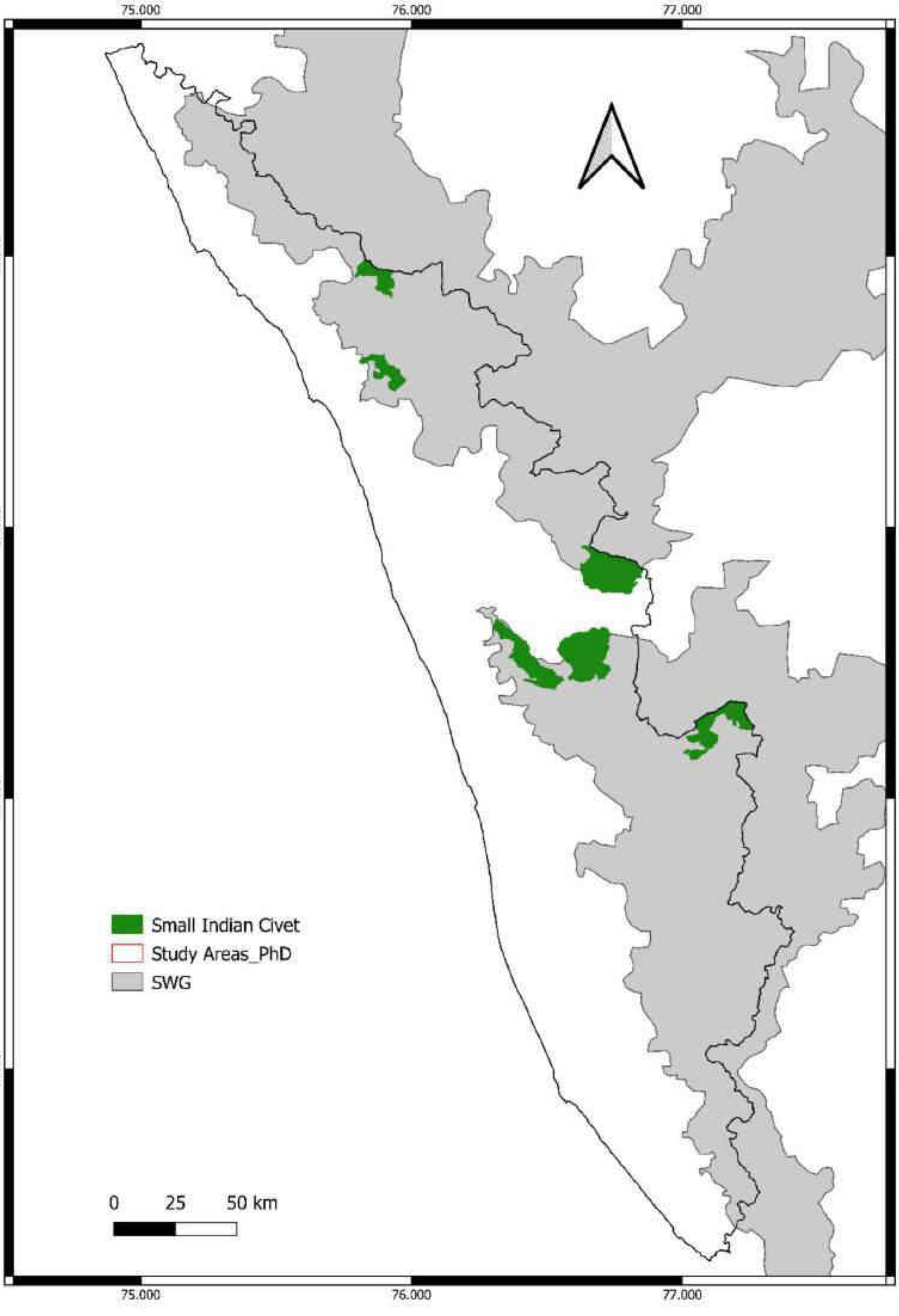

Figure 65. Distribution map of Small Indian Civet in Kerala

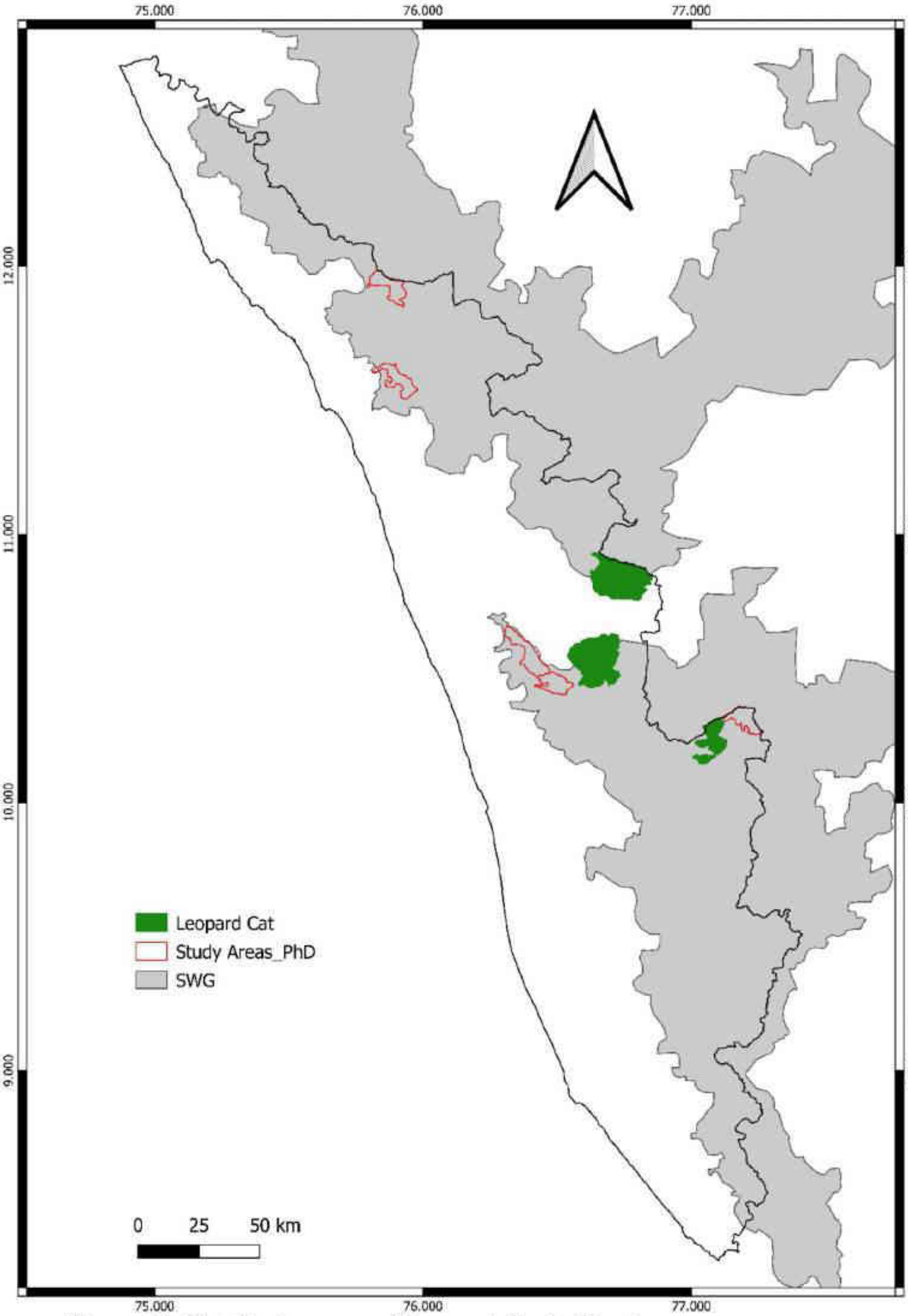

Figure 66. Distribution map of Leopard Cat in Kerala

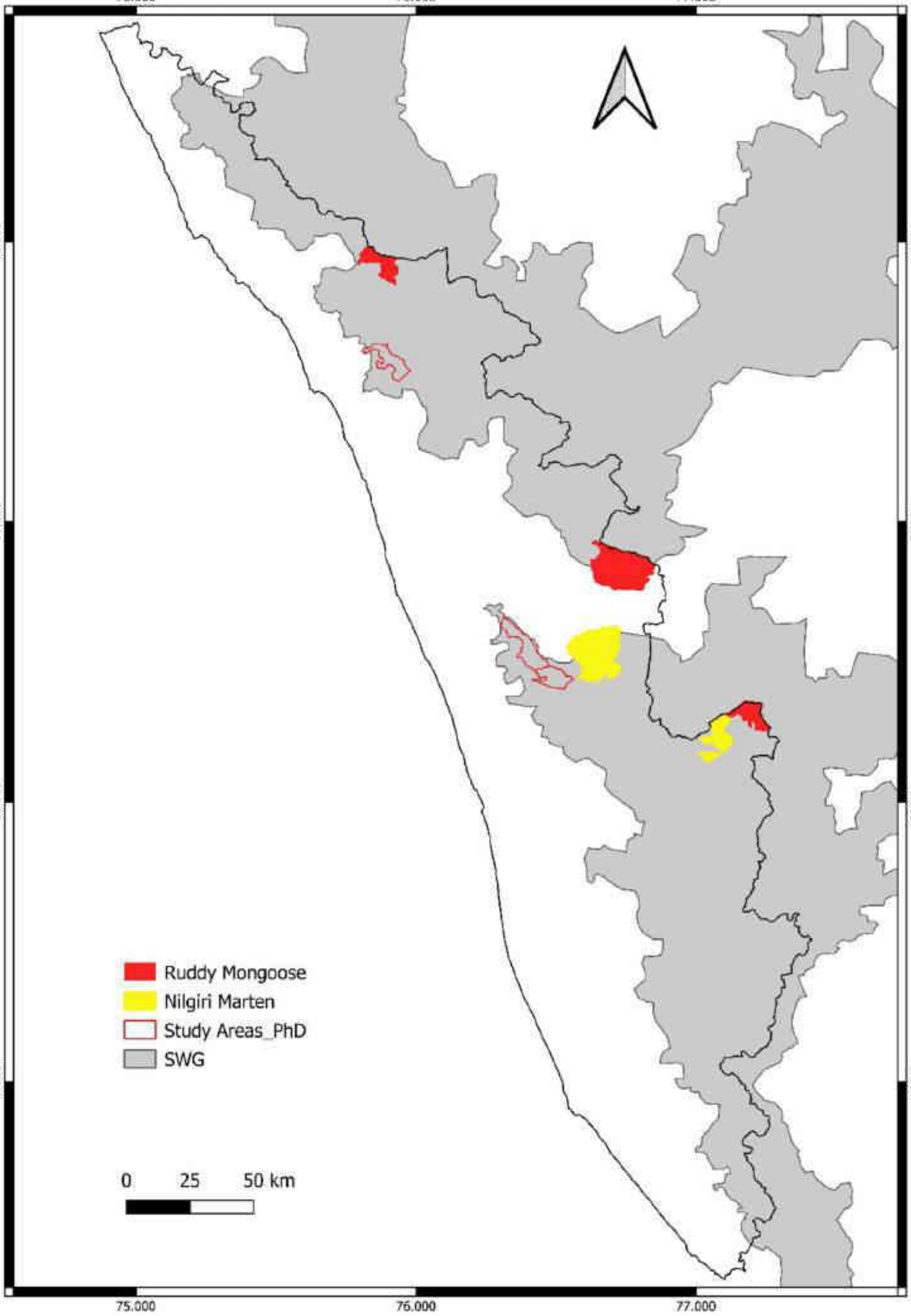

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Figure 67. Distribution map of ruddy Mongoose and Nilgiri Marten in Kerala

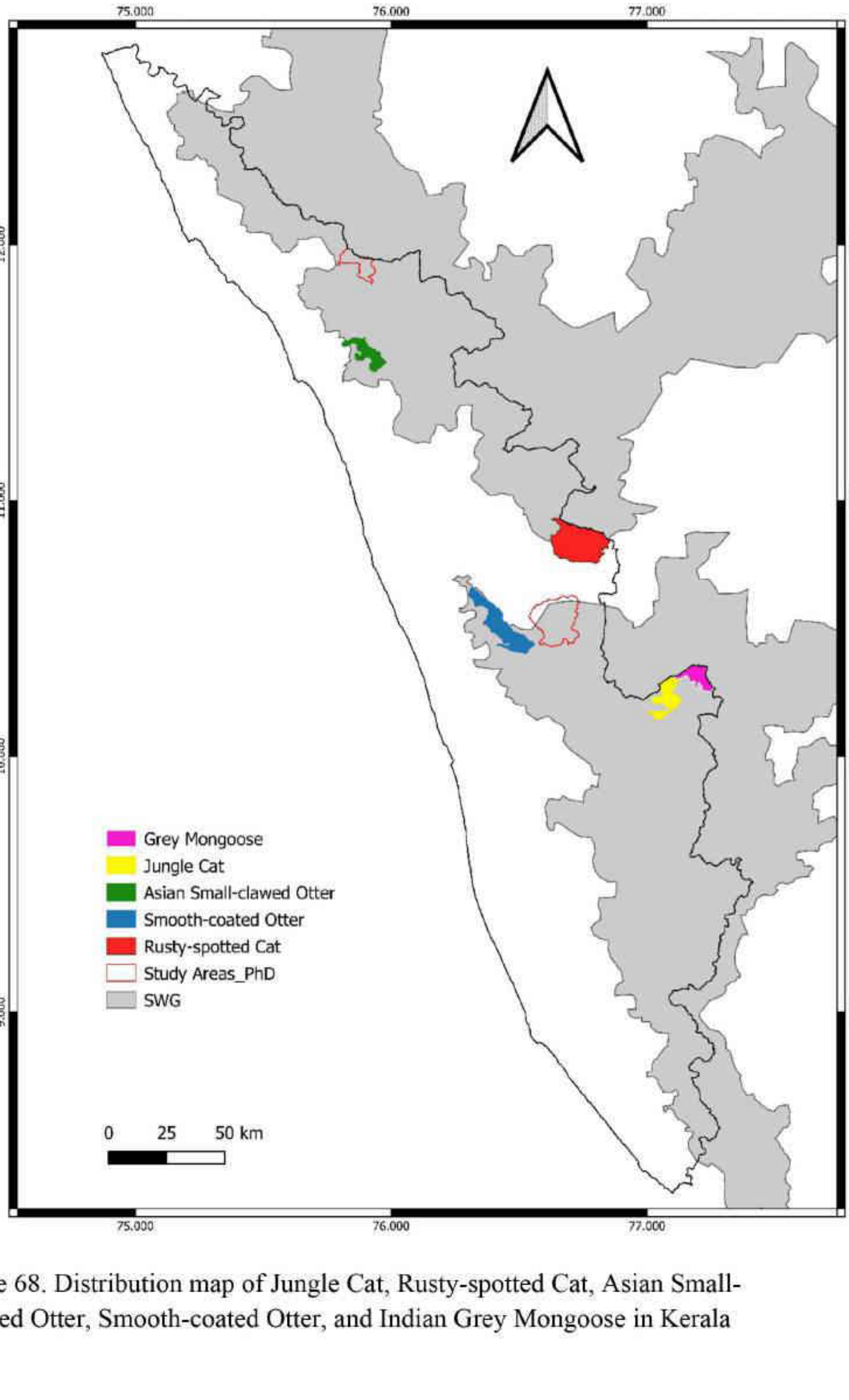


Figure 68. Distribution map of Jungle Cat, Rusty-spotted Cat, Asian Small-clawed Otter, Smooth-coated Otter, and Indian Grey Mongoose in Kerala

4.15. SOCIO-ECONOMIC SURVEY TO UNDERSTAND THE AWARENESS, ATTITUDE, AND PERCEPTION ABOUT SMALL CARNIVORES AND SMALL CARNIVORE CONSERVATION

4.15.1. Personal details

The summary of personal details of respondents among the three categories surveyed from the selected study locations are given below (Table 48).

4.15.1.1. Age class of the respondents

The table shows that the age class 30-40 years were dominant among the respondent (37.50%), followed by age class 40-50 years (30%). Age class, 60-70 years is the least represented age class.

4.15.1.2. Nature of residency of the people at the study sites

The table shows the nature of residency of the respondents. 98.75 percentage of the respondents were residing in the study locations for more than 20 years.

4.15.1.3. Distance from the house to the nearby forest

The table shows the distance from the house of the respondent to the nearby forest. The majority of the people lived near to the forest area, 0-1.5 km (78.75%) followed by 1.5-3 km (15%).

4.15.1.4. Economic status of the respondents

The economic status of the respondents is given in the Table 48 and it shows that 78.75% of the respondents come under Below Poverty Line and the rest were Above Poverty Line.

4.15.1.5. Educational Qualification of the respondents

The table shows that the majority of the respondents have not completed their schooling (40.83%) followed by graduates 22.5% and people who cleared SSLC (20.83%).

Table 48. Summary of personal details of the respondents

Category	Variable	Frequency	Percentage (%)
Age	20-30	11	9.17
	30-40	45	37.50
	40-50	36	30.00
	50-60	26	21.67
	60-70	2	1.67
Residing Period	10-20 years	1	1.25
	20 or more years	79	98.75
Gender	Female	9	7.50
	Male	111	92.50
Distance from the house to the nearby forest	0-1.5 km	63	78.75
	1.5-3 km	12	15.00
	3-4.5 km	5	6.25
Economic Status	BPL	63	78.75
	APL	17	21.25
Education Qualification	Non-Schooling	1	0.83
	Schooling not completed	49	40.83
	SSLC	25	20.83
	Plus Two	11	9.17
	Graduate	27	22.50
	Post Graduate	7	5.83

4.15.2. Ability to identify small carnivores

Among all three categories of respondents, 25 percent of respondents could identify all the 13 species of small carnivores of Kerala. Six species of small carnivores were identified by 15.83% (19 individuals) of the respondent (Figure 69). Villagers could only identify up to seven species of small carnivores. Only one of the individuals of the villagers could identify seven species of small carnivores. The majority of the villagers could identify four to five species of small carnivores. Among the tribal people interviewed, they could identify up to 12 species of small carnivores. Only one individual could identify 12 species of small carnivores. The majority (17 individuals) of the tribes could identify up to six species of small carnivores. Among the interviewed Kerala

Forest Department staff, 30 people could identify all the 13 species of the small carnivores followed by two people who could identify 11 species (Figure 70).

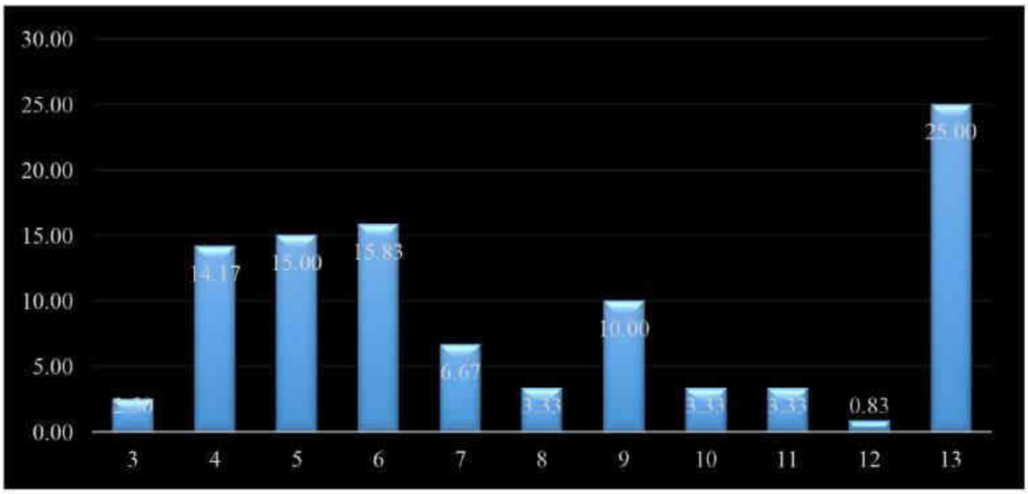


Figure 69. Ability of the respondents to identify small carnivores (Percentage) in Kerala

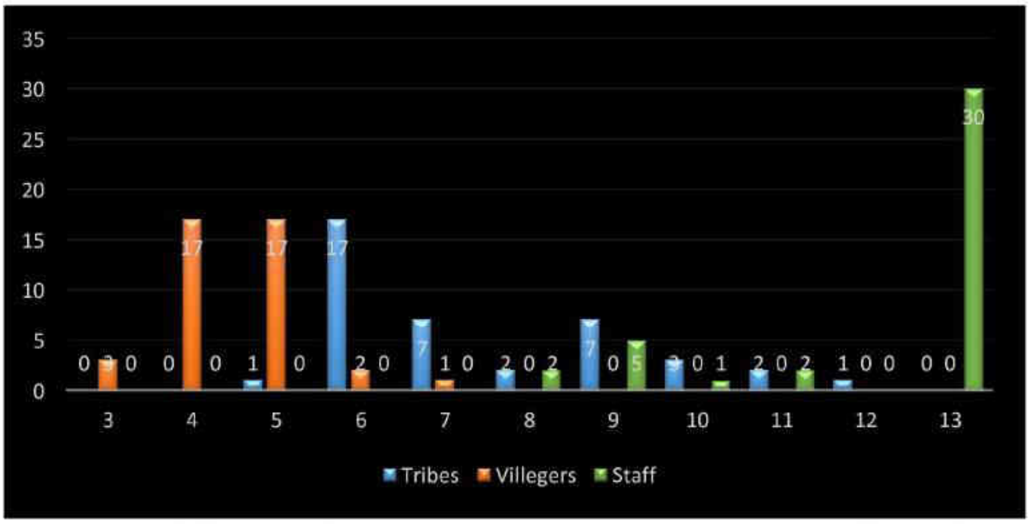


Figure 70. Ability of different categories of respondents to identify small carnivores in Kerala

4.15.3. Sighting of small carnivores

Considering the frequency of sighting a small carnivore in study areas was enquired among the respondents and it was found that the small carnivores were sighted often by only tribal people. The majority sighted small carnivores sometimes. And among the villagers, the small carnivores were sighted rarely (Figure 71).

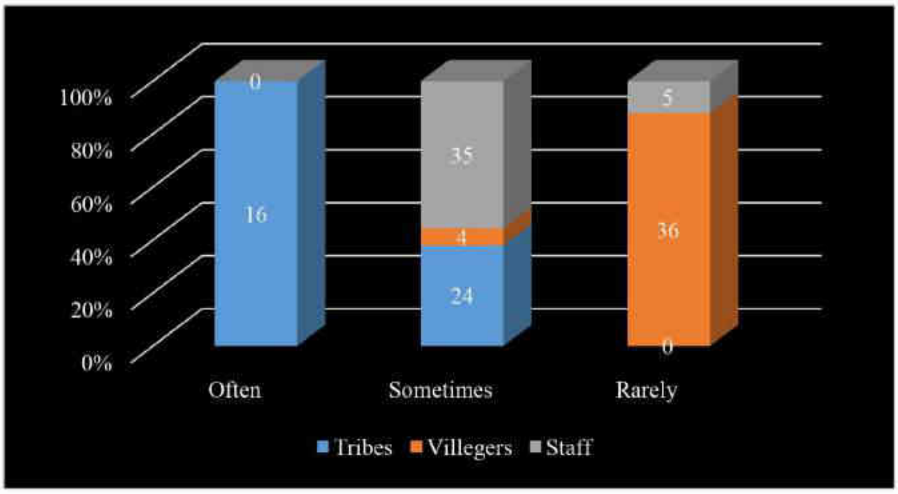


Figure 71. Frequency of sighting of small carnivores by the respondents

4.15.4. People's reaction to the sighting of a small carnivore in their homestead

The question about people's reaction to the sighting of small carnivores in their homestead was asked between villagers and the tribal community. Apart from a single respondent, all agree that they will leave the animal as it was there and do not try to drive away the species (Figure 72).

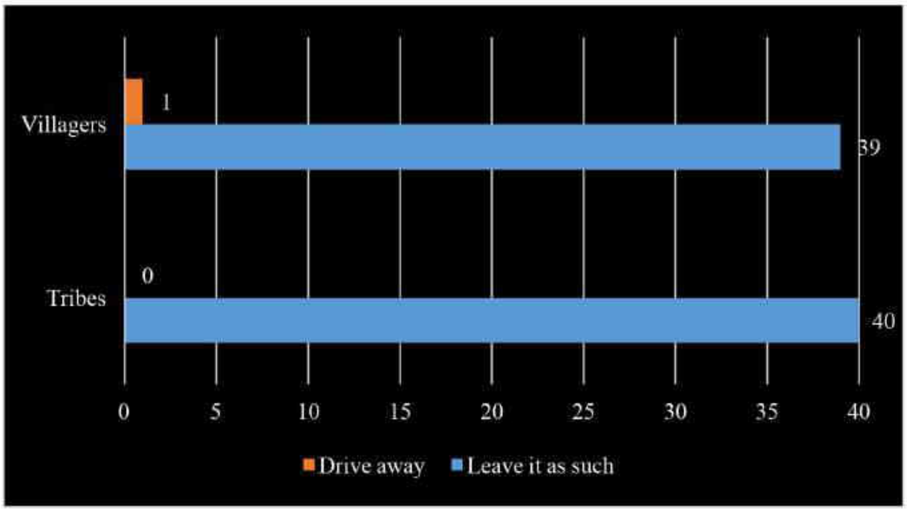


Figure 72. Response of tribes and villagers towards sighting of small carnivores in their homestead

4.15.5. Perception of people towards small carnivore conservation

Among the three groups of the respondent, the majority of the people think that small carnivores are species that need conservation activities. All of the Kerala Forest Department staff and tribes were certain about the small carnivore conservation. Among the villagers surveyed, 57% of the respondents believe that small carnivores should certainly be conserved whereas, 43% of the villagers believe that small carnivore conservation is needed to a certain extend (Figure 73).

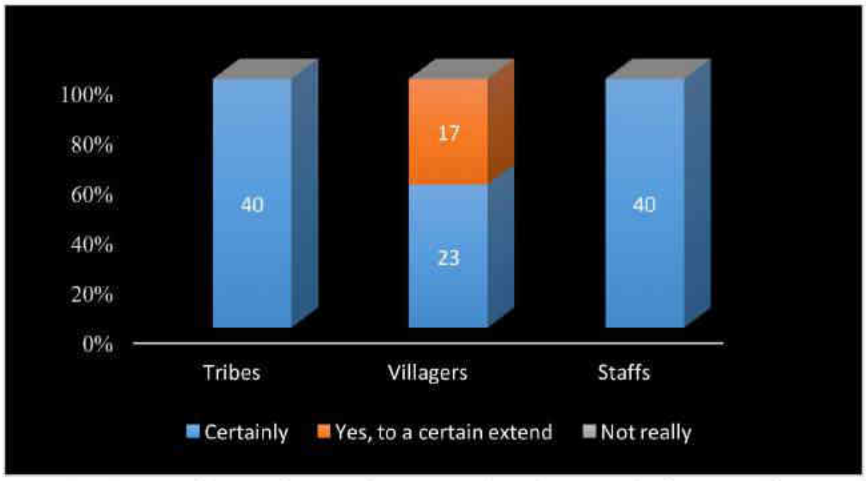


Figure 73. Perception of people towards the need for small carnivore conservation

4.15.6. Reasons to conserve the small carnivores

Importance or reasons for small carnivore conservation was asked among the respondents. Six statements were given as options and each ranking such as most apt, apt, neutral, not very apt, and least apt were given for each statement. Most of the respondents (99.2%) agreed that small carnivores have as much right to live as we do. Around 65% of the respondents believe that there are religious or cultural reasons to conserve small carnivores. About 95.8% of the respondents believe that it is important to conserve these animals for future generations and 90% believe that small carnivore conservation is needed for educational purposes. Most of the respondents (78%) think that small carnivore conservation is needed for tourism in the area. The majority of the respondents (48%) disagree with the concept that the small carnivores should be conserved for the wildlife products (Figure 74).

Statements
S1: Small carnivores have as much right to live as we do
S2: Religious or Cultural reasons
S3: For future generations
S4: Education purposes
S5: Tourism
S6: Value of wildlife products to the economy

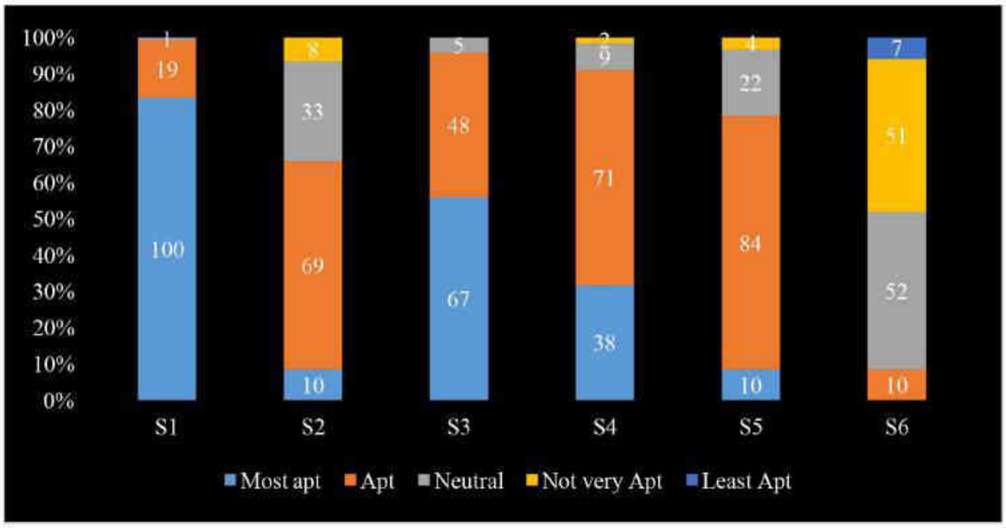


Figure 74. Respondents ranking towards reasons to conserve small carnivores

Among the tribal people and Kerala Forest Department interviewed, all the respondents believe that small carnivores have the right as humans to live (Figure 75 and 77). Ninety-five percentage of villagers agree with the statement (Figure 76). Among the tribal, 40% agree with the statement that small carnivores should be conserved for religious or cultural values. Whereas among the villagers, 35% have a neutral attitude towards religious or cultural reasons for conservation of small carnivores and 20% disagree with this reason. In the interviewed KFD staff, 82.5% agree with it. Among the respondents from tribal communities and KFD staff, all of them (100%) agree that it is important to conserve the species for future generations and 12.5% of the villagers have a neutral attitude towards this statement and others agree with the statement. The majority of the respondents from the tribal communities and KFD staff (97.5%), and villagers agreed that the small carnivores should be conserved for education purposes. Most of the respondents from the tribal communities (62.5%), villagers (82.5%), and KFD staffs (90%) agree that tourism is a reason for small carnivore conservation.

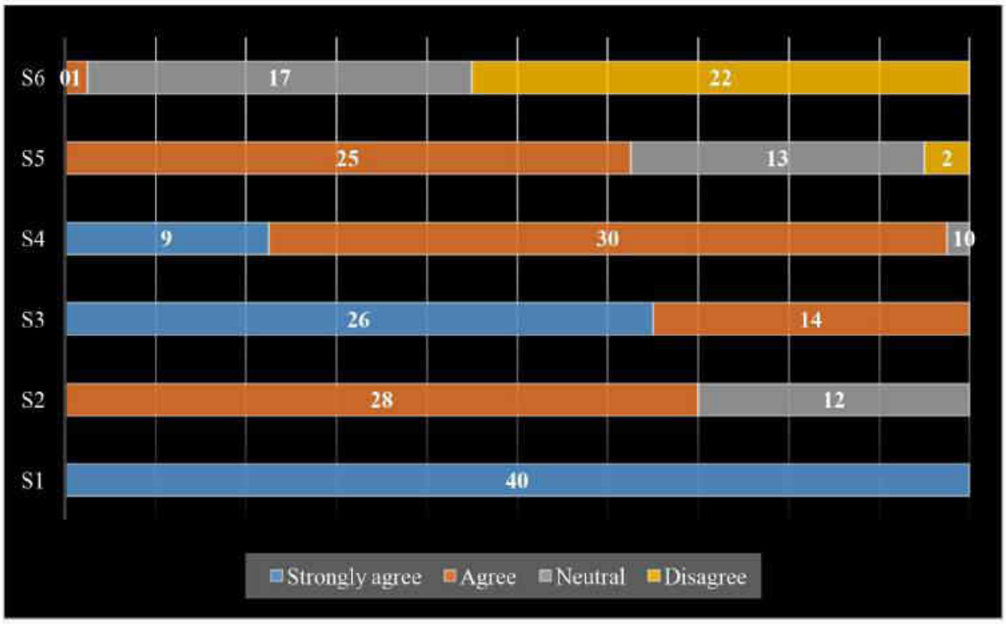


Figure 75. Response of tribes towards reasons to conserve small carnivores

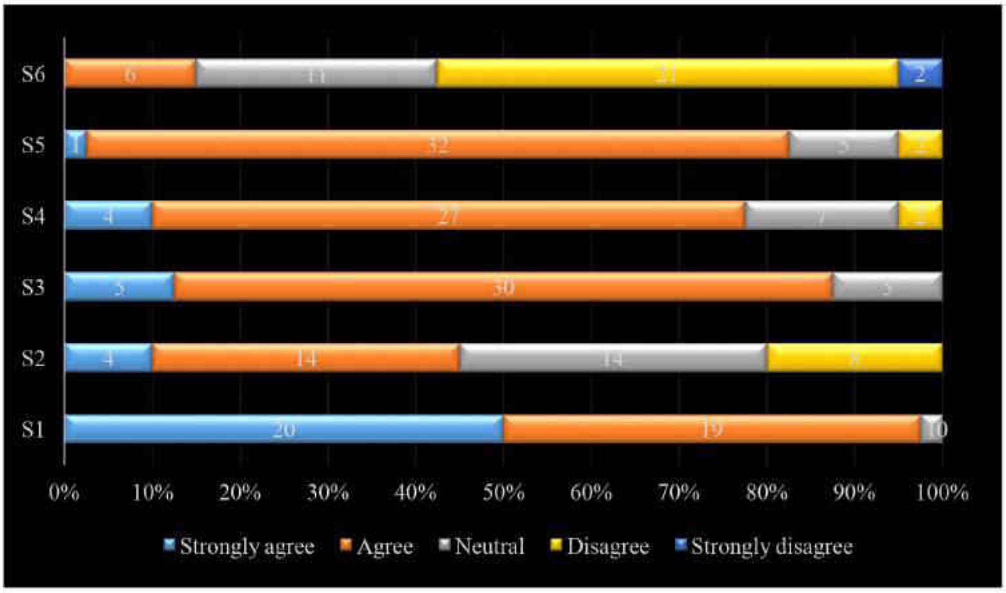


Figure 76. Response of villagers towards reasons to conserve small carnivores

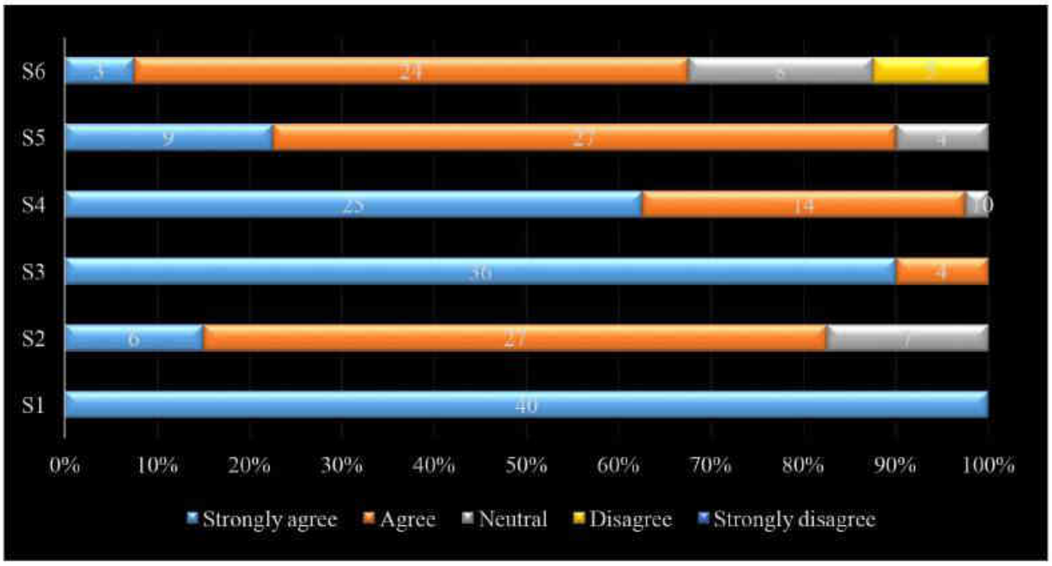


Figure 77. Response of KFD staffs towards reasons to conserve small carnivores

4.15.7. Attitude towards small carnivore conservation

Table 35 and Figure 78 represents the attitude of the respondents regarding the small carnivore conservation. Most of the respondents (95.83%) agree that small carnivore conservation is urgently needed. All (100%) of the respondents agree with the statement that people who harm small carnivores should be punished. Even though 85% of the respondents have the opinion that we should be prepared to live in harmony with small carnivores, 4.16% disagree with it. Around 86% of the respondents believe that without conserving small carnivores there is no existence for human beings. Among the respondents, 58.33% disagree that people should be restricted from using natural resources from the protected areas and 39.16% have a neutral attitude towards this. Ninety percent of the respondents disagree that it would not matter if small carnivores were lost from the ecosystem. Eighty-five percent of the respondents disagree with the idea of small carnivores could be sustained by confining them to protected areas however, 4.16% want to confine small carnivores to protected areas. Among the respondents, 51.66% showed a neutral attitude towards the statement "It is not the forest based communities, but the urban interests that cause widespread destruction of small carnivores". Even though 4.16% of the respondents agree with the statement that human needs should come first and only then conservation, 93.33% believe that it is not true. Around 85% of the respondents disagree that all this hue and cry for conservation is too much (Table 49).

Table 49. The attitude of the respondents to small carnivore conservation (in percentage)

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
S1	74.17	21.67	4.17	0.00	0.00
S2	73.33	26.67	0.00	0.00	0.00
S3	37.50	47.50	10.83	4.17	0.00
S4	28.33	58.33	10.83	2.50	0.00
S5	0.00	2.50	39.17	50.83	7.50
S6	0.00	2.50	7.50	40.83	49.17
S7	0.00	4.17	8.33	42.50	45.00
S8	0.83	27.50	51.67	17.50	2.50
S9	0.00	4.17	2.50	41.67	51.67
S10	0.00	5.83	8.33	43.33	42.50

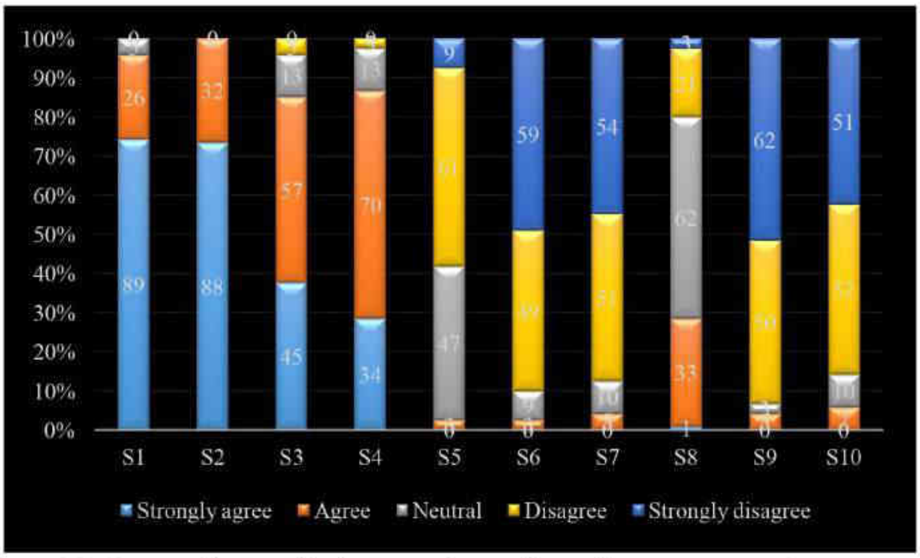


Figure 78. Respondents attitude towards small carnivore conservation

Statements

S1: Small carnivore conservation is something that is urgently required now

S2: People who harm small carnivores should be punished

S3: We prepare to live in harmony with small carnivores

S4: Without conserving small carnivores there is no existence for human beings

S5: People who use natural resources in protected areas should be stopped from continuing with that

S6: It would not matter if small carnivores were lost from the ecosystem

S7: small carnivores can be sustained by confining them to protected areas

S8: It is not the forest-based communities, but the urban interests that cause widespread destruction of small carnivores

S9: Human needs should come first and only then, that of small carnivores

S10: All this hue and cry for conserving small carnivores is too much

While comparing the attitude of three categories of respondents (Table 50-52 and Figure 79-81), it found that all (100%) of the tribal people and KFD staff agree that small carnivore conservation is something that is urgently required now. Among the villagers, 87.5 % of the respondents agree with the statement. All (100%) of the respondents from all three categories agree that people who harm small carnivores should be punished. All (100%) of the tribal people and KFD staff agree that we have to prepare to live in harmony with these animals whereas, among the villagers, only 55% of the respondents agree with the statement. While comparing the responses of tribal people and villagers, 97.5% of the tribes and 62.5% of the villagers agree that there is no existence for humans without conserving the small carnivores. And 100% of KFD staff agree with this. Among the tribal people, 97.5% of the respondents and 72.5% of the villagers disagree that the people who use natural resources in protected areas should be stopped from continuing with that. And 90% of KFD staff had a neutral attitude towards it. Among the respondents from the tribal communities (97.5%) disagree that it would not matter if small carnivores were lost from the ecosystem and where only 70% of the villagers disagree with the statement. All of the KFD staff disagree with this. All of the respondents from the tribal communities and KFD staff disagree that small carnivores should be sustained by confining them to protected areas whereas only 62% of the believers disagree with the statement and even 12.5% agree with this concept. The majority of the respondents from tribes (67.5%) and KFD staff (55%) showed a neutral attitude towards the statement that it is not the forest based communities, but the urban interests that cause widespread destruction of small carnivores and 40% of the respondents from villagers agree with this. All of the respondents from the tribal communities and KFD staff disagree that human needs should come first and only that of small carnivores. Whereas only 80% of the villagers disagree with statement and even 12.5% agree with this concept. Ninety-seven point five percentage of the respondents from tribes, 60% from villagers and 100% of the KFD staff disagree that all this hue and cry for conserving small carnivores is too much.

Table 50. Tribes attitude towards small carnivore conservation

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
S1	97.5	2.5	0	0	0
S2	97.5	2.5	0	0	0
S3	35	65	0	0	0
S4	42.5	55	2.5	0	0
S5	0	0	2.5	85	12.5
S6	0	0	0	37.5	62.5
S7	0	0	0	37.5	62.5
S8	2.5	27.5	67.5	2.5	0
S9	0	0	0	27.5	72.5
S10	0	0	2.5	40	57.5

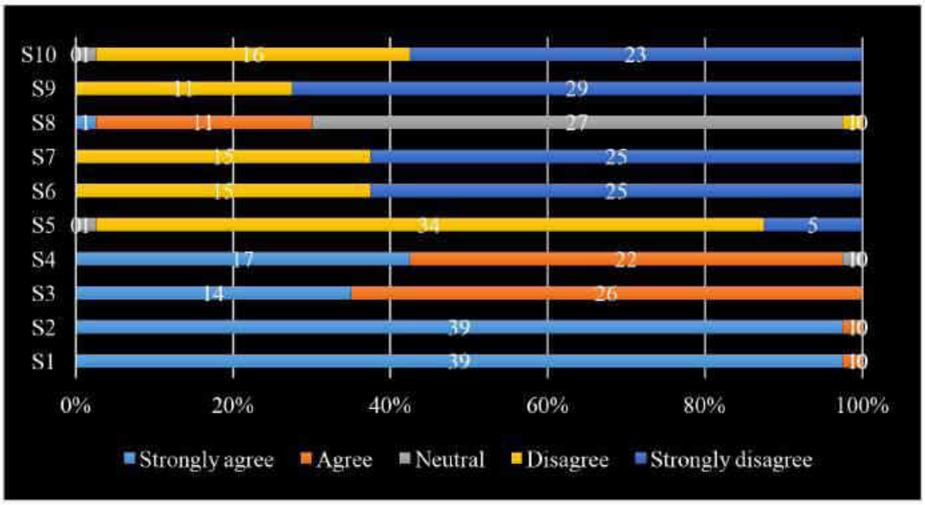


Figure 79. Tribes attitude towards small carnivore conservation

Table 51. Villagers attitude towards small carnivore conservation

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
S1	27.5	60	12.5	0	0
S2	22.5	77.5	0	0	0
S3	12.5	42.5	32.5	12.5	0
S4	7.5	55	30	7.5	0
S5	0	2.5	25	62.5	10
S6	0	7.5	22.5	57.5	12.5
S7	0	12.5	25	52.5	10
S8	0	40	32.5	22.5	5
S9	0	12.5	7.5	77.5	2.5
S10	0	17.5	22.5	55	5

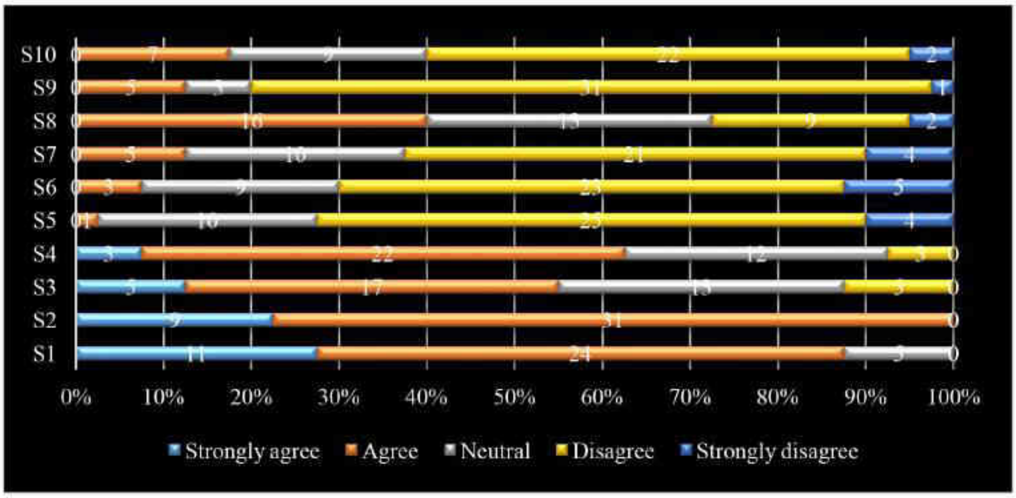


Figure 80. Villagers attitude towards small carnivore conservation

Table 52. KFD staff's attitude towards small carnivore conservation

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
S1	97.5	2.5	0	0	0
S2	100	0	0	0	0
S3	65	35	0	0	0
S4	32.5	67.5	0	0	0
S5	0	5	90	5	0
S6	0	0	0	27.5	72.5
S7	0	0	0	42.5	57.5
S8	0	15	55	27.5	2.5
S9	0	0	0	20	80
S10	0	0	0	35	65

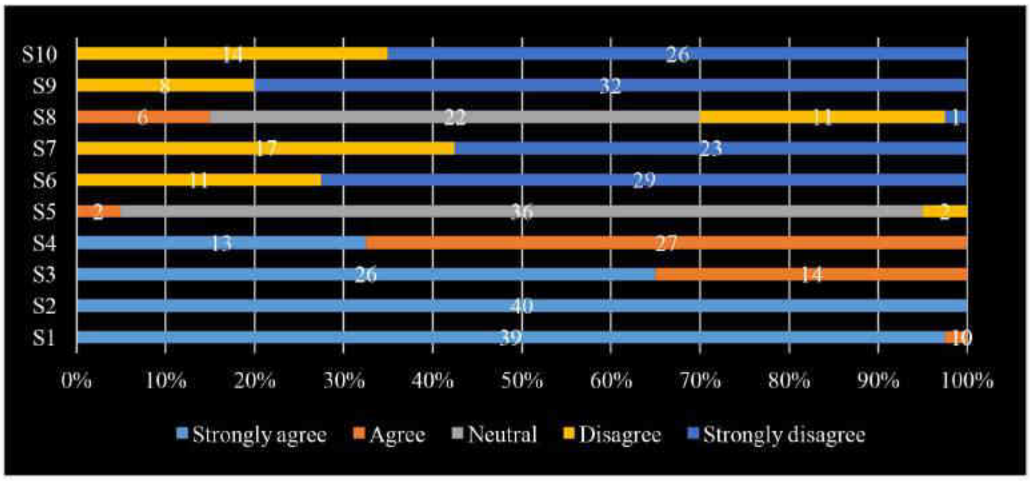


Figure 81. KFD staff attitude towards small carnivore conservation

4.15.8. Human-small carnivore conflict

Queries regarding small carnivore conflict were asked among the tribal community and villagers and only 13 (16.25%) individuals were positively responded to this (Table 53 and Figure 82). Others did not have any experience with small carnivore conflicts. Among the tribal respondent, only 5% (one respondent) reported about the small carnivore conflict. Whereas, around 30% of the villagers interviewed agree that they have experienced small carnivore conflicts. But, only two types of damages were made by small carnivores. They were livestock damage (92.30%) and crop-raiding (7.69%). No injury or loss of life of humans, damage to human properties, or public property were reported. The majority of the livestock loss was due to the attack of Jungle Cat followed by the mongoose. The crop-raiding incident was by civet.

Table 53. Types of human-small carnivore conflict

	Total	Percentage (%)
Crop raiding	1	7.69
livestock	12	92.30
Human life	0	0
Human property	0	0
Public property	0	0
Total	13	

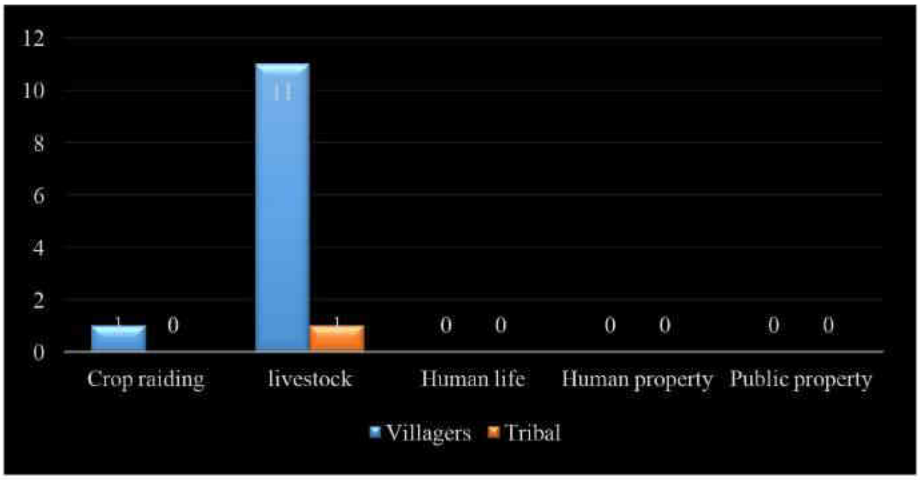


Figure 82. Types of human-small carnivore conflict

4.15.9. Compensation for human-small carnivore conflicts

Compensation for the damage caused by wildlife is important to reduce the human-wildlife conflicts and to reduce the negative attitude of people towards the wildlife. Respondents were asked about their attitude about compensation for human-small carnivore conservation. All (100%) of the respondents agree that compensation is very much needed to address human-small carnivore conflict (Figure 83-85).

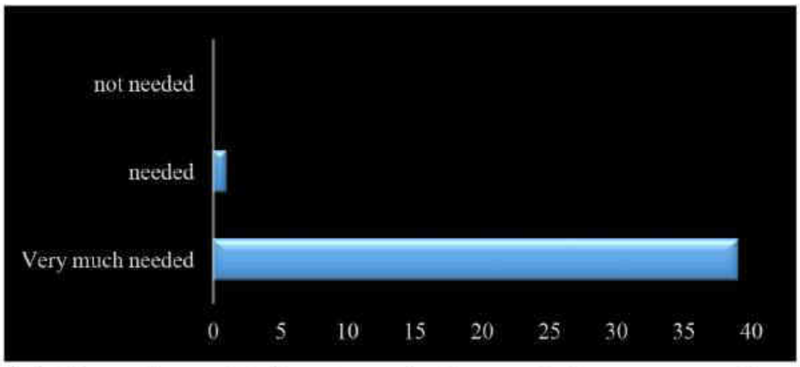


Figure 83. Perception of tribes towards the need for compensation for the damage caused by small carnivore

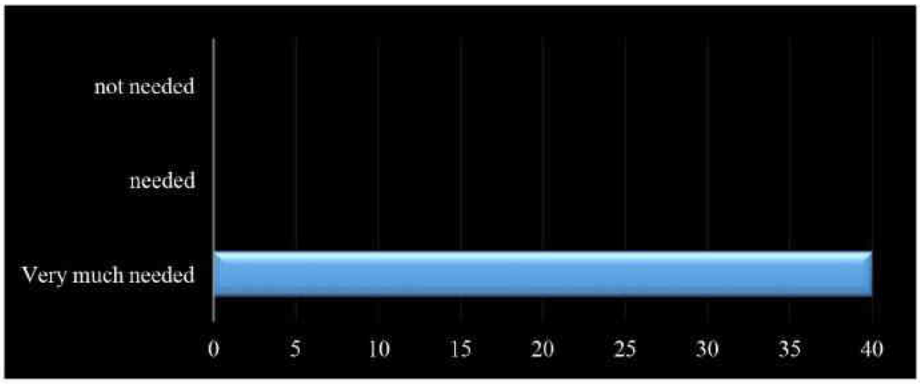


Figure 84. Perception of villagers towards the need for compensation for the damage caused by small carnivore

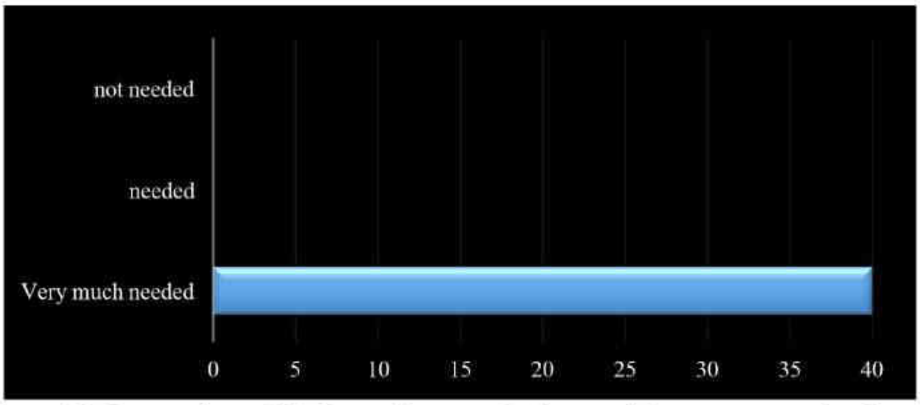


Figure 85. Perception of KFD staffs towards the need for compensation for the damage caused by small carnivore

4.15.10. Suggestions to the administrators in the event of a conflict

Suggestions to the administrators in the event of human-small carnivore conflict were asked among tribes and villagers (Table 54 and Figure 86). All (100%) of the respondent agree with the need for proper coordination between the agencies, awareness/help desk at relevant places, and quick compensation for the damage. Among the people interviewed, 71.25% of the respondents, believe that it is not needed to relocate the animal from the point of issue. Among the respondents 80% believe that no politicization of the conflict is needed and 96.25% believe that it is important to avoid the bureaucratic hurdles.

Table 54. Suggestions to the administrators in the event of human-small carnivore conflict (Percentage)

Statements	Needed	Not needed
S1	100	0
S2	100	0
S3	100	0
S4	28.75	71.25
S5	80	20
S6	96.25	3.75

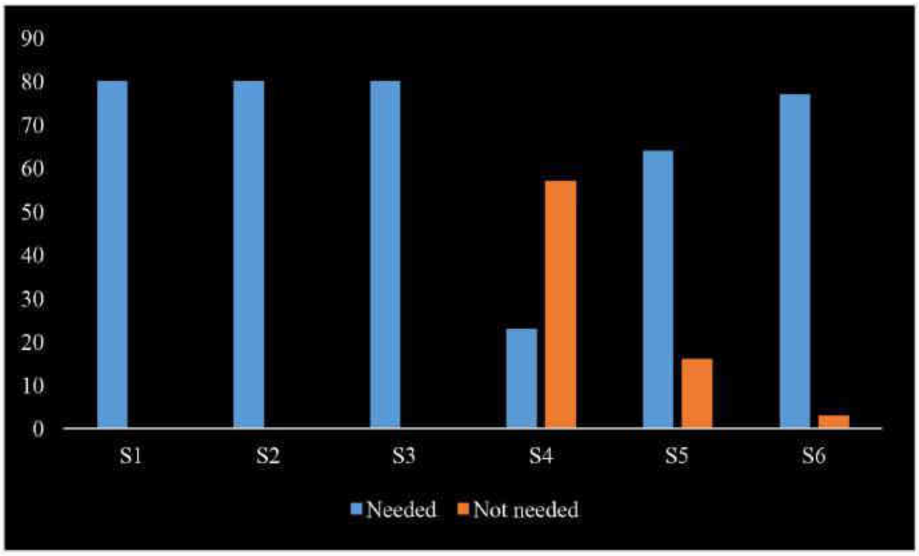


Figure 86. Suggestions to the administrators in the event of human-small carnivore conflict

Statements

S1: Proper co-ordination between agencies

S2: Awareness/help desk at relevant places

S3: Quick compensation for conflict

S4: Relocation of small carnivore

S5: No politicization

S6: Avoiding the bureaucratic hurdles

Among the tribal community, all (100%) of the respondent agree with the need for proper coordination between the agencies, awareness/help desk at relevant places, quick compensation for the damage, and avoiding the bureaucratic hurdles (Table 55 and Figure 87). Ninety-five percentage of the tribal people interviewed believe that it is not needed to relocate the small carnivores from the area and 85% of them believe that non-politicization of the events is needed. Among the villagers, all (100%) of the respondent agree with the need for proper coordination between the agencies and quick compensation for the damage (Table 56 and Figure 75). The majority of them (95%) agree with the need for awareness/help desk at relevant places. Around 52% needed relocation of animals from the area. Most (75%) agreed to the importance of non-politicization of the incidents. And ninety-two percentages of them agreed on the need for avoiding bureaucratic hurdles.

Table 55. Suggestions to the administrators in the event of human-small carnivore conflict by tribal people (Percentage)

Statements	Needed	Not needed
S1	100	0
S2	100	0
S3	100	0
S4	5	95
S5	85	15
S6	100	0

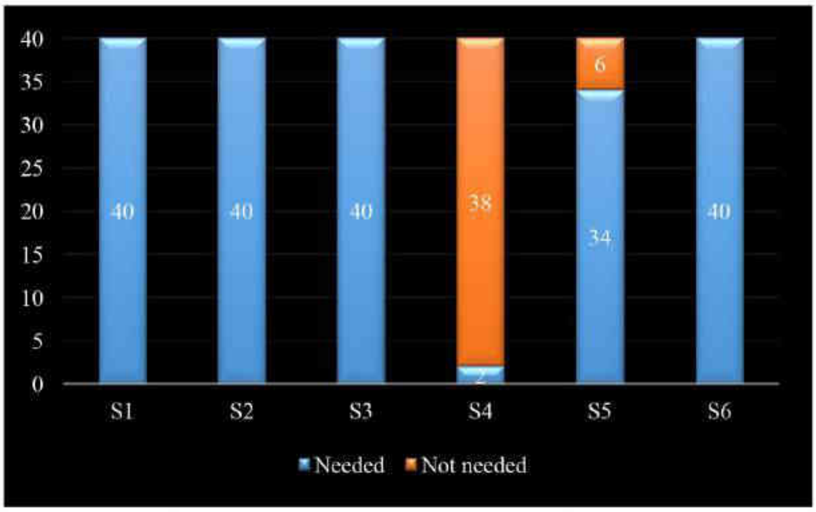
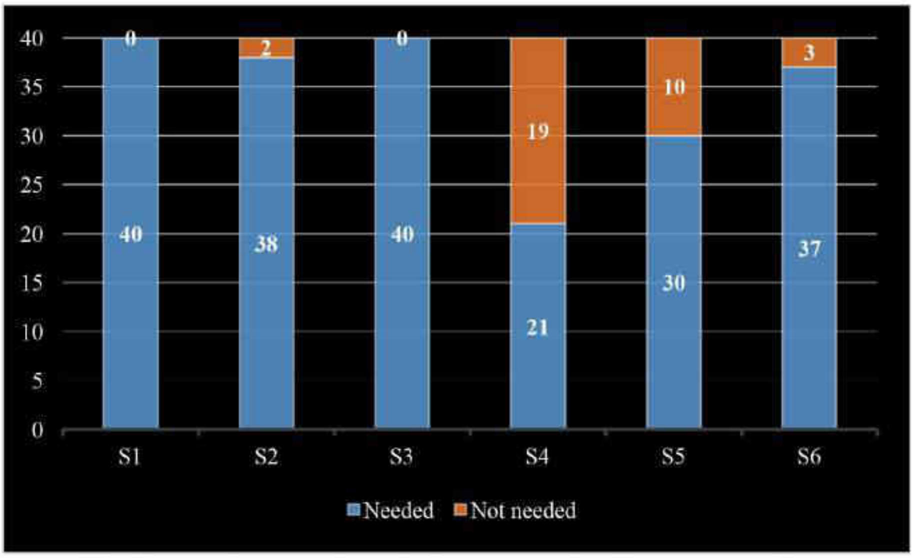


Figure 87. Suggestions to the administrators in the event of human-small carnivore conflict by tribal people

Table 56. Suggestions to the administrators in the event of human-small carnivore conflict by villagers (Percentage)

Statements	Needed	Not needed
S1	100	0
S2	95	5
S3	100	0
S4	52.5	47.5
S5	75	25
S6	92.5	7.5



Figures 88. Suggestions to the administrators in the event of human-small carnivore conflict by villagers

Statements

S1: Proper co-ordination between agencies

S2: Awareness/help desk at relevant places

S3: Quick compensation for conflict

S4: Relocation of small carnivore

S5: No politicization

S6: Avoiding the bureaucratic hurdles

4.15.11. Problems faced by small carnivores in the studied areas

To understand the problems faced by small carnivores in the studied areas, questions about road kills, poaching, and trapping of small carnivores were asked. Only 11 people (9.16%) told about their observation of small carnivore road kills (Figure 89). No incidents of trapping or poaching of the small carnivores were reported from the areas. Road kills were majorly observed by the villagers (22.5%) and tribes (5%).

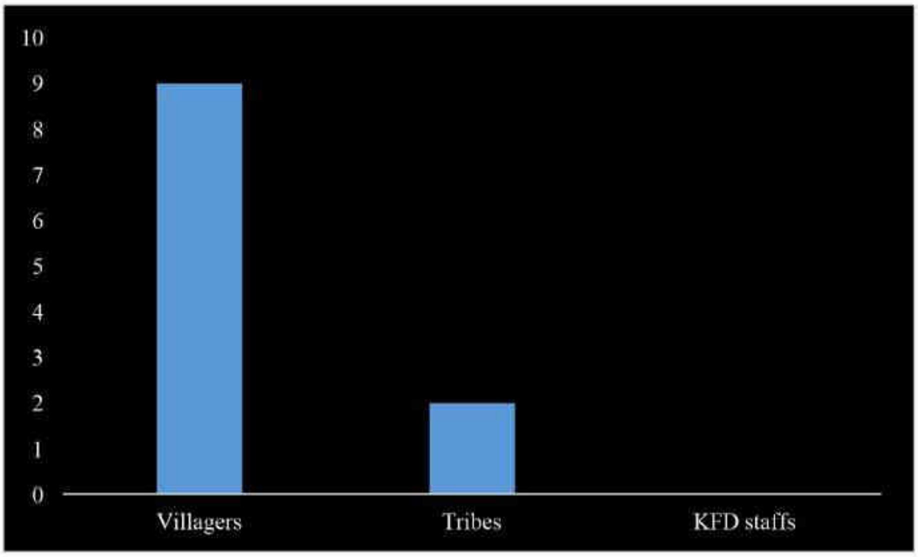


Figure 89. number of respondents positively responded to sighting of road kills of small carnivores

4.15.12. Association between studied parameters in Kerala

Association between studied parameters was analyzed using Chi-square test (Table 57). The association of different variables that describe the respondents to responses made by them on the awareness about small carnivores, attitude, and perception towards the small carnivore conservation was analyzed using this test. It was found that the association between the parameters, Age of the respondent, and Identification of small carnivore was significant at 0.05 level. Distance of home to the forest with the sighting of small carnivores, distance of home to forest with attitude towards small carnivore conservation, economic status and sighting of small carnivores, economic status and identification of small carnivores, economic status and reasons for conservation, economic status and attitude towards small carnivore conservation, Education of the respondent and sighting of small carnivores, identification of small carnivores, and reasons for conservation were significant at 0.01 level.

Table 57. Association between studied parameters in Kerala

Parameter	Pearson Chi-square	P Value
Age x Sighting of small carnivore	22.762	0.1203
Age x Identification	104.97*	0.0321
Age x Reasons for conservation	19.933	0.2232
Age x Attitude	16.994	0.8489
Gender x Sighting of small carnivore	1.5582	0.4588
Gender x Identification	8.8334	0.548
Gender x Reasons for conservation	3.4107	0.1817
Gender x attitude	4.0655	0.2545
Distance x Sighting	72.172**	0.000
Distance x Reason for conservation	9.346	0.6731
Distance x attitude	40.618**	0.0017
Duration x Sighting	1.2377	0.5386
Duration x Reasons for conservation	0.294	0.8633
Duration x Attitude	6.3521	0.09568
Economic status x sighting	17.698**	0.0001
Economic status x Identification	58.762**	0.000
Economic status x Reasons for conservation	15.101**	0.0005
Economic status x Attitude	14.211**	0.002
Education x Sighting	131.62**	0.000
Education x Identification	23.407**	0.0009
Education x Reasons for conservation	25.826**	0.003
Education x Attitude	24.649	0.054

4.15.13. Comparing the significance of responses between the respondents

Statistical significance of the difference between more than two groups of an independent variable on a dependent variable was tested using the Kruskal-Wallis test. It is a non-parametric test. Three categories of the respondents are considered as independent variables and identification of small carnivores, reasons for conservation of small carnivores, and attitude towards small carnivore conservation are considered as the dependent variables.

H_0: All the categories are equal

H_1: At least one category is different from the other categories

Table 58. Kruskal-Wallis test statistics and pairwise comparison of independent categories

Variables	Kruskal value	P-value		Pairwise comparison					
				Tribes X Villagers		Tribes X KFD Staffs		Villager X KFD Staffs	
Category X Identification of small carnivore	85.83	3.58E-14	**	7.60E-07	**	3.80E-06	**	2.00E-16	**
Category X Reasons for conservation	28.99	0.001248	**	0.00678	**	0.00016	**	4.00E-12	**
Category X Attitude towards conservation	43.63	3.83E-06	**	5.60E-09	**	1.40E-08	**	1	ns

While comparing the ability of small carnivore identification between three categories of respondents from the survey, it was found that there is a significant difference at 0.01 level, between at least one of the categories with others (Table 58). A post hoc Dunn test was carried out to identify which pair of categories are significantly different. All the three categories differed significantly from each other in identifying a small carnivore. There is a significant difference (0.01 level) in the reasons for small carnivores between these three categories. And after the post hoc analysis, it was found that all the categories have a difference from other categories of respondents and the difference was significant at level. Attitude towards small carnivore conservation also differed among the three respondent categories at the level. Here the post hoc analysis found that there is no significant difference between the attitude of villagers and the attitude of Kerala Forest department staffs towards small carnivore conservation whereas the attitude varies significantly between tribes and villagers and tribes and KFD staffs at 0.01 level.

4.15.14. Comparing the significance of the difference between the respondents

Mann-Whitney U test is a non-parametric test to compare two populations. In this study, the test was done to understand if there exists any relationship between the respondents from two categories (Tribal community and villagers) in their suggestions to reduce human-small carnivore conflict. And it was found that these two categories differ in their suggestions significant at 0.05 level (Table 59).

H_0: Two categories are equal

H_1: One category is different from the other categories

Table 59. Comparison of suggestions given by villagers and tribes using Mann-Whitney U test

Variables	Mann-Whitney statistics	P-value
Category X Suggestion	85.83*	0.0338

Discussion

DISCUSSION

During the present research to study the small carnivores of Kerala, various habitats were selected from different protected areas and surveyed using various methods like camera traps and line transects. The observations made were small carnivore diversity, their relative abundance, camera trap success rate, their activity pattern and overlap in the activity, and habitat preferences and factors affecting small carnivore distribution in a habitat. Diet of three small carnivore species were analyzed using scat analysis and identification of prey items were made generally up to family level. A semi structured interview was conducted among three categories of respondents, such as, tribal people, villagers, and Kerala Forest Department staffs. The aim of questionnaire survey was to obtain the idea of people's awareness about small carnivores, their attitude towards conservation and to know their suggestions. The people were also asked about the problems faced by small carnivores in the areas, like poaching, road kills, trade etc.

5.1. DIVERSITY OF SMALL CARNIVORES OF KERALA

The thirteen species of small carnivores recorded during this present study were distributed among four families such as Viverridae, Herpestidae, Mustelidae and Felidae (small cats). This includes of four species of herpestids (mongooses) namely *Herpestes edwardsi, H. fuscus, H. smithii, and H. vitticollis*, three species of viverrids (Civets) such as *Paradoxurus hermaphroditus*, *P. jerdoni*, and *Viverricula indica,* three species of mustelids (otters and martens) such as two otters, *Aonyx cinereus*, *Lutrogale perspicillata, and* one species of marten *Martes gwatkinsi,* and three species of felids (small cats) such as *Felis chaus, Prionailurus bengalensis, and P. rubigenosus*. All of these species were camera trapped during the present study at least for one time. During the transect walks, Stripe-necked Mongoose, Brown Palm Civet, and Jungle Cat was directly sighted and indirect evidences for Brown Palm Civet, Smooth-coated Otter, Asian Small-clawed Otter, and small cat were identified from different habitats.

Eleven species of small carnivores were recorded from the state Karnataka during an extensive study conducted (Kumara and Singh, 2006). Eleven species include, 3 species each of cats, civets and mongooses and unidentified otters. From a recent study on small carnivores of southern Western Ghats, nine species were reported (Pillay, 2009). During this study, three species of civets and mongooses and one species of otter were sighted. The small carnivores of Mudumalai Tiger Reserve were studied using camera traps and 10 species were reported from the reserve. This includes three species of cats, three species of civets, four species of mongooses, and one species of otter (Kalle *et al.,* 2013b). Nine species of small carnivores, 3 species of cats and mongooses, two species of civets, and one species of otter were recorded from Biligiri Rangaswamy Temple Tiger Reserve (Kumara *et al.,* 2014). Four species of mongooses, three species of civets, two species of cats, one species of marten, and one species of otter were recorded from the Parambikulam Tiger reserve during a study on small carnivores (Sreehari and Nameer, 2016). During a study in Eravikulam National Park, nine species of small carnivores were recorded. This includes three species of mongooses, two species each of civets and cats, and one species each of marten and otter (Nikhil and Nameer, 2017). Nine small carnivore species including three species each of mongooses and civets, two species of cats and one otter were camera trapped during the study in Wayanad Wildlife Sanctuary (Sreekumar and Nameer, 2018). During a camera trap study on the small carnivores of Silent Valley National Park, two species each of civets and mongooses, and one species each of cats, martens, and otters were recorded (Sanghamithra and Nameer, 2018). And here, during the present study, all the small carnivore species (13) from the Kerala part of Western Ghats were recorded from various habitats.

The proportion of detection of small carnivores in different habitats in Kerala is calculated by comparing the camera trap events of each species. The sightings of small carnivores were more in the evergreen habitat (45.03%), followed by grassland habitat (23.62%), dry deciduous habitat (19.43), and moist deciduous habitat (11.92%). Some of the species showed higher preferences for some habitats or they showed restricted distribution. For example, Jungle Cat was only camera trapped from the grassland habitat. Among the small carnivores recorded, their distribution and abundance varied between habitats. Vegetation types have a strong impact on the presence or absence of each species in a habitat (Kumara *et al.*, 2014). Stripe-necked Mongoose and Small Indian Civet were reported from all the four habitat types of Kerala. During the study, no Stripe-necked Mongoose image was obtained from dry deciduous forest situated south of the Palghat gap. Ruddy Mongoose and Common Palm Civet were only reported from camera traps from dry deciduous habitats and moist deciduous habitats. Ruddy Mongoose was more common in moist deciduous habitat than dry deciduous habitats (Kumara *et al.*, 2014) and during the present study Ruddy Mongoose proportion was more in dry deciduous habitat. Brown Mongoose and Brown Palm Civet were photographed from three habitats, Evergreen forests (both south and north), grassland shola, and moist deciduous forests. Leopard Cat was reported from evergreen habitat, grassland, and dry deciduous habitat. Nilgiri Marten was photo captured only from the southern part of the Western Ghats (evergreen and grassland habitat). Asian Small-clawed Otters were photographed from evergreen forests. But Asian Small-clawed Otter Presence in grassland habitat was identified with the help of indirect evidence. Indian Grey Mongoose, Rusty-spotted Cat, and Smooth-coated Otter were camera trapped only once during the whole study period. During the present study Rusty-spotted Cat was reported from dry deciduous habitat of Walayar Reserve Forest (Sanghamithra and Nameer, 2021a)

During the small carnivore study in Karnataka, Rusty-spotted Cat was spotted nearer to the dry scrub and dry deciduous forest in Karnataka. The majority of the sightings of Jungle Cat in Karnataka occurred near water bodies or croplands where Small Indian Civet was reported from a wide range of habitats. Ruddy Mongoose was known to be common in drier forests and forests with rocks. Common Palm Civets were sighted frequently from dry deciduous or moist deciduous forests whereas Brown Palm Civet was only reported from evergreen habitats (Kumara and Singh, 2007). While studying the small carnivores of southern Western Ghats, Pillay (2009) has observed that Common Palm Civet, Ruddy Mongoose, and Indian Grey Mongoose were sighted only from dry deciduous habitat, whereas Smooth-coated Otter, Brown Palm Civet, and Stripe-necked Mongoose were sighted only from moist deciduous habitat. All of the sightings of Small Indian Civet were from dry deciduous forest except one from the moist deciduous forest in Parambikulam. Small Indian Civet and Stripe-necked Mongoose were reported from the dry deciduous forest, semi-evergreen forest, and dry thorn forest in Mudumalai Tiger Reserve. Common Palm Civet, Indian Grey Mongoose, and Ruddy Mongoose were recorded only from dry deciduous and dry thorn habitats whereas Brown Palm Civet was only camera trapped from semi-evergreen habitats (Kalle *et al.,* 2013b). The observations on habitats of Common Palm Civet, Indian Grey Mongoose, and Ruddy Mongoose were similar in both studies.

From the study on small carnivores of Biligiri Rangaswamy Tiger Reserve, observations were made on the species in different habitats. Leopard Cat was only recorded from the evergreen habitat, whereas Common Palm Civet, Ruddy Mongoose, and Small Indian Civet were reported from all habitat types. Jungle Cat and Rusty-spotted Cat were only observed from dry and moist deciduous forests. Indian Grey Mongoose was present in all habitats except in evergreen habitat and Stripe-necked Mongoose was present in all habitats except scrub lands (Kumara *et al.,* 2014). Common Palm Civet, Small Indian Civet, and Smooth-coated Otter were present in all the habitats studied such as evergreen habitat, moist deciduous habitat and teak plantation in Parambikulam Tiger Reserve. Brown Palm Civet, Brown Mongoose, and Leopard Cat were recorded from evergreen habitat and moist deciduous habitat whereas, Stripe-necked Mongoose were recorded only from all habitat except evergreen habitat. Indian Grey Mongoose, Ruddy Mongoose, Nilgiri Marten, and Jungle Cat were only recorded from moist deciduous habitats (Sreehari and Nameer, 2016).

During the present study, the mean values of species from each location was used to compare the species distribution between habitats. Species occurred in more than two habitats were used for the comparisons. Comparison was also made between habitats present south and north of the Palghat gap. While comparing the species distribution between two habitats of south of the Palghat gap, significant difference was observed for some species. Small Indian Civet distribution was significantly different between evergreen habitat and grassland habitat, evergreen habitat and moist deciduous habitat, evergreen habitat and dry deciduous habitat, grassland habitat and moist deciduous habitat and moist deciduous habitat and dry deciduous habitat. The distribution of Brown Palm Civet significantly varied between evergreen habitat and grassland habitat and evergreen habitat and moist deciduous habitat. The distribution of Stripe-necked Mongoose and Brown Mongoose varied significantly in grassland and moist deciduous habitat and evergreen and grassland habitat respectively.

However, significant difference in species distribution was identified among some habitats situate north of the Palghat gap. Here, Small Indian Civet distribution was significantly different between only moist deciduous habitat and dry deciduous habitat. In the case of Stripe-necked Mongoose, significant difference was identified between evergreen habitat and dry deciduous habitat and between moist deciduous habitat and dry deciduous habitat. For all other species there was no significant difference in their distribution.

The mean values of small carnivore abundance were compared between habitats found north and south of the Palghat gap. Significant differences were observed for some species. There was a significant difference between evergreen habitats situated south and north of the Palghat gap for three species like Brown Palm Civet, Brown Mongoose, and Stripe-necked Mongoose. And for Small Indian Civet the difference was significant between moist deciduous habitat in south and north of the Palghat gap.

5.2. SPECIES RICHNESS AND ABUNDANCE OF SMALL CARNIVORES IN KERALA USING CAMERA TRAP STUDIES

The total camera trap effort in days was 7925 camera trap days and the total photographs obtained of small carnivores was 455 images recording all the 13 small carnivores present in the state territory. From a previous study on small carnivores of Kalakad-Mundanthurai Tiger Reserve, we could see that three species of small carnivores were recorded from the reserve during 295 camera trap days, whereas a camera trap study in Anamai hills recorded three small carnivore species from 95 camera trap days (Mudappa *et al.*, 2007). Only four species of small carnivores were reported from Kerala and Karnataka during a study despite a camera trap effort of 1084 days (Rao *et al.*, 2007). Six species of small carnivores were reported from Namdapha National Park after completing 1537 trap days, while four species were recorded from Pakke Wildlife Sanctuary after 231 camera trap days (Datta *et al.*, 2008). After completing 7380 camera trap nights in Mudumalai Tiger Reserve, Kalle *et al.* (2013) reported nine species from the reserve. A total of 1350 camera trap nights were carried out in Parmbikulam Tiger Reserve and eight small carnivore species were recorded during the study (Sreehari and Nameer, 2016). Eight species of small were reported from Eravikulam National Park from 900 camera trap days

(Nikhil and Nameer, 2017). A total camera trap effort of 1932 trap days was conducted in Wayanad Wildlife Sanctuary and camera trapped nine small carnivores (Sreekumar and Nameer, 2018). A camera trap study in Silent Valley National Park recorded seven species of small carnivores from 1500 camera trap days. Results of the present study also validate the general camera trap capture success from studies conducted in a different part of the nation and the Western Ghats.

While discussing the small carnivore diversity from each habitat during the present study, we could see that the grassland habitat that is situated south of the Palghat gap has the highest small carnivore diversity. Seven species of small carnivores were recorded from the habitat from 915 camera trap days. A previous study from the same location obtained eight species during a camera trap study with 900 camera trap days (Nikhil and Nameer, 2017). However, Brown Mongoose was not camera trapped during the previous study, but it was present from Eravikulam National park during this study. And Asian Small-clawed Otter, Indian Grey Mongoose, and Common Palm Civet was photographed earlier but did not record during the current study. The number of species recorded from evergreen habitat (south) and dry deciduous habitat (north) was six from camera trap effort of 840 days and 1140 days respectively. Five species of small carnivores were reported from moist deciduous habitat (south) from 825 trap days. four species of small carnivores were reported from dry deciduous habitat (south) with 1140 camera trap days. From moist deciduous habitat (north), four species of small carnivores were recorded by a camera trap effort of 840 days. From a camera trap effort of 1275 days in evergreen habitat (north), four species of small carnivores were camera trapped. Only three species of small carnivores were camera trapped from grassland habitat (north) from 950 camera trap days.

5.3. SUCCESS RATE OF CAMERA TRAPS IN VARIOUS HABITATS

A strong correlation between camera trap success rate and density of species is identified. It was also found that the camera trapping rates touch a reasonable accuracy when the camera trap effort is about 200-350 camera trap days (Rovereo and Marshall, 2009). The total small carnivore success rate from all the studied habitats was 5.74 per 100 trap nights. The overall camera trap success rate during the study falls in line with success rates from previous studies. For example, in Parambikulam Tiger Reserve, the camera trap success rate was 4.4 per 100 camera trap nights (Sreehari and Nameer, 2016), where that of Eravikulam National Park was 2.1 per 100 trap nights (Nikhil and Nameer, 2017). The camera trap success rate of small carnivores of Silent Valley National Park was 10.9 per 100 trap nights (Sanghamithra and Nameer, 2018). However, the camera trap success rate was higher (41.1 per 100 trap nights) from Kalakkad Mundanthurai Tiger Reserve (Mudappa *et al.*, 2007).

While comparing the success rates from each habitat, the evergreen habitat of the south of Palghat gap showed the highest success rate, 22.14 per 100 trap nights, and the least rate of camera trap success was shown by evergreen habitat, north of the Palghat gap (1.41 per 100 trap nights). The second-highest success rate was obtained from grassland habitat (9.84 per 100 trap nights), south of Palghat gap followed by dry deciduous habitat north of Palghat gap (6.05 per 100 trap nights) and moist deciduous habitat, south of Palghat gap (4.85 per 100 trap nights). The value is much higher than earlier camera trap studies from various locations in the Western Ghats.

5.4. RELATIVE ABUNDANCE OF SMALL CARNIVORES

A total of 4369 photographs were obtained during the study. The relative abundance of other mammals was higher (79%, 4502 images) followed by carnivores (16.03%, 909 images) and birds (4%, 253 images). Out of the carnivores, 52% were small carnivores (480 images). The most abundant species recorded were Stripe-necked Mongoose followed by Brown Palm Civet and Small Indian Civet. The least abundant species recorded were Smooth-coated Otter and Rusty-spotted Cat.

While considering the relative abundance of wildlife in various habitats, other mammals (76%) were most abundant in evergreen habitats studied, followed by small carnivores (18%). This followed the overall relative abundance of wildlife in the study. The most abundant species in evergreen habitat was Brown Palm Civet (41%) followed by Stripe-necked Mongoose (26%), Brown Mongoose (14%), and Small Indian Civet (11%). In the evergreen habitats of Parambikulam Tiger Reserve also Brown Palm Civet was the most frequently occurring species. The following species were Common Palm Civet and Small Indian Civet (Sreehari and Nameer, 2016). The most abundant species of evergreen forests of Silent Valley National Park was Small Indian Civet followed by Brown Palm Civet, Stripe-necked Mongoose, and Brown Mongoose (Sanghamithra and Nameer, 2018). From comparing the two evergreen habitats studied it was found that the relative abundance of small carnivores among the total wildlife photographed was more for evergreen habitat situated south of the Palghat Gap. In the evergreen habitat (south) Brown Palm Civet was the most abundant species followed by Stripe-necked Mongoose and Brown Mongoose. Whereas, the most abundant species of evergreen habitat (north) was Asian Small-clawed Otter followed by Brown Palm Civet and Stripe-necked Mongoose and Brown Mongoose.

Two moist deciduous habitats were studied during this present study and in that other mammals were the most abundant while comparing all the wildlife photographed. Other mammals comprised 86% of the total individuals followed by other carnivores (6%) and small carnivores (4%). The most abundant small carnivore of this habitat was Small Indian Civet (49%) followed by Common Palm

Civet (14%) and Stripe-necked Mongoose (12%). In the moist deciduous habitat of Parambikulam Tiger Reserve, a similar trend in species abundance was observed. Small Indian Civet was the most abundant species followed by Common Palm Civet and Stripe-necked Mongoose (Sreehari and Nameer, 2016). By comparing the two moist deciduous habitats studied it was observed that the relative abundance of small carnivores among the total wildlife photographed was more for moist deciduous habitat situated south of the Palghat Gap. In the moist deciduous (south) Small Indian Civet was the most abundant species followed by Common Palm Civet and Stripe-necked Mongoose. Whereas the most abundant species of moist deciduous habitat (north) was Ruddy Mongoose followed by Small Indian Civet and Brown Mongoose. In Biligiri Rangaswamy Tiger Reserve, Ruddy Mongoose was more frequently sighted in moist deciduous habitats than dry habitats (Kumara *et al.*, 2014). The trend was contrasting for the present study. The relative abundance of Ruddy Mongoose was more in dry deciduous habitat than that of moist deciduous habitat in Kerala.

The relative abundance of dry deciduous habitats studied during this present study was calculated and other mammals comprised 81% of the total individuals followed by other carnivores (11%) and small carnivores (4%). The most abundant small carnivore of this habitat was the the Stripe-necked Mongoose (32%) followed by Common Palm Civet (29%) and Small Indian Civet (24%). The small carnivore abundance was similar for both moist deciduous and dry deciduous habitats. By comparing the two dry deciduous habitats studied, it was observed that the relative abundance of small carnivores among the total wildlife photographed was more for dry deciduous habitat situated north of the Palghat Gap. In the dry deciduous (south) Common Palm Civet was the most abundant species followed by Small Indian Civet and Ruddy Mongoose. Stripe-necked Mongoose was not recorded from the southern dry deciduous habitat studied. It is the only study location from where no individual of this species was recorded. Whereas, most abundant species of dry deciduous habitat (north) was Stripe-necked Mongoose followed by Small Indian Civet and Common Palm Civet. In Biligiri Rangaswamy Tiger Reserve also the sighting of small carnivores varied between habitats and dry deciduous habitat had higher sighting than moist deciduous, evergreen, and scrub forest habitats. Moreover, the abundance of Rusty-spotted Cat was higher in the reserve than that of other small cats (Kumara *et al.,* 2014). Whereas in the present study, Rusty-spotted Cat was only recorded once from the dry deciduous habitat.

Other mammals (67%) were most abundant in grassland habitats studied, followed by small carnivores (14%). This followed the overall relative abundance of wildlife in the study. The most abundant small carnivore species in grassland habitat was Jungle Cat (32%) followed by Stripe-necked Mongoose (28%) and Small Indian Civet (11%). Jungle cat was the most abundant small carnivore species in grassland habitat in a previous study from Eravikulam National Park (Nikhil and Nameer, 2017). From comparing the two grassland habitats studied it was found that small carnivores were the second abundant wildlife in these habitats. Among the total wildlife photographed, small carnivores were more abundant for grassland habitat situated south of the Palghat Gap. In the grassland habitat (south) Jungle Cat was the most abundant species followed by Stripe-necked Mongoose and Leopard Cat. Whereas, the most abundant species of grassland habitat (north) was Small Indian Civet followed by Stripe-necked Mongoose and Brown Palm Civet.

5.5. SPECIES RICHNESS AND DIVERSITY OF THE SMALL CARNIVORES OF KERALA

The various diversity indices and species richness parameters such as the number of taxa (S), number of individuals (n), Dominances, Shannon-Weiner index (H), Simpson's index (1-D), Berger Parker index, and Margalef index (M) were calculated for each habitat.

The diversity index Shannon-Weiner index was more for the grassland habitat compared to others. A t-test was conducted to compare the Shannon indices and there was no significant difference between these habits at 0.05 level. However, there was a significant variation was observed among habitats situated north of the Palghat gap. A significant difference was observed between evergreen habitat and grassland habitat at 0.05 level and dry deciduous habitat and grassland habitat at 0.01 level. Significant differences were observed among habitats south of the Palghat gap and it was found to be significant at 0.05 level between moist deciduous habitat and grassland habitat and dry deciduous habitat and grassland habitat.

The dominance index Simpson index was also compared between habitats and among habitats situated south and north of the Palghat gap. T-values for comparing the indices between habitats were found to be non-significant at 0.05 levels. While comparing the Simpson index among the habitats situated north of the Palghat gap, dry deciduous habitat and grassland habitats were found to be significant at 0.05 levels. All other habitats compared were non-significant at 0.05 level. And that of habitats north of the Palghat gap was not significant at 0.05 level.

The student t-test was used to compare the Shannon diversity index among different habitats of Parambikulam Tiger Reserve in two different seasons and it was found that there is no significant variation between both seasons at 0.05 level (Sreehari, 2012). In Silent Valley National Park also the species diversity was compared between the two seasons and a significant difference between the rainy season and non-rainy season was found at 0.05 level (Sanghamithra, 2016).

5.6. HABITAT USE AND PREDICTION OF SPECIES PRESENCE

Binary logistic regression was used to predict the correlation between a categorical dependent variable and values of independent variables. The presence or absence of small carnivores in the habitat was predicted using the continuous habitat parameters. Eleven micro-habitat parameters were used for the regression analysis they were Distance to the waterbody, width of the waterbody, GBH (cm), Slope of the land (in degrees), Canopy height (m), Canopy cover (percentage), Litter depth (cm), shrub density (shrubs/area), tree density (trees/area), climber density (climbers/area), and altitude (m AMSL). The analysis was done for each study location and the species with more than ten occurrences from each location was selected for the analysis.

The Akaike Information Criterion (AIC) score was 27.97 for the logistic regression model of Stripe-necked Mongoose in dry deciduous habitat. This model has a predictive accuracy of 84%. The presence of Stripe-necked Mongoose in dry deciduous habitat was best predicted by independent factors such as the width of the waterbody and altitude. Both the independent factors had a positive impact on the presence of the species in the habitat. Whereas The AIC score for the logistic regression model of the species in evergreen habitat was 35.10. This model had a predictive accuracy of 76%. Shrub density and tree density were identified as independent factors with a significant effect on the species distribution in evergreen habitat. But here, both the factors had a negative impact on the presence of the Stripe-necked Mongoose in the evergreen habitat. In the case of the logistic regression model for Stripe-necked Mongoose of grassland habitat, the AIC score was 37.45 and the predictive accuracy of the model was 75%. Two independent factors have a significant effect on the distribution of the species in grassland habitat. Here, tree density had a positive impact and altitude had a negative impact. Earlier in the case of dry deciduous habitat, the impact of altitude was affected positively, which was different from that of grassland habitat. And in the case of tree density, had a negative impact in evergreen habitat, and in grassland, it had a positive influence on the species. The impact of shrub density and tree density followed a similar pattern from a study conducted in the evergreen habitat of Silent Valley National Park. Both these factors had a negative influence on the species distribution in Silent Valley National Park (Sanghamithra, 2016).

The Akaike Information Criterion (AIC) score was 34.88 for the logistic regression model of Small Indian Civet in dry deciduous habitat. This model has a predictive accuracy of 81%. The presence of Small Indian Civet in dry deciduous habitat was best predicted by independent factors such as distance to the water body and altitude. distance to the water body had a negative relation and altitude had a positive relationship with the presence of the Small Indian Civet in the habitat. Whereas the AIC score for the logistic regression model of the species in evergreen habitat was 32.16. This model had a predictive accuracy of 79%. Shrub density and tree density were identified as independent factors with a significant effect on the species distribution in evergreen habitat. But here, both the factors had a negative impact on the presence of the Small Indian Civet in the evergreen habitat. In the case of the logistic regression model for Small Indian Civet of moist deciduous habitat, the AIC score was 41.07 and the predictive accuracy of the model was only 66%. Two independent factors have a significant effect on the distribution of the species in moist deciduous habitat. Here, tree density had a positive impact and the slope of the land had a negative impact. In the case of tree density, had a negative impact in evergreen habitat, and in moist deciduous, it had a positive influence on the species. The slope of the land had a negative impact on the species prediction model formulated from Southern Taiwan (Chen *et al*., 2009). The impact of tree density in an evergreen forest of Silent Valley National Park was contradicting to the present findings. Tree density in Silent Valley National Park had a positive influence on the Small Indian Civet of the habitat and slope also had a positive relationship on the species present in the National Park (Sanghamithra, 2016).

The AIC score for the logistic regression model of Brown Palm Civet in evergreen habitat was 41.43. This model had a predictive accuracy of 72%. Slope and tree density were identified as independent factors with a significant effect on the species distribution in evergreen habitat. Here, the slope of the land had a positive influence and tree density had a negative impact on the presence of the Brown Palm Civet in evergreen habitat. Considering the logistic regression model for the Brown Palm Civet in the Evergreen habitat of Silent Valley National Park, both slope and tree density had a positive impact on the presence of the species. But both these variables were not significant in the model (Sanghamithra, 2016).

In the case of the logistic regression model of Brown Mongoose in evergreen habitat, the AIC score was 35.19 and the predictive accuracy of the model was 79%. Two independent factors have a significant effect on the distribution of the species in evergreen habitat. Both width of the water body and slope had a positive impact. But, both these factors were significant and had a negative impact on the species in Silent Valley National Park (Sanghamithra, 2016).

The AIC score for the logistic regression model of Jungle Cat in grassland habitat was 38.33. This model had a predictive accuracy of 68%. Distance to waterbody and litter depth was identified as independent factors with a significant effect on the species distribution in grassland habitat. The Distance to the waterbody had a positive influence and litter depth had a negative impact on the presence of the Jungle Cat in grassland habitat.

5.7. DIFFERENTIAL PREFERENCES OF SMALL CARNIVORES FOR HABITAT VARIABLES

The discriminant analysis was used to analyze species differential preferences for the recorded habitat parameters. Niche partitioning between or amongst the species was identified by this analysis. During the current study, preferences for microhabitat parameters of evergreen habitat were compared between Brown Mongoose, Brown Palm Civet, Small Indian Civet, and Stripe-necked Mongoose, and it was found that there was no significant clustering or niche partitioning between these species in the habitat. The result showed similar trends with a previous study in Silent Valley National Park. In the evergreen habitat of Silent Valley National Park, studied small carnivores, Brown Mongoose, Brown Palm Civet, Leopard Cat, Small Indian Civet, and Stripe-necked Mongoose showed a niche overlap (Sanghamithra and Nameer, 2018). This niche overlap suggests that the small carnivores have to share the limited resources in their habitat.

In the dry deciduous habitat studied the discriminant analysis was done to understand niche portioning between Common Palm Civet, Ruddy Mongoose, Small Indian Civet, and Stripe-necked Mongoose. And it was found that there was niche overlap between Common Palm Civet, Small Indian Civet, and Stripe-necked Mongoose and Ruddy Mongoose showed clear and distinct niche partitioning from all the other three species. From the camera traps observed it was found that no other small carnivores were recorded from camera trap stations that captured Ruddy Mongoose in the dry deciduous habitat.

If there is no partitioning in the niche of sympatric species, it is alarming considering the conservation aspects. Overlap in the habitats means, the animals part equal inadequate resources in the small habitats increasing competition between them. From the analysis of the diel activity pattern of small carnivores of Kerala, it was found that the sympatric small carnivores have a difference in their activity pattern and activity peaks which is an important niche dimension. Competition and predation risk are reduced by adjusting the activity overlap between sympatric species (Gerber *et al.*, 2012).

5.8. DIEL ACTIVITY PATTERN OF SMALL CARNIVORES

The diel activity pattern of small carnivores has an important role in defining their ecological niche and it acts as a significant tool for the co-existence of the species (Gerber *et al.*, 2012). The temporal separation between two species helps them to reduce the interspecific competition and it also helps to reduce the predation risk in a habitat (Selvan *et al.*, 2018). Moreover, changes in the diel activity pattern can be used as an indication to understand the effect of environmental and climate change on the population of the species (Greggor *et al.*, 2016).

From the camera trap images obtained diel activity patterns of ten small carnivores were studied. Species like Asian Small-clawed Otter, Brown Mongoose and Jungle Cat showed a cathemeral activity pattern. The activity peak of Asian Small-clawed Otter is from 1800 hrs to 2000 hrs. Diel activity peak of Brown Mongoose is during midnight hours (2300 hrs - 2400 hrs). The species also showed some activity during the daytime. The Jungle Cat showed the activity peak during 0200 hrs to 0300 hrs. Some crepuscular hour activity is also observed for the animal. During the small carnivore study in Silent Valley National Park, the activity pattern of Brown Mongoose was analyzed and showed that the species was mostly nocturnal with peak activity during 2200 hrs to 2300 hrs (Sanghamithra, 2016). Jungle Cat in an activity analysis from Tamil Nadu showed similar results. The species showed some activity during midnight hours and just before dawn and the activity peak was just after the sunset (Selvan *et al.*, 2019). Jungle Cats of Manas National Park showed nocturnal activity (Bhatt *et al.*, 2020).

The activity pattern Brown Palm Civet, Common Palm Civet, and Leopard Cat showed mostly nocturnal activity patterns. The maximum activity of Brown Palm Civet is observed during the night (1900 hrs to 2100 hrs) and in the early morning hours (0300 hrs to 0500 hrs). the species showed very little activity during the daytime. The Common Palm Civet was almost active throughout the night hours. Even though it showed more activity during 2100 hrs to 2200 hrs and 2300 hrs to 2400 hrs. Leopard Cat was mostly nocturnal with more activity during 2300 hrs to 0200 hrs, and it also showed some activity during crepuscular hours. Direct sighting of Common Palm Civet was made during the night drives in dry deciduous habitat (Pillay, 2009) and the species in Mudumalai Tiger Reserve also showed similar activity (Kalle *et al.*, 2013b). All the camera trap images of the species from the reserve were during the night (1800 hrs- 0500 hrs). In the case of Brown Palm Civet of Mudumalai Tiger Reserve, all the images were captured from 2300 hrs to 0345 hrs (Kalle *et al.*, 2013b) where midnight activity was low for the species during the present study. The activity of Leopard Cat has been observed between 2100 hrs - 0700 hrs in Silent Valley National Park and the species showed activity peaks during 2200 hrs – 2300 hrs and 0500 hrs – 0600 hrs (Sanghamithra, 2016). The Common Palm Civet showed a similar activity pattern in western Sumatra. The activity of the species was between 1700 hrs to 0700 hrs with activity peaks from 2000 hrs to 2100 hrs, from 0000 hrs to 0100 hrs, and from 0500 hrs to 0600 hrs (Solina *et al.*, 2018). Similar activity patterns of Common Palm Civet and Brown Palm Civet were observed from Wayanad Wildlife Sanctuary (Sreekumar and Nameer, 2018). The Leopard Cat showed a similar activity pattern in a study conducted in north-eastern India. And a slight variation in the activity pattern of Leopard Cat was observed between the species is detected alone in a camera trap location and the species was detected in the same camera trap location as another sympatric species (Mukherjee *et al.,* 2019). The Common Palm Civet had mostly nocturnal activity patterns in Tamil Nadu with activity peaks between midnight and sunrise and others just after sunset (Selvan *et al.*, 2019). The activity of Common Palm Civet in Manas National Park was found to be cathemeral (Bhatt *et al.*, 2020). A similar activity pattern was observed for Leopard Cats in China. Even though variation in activity pattern was there between seasons, overall activity was nocturnal. During autumn, activity was more towards the dawn and dusk (Zhao *et al.*, 2020).

Small Indian Civet was the only small carnivore that showed a complete nocturnal activity pattern. The activity peaks of Small Indian Civet are 2000 hrs to 2200 hrs and 0000 hrs to 0200 hrs. Small Indian Civet was directly sighted in a previous study in the southern Western Ghats and it was during a night driving (Pillay, 2009). In southern Taiwan, the species showed a similar activity pattern (1800 hrs – 0600 hrs) (Chen *et al.*, 2009). All the camera trap images of Small Indian Civet from Mudumalai Tiger Reserve were during night hours (1800 hrs-0600 hrs) (Kalle *et al.,* 2013b) and this result was identical to current findings. During a camera trap study of small carnivores in Parambikulam Tiger Reserve, the activity pattern of Brown Palm Civet, Common Palm Civet, and Small Indian Civet was analyzed and it was found that all the civets showed nocturnal activity (Sreehari, 2012). A similar activity pattern was observed from Wayanad Wildlife Sanctuary (Sreekumar and Nameer, 2018). A contrasting activity pattern of Small Indian Civet was observed from Villupuram district in Tamil Nadu. Here, the species was mostly diurnal with peak activity during the afternoon and before sunset (Selvan *et al.*, 2019). In Manas National Park, the activity pattern of the species was mostly nocturnal (Bhatt *et al.*, 2020).

Stripe-necked Mongoose, Ruddy Mongoose, and Nilgiri Marten had a complete diurnal activity pattern. Stripe-necked Mongoose even showed some activity during crepuscular hours and its activity peak during 0700 hrs to 0900 hrs, 1000 hrs to 1200 hrs, and 1500 hrs to 1700 hrs. Ruddy Mongoose showed very little activity during crepuscular hours and the activity peaks are during 0800 hrs -1000 hrs. Nilgiri Marten had activity peaks during 0800 hrs to 1000 hrs and it also showed little activity during dawn. All the sightings of Stripe-necked Mongoose from Kerala were during the daytime. Contradicting to the present results, Ruddy Mongoose were sighted during night drives from dry deciduous habitat (Pillay, 2009). Stripe-necked Mongoose of Mudumalai Tiger Reserve was observed mostly during day hours and some were photographed between 2000 hrs to 2130 hrs (Kalle *et al.*, 2013b). Observation on Ruddy Mongoose of Mudumalai Tiger Reserve also showed similar results and states that the species were majorly active during day time and sometimes photographed during early night hours (1800 hrs – 2030 hrs) (Kalle *et al.*, 2013b). The activity pattern of Stripe-necked mongoose was found to be diurnal from Silent Valley National Park (Sanghamithra, 2016) which falls in line with the present findings. The activity Pattern of Nilgiri Marten was studied from Pampadum Shola National Park and it was found that the species has a diurnal activity pattern with peak activity between 0900 hrs to 1100 hrs and between 1500 hrs to 1700 hrs (Anil *et al.*, 2018). Ruddy Mongoose and Stripe-necked Mongoose of Wayanad Wildlife Sanctuary showed similar activity patterns Both of them were diurnal with varying activity peaks. Here also Stripe-necked Mongoose showed an activity peak between 0700 hrs to 0800 hrs which was similar in the current study. The activity peak of Ruddy Mongoose was during noon hours (Sreekumar and Nameer, 2018).

5.9. DIEL ACTIVITY PATTERN OVERLAP

Diel activity overlap of sympatric small carnivores was analyzed and it was found that Small Indian Civet and Brown Palm Civet have the most overlap between their activity pattern (87%; 0.77-0.95). The next pair of small carnivores with more overlap was Common Palm Civet and Leopard Cat (86%; 0.69-1.00) followed by

Strip-necked Mongoose and Ruddy Mongoose (84%; 0.68-0.96). The former two pairs were nocturnal in their activity whereas the latter pair had a diurnal activity pattern. In the study of the activity pattern of meso carnivores of Tamil Nadu, the highest activity overlap was observed among Golden Jackal and Jungle Cat. The overlap was 78% and both of them were cathemeral (Selvan *et al.*, 2019). In Nelliampathy hills of Kerala also the maximum overlap was observed between Small Indian Civet and Brown Palm Civet (Sanghamithra and Nameer, 2021b)

The least activity overlap was observed between Stripe-necked Mongoose and Small Indian Civet (9%; 0.06-0.018) and Small Indian Civet and Nilgiri Marten (10%; 0.01-0.21). The activity overlap between a diurnal species and a nocturnal species will be always less compared to two species with similar activity patterns. In the study of the activity pattern of meso carnivores of Tamil Nadu, the lowest activity overlap was observed between Common Palm Civet and Indian Grey Mongoose. The overlap was only 11% and Common Palm Civet was a nocturnal species and the Indian Grey Mongoose was a diurnal species (Selvan *et al.*, 2019). In Nelliampathy hills the least activity overlap was observed between Small Indian Civet and Stripe-necked Mongoose (Sanghamithra and Nameer, 2021b)

More than 50% overlap in activity have been shown by sympatric small carnivores like Brown Mongoose and Small Indian Civet (66%; 0.52-0.78), Brown Mongoose and Brown Palm Civet (65%; 0.51-0.78), Brown Mongoose and Leopard Cat (67%; 0.50-0.84), Brown Mongoose and Jungle Cat (74%; 0.58-0.87), Stripe-necked Mongoose and Nilgiri Marten (72%; 0.52-0.88), Stripe-necked Mongoose and Asian Small-clawed Otter (50%; 0.235-0.73).

Since the activity overlap was maximum between Brown palm Civet and Small Indian Civet during the study, it is expected to increase the competition between these two species. Even though they have similar body sizes and diel patterns, the struggle for resources will be abridged by the variation in their feeding habits. Brown palm Civet mostly feeds on fruits (Rajamani *et al.*, 2002; Mudappa *et al.*, 2010) but the Small Indian Civet is mostly known as an omnivore (Mudappa *et al.*, 2007).

To understand more about the diel activity overlap, cohabitation, and reduction of competition, in-depth research on the diet of these small carnivores is needed. Since Brown Palm Civet and Common Palm Civet are commonly frugivorous species, the competition of these species with other generalist and omnivorous small carnivores will be less. But the competition between Brown Palm Civet and Common Palm Civet would be high. Generally, there exists a spatial separation between these two species. The competition for resources between sympatric species will be there and this may affect more specialist and endemic species like Brown Mongoose and Nilgiri Marten comparing with the generalist species like Small Indian Civet and Stripe-necked Mongoose. The competition between Asian Small-clawed Otter and other small carnivores will be less as the former is found mainly along with the water bodies and its diet is varying considerably from other small carnivores.

Apart from the diet and distribution, the competition among these species was abated by the chronological separation between them (Gerber *et al.*, 2012). They all showed varying activity peaks probably to reduce the competition. In a study of diel overlap between Common Palm Civet and Small Indian Civet, both showed nocturnal activity but with varying activity peaks (Su and Sale 2007). Even though the activity of Small Indian Civet and other sympatric small carnivores were nocturnal, their activity peaks varied (Chen *et al.*, 2009). The activity pattern of Brown Palm Civet, Small Indian Civet, and Brown Mongoose was overlapping in Silent Valley National Park, but their activity peaks varied considerably (Sanghamithra, 2016). Temporal overlap was observed between nocturnal small carnivores like Small Indian Civet, Common Palm Civet, and Brown Palm Civet and between diurnal small carnivores like Stripe-necked Mongoose and Stripe-necked Mongoose in Wayanad Wildlife Sanctuary, they had a change in their activity peaks (Sreekumar and Nameer, 2018).

The activity pattern of animals also depends on seasonal variations (Ikeda *et al.*, 2016), fluctuations in daytime temperatures (Fuller *et al.*, 2016) and prey-predator relations (Harmse *et al.*, 2011; Linkie and Ridout, 2011), and human involvements and anthropological activities (Cruz *et al.*, 2018).

5.10. SOCIO-ECONOMIC SURVEY TO UNDERSTAND THE AWARENESS, ATTITUDE, AND PERCEPTION ABOUT SMALL CARNIVORES AND SMALL CARNIVORE CONSERVATION

A socio-economic survey was conducted among three categories of people like villagers, tribal people, and Kerala Forest Department staff. A total of 120 individuals were interviewed (40 from each category). Among the respondents 37% fall in the age class of 30-40 years. Age class 60-70 was the least represented age class. In an earlier study on the efficiency of mitigation measures for crop-raiding in Wayanad Wildlife Sanctuary, 46% of the respondents were from the 30-50-year age class (Humam, 2019). The majority of the respondents in the tribal community and villagers were residing in the same location for more than 20 years. This was similar in the case of Wayanad Wildlife Sanctuary (Humam, 2019). More than 75% of the respondents in these two categories were living within a distance of 1.5 km from the forest. Coming to the economic status of the interviewed persons, 78.75% were Below Poverty Line. The majority of the respondents have not completed their schooling (41%).

5.10.1. Ability to identify small carnivores

The majority of the respondent could identify up to six species of small carnivores. Villagers could only identify up to seven species of small carnivores. Only one of the individuals of the villagers could identify seven species of small carnivores. Among the tribal people interviewed, they could identify up to 12 species of small carnivores. Only one individual could identify 12 species of small carnivores. The majority of the tribes could identify up to six species of small carnivores. Among the interviewed Kerala Forest Department staff, 30 people could identify all the 13 species of the small carnivores followed by two people who could identify 11 species. From a questionnaire survey conducted on the small carnivores of Parambikulam Tiger Reserve, 84% percent of respondents had preliminary knowledge about the small carnivores (Sreehari, 2012).

5.10.2. Sighting of small carnivores and people's reaction to the sighting of a small carnivore in their homestead

Regarding the sighting of a small carnivore in the area, the majority of the respondents said that they sometimes sighted small carnivores. The small carnivores were often sighted by tribal people. Among the villagers, small carnivores were sighted rarely. The queries were made among the respondents from villagers and tribal communities to understand their response or reaction to the sighting of a small carnivore in their homestead. Apart from a single respondent, all agree that they will leave the animal as it was there and do not try to drive away the species.

5.10.3. Perception of people towards small carnivore conservation

Among the three groups of respondents, the majority of the people think that small carnivores are species that need to be conserved. All of the Kerala Forest Department staff and tribes were certain about the small carnivore conservation.

Among the villagers surveyed, 57% of the respondents believe that small carnivores should certainly be conserved whereas, 43% of the villagers believe that small carnivore conservation is needed to a certain extend.

5.10.4. Reasons to conserve the small carnivores

Reasons for small carnivore conservation were asked among the respondents. Six statements were given as options and each ranking such as most apt, apt, neutral, not very apt, and least apt were given for each statement. Most of the respondents (99.2%) agreed that small carnivores have as much right to live as we do. Around 65% of the respondents believe that there are religious or cultural reasons to conserve small carnivores. About 95.8% of the respondents believe that it is important to conserve these animals for future generations and 90% believe that small carnivore conservation is needed for educational purposes. Most of the respondents (78%) think that small carnivore conservation is needed for tourism in the area. The majority of the respondents (48%) disagree with the concept that the small carnivores should be conserved for wildlife products.

While analyzing the responses of each category interviewed, it was observed that among the tribal people and Kerala Forest Department interviewed, all the respondents believe that small carnivores have the right as humans to live. Ninety-five percentage of villagers agree with the statement. Among the tribal, 40% agree with the statement that small carnivores should be conserved for religious or cultural values. Whereas among the villagers, 35% have a neutral attitude towards religious or cultural reasons for conservation of small carnivores and 20% disagree with this reason. In the interviewed KFD staff, 82.5% agree with it. Among the respondents from the tribal community and KFD, all of them (100%) agree that it is important to conserve the species for future generations and 12.5% of the villagers have a neutral attitude towards this statement and others agree with the statement. The majority of the respondents from the tribal communities and KFD staff (97.5%), and villagers agreed that the small carnivores should be conserved for education purposes. The majority of the respondents from the tribal communities (62.5%), villagers (82.5%), and KFD staffs (90%) agree that tourism is a reason for small carnivore conservation.

A questionnaire survey was conducted in Mannarkkad Forest Division and Thrissur Forest Division. It was perceived that 89% of the respondents of Mannarkkad Forest Division believe that wildlife has the right to live and it is a reason for their protection. Majority (86%) believe that the conservation in the name of religious or cultural reasons was effective. In Thrissur Forest Division 87% of the respondent agree that wildlife has the rights to live as humans do. Only 64% of the respondents from Thrissur believe that the conservation in the name of religious or cultural reasons was effective (Shaji, 2019). This percentage is more than that occurred during the present study. Eighty-six percent of the respondents from Mannarkkad and 89% of the respondents from Thrissur Forest Division states that it is important to conserve wildlife for future generations whereas 96% of the respondents from the present study believe in the mentioned statement. Among the respondents of the Mannarkkad Division, 84% agree that wildlife is important for tourism and 86% believe that wildlife protection is important for the availability of wildlife products. And 68% of the respondents from Thrissur agree that wildlife is important for tourism and 80% believe that wildlife protection is important for the availability of wildlife products (Shaji, 2019). The majority from the present study disagree with the statement regarding wildlife products.

5.10.5. Attitude towards small carnivore conservation

Most of the respondents (95.83%) agree that small carnivore conservation is something needed urgently. All (100%) of the respondents agree with the statement that people who harm small carnivores should be punished. Even though 85% of the respondents have the opinion that we should be prepared to live in harmony with small carnivores, 4.16% disagree with it. Around 86% of the respondents believe that without conserving small carnivores there is no existence for human beings. Among the respondents, 58.33% disagree that people should be restricted from using natural resources from the protected areas and 39.16% have a neutral attitude towards this. Ninety percent of the respondents disagree that it would not matter if small carnivores were lost from the ecosystem. Eighty-five percent of the respondents disagree with the idea of small carnivores could be sustained by confining them to protected areas however, 4.16% want to confine small carnivores to protected areas. Among the respondents, 51.66% showed a neutral attitude towards the statement "It is not the forest-based communities, but the urban interests that cause widespread destruction of small carnivores". Even though 4.16% of the respondents agree with the statement that human needs should come first and only then conservation, 93.33% believe that it is not true.

An earlier study on the Spatio-temporal patterns in human-wildlife conflict in Kerala had enquired about peoples' attitude towards the wildlife conservation in Mannarkkad Forest Division and Thrissur Forest Division. It was found that 83% of the respondents from each divisions have opinions in favor of wildlife conservation (Shaji, 2019). While comparing the attitude of three categories of respondents, it found that all (100%) of the tribal people and KFD staff agree that small carnivore conservation is something that is urgently required now. Among the villagers,, 87.5 % of the respondents agree with the statement. Only 57% percentage of respondents from Mannarkkad and 55% from Thrissur agreed that people who harm wildlife should be punished (Shaji, 2019). But, during the present study, all of the respondents agree that people who harm small carnivores should be punished. In Mannarkkad, 82% of the respondents were ready to live in harmony with the wildlife, whereas in Thrissur, only 69% of the respondents were ready to live in harmony with the wildlife (Shaji, 2019). During the present study all (100%) of the tribal people and KFD staff agree that we have to prepare to live in harmony with these animals whereas, among the villagers, only 55 % of the respondents agree with the statement.

In the respondents from Mannarkkad Division, 67% agree that there is no existence for humans without conserving the wildlife, wherein in Thrissur Division, only 57% agree with this (Shaji, 2019). During the present study, the respondents agree (86%) with this is more. While comparing the responses of tribal people and villagers, 97.5% of the tribes and 62.5% of the villagers agree that there is no existence for humans without conserving the small carnivores. And 100% of KFD staff agree with this. 53% of the respondents from Mannarkkad and 66% from Thrissur did not support that people who use natural resources in protected areas should be stopped from continuing with that (Shaji, 2019). In the present study, 58% disagreed with this. Among the tribal people, 97.5% of the respondents and 72.5% of the villagers disagree that. And 90% of KFD staff had a neutral attitude towards it. During the present study, 90% of the respondents disagreed that it would not matter if small carnivores were lost from the ecosystem. While comparing the responses between categories, among the respondents from the tribal communities (97.5%) disagree that it would not matter if small carnivores were lost from the ecosystem and where only 70% of the villagers disagree with the statement. All of the KFD staff disagree with this. 54% of the respondents from Mannarkkad and 61% from Thrissur were against this statement (Shaji, 2019).

During the current study, only 4.16% of the respondents wanted to confine the small carnivores to the protected areas. All of the respondents from the tribal community and KFD staff disagree that small carnivores should be sustained by confining them to protected areas whereas only 62% of the respondents disagree with the statement and even 12.5% agree with this concept. Among the respondents from Mannarkkad, 97% of them believe that wildlife should be confined to protected areas. And in Thrissur, 92% of the respondents agreed with this (Shaji, 2019). Considering the statement that states it is not the forest-based communities, but the urban interests that cause widespread destruction, only 32% of the respondents from Mannarkkad and 26% of respondents from Thrissur agreed with this. From the present study, it was found that the majority of the respondents from tribes (67.5%) and KFD staff (55%) showed a neutral attitude towards the statement that it is not the forest-based communities, but the urban interests that cause widespread destruction of small carnivores and 40% of the respondents from villagers agree with this.

In Mannarkkad Division, 94% of the respondents consider that human needs should come first and only then conservation. And 77% of the respondents from Thrissur believe the same (Shaji, 2019). Contradicting to this only 4.16% of the respondents from the present study on small carnivores agree with the statement that human needs should come first and only then conservation, 93.33% believe that it is not true. All of the respondents from the tribal community and KFD staff disagree that human needs should come first and only then that of small carnivores. Whereas only 80% of the villagers disagree with the statement and even 12.5% agree with this concept. During the present study, around 85% of the respondents disagree that all this hue and cry for conservation is too much. And 97% of the respondents from tribes, 60% from villagers, and 100% of the KFD staff disagree that all this hue and cry for conserving small carnivores is too much. But, 85% of the respondents from Mannarkkad and 80% of respondents from Thrissur agreed that all this hue and cry for conserving wildlife is too much (Shaji, 2019).

It has been found that the people who benefit from conservation programs develop a positive attitude towards wildlife conservation (Infield and Namara, 2001). Attitude towards the predators varied among the respondents of Kenya. They showed a positive attitude towards Lion and Leopard, but they have a negative attitude towards African Wild dog and Hyenas (Mitchell *et al.,* 2018). The majority of the interviewed people were positive towards the conservation of Leopard Cat. A negative attitude towards the conservation of the species was more among the farmers mainly due to the predation of species on poultry (Best and Pei, 2019). Fifty-two percent of the respondents said that they were not benefitted from nature or wildlife, but 47% believe that they are availing ecological benefits from the forest and wildlife (Nair and Jayson, 2020).

5.10.6. Human-small carnivore conflict

Queries regarding small carnivore conflict were asked among the tribal community and villagers and only 13 (16.25%) individuals were positively responded to this. Others did not have any experience with small carnivore conflicts. Among the tribal respondent, only 5% (one respondent) reported about the small carnivore conflict. Whereas, around 30% of the villagers interviewed agree that they have experienced small carnivore conflicts. But, only two types of damages were made by small carnivores. They were livestock damage (92.30%) and crop-raiding (7.69%). No injury or loss of life of humans, damage to human properties or public property were reported. The majority of the livestock loss was due to the attack of Jungle Cat followed by a mongoose. The crop-raiding incident was by civet. In Parambikulam Tiger Reserve, 68% of the respondents replied that conflict between human and small carnivores exist in the reserve (Sreehari, 2012). And they also said that Jungle Cat and Common Palm Civet were the most common problem causing small carnivores in the reserve. Damage to poultry was a major problem (Sreehari, 2012). In an earlier study on the Spatio-temporal patterns in human-wildlife conflict in Kerala, a total of 40 incidents of human-small carnivore conflict were occurred in Kerala during a 10-year duration from 2006 to 2016. This comprises 28 events involving mongooses, 10 events involving Jungle Cat, and two events involving civets (Shaji, 2019). The Majority (86%) of the conflict was conflicted by elephants, Wild Boar and Bonnet Macaque. Among the carnivores, Leopard, Tiger, and Wild Dog were the major animals in conflict events (Shaji, 2019).

The construction of confinement to the farm was identified as an effective method to reduce the predation of small carnivores on farm animals (Sacristan *et al.*, 2018). In a study from Kerala, most of the respondents believe that the forest department and government are responsible for mitigating the human-wildlife conflict Nair and Jayson, 2020).

5.10.7. Compensation for human-small carnivore conflicts

Compensation for the damage caused by wildlife is important to reduce the human-wildlife conflicts and to reduce the negative attitude of people towards wildlife. Respondents were asked about their attitude about compensation for human-small carnivore conservation. All (100%) of the respondents agree that compensation is very much needed to address human-small carnivore conflict. Ninety-two percent of the respondents of Mannarkkad Forest Division agree that timely compensation could lessen the miseries of people due to wildlife attacks and 84% of the respondents think it is important to give a sufficient amount of compensation to the farmers to sustain their financial loss (Shaji, 2019). In Thrissur Forest Division, 92% of the respondents think that it is important to give a sufficient amount of compensation to the farmers to sustain their financial loss and 98.5% believe that timely compensation could lessen the miseries of people due to wildlife attacks (Shaji, 2019). In Wayanad Wildlife Sanctuary, 90% of the respondents were not satisfied with the compensation they were getting for conflict events (Wahiba, 2019).

5.10.8. Suggestions to the administrators in the event of a conflict

Suggestions to the administrators in the event of human-small carnivore conflict were asked among tribes and villagers. All (100%) of the respondent agree with the need for proper coordination between the agencies, awareness/help desk at relevant places, and quick compensation for the damage. Among the people interviewed, 71.25% of the respondents believe that it is not needed to relocate the animal from the point of issue. Among the respondents, 80% believe that no politicization of the conflict is needed and 96.25% believe that it is important to avoid the bureaucratic hurdles.

In an earlier study on the Spatio-temporal patterns in human-wildlife conflict in Kerala, 13% of the respondents from the Mannarkkad Division suggested that it is important to have proper coordination between agencies, and in Thrissur, 5% agree with this (Shaji, 2019). Among the tribal community, all (100%) of the respondent agree with the need for proper coordination between the agencies, awareness/help desk at relevant places, quick compensation for the damage, and avoiding the bureaucratic hurdles. Ninety-five percentage of the tribal people interviewed believe that it is not needed to relocate the small carnivores from the area and 85% of them believe that non-politicization of the events is needed. Among the villagers, all (100%) of the respondent agree with the need for proper coordination between the agencies, and quick compensation for the damage. The majority of them (95%) agree with the need for awareness/help desk at relevant places. Around 52% needed relocation of animals from the area. The majority (75%) agreed with the importance of the non-politicization of the incidents. And ninety-two percentages of them agreed to the need for avoiding bureaucratic hurdles. Avoiding bureaucratic hurdles during the event of conflict was suggested by 14% of the respondents of Mannarkkad and 21% of the respondents from Thrissur (Shaji, 2019).

5.10.9. Problems faced by small carnivores in the studied areas

To understand about the problems faced by small carnivores in the studied areas, questions about road kills, poaching, and trapping of small carnivores were asked. Only 11 people (9.16%) told about their observation of small carnivore road kills. No incidents of trapping or poaching of the small carnivores were reported from the areas. Road kills were majorly observed by the villagers (22.5%) and tribes (5%). No events of small carnivore poaching or hunting have been recorded during the survey. The case was similar to that of Parambikulam Tiger Reserve. Almost all the respondents during the survey in the reserve stated that no hunting or poaching was taking place in the Tiger Reserve (Sreehari, 2012).

5.10.10. Association between studied parameters in Kerala

With the increase of respondents' educational qualification, there was a positive tendency in the attitude of people in Africa towards the attitude was observed (Infield, 1988). However, no significant correlation between education and positive attitude towards conservation was observed in Kerala (Nair and Jayson, 2020). Association between studied parameters were analysed using Chi square test. The association of different variables that describe the respondents to responses made by them on the awareness about small carnivores, attitude and perception towards the small carnivore conservation was analysed using this test. It was found that the association between the parameters, Age of the respondent and Identification of small carnivore was significant at 5% interval. Distance of home to forest with sighting of small carnivores, distance of home to forest with attitude towards small carnivore conservation, economic status and sighting of small carnivores, economic status and identification of small carnivores, economic status and reasons for conservation, economic status and attitude towards small carnivore conservation, Education of the respondent and sighting of small carnivores, identification of small carnivores, and reasons for conservation were significant at 1% level. Association between age, gender, duration of residing period, compensation, and government involvement was studied with attitude and perception of respondents from Wayanad Wildlife Sanctuary. All the associations have significant effect at 0.01 level (Humam, 2019).

5.10.11. Comparing the significance of responses between the respondents

Statistical significance of difference between more than two groups of an independent variable on a dependent variable were tested using Kruskal-Wallis test. It is a non-parametric test. Three categories of the respondents are considered as independent variables and identification of small carnivores, reasons for conservation of small carnivores, and attitude towards small carnivore conservation are considered as the dependent variables.

While comparing the ability of small carnivore identification between three categories of respondents from the survey, it was found that there is a significant difference at 0.01 level, between at least one of the categories with others. Post hoc Dunn test was carried out to identify which pair of categories are significantly different. All the three categories differed significantly from each other in identifying a small carnivore. There is a significant difference (0.01 level) in the reasons for small carnivore between these three categories. And after the post hoc analysis it was found that all the categories have a difference from other categories of respondents and the difference was significant at level. Attitude towards small carnivore conservation was also differed among the three respondent categories at level. Here the post hoc analysis found that there is no significant difference between the attitude of villagers and attitude of Kerala Forest department staffs towards small carnivore conservation whereas the attitude varies significantly between tribes and villagers and tribes and KFD staffs at 0.01 level.

5.10.12. Comparing the significance of responses between the respondents

Mann-Whitney U test is a non-parametric test to compare two populations. In this study, the test was done to understand if there exist any relation between the respondents from two categories (Tribal community and villagers) in their suggestions to reduce human-small carnivore conflict. And it was found that these two categories differ in their suggestions significant at 0.05 level. Comparison of attitude of the respondents from various forest ranges of Wayanad Wildlife Sanctuary were measure using Mann-Whitney U test. And found that there was no significant difference in the attitude of respondents from different ranges (Humam, 2019). The perception of these respondents were also compared using this test and found that, there was significant difference between two pairs of ranges at 0.05 level (Humam, 2019).

5.11. DIET OF ASIAN SMALL-CLAWED OTTER SMOOTH-COATED OTTER

During the present study crabs were found to be the primary food of Asian Small-clawed Otter in Kerala. Fishes and insects also contribute to the diet of the species. While studying the conservation of Asian Small-clawed Otters, diet analysis of spraints was done. Crabs constituted around 80% (percentage Frequency occurrence) followed by fishes (77%), insects (12%) and snail (4%). Mudskippers and crabs were found to be the major prey of Asian Small-clawed Otter (Foster-turley, 1992). Asian Small-clawed Otters of Sundarbans were studied and three spraints were analyzed during the study period. Even though this could not derive any strong conclusions, it was found that fish bones and spines were the major component in two samples and one sample contained a mixture of fish remains and crabs (Aziz, 2018).

The SCO was found to be a fish eater. Percentage frequency of occurrence of fishes in the SCO diet was 87%. Trichogatsers an Anabas was the major fishes. Bigger fishes like Channa and Claris were also consumed frequently. Rats were found next to the order to fishes (23%) and invertebrate occurred in 8% of the scats (Foster-turley, 1992). Fish constituted the major diet of SCO (Haque and Vijayan, 1993; Hussain and Choudhury, 1997). Among the SCO of Periyar Tiger Reserve, 96% of the otter diet was included by fishes, followed by frogs (1.08%) and crabs and birds (1.07%). Tilapia, Carp, Catfish, Masheer, and Curmuca Barb were the major fishes in the diet of the species (Anoop and Hussain, 2005). The diet composition of Smooth-coated Otter in upper Gangetic plains include fishes followed by amphibians, crabs and birds (Nawab and Hussain, 2011). The results were similar in the diet of the species in Singapore. Fishes were the major prey species followed by prawns, crabs and mollusks. Major fish families were latidae, mugallidae, channidae and gobidae (Theng *et al.,* 2016). In the current study also fishes constituted the major diet of the species. Larger fishes like Channa sps. were also taken frequently. The diet composition varies between locations (Nawab and Hussain, 2011; Theng *et al.,* 2016).

The dietary composition between SCO and ASCO were compared as it has a very important role in the species co-existence. Their diets varied significantly. Only similarity was found in the case of insects and snail. But their portion in overall diet was very little. (Foster-turley, 1992). Variation in the diet of Asian Small-clawed Otter and Smooth-coated Otter was observed during the present study. Even though the major components in their diet were similar. Asian Small-clawed Otter fed frequently on crabs followed by fishes and insects. In the case of Smooth-coated Otter, fishes were observed most frequently followed by insects and crabs.

5.12. DIET OF BROWN PALM CIVET

Fruits was the major component of the Brown Palm Civet diet. Fruits were included in 97.04% of the scats. In that 91% was of fruits from native plants. Flowers of *Cullenia exarillata* and Syzygium sps were present in the scats (1.48%). Remnants of invertebrates (11%) were more than that of vertebrates (3.75%) in the scats. A single food item was recorded in the majority of the scats (79%) and 16% of the scats contained 2 categories of food. The maximum number of macroscopically distinct food items was four in the scats (Mudappa et al., 2010). Predation by Brown Palm Civet on a Malabar Grey Slender Loris *Loris lydekkerianus* was reported from Aralam Wildlife Sanctuary. This was the first sighting of predation on Slender Loris by Brown Palm Civet (Gnanaolivu and Singh, 2019).

Summary

SUMMARY

Small carnivores are a vital part of the ecosystem and play an integral role in its functioning. They aid in the energy flow and nutrient cycling and playing significant role as predators of small mammals and also act as important prey base for other predators. In case of frugivorous small carnivores, they help in seed dispersal. Due to their nocturnal and cryptic nature, many species are considered as rare or uncommon and knowledge about their ecology and their necessities are also limited. By the integration of modern technologies such as camera trapping to the traditional ways of sampling more records of these elusive species are being made. The project entitled "Small carnivores of selected protected areas of Kerala" aims to study the status of small carnivores such as felids (lesser cats), herpestids (mongooses), viverrids (civets) and mustelids (otters and martens) in selected protected areas. It is also intended to study habitat preferences of small carnivores and their distribution in selected protected areas. It is proposed to study the temporal segregation between sympatric small carnivores. It is also proposed to study the feeding ecology of the selected species of small carnivores. In addition to the above, conservation challenges faced by the small carnivores in these selected study areas will also be studied.

The approaches made to study the small carnivores were, camera trapping, day transect survey for collection of direct and indirect evidences and questionnaire survey. The microhabitat parameters from each camera trap location is collected to study the habitat preferences of small carnivores. A total of 7925 camera trap days, 438 kilometers of transect walks and 120 personal interviews were done.

The highlights of the findings are summarized below:

- Thirteen species of small carnivores were recorded from Kerala. This includes four species of Herpestidae, three species of Felidae, Mustelidae and Viverridae
- All small carnivores present in Kerala part of Western Ghats is reported during the current study
- The mongooses reported from Kerala are Indian Grey Mongoose *Herpestes edwardsi*, Brown Mongoose *H. fuscus*, Ruddy Mongoose *H. smithii* and Stripe-necked Mongoose *H. vitticollis*
- The small cats reported from Kerala are Jungle Cat *Felis chaus*, Leopard Cat *Prionailurus bengalensis*, and Rusty-spotted Cat *P. rubiginosus*
- The mustelids reported from Kerala includes two species of otters, Asian-small-clawed Otter *Aonyx cinereus* and Smooth-coated Otter *Lutrogale perspicillata* and one species of marten Nilgiri Marten *Martes gwatkinsii*
- The civets recorded in the present study are Brown Palm Civet *Paradoxurus jerdoni*, Common Palm Civet *P. hermaphrodites*, and Small Indian Civet *Viverricula indica*
- Stripe-necked Mongoose and Small Indian Civet were reported from all the four habitat types of Kerala
- Brown Mongoose and Brown Palm Civet was photographed from three habitats, evergreen habitat, grassland shola habitat, and moist deciduous habitat
- Leopard Cat was reported from evergreen habitat, grassland shola habitat, and dry deciduous habitat
- Ruddy Mongoose and Common Palm Civet was only reported from dry deciduous habitats and moist deciduous habitats

- Nilgiri Marten was photo captured from evergreen habitat and grassland shola habitat
- Jungle Cat was only reported from the grassland habitat
- Asian Small-clawed Otters were photographed from evergreen habitat
- Smooth-coated Otter was only reported from moist deciduous habitat
- Indian Grey Mongoose and Rusty-spotted Cat were reported from dry deciduous habitat
- Higher small carnivore detection was in evergreen habitat followed by grassland shola habitat and dry deciduous habitat. Most frequently detected small carnivore was Stripe-necked Mongoose followed by Brown Palm Civet and Small Indian Civet
- While comparing the habitat wise relative abundance of small carnivores, higher relative abundance was observed in evergreen habitat followed by grassland shola habitat and dry deciduous habitat. In evergreen habitat Brown Palm Civet was the most abundant species followed by Stripe-necked Mongoose and Brown Mongoose. In grassland shola habitat, the most abundant species was Small Indian Civet followed by Common Palm Civet and Stripe-necked Mongoose. The most abundant small carnivore species of dry deciduous habitat was Stripe-necked Mongoose followed by Common Palm Civet and Small Indian Civet. Small Indian Civet was the most abundant species in moist deciduous habitat followed by Common Palm Civet and Stripe-necked Mongoose
- The presence or absence of small carnivores in a habitat was predicted using the continuous habitat variables. The presence of Stripe-necked Mongoose in dry deciduous habitat was best predicted by width of the waterbody and altitude. Whereas shrub density and tree density were found to be the significant habitat parameters in the occurrence of the species in evergreen

habitat and tree density and altitude have an influence on the species presence in grassland shola habitat

- The occurrence of Small Indian Civet in dry deciduous habitat is best predicted using distance to the waterbody and altitude and that in evergreen habitat is shrub density and tree density
- The prediction of presence of Brown Palm Civet in evergreen habitat is made with two habitat factors such as slope of the land and tree density
- The Brown Mongoose occurrence in evergreen habitat is best predicted by width of the waterbody and slope of the land
- The presence of Jungle Cat is best predicted by distance to waterbody and litter depth
- Niche partitioning between or among the small carnivores of a habitat was identified using discriminant analysis. During the current study no significant habitat partitioning was observed among the small carnivores of grassland shola habitat and in evergreen habitat. However, in dry deciduous habitat, Ruddy Mongoose showed a clear and distinct niche partitioning from all other small carnivores studied
- Cathemeral activity was observed among Asian Small-clawed Otter, Brown Mongoose and Jungle Cat
- Diurnal activity pattern was detected among Nilgiri Marten, Ruddy Mongoose and Stripe-necked Mongoose
- A nocturnal activity was observed among Small Indian Civet, Brown Palm Civet, Common Palm Civet and Leopard Cat.
- Highest activity overlap was observed between Small Indian Civet and Brown Palm Civet. Least activity overlap was observed between Stripe-necked Mongoose and Small Indian Civet.
- Crabs were found to be the primary food of Asian Small-clawed Otter in Kerala followed by fishes and insects

- Smooth-coated Otter, it is found to be a piscivorous species and the diet of the species also include insects and crabs
- Fruits were the major diet component of Brown Palm Civet. During the present study both fruit items and animal remains were there in the scats of Brown Palm Civet
- From the socio economic survey it has concluded that, majority of the respondents agree that the conservation of small carnivores is certainly needed
- There observed a positive attitude towards the conservation of small carnivores
- Poultry predation was found to be the major negative interaction between human and small carnivores
- Among the various threats faced by small carnivores, roadkill was found to be the major one

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SMALL CARNIVORES OF SELECTED PROTECTED AREAS OF KERALA

By

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(2016-27-001)

ABSTRACT

Submitted in partial fulfilment of the requirement for the degree of

DOCTOR OF PHILOSOPHY IN FORESTRY

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ABSTRACT

The present study "Small carnivores of selected protected areas of Kerala" have recorded all the 13 species of small carnivores seen in Kerala. These include three species of cats such as *Felis chaus, Prionailurus bengalensis,* and *P. rubiginosus*, four species of mongoose such as *Herpestes edwardsii, H. fuscus, H. smithii* and *H. vitticollis*, three species of musteids such as *Martes gwatkinsii, Aonyx cinereus* and *Lutrogale perspicillata* and three species of civets such as *Paradoxurus jerdoni, P. hermaphrodites,* and *Viverricula indica*.

While comparing the small carnivores of four different habitats, evergreen habitat had higher small carnivore abundance followed by grassland-shola habitat and dry deciduous habitat. And among the small carnivores, Stripe-necked Mongoose was found to be the most abundant small carnivore in Kerala followed by Brown Palm Civet and Small Indian Civet.

The presence or absence of small carnivores in a habitat was predicted using the continuous habitat variables. The presence of Stripe-necked Mongoose in dry deciduous habitat was positively influenced by both width of the water body and altitude. Whereas shrub density has a positive influence and tree density has a negative influence on the occurrence of the species in evergreen habitat and tree density has a positive influence and altitude has a negative influence on occurrence of the species in grassland shola habitat. The occurrence of Small Indian Civet in dry deciduous habitat is negatively affected by distance to the water body and positively affected by altitude and that in evergreen habitat negatively affected by both shrub density and tree density. The presence of Brown Palm Civet in evergreen habitat is influenced positively by slope of the land and negatively by tree density. The Brown Mongoose occurrence in evergreen habitat is affected positively by width of the water body and slope of the land. The presence of Jungle Cat in grassland shola habitat is positively influenced by distance to water body and negatively influenced by litter depth.

During the current study no significant habitat partitioning was observed among the small carnivores of grassland shola habitat and in evergreen habitat. However, in dry deciduous habitat, Ruddy Mongoose showed a clear and distinct niche partitioning from all other small carnivores studied.

Regarding the activity pattern of small carnivores, a cathemeral activity was observed among Asian Small-clawed Otter, Brown Mongoose and Jungle Cat and diurnal activity pattern was detected among Nilgiri Marten, Ruddy Mongoose and Stripe-necked Mongoose. A nocturnal activity was observed among Small Indian Civet, Brown Palm Civet, Common Palm Civet and Leopard Cat. Regarding the temporal activity overlap, highest activity overlap was observed between Small Indian Civet and Brown Palm Civet. Least activity overlap was observed between Stripe-necked Mongoose and Small Indian Civet.

Diet of Asian Small-clawed Otter, Smooth-coated Otter and Brown Palm Civet were studied by analysing the faecal matter. Crabs were found to be the primary food of Asian Small-clawed Otter in Kerala, while in the case of Smooth-coated Otter, it is found to be primarily a piscivorous species. Fruits were the major diet component of Brown Palm Civet.

The socio-economic survey conducted among the respondents such as indigenous community, villagers and Kerala forest department officials, majority of the respondents agree that the conservation of small carnivores is certainly needed. There observed a positive attitude towards the conservation. Poultry predation was found to be the major negative interaction between humans and small carnivores. The road kill was found to be the major threat to small carnivores.

Appendices

Appendix I

Questionnaire for survey among tribal people

STUDY ON THREATS AND CONSERVATION ISSUES FACED BY SMALL CARNIVORES IN SELECTED PROTECTED AREAS OF KERALA (TRIBES)

College of Forestry, Vellanikkara

Interviewer name: **Date:**

Personal details

1) Name:
2) Age:
3) Sex: Male ☐ Female ☐ Transgender ☐
4) Name of the village and ward: _________________
5) Distance from house to nearby forest: ______ km
6) How long have you been living in this village or location?

   Less than 5 Year ☐ 5-10 years ☐

   10 – 20 Years ☐ 20 years or more ☐

7) Family members-occupation and income

Family Member	Occupation	Income

8) Economic status:

   APL ☐ BPL ☐

9) Education qualification:

No schooling ☐ Schooling not completed ☐ SSLC ☐

Pre-degree ☐ Graduate ☐ Post graduate ☐

10) Food habits:

Veg/ Mostly veg/ Mixed/ Mostly non-veg/ non-veg

Awareness

11) Are you able to recognize the small carnivore: All of them/ many of them/ some of them/ few of them? (Numbers of species)?

12) Have you sighted any small carnivore in this protected area? Very often/ often/ sometimes/ rarely

13) What will you do if you sight a small carnivore in your homestead? Drive away/Leave it as it is

14) Do you believe small carnivores should be protected?

Certainly/ Yes, to a certain extent/ not really

Reasons for Protection

SL NO:	Statements	Most apt	Apt	Neutral	Not very apt	Least apt
I	They have as much right to live as we do					
Ii	Religious/cultural					
Iii	For future generations					
Iv	Education					
V	Tourism					
Vi	Value of wildlife products to the economy					

Conflict and Threat

15) Do you face any problem by small carnivores: Yes / No

    a. If yes, then mention the conflict

16) Have you ever noticed any problem by small carnivores to anyone else in your area? Yes / No

    a. If yes, then mention the conflict

17) If any damage happened by small carnivores:

SL No:	Damage	Yes/No	Specify Loss
1	Crop raiding		
2	Livestock loss		
3	Injury and loss of life of humans		
4	Damage to human property		
5	Public property		

18) If damage occurred, Any preventive measures under taken in your area? Are they effective?

19) Are you aware of any problems faced by small carnivores in your area?

20) If yes, what kind?

21) Have you seen any road kill of small carnivores? Very frequently/frequently/ sometimes/rarely Species?

22) Have you ever noticed/seen/heard of trapping and poaching of these animals?

23) If yes, what kind?

Attitude Towards Conservation

24) Attitudes towards wildlife/small carnivore conservation

SL NO:	Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
i	Wildlife conservation is something that is urgently required now					
ii	People who harm wildlife should be punished					
iii	We prepare to live in harmony with wildlife					
iv	Without conserving wildlife there is no existence for human beings					
v	It would not matter if small carnivores were lost from the ecosystem					
vi	Wildlife can be sustained by confining them to protected areas					
vii	It is not the forest based communities, but the urban interests that cause widespread destructions of wildlife					
viii	Human needs should come first and only then, that of wildlife					
ix	All this hue and cry for conserving wildlife is too much					

25) Do you feel that any compensation from government is required to address if human-small carnivore conflict occurs?

Very much needed/ needed/ not needed

26) Which of the following suggestions would you like to give to the administrators to conserve small carnivores?

- [ ] Proper co-ordination between agencies
- [ ] Awareness/Help desks at relevant places
- [ ] Quick compensation
- [ ] Relocation of small carnivores
- [ ] No politicization
- [ ] Avoiding the bureaucratic hurdles
- [ ] Others: ______________________________

Appendix II

Questionnaire for survey among villagers

STUDY ON THREATS AND CONSERVATION ISSUES FACED BY SMALL CARNIVORES IN SELECTED PROTECTED AREAS OF KERALA (VILLAGERS)

College of Forestry, Vellanikkara

Interviewer name: **Date:**

Personal details

1) Name:
2) Age:
3) Sex: Male ☐ Female ☐ Transgender ☐
4) Name of the village and ward: ____________________________
5) Distance from house to nearby forest: ______ km
6) How long have you been living in this village or location?

   Less than 5 year ☐ 5-10 years ☐

   10 – 20 years ☐ 20 years or more ☐
7) Family members-occupation and income

Family Member	Occupation	Income

8) Economic status:

   APL ☐ BPL ☐

9) Education qualification:

No schooling ☐ Schooling not completed ☐ SSLC ☐

Pre-degree ☐ Graduate ☐ Post graduate ☐

10) Food habits:

Veg/ Mostly veg/ Mixed/ Mostly non-veg/ non-veg

Awareness

11) Are you able to recognize the small carnivore: All of them/ many of them/ some of them/ few of them? (Numbers of species)?

12) Have you sighted any small carnivore in this protected area? Very often/ often/ sometimes/ rarely

13) What will you do if you sight a small carnivore in your homestead? Drive away/Leave it as it is

14) Do you believe small carnivores should be protected?

Certainly/ Yes, to a certain extent/ not really

Reasons for Protection

SL NO:	Statements	Most apt	Apt	Neutral	Not very apt	Least apt
I	They have as much right to live as we do					
Ii	Religious/cultural					
Iii	For future generations					
Iv	Education					
V	Tourism					
Vi	Value of wildlife products to the economy					
Vii	All of the above					

Conflict and Threat

15) Do you face any problem by small carnivores: Yes / No

a. If yes, then mention the conflict

16) Have you ever noticed any problem by small carnivores to anyone else in your area?

Yes / No

a. If yes, then mention the conflict

17) If any damage happened by small carnivores:

SL No:	Damage	Yes/No	Specify Loss
1	Crop raiding		
2	Livestock loss		
3	Injury and loss of life of humans		
4	Damage to human property		
5	Public property		

18) Any preventive measures under taken in your area? Are they effective?

19) Have you seen any road kill of small carnivores? Species?

20) Are you aware of any problems faced by small carnivores in your area?

21) If yes, what kind?

22) Have you ever noticed/seen/heard of trapping and poaching of these animals?

23) If yes, what kind?

Attitude Towards Conservation

24) Attitudes towards wildlife/small carnivore conservation

SL NO:	Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
i	Wildlife conservation is something that is urgently required now					
ii	People who harm wildlife should be punished					
iii	We prepare to live in harmony with wildlife					
iv	Without conserving wildlife there is no existence for human beings					
v	People who use natural resources in protected areas should be stopped from continuing with that					
vi	It would not matter if small carnivores were lost from the ecosystem					
vii	Wildlife can be sustained by confining them to protected areas					
viii	It is not the forest based communities, but the urban interests that cause widespread destructions of wildlife					
ix	Human needs should come first and only then, that of wildlife					
x	All this hue and cry for conserving wildlife is too much					

25) Do you feel that any compensation from government is required to address if human-small carnivore conflict occurs?

Very much needed/ needed/ not needed

26) Which of the following suggestions would you like to give to the administrators to conserve small carnivores?

- [ ] Proper co-ordination between agencies
- [ ] Awareness/Help desks at relevant places
- [ ] Quick compensation
- [ ] Prompt re-settlement
- [ ] Relocation of small carnivores
- [ ] No politicization
- [ ] Avoiding the bureaucratic hurdles

Appendix III

Questionnaire for survey among Kerala Forest Department staffs

STUDY ON THREATS AND CONSERVATION ISSUES FACED BY SMALL CARNIVORES IN SELECTED PROTECTED AREAS OF KERALA (KFD STAFF)

College of Forestry, Vellanikkara

Interviewer name: **Date:**

Personal details

1) Name of person interviewed:
2) Age:
3) Sex: Male ☐ Female ☐ Transgender ☐
4) How long have you been working in this locality?

   Less than 5 year ☐ 5-10 years ☐

   10 – 20 years ☐ 20 years or more ☐
5) Occupation
6) Education qualification:

   No schooling ☐ Schooling not completed ☐ SSLC ☐

   Pre-degree ☐ Graduate ☐ PG and above ☐
7) Food habits:

   Veg/ Mostly veg/ Mixed/ Mostly non-veg/ non-veg

Awareness

8) Are you able to recognize the small carnivore: All of them/ many of them/ some of them/ few of them? (Numbers of species)?

9) Have you sighted any small carnivore in this protected area? Very often/ often/ sometimes/ rarely

10) Do you believe small carnivores should be protected?

Certainly/ Yes, to a certain extent/ not really

Reasons for Protection

SL NO:	Statements	Most apt	Apt	Neutral	Not very apt	Least apt
I	They have as much right to live as we do					
Ii	Religious/cultural					
Iii	For future generations					
Iv	Education					
V	Tourism					
Vi	Value of wildlife products to the economy					

Conflict and Threat

11) Do you face any problem by small carnivores: Yes / No

  a. If yes, then mention the conflict

12) Have you ever noticed any problem by small carnivores to anyone in your area? Yes / No

  a. If yes, then mention the conflict

13) If any damage happened by small carnivores:

SL No:	Damage	Yes/No	Specify Loss
1	Crop raiding		
2	Livestock loss		
3	Injury and loss of life of humans		
4	Damage to human property		
5	Public property		

14) Any preventive measures under taken in your area? Are they effective?

15) Have you seen any road kill of small carnivores? Species?

16) Are you aware of any problems faced by small carnivores in your area?

17) If yes, what kind?

18) Have you ever noticed/seen/heard of trapping and poaching of these animals?

19) If yes, what kind?

Attitude Towards Conservation

20) Attitudes towards wildlife/small carnivore conservation

SL NO:	Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
i	Wildlife conservation is something that is urgently required now					
ii	People who harm wildlife should be punished					
iii	We prepare to live in harmony with wildlife					
iv	Without conserving wildlife there is no existence for human beings					
v	People who use natural resources in protected areas should be stopped from continuing with that					
vi	It would not matter if small carnivores were lost from the ecosystem					
vii	Wildlife can be sustained by confining them to protected areas					
viii	It is not the forest based communities, but the urban interests that cause widespread destructions of wildlife					
ix	Human needs should come first and only then, that of wildlife					
x	All this hue and cry for conserving wildlife is too much					

21) Do you feel that any compensation from government is required to address if human-small carnivore conflict occurs?

Very much needed/ needed/ not needed

Appendix IV

Details of camera trap records of small carnivores during present study

Date	Time	Species	No of individual	Forest type	Latitude (N)	Longitude (E)	Altitude (m)
14/06/19	18.16	Asian Small-clawed Otter	3	Evergreen	11.540879	75.941332	805
16/06/19	12.01	Asian Small-clawed Otter	1	Evergreen	11.540879	75.941332	805
17/06/19	10.12	Asian Small-clawed Otter	1	Evergreen	11.540879	75.941332	805
20/06/19	19.4	Asian Small-clawed Otter	3	Evergreen	11.540879	75.941332	805
27/06/19	8.21	Asian Small-clawed Otter	2	Evergreen	11.540879	75.941332	805

Date	Time	Species	No of individual	Forest type	Longitude (E)	Latitude (N)	Altitude (m)
05/01/19	23.11	Brown Mongoose	1	Evergreen	76.63409	10.45774	832
06/01/19	18.37	Brown Mongoose	1	Evergreen	76.63409	10.45774	832
09/01/19	21.28	Brown Mongoose	1	Evergreen	76.63409	10.45774	832
09/01/19	22.48	Brown Mongoose	1	Evergreen	76.63409	10.45774	832
20/01/19	23.45	Brown Mongoose	1	Evergreen	76.63409	10.45774	832

26/01/19	22.26	Brown Mongoose	1	Evergreen	76.63409	10.45774	832
03/01/19	0.35	Brown Mongoose	1	Evergreen	76.62732	10.44839	900
03/01/19	23.49	Brown Mongoose	1	Evergreen	76.62732	10.44839	900
05/01/19	0.38	Brown Mongoose	1	Evergreen	76.62732	10.44839	900
05/01/19	6.47	Brown Mongoose	1	Evergreen	76.62732	10.44839	900
05/01/19	1.39	Brown Mongoose	1	Evergreen	76.63186	10.44966	901
07/01/19	6.29	Brown Mongoose	1	Evergreen	76.63186	10.44966	901
07/01/19	23..48	Brown Mongoose	1	Evergreen	76.63186	10.44966	901
18/01/19	19.17	Brown Mongoose	1	Evergreen	76.63186	10.44966	901
23/01/19	6.43	Brown Mongoose	1	Evergreen	76.63186	10.44966	901
25/01/19	20.29	Brown Mongoose	1	Evergreen	76.63186	10.44966	901
05/01/19	19.15	Brown Mongoose	1	Evergreen	76.63424	10.44098	930
13/01/19	3.23	Brown Mongoose	1	Evergreen	76.63424	10.44098	930
17/01/19	21.22	Brown Mongoose	1	Evergreen	76.63424	10.44098	930
17/01/19	21.27	Brown Mongoose	1	Evergreen	76.63424	10.44098	930
05/01/19	4.49	Brown Mongoose	1	Evergreen	76.64374	10.49299	1115
12/01/19	23.45	Brown Mongoose	1	Evergreen	76.64374	10.49299	1116
18/01/19	0.27	Brown Mongoose	1	Evergreen	76.64374	10.49299	1115
18/01/19	23.48	Brown Mongoose	1	Evergreen	76.65538	10.4869	1116

13/01/19	9.15	Brown Mongoose	1	Evergreen	76.653362	10.4707522	1041
13/01/19	19.26	Brown Mongoose	1	Evergreen	76.63333	10.49024	1041
18/06/19	7	Brown Mongoose	1	Evergreen	75.93907	11.544722	805
18/06/19	8.28	Brown Mongoose	1	Evergreen	75.93907	11.544722	805
18/06/19	18.39	Brown Mongoose	1	Evergreen	75.93907	11.544722	805
14/06/19	15.51	Brown Mongoose	1	Evergreen	75.947694	11.538763	855
02/05/19	10.19	Brown Mongoose	1	Moist Deciduous	75.796096	11.925136	90
02/05/19	10.19	Brown Mongoose	1	Moist Deciduous	75.800799	11.927756	86
04/03/19	17.43	Brown Mongoose	1	Grassland-Shola	77.087475	10.228259	1940
16/03/19	15.56	Brown Mongoose	1	Grassland-Shola	77.087475	10.228259	1940
06/03/19	8.36	Brown Mongoose	1	Grassland-Shola	77.085895	10.230413	2017
14/04/19	15.13	Brown Mongoose	1	Grassland-Shola	77.091336	10.218993	1877

Date	**Time**	**Species**	**No of individual**	**Forest type**	**Longitude (E)**	**Latitude (N)**	**Altitude (m)**
03/01/19	19.39	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
04/01/19	3.46	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
04/01/19	4.54	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832

04/01/19	19.02	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
04/01/19	22.12	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
05/01/19	19.29	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
06/01/19	1.1	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
06/01/19	1.11	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
10/01/19	23.04	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
11/01/19	0.54	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
11/01/19	21.51	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
11/01/19	22.3	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
13/01/19	19.08	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
14/01/19	21.24	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
17/01/19	3.37	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
19/01/19	22.39	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
20/01/19	19.46	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832

21/01/19	18.55	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
21/01/19	19	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
21/01/19	19.03	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
23/01/19	0.05	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
24/01/19	21.02	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
25/01/19	19.05	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
29/01/19	0.54	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
29/01/19	2.3	Brown Palm Civet	1	Evergreen	76.63409	10.45774	832
03/01/19	20.11	Brown Palm Civet	1	Evergreen	76.62503	10.45707	78
06/01/19	16.12	Brown Palm Civet	1	Evergreen	76.62503	10.45707	78
08/01/19	19.19	Brown Palm Civet	1	Evergreen	76.62503	10.45707	78
10/01/19	18.59	Brown Palm Civet	1	Evergreen	76.62503	10.45707	78
14/01/19	16.17	Brown Palm Civet	1	Evergreen	76.62503	10.45707	78
15/01/19	16.37	Brown Palm Civet	1	Evergreen	76.62503	10.45707	78

03/01/19	2.33	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
03/01/19	4.2	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
03/01/19	4.35	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
03/01/19	20.2	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
05/01/19	9.02	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
05/01/19	23.43	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
06/01/19	1.4	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
08/01/19	2.13	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
08/01/19	19	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
09/01/19	20.33	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
10/01/19	3.4	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
10/01/19	22.5	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
12/01/19	2.37	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
13/01/19	18.5	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900

18/01/19	18.54	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
19/01/19	22.54	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
19/01/19	22.57	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
21/01/19	4.58	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
21/01/19	4.58	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
21/01/19	18.38	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
23/01/19	0.29	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
25/01/19	5.31	Brown Palm Civet	1	Evergreen	76.62732	10.44839	900
15/01/19	22.02	Brown Palm Civet	1	Evergreen	76.63186	10.44966	901
21/01/19	19.42	Brown Palm Civet	1	Evergreen	76.63186	10.44966	901
23/01/19	1.13	Brown Palm Civet	1	Evergreen	76.63186	10.44966	901
28/01/19	3.33	Brown Palm Civet	1	Evergreen	76.63186	10.44966	901
03/01/19	3.3	Brown Palm Civet	1	Evergreen	76.63424	10.44098	930
05/01/19	22.01	Brown Palm Civet	1	Evergreen	76.63424	10.44098	930

13/01/19	3.15	Brown Palm Civet	1	Evergreen	76.63424	10.44098	930
21/01/19	19.12	Brown Palm Civet	1	Evergreen	76.63424	10.44098	930
25/01/19	20.57	Brown Palm Civet	1	Evergreen	76.63424	10.44098	930
08/01/19	20.54	Brown Palm Civet	1	Evergreen	76.69591	10.48174	1058
18/01/19	21.34	Brown Palm Civet	1	Evergreen	76.69591	10.48174	1058
20/01/19	4.27	Brown Palm Civet	1	Evergreen	76.69591	10.48174	1058
09/01/19	20.05	Brown Palm Civet	1	Evergreen	76.6957	10.45626	1069
09/01/19	4.39	Brown Palm Civet	1	Evergreen	76.655561	10.474089	999
14/01/19	4.37	Brown Palm Civet	1	Evergreen	76.655561	10.474089	999
26/01/19	19.57	Brown Palm Civet	1	Evergreen	76.655561	10.474089	999
11/01/19	19.59	Brown Palm Civet	1	Evergreen	76.64374	10.49299	1115
03/01/19	18.22	Brown Palm Civet	1	Evergreen	76.64374	10.49299	1115
06/01/19	20.15	Brown Palm Civet	1	Evergreen	76.64374	10.49299	1115
12/01/19	0.51	Brown Palm Civet	1	Evergreen	76.64374	10.49299	1115

24/01/19	21.15	Brown Palm Civet	1	Evergreen	76.64374	10.49299	1115
06/01/19	3.35	Brown Palm Civet	1	Evergreen	76.653362	10.4707522	1041
06/01/19	20.33	Brown Palm Civet	1	Evergreen	76.653362	10.4707522	1041
21/01/19	19.34	Brown Palm Civet	1	Evergreen	76.63333	10.49024	1044
11/01/19	4.54	Brown Palm Civet	1	Evergreen	76.668274	10.524491	960
13/01/19	20.34	Brown Palm Civet	1	Evergreen	76.668274	10.524491	960
08/01/19	4.48	Brown Palm Civet	1	Evergreen	76.665131	10.52119	977
12/01/19	5.07	Brown Palm Civet	1	Evergreen	76.665131	10.52119	977
15/01/19	23.06	Brown Palm Civet	1	Evergreen	76.665131	10.52119	977
16/01/19	1.12	Brown Palm Civet	1	Evergreen	76.665131	10.52119	977
17/01/19	0.19	Brown Palm Civet	1	Evergreen	76.665131	10.52119	977
19/01/19	22.36	Brown Palm Civet	1	Evergreen	76.665131	10.52119	977
21/01/19	18.56	Brown Palm Civet	1	Evergreen	76.665131	10.52119	977
27/11/18	23.27	Brown Palm Civet	1	Moist Deciduous	76.472044	10.4228	110

12/11/18	4.07	Brown Palm Civet	1	Moist Deciduous	76.475777	10.42418	97
14/11/18	2.52	Brown Palm Civet	1	Moist Deciduous	76.475777	10.42418	97
20/02/19	3.2	Brown Palm Civet	1	Grassland-Shola	77.087475	10.228259	1940
11/03/19	23.4	Brown Palm Civet	1	Grassland-Shola	77.085895	10.230413	2017
13/04/19	2.48	Brown Palm Civet	1	Grassland-Shola	77.091336	10.218993	1877
17/04/19	20.04	Brown Palm Civet	1	Grassland-Shola	77.091336	10.218993	1877
18/06/19	3.06	Brown Palm Civet	1	Grassland	75.940236	11.499233	885
06/06/19	19.09	Brown Palm Civet	1	Evergreen	75.93907	11.544722	805
17/06/19	0.04	Brown Palm Civet	1	Evergreen	75.93907	11.544722	805
18/06/19	3.06	Brown Palm Civet	1	Evergreen	75.94126	11.538937	781
01/06/19	23.08	Brown Palm Civet	1	Evergreen	75.94504	11.540098	816
27/06/19	22.11	Brown Palm Civet	1	Evergreen	75.958897	11.52446	804

Date	Time	Species	No of individual	Forest type	Latitude (N)	Longitude (E)	Altitude (m)
28/03/19	18.3	Grey Mongoose	1	Dry Deciduous	10.341587	77.226513	437
24/03/19	9.4	Grey Mongoose	1	Dry Deciduous	10.336457	77.221877	447

Date	Time	Species	No of individual	Forest type	Latitude (N)	Longitude (E)	Altitude (m)
19/02/19	18.53	Jungle Cat	1	Grassland-Shola	77.060364	10.224232	2243
20/02/19	19.29	Jungle Cat	1	Grassland-Shola	77.060364	10.224232	2243
23/02/19	22.16	Jungle Cat	1	Grassland-Shola	77.083714	10.225622	2073
26/02/19	2.37	Jungle Cat	1	Grassland-Shola	77.083714	10.225622	2073
04/03/19	21.3	Jungle Cat	1	Grassland-Shola	77.083714	10.225622	2073
05/03/19	1.31	Jungle Cat	1	Grassland-Shola	77.083714	10.225622	2073
13/03/19	22.06	Jungle Cat	1	Grassland-Shola	77.083714	10.225622	2073
26/02/19	21.43	Jungle Cat	1	Grassland-Shola	77.08786	10.220196	1964
20/02/19	2.44	Jungle Cat	1	Grassland-Shola	77.088836	10.224481	1887
27/02/19	2.14	Jungle Cat	1	Grassland-Shola	77.087475	10.228259	1940
01/04/19	6.29	Jungle Cat	1	Grassland-Shola	77.096038	10.212102	1922
19/04/19	2.28	Jungle Cat	1	Grassland-Shola	77.096038	10.212102	1922

20/03/19	17.5	Jungle Cat	1	Grassland-Shola	77.098579	10.206632	1915
29/03/19	19.2	Jungle Cat	1	Grassland-Shola	77.093587	10.215195	1870
31/03/19	17.39	Jungle Cat	1	Grassland-Shola	77.093587	10.215195	1870
04/04/19	4.01	Jungle Cat	1	Grassland-Shola	77.093587	10.215195	1870
11/04/19	8.1	Jungle Cat	1	Grassland-Shola	77.093587	10.215195	1870
16/04/19	0.29	Jungle Cat	1	Grassland-Shola	77.093587	10.215195	1870
19/04/19	1.38	Jungle Cat	1	Grassland-Shola	77.093587	10.215195	1870
22/03/19	20.12	Jungle Cat	1	Grassland-Shola	77.091336	10.218993	1877
23/03/19	23.3	Jungle Cat	1	Grassland-Shola	77.091336	10.218993	1877
04/04/19	0.35	Jungle Cat	1	Grassland-Shola	77.091336	10.218993	1877
09/04/19	20.24	Jungle Cat	1	Grassland-Shola	77.091336	10.218993	1877
19/04/19	2.52	Jungle Cat	1	Grassland-Shola	77.091336	10.218993	1877
13/04/19	8.16	Jungle Cat	1	Grassland-Shola	77.088017	10.238098	1988
04/04/19	15.26	Jungle Cat	1	Grassland-Shola	77.092342	10.240852	2085
05/04/19	14.49	Jungle Cat	1	Grassland-Shola	77.092342	10.240852	2085
10/04/19	15.37	Jungle Cat	1	Grassland-Shola	77.092342	10.240852	2085
10/04/19	15.39	Jungle Cat	1	Grassland-Shola	77.092342	10.240852	2085
17/04/19	18.31	Jungle Cat	1	Grassland-Shola	77.092342	10.240852	2085
20/03/19	19.12	Jungle Cat	1	Grassland-Shola	77.097625	10.248483	2211

24/03/19	21.24	Jungle Cat	1	Grassland-Shola	77.097625	10.248483	2211
17/04/19	18.39	Jungle Cat	1	Grassland-Shola	77.097625	10.248483	2211
19/04/19	1.18	Jungle Cat	1	Grassland-Shola	77.097625	10.248483	2211

Date	**Time**	**Species**	**No of individual**	**Forest type**	**Longitude (E)**	**Latitude (N)**	**Altitude (m)**
07/01/19	1.29	Leopard Cat	1	Evergreen	76.63409	10.45774	832
07/01/19	1.01	Leopard Cat	1	Evergreen	76.63186	10.44966	901
11/01/19	20.54	Leopard Cat	1	Evergreen	76.69353	10.47403	1028
13/12/18	19.38	Leopard Cat	1	Dry Deciduous	76.81623	10.83421	451
13/12/18	23.22	Leopard Cat	1	Dry Deciduous	76.81623	10.83421	451
16/04/19	1.18	Leopard Cat	1	Grassland-Shola	77.093587	10.215195	1870
28/03/19	2.49	Leopard Cat	1	Grassland-Shola	77.091336	10.218993	1877
01/04/19	22.41	Leopard Cat	1	Grassland-Shola	77.091336	10.218993	1877
03/04/19	23.54	Leopard Cat	1	Grassland-Shola	77.091336	10.218993	1877
08/04/19	3.42	Leopard Cat	1	Grassland-Shola	77.091336	10.218993	1877
10/04/19	22.28	Leopard Cat	1	Grassland-Shola	77.091336	10.218993	1877

16/04/19	5.05	Leopard Cat	1	Grassland-Shola	77.091336	10.218993	1877
05/04/19	5.37	Leopard Cat	1	Grassland-Shola	77.088017	10.238098	1988
05/04/19	5.38	Leopard Cat	1	Grassland-Shola	77.088017	10.238098	1988
05/04/19	5.38	Leopard Cat	1	Grassland-Shola	77.088017	10.238098	1988

Date	Time	Species	No of individual	Forest type	Longitude (E)	Latitude (N)	Altitude (m)
11/01/19	7.26	Nilgiri Marten	1	Evergreen	76.63424	10.44098	930
13/01/19	15.47	Nilgiri Marten	1	Evergreen	76.63424	10.44098	930
17/01/19	7.41	Nilgiri Marten	1	Evergreen	76.63424	10.44098	930
08/01/19	14.58	Nilgiri Marten	1	Evergreen	76.668274	10.524491	960
08/01/19	14.58	Nilgiri Marten	1	Evergreen	76.668274	10.524491	960
07/03/19	8.09	Nilgiri Marten	1	Grassland-Shola	77.085895	10.230413	2017
07/03/19	8.16	Nilgiri Marten	1	Grassland-Shola	77.085895	10.230413	2017
06/04/19	9.27	Nilgiri Marten	1	Grassland-Shola	77.085553	10.233638	2003
01/04/19	10.45	Nilgiri Marten	1	Grassland-Shola	77.093587	10.215195	1870
19/04/19	5.33	Nilgiri Marten	2	Grassland-Shola	77.093587	10.215195	1870
29/03/19	6.23	Nilgiri Marten	1	Grassland-Shola	77.091336	10.218993	1877
14/04/19	7	Nilgiri Marten	1	Grassland-Shola	77.091336	10.218993	1877

Date	Time	Species	No of individual	Forest type	Latitude (N)	Longitude (E)	Altitude (m)
20/03/19	10.35	Ruddy Mongoose	2	Dry Deciduous	10.336457	77.221877	447
12/05/19	16.03	Ruddy mongoose	1	Moist Deciduous	11.931745	75.83232	140
26/05/19	8.42	Ruddy mongoose	1	Moist Deciduous	11.934319	75.84342	124
10/05/19	9.55	Ruddy mongoose	1	Moist Deciduous	11.9362	75.844124	116
10/05/19	9.58	Ruddy mongoose	1	Moist Deciduous	11.9362	75.844124	116
05/05/19	8	Ruddy mongoose	1	Moist Deciduous	11.936619	75.849465	126
10/05/19	8.39	Ruddy mongoose	1	Moist Deciduous	11.936619	75.849465	126
21/05/19	10.08	Ruddy mongoose	1	Moist Deciduous	11.939965	75.80521	136
28/12/18	15.35	Ruddy Mongoose	1	Dry Deciduous	76.818146	10.844967	281
16/12/18	6.29	Ruddy Mongoose	2	Dry Deciduous	76.811735	10.842446	233
14/12/18	7.3	Ruddy Mongoose	1	Dry Deciduous	76.807756	10.843329	211
31/12/18	14.18	Ruddy Mongoose	1	Dry Deciduous	76.807756	10.843329	211
04/01/19	11.11	Ruddy Mongoose	1	Dry Deciduous	76.807756	10.843329	211
06/01/19	18.24	Ruddy Mongoose	1	Dry Deciduous	76.807756	10.843329	211

Date	Time	Species	No of individual	Forest type	Longitude (E)	Latitude (N)	Altitude (m)
08/12/19	21.23	Rusty-spotted Cat	1	Dry Deciduous	76.80989	10.8556	516

Date	Time	Species	No of individual	Forest type	Longitude (E)	Latitude (N)	Altitude (m)
04/01/19	20.17	Small Indian Civet	1	Evergreen	76.63409	10.45774	832
08/01/19	22.09	Small Indian Civet	1	Evergreen	76.63409	10.45774	832
11/01/19	23	Small Indian Civet	1	Evergreen	76.63409	10.45774	832
25/01/19	22.44	Small Indian Civet	1	Evergreen	76.63409	10.45774	832
04/01/19	19.32	Small Indian Civet	1	Evergreen	76.62732	10.44839	900
07/01/19	22.41	Small Indian Civet	1	Evergreen	76.62732	10.44839	900
18/01/19	3.35	Small Indian Civet	1	Evergreen	76.63186	10.44966	901
04/01/19	19.09	Small Indian Civet	1	Evergreen	76.63424	10.44098	930
04/01/19	21.07	Small Indian Civet	1	Evergreen	76.63424	10.44098	930
15/01/19	19.43	Small Indian Civet	1	Evergreen	76.63424	10.44098	930
16/01/19	0.59	Small Indian Civet	1	Evergreen	76.63424	10.44098	930
18/01/19	1.11	Small Indian Civet	1	Evergreen	76.63424	10.44098	930
10/01/19	22.3	Small Indian Civet	1	Evergreen	76.69353	10.47403	1028

18/01/19	0.31	Small Indian Civet	1	Evergreen	76.69353	10.47403	1028
09/01/19	19.33	Small Indian Civet	1	Evergreen	76.69591	10.48174	1058
13/01/19	20.13	Small Indian Civet	1	Evergreen	76.69591	10.48174	1058
25/01/19	3.52	Small Indian Civet	1	Evergreen	76.69591	10.48174	1058
05/01/19	21.21	Small Indian Civet	1	Evergreen	76.69448	10.46296	1098
05/01/19	21.22	Small Indian Civet	1	Evergreen	76.69448	10.46296	1098
08/01/19	3.36	Small Indian Civet	1	Evergreen	76.69448	10.46296	1098
09/01/19	0.31	Small Indian Civet	1	Evergreen	76.69448	10.46296	1098
07/01/19	20.3	Small Indian Civet	1	Evergreen	76.6957	10.45626	1069
11/01/19	5.18	Small Indian Civet	1	Evergreen	76.6957	10.45626	1069
18/01/19	20.15	Small Indian Civet	1	Evergreen	76.6957	10.45626	1069
27/01/19	5.19	Small Indian Civet	1	Evergreen	76.6957	10.45626	1069
12/03/19	0.02	Small Indian Civet	1	Dry Deciduous	77.221877	10.336457	447
07/03/19	2.28	Small Indian Civet	1	Dry Deciduous	77.225484	10.328855	445
08/03/19	2.53	Small Indian Civet	1	Dry Deciduous	77.225484	10.328855	445
29/03/19	4.34	Small Indian Civet	1	Dry Deciduous	77.227827	10.550767	444
15/05/19	21.48	Small Indian Civet	1	Moist Deciduous	75.814529	11.936875	100
02/05/19	20.02	Small Indian Civet	1	Moist Deciduous	75.827576	11.930618	146
12/05/19	3.45	Small Indian Civet	1	Moist Deciduous	75.851037	11.931554	160

08/05/19	4.43	Small Indian Civet	1	Moist Deciduous	75.80521	11.939965	136
06/12/18	23.51	Small Indian Civet	1	Dry Deciduous	76.808147	10.875418	317
04/12/18	20.51	Small Indian Civet	1	Dry Deciduous	76.8016	10.87652	446
22/12/18	2	Small Indian Civet	1	Dry Deciduous	76.82099	10.85375	512
05/12/18	22.55	Small Indian Civet	1	Dry Deciduous	76.82078	10.84587	304
17/12/18	23.21	Small Indian Civet	1	Dry Deciduous	76.816786	10.846945	288
08/12/18	21.41	Small Indian Civet	1	Dry Deciduous	76.799462	10.861104	278
08/12/18	21.45	Small Indian Civet	1	Dry Deciduous	76.799462	10.861104	278
17/12/18	20.48	Small Indian Civet	1	Dry Deciduous	76.799462	10.861104	278
19/12/18	3.31	Small Indian Civet	1	Dry Deciduous	76.799462	10.861104	278
21/12/18	2.49	Small Indian Civet	1	Dry Deciduous	76.799462	10.861104	278
05/12/18	21.36	Small Indian Civet	1	Dry Deciduous	76.81435	10.83721	450
06/12/18	4.3	Small Indian Civet	1	Dry Deciduous	76.81435	10.83721	450
27/12/18	23.03	Small Indian Civet	1	Dry Deciduous	76.81435	10.83721	450
10/12/18	3.14	Small Indian Civet	1	Dry Deciduous	76.81623	10.83421	451
30/12/18	20.24	Small Indian Civet	1	Dry Deciduous	76.81623	10.83421	451
02/01/19	23.04	Small Indian Civet	1	Dry Deciduous	76.82036	10.83548	570
03/01/19	4.11	Small Indian Civet	1	Dry Deciduous	76.82036	10.83548	570
05/01/19	1.59	Small Indian Civet	1	Dry Deciduous	76.82036	10.83548	570

02/11/18	3.04	Small Indian Civet	1	Moist Deciduous	76.405702	10.516827	63
31/10/18	20.26	Small Indian Civet	1	Moist Deciduous	76.393001	10.506001	86
01/11/18	22.16	Small Indian Civet	1	Moist Deciduous	76.393001	10.506001	86
11/11/18	17.52	Small Indian Civet	1	Moist Deciduous	76.393001	10.506001	86
31/10/18	22.45	Small Indian Civet	1	Moist Deciduous	76.378008	10.526042	86
01/11/18	19.04	Small Indian Civet	1	Moist Deciduous	76.378008	10.526042	86
02/11/18	22.26	Small Indian Civet	1	Moist Deciduous	76.378008	10.526042	86
04/11/18	0.08	Small Indian Civet	1	Moist Deciduous	76.378008	10.526042	86
12/11/18	18.11	Small Indian Civet	1	Moist Deciduous	76.463688	10.42404	125
19/11/18	1.25	Small Indian Civet	1	Moist Deciduous	76.463688	10.42404	125
20/11/18	4.3	Small Indian Civet	1	Moist Deciduous	76.463688	10.42404	125
20/11/18	4.49	Small Indian Civet	1	Moist Deciduous	76.463688	10.42404	125
20/11/18	5.36	Small Indian Civet	1	Moist Deciduous	76.463688	10.42404	125
27/11/18	19.01	Small Indian Civet	1	Moist Deciduous	76.463688	10.42404	125
21/11/18	20.28	Small Indian Civet	1	Moist Deciduous	76.472044	10.4228	110
24/11/18	21.21	Small Indian Civet	1	Moist Deciduous	76.472044	10.4228	110
17/11/18	20.21	Small Indian Civet	1	Moist Deciduous	76.475777	10.42418	97
26/11/18	19.2	Small Indian Civet	1	Moist Deciduous	76.475777	10.42418	97
08/11/18	18.31	Small Indian Civet	1	Moist Deciduous	76.489453	10.45628	89

06/11/18	20.08	Small Indian Civet	1	Moist Deciduous	76.497941	10.454652	82
19/11/18	0.28	Small Indian Civet	1	Moist Deciduous	76.497941	10.454652	82
21/11/18	23.58	Small Indian Civet	1	Moist Deciduous	76.512685	10.436102	87
25/11/18	18.26	Small Indian Civet	1	Moist Deciduous	76.512685	10.436102	87
16/03/19	0.29	Small Indian Civet	1	Grassland-Shola	77.085895	10.230413	2017
16/03/19	0.32	Small Indian Civet	1	Grassland-Shola	77.085895	10.230413	2017
29/06/19	1.39	Small Indian Civet	1	Grassland	75.9353	11.506642	1007
29/06/19	1.41	Small Indian Civet	1	Grassland	75.9353	11.506642	1007
01/06/19	4.08	Small Indian Civet	1	Grassland	75.940236	11.499233	885
10/06/19	1.16	Small Indian Civet	1	Grassland	75.940236	11.499233	885
15/06/19	1.03	Small Indian Civet	1	Grassland	75.940236	11.499233	885
16/06/19	19.19	Small Indian Civet	1	Grassland	75.940236	11.499233	885
18/06/19	5.05	Small Indian Civet	1	Grassland	75.940236	11.499233	885
21/06/19	3.18	Small Indian Civet	1	Grassland	75.940236	11.499233	885
29/06/19	21.25	Small Indian Civet	1	Grassland	75.940236	11.499233	885
01/07/19	21.27	Small Indian Civet	1	Grassland	75.940236	11.499233	885

Date	Time	Species	No of individual	Forest type	Latitude (N)	Longitude (E)	Altitude (m)
01/11/18	15.08	Smooth-coated Otter	1	Moist Deciduous	10.526042	76.378008	86

Date	Time	Species	No of individual	Forest type	Longitude (E)	Latitude (N)	Altitude (m)
06/01/19	14.55	Stripe-necked Mongoose	1	Evergreen	76.63409	10.45774	832
06/01/19	16.15	Stripe-necked Mongoose	1	Evergreen	76.63409	10.45774	832
06/01/19	16.16	Stripe-necked Mongoose	1	Evergreen	76.63409	10.45774	832
09/01/19	18.2	Stripe-necked Mongoose	2	Evergreen	76.63409	10.45774	832
13/01/19	15.42	Stripe-necked Mongoose	2	Evergreen	76.63409	10.45774	832
23/01/19	15.43	Stripe-necked Mongoose	1	Evergreen	76.63409	10.45774	832
04/01/19	17.11	Stripe-necked Mongoose	2	Evergreen	76.62732	10.44839	900
05/01/19	7.47	Stripe-necked Mongoose	1	Evergreen	76.62732	10.44839	900
13/01/19	16.21	Stripe-necked Mongoose	1	Evergreen	76.62732	10.44839	900
14/01/19	6.58	Stripe-necked Mongoose	1	Evergreen	76.62732	10.44839	900
14/01/19	7.01	Stripe-necked Mongoose	2	Evergreen	76.62732	10.44839	900
14/01/19	7.26	Stripe-necked Mongoose	2	Evergreen	76.62732	10.44839	900
18/01/19	15.03	Stripe-necked Mongoose	2	Evergreen	76.62732	10.44839	900
21/01/19	8.45	Stripe-necked Mongoose	1	Evergreen	76.62732	10.44839	900

23/01/19	8.18	Stripe-necked Mongoose	2	Evergreen	76.62732	10.44839	900
23/01/19	17.18	Stripe-necked Mongoose	1	Evergreen	76.62732	10.44839	900
25/01/19	6.44	Stripe-necked Mongoose	1	Evergreen	76.62732	10.44839	900
25/01/19	6.48	Stripe-necked Mongoose	1	Evergreen	76.62732	10.44839	900
03/01/19	11.18	Stripe-necked Mongoose	1	Evergreen	76.63186	10.44966	901
06/01/19	8.54	Stripe-necked Mongoose	1	Evergreen	76.63186	10.44966	901
10/01/19	7.57	Stripe-necked Mongoose	2	Evergreen	76.63186	10.44966	901
16/01/19	6.41	Stripe-necked Mongoose	1	Evergreen	76.63186	10.44966	901
16/01/19	16.3	Stripe-necked Mongoose	1	Evergreen	76.63186	10.44966	901
19/01/19	8.55	Stripe-necked Mongoose	1	Evergreen	76.63186	10.44966	901
21/01/19	14.58	Stripe-necked Mongoose	1	Evergreen	76.63186	10.44966	901
24/01/19	8.3	Stripe-necked Mongoose	2	Evergreen	76.63186	10.44966	901
25/01/19	7.55	Stripe-necked Mongoose	1	Evergreen	76.63186	10.44966	901
18/01/19	14.48	Stripe-necked Mongoose	1	Evergreen	76.63424	10.44098	930
19/01/19	10.04	Stripe-necked Mongoose	1	Evergreen	76.63424	10.44098	930
19/01/19	10.04	Stripe-necked Mongoose	2	Evergreen	76.63424	10.44098	930
19/01/19	10.06	Stripe-necked Mongoose	1	Evergreen	76.63424	10.44098	930
04/01/19	13.19	Stripe-necked Mongoose	1	Evergreen	76.64318	10.43976	969
07/01/19	8.39	Stripe-necked Mongoose	1	Evergreen	76.6957	10.45626	1069

13/01/19	8.09	Stripe-necked Mongoose	1	Evergreen	76.6957	10.45626	1069
22/01/19	10.43	Stripe-necked Mongoose	1	Evergreen	76.6957	10.45626	1069
12/01/19	18.12	Stripe-necked Mongoose	1	Evergreen	76.655561	10.474089	999
04/01/19	16.47	Stripe-necked Mongoose	1	Evergreen	76.64374	10.49299	1115
10/01/19	16.19	Stripe-necked Mongoose	2	Evergreen	76.64374	10.49299	1115
08/01/19	7	Stripe-necked Mongoose	1	Evergreen	76.64374	10.49299	1115
08/01/19	9.32	Stripe-necked Mongoose	1	Evergreen	76.65343	10.47581	1112
24/01/19	8.23	Stripe-necked Mongoose	1	Evergreen	76.65343	10.47581	1112
05/05/19	8.35	Stripe-necked Mongoose	1	Moist deciduous	75.827576	11.930618	146
11/12/18	7.4	Stripe-necked Mongoose	2	Dry Deciduous	76.8016	10.87652	446
12/12/18	16.06	Stripe-necked Mongoose	1	Dry Deciduous	76.8016	10.87652	446
13/12/18	17.37	Stripe-necked Mongoose	1	Dry Deciduous	76.8016	10.87652	446
14/12/18	7.04	Stripe-necked Mongoose	1	Dry Deciduous	76.8016	10.87652	446
14/12/18	7.15	Stripe-necked Mongoose	1	Dry Deciduous	76.8016	10.87652	446
15/12/18	8.02	Stripe-necked Mongoose	1	Dry Deciduous	76.8016	10.87652	446
10/12/18	18.03	Stripe-necked Mongoose	1	Dry Deciduous	76.799462	10.861104	278
10/12/18	18.03	Stripe-necked Mongoose	1	Dry Deciduous	76.799462	10.861104	278
22/12/18	5.07	Stripe-necked Mongoose	1	Dry Deciduous	76.799462	10.861104	278
22/12/18	5.15	Stripe-necked Mongoose	1	Dry Deciduous	76.799462	10.861104	278

23/12/18	7.3	Stripe-necked Mongoose	1	Dry Deciduous	76.799462	10.861104	278
24/12/18	9.22	Stripe-necked Mongoose	1	Dry Deciduous	76.799462	10.861104	278
30/12/18	7.1	Stripe-necked Mongoose	1	Dry Deciduous	76.799462	10.861104	278
04/01/19	6.33	Stripe-necked Mongoose	1	Dry Deciduous	76.799462	10.861104	278
04/01/19	8.4	Stripe-necked Mongoose	1	Dry Deciduous	76.799462	10.861104	278
18/12/18	10.09	Stripe-necked Mongoose	2	Dry Deciduous	76.801915	10.86136	359
18/12/18	10.12	Stripe-necked Mongoose	1	Dry Deciduous	76.801915	10.86136	359
07/12/18	11.2	Stripe-necked Mongoose	1	Dry Deciduous	76.81143	10.83892	380
28/12/18	14.24	Stripe-necked Mongoose	1	Dry Deciduous	76.81143	10.83892	380
14/12/18	16.34	Stripe-necked Mongoose	1	Dry Deciduous	76.81623	10.83421	451
18/12/18	7.56	Stripe-necked Mongoose	1	Dry Deciduous	76.82036	10.83548	432
03/01/19	11.33	Stripe-necked Mongoose	1	Dry Deciduous	76.82036	10.83548	432
05/01/19	8.11	Stripe-necked Mongoose	2	Dry Deciduous	76.82036	10.83548	432
06/12/18	15.1	Stripe-necked Mongoose	1	Dry Deciduous	76.82036	10.83548	570
10/12/18	14.5	Stripe-necked Mongoose	1	Dry Deciduous	76.82036	10.83548	570
23/12/18	8.33	Stripe-necked Mongoose	1	Dry Deciduous	76.82036	10.83548	570
29/12/18	16.01	Stripe-necked Mongoose	1	Dry Deciduous	76.82036	10.83548	570
05/11/18	7.31	Stripe-necked Mongoose	2	Moist Deciduous	76.463688	10.42404	125
26/11/18	14.51	Stripe-necked Mongoose	1	Moist Deciduous	76.463688	10.42404	125

05/11/18	15.45	Stripe-necked Mongoose	1	Moist Deciduous	76.466887	10.423512	100
16/11/18	10.59	Stripe-necked Mongoose	1	Moist Deciduous	76.491829	10.454758	75
20/11/18	7.56	Stripe-necked Mongoose	1	Moist Deciduous	76.489453	10.45628	89
17/02/19	15.01	Stripe-necked Mongoose	1	Grassland-Shola	77.068192	10.217441	2208
13/03/19	18.31	Stripe-necked Mongoose	1	Grassland-Shola	77.08786	10.220196	1964
01/03/19	12.04	Stripe-necked Mongoose	2	Grassland-Shola	77.088836	10.224481	1887
14/03/19	11.12	Stripe-necked Mongoose	2	Grassland-Shola	77.088836	10.224481	1887
21/02/19	10.07	Stripe-necked Mongoose	1	Grassland-Shola	77.087475	10.228259	1940
02/03/19	12.5	Stripe-necked Mongoose	1	Grassland-Shola	77.087475	10.228259	1940
02/03/19	13.35	Stripe-necked Mongoose	1	Grassland-Shola	77.087475	10.228259	1940
02/03/19	13.37	Stripe-necked Mongoose	1	Grassland-Shola	77.087475	10.228259	1940
09/03/19	8.32	Stripe-necked Mongoose	1	Grassland-Shola	77.087475	10.228259	1940
05/03/19	18.26	Stripe-necked Mongoose	1	Grassland-Shola	77.085895	10.230413	2017
11/04/19	10.21	Stripe-necked Mongoose	1	Grassland-Shola	77.085553	10.233638	2003
16/04/19	16.35	Stripe-necked Mongoose	1	Grassland-Shola	77.096038	10.212102	1922
26/03/19	9.16	Stripe-necked Mongoose	1	Grassland-Shola	77.098579	10.206632	1915
23/03/19	14	Stripe-necked Mongoose	1	Grassland-Shola	77.093587	10.215195	1870
12/04/19	10.25	Stripe-necked Mongoose	1	Grassland-Shola	77.093587	10.215195	1870
12/04/19	10.29	Stripe-necked Mongoose	1	Grassland-Shola	77.093587	10.215195	1870

12/04/19	10.3	Stripe-necked Mongoose	1	Grassland-Shola	77.093587	10.215195	1870
13/04/19	15.29	Stripe-necked Mongoose	1	Grassland-Shola	77.093587	10.215195	1870
18/04/19	14.47	Stripe-necked Mongoose	1	Grassland-Shola	77.093587	10.215195	1870
06/04/19	9.23	Stripe-necked Mongoose	1	Grassland-Shola	77.091336	10.218993	1877

APPENDIX V

Micro habitat data of camera trap locations

Cam no.	Latit.	Long.	Habitat	Altitude	WB	Dist WB	Width WB	GBH	Slope	CH	CC	LD	SD	TD	CD	B	C	H	Rock	Fruit	S	R	L	O
1	10.45664	76.63986	EG(S)	906	1	5	30	340	30	25	80	3.2	7	9	0	0	0	0	0	0	0	0	1	1
2	10.45774	76.63409	EG(S)	832	1	0	1	400	30	35	50	2	7	6	0	0	0	1	1	1	0	0	0	0
3	10.45707	76.62503	EG(S)	78	0	0	0	160	45	30	60	2	8	9	0	0	0	0	1	1	0	0	0	0
4	10.45496	76.6193	EG(S)	860	0	0	0	252	20	35	80	5	6	10	0	0	0	0	0	1	0	0	0	1
5	10.44839	76.62732	EG(S)	789	1	3	4	70	45	25	50	2	5	6	0	0	1	0	1	1	0	0	0	0
6	10.44966	76.63186	EG(S)	901	1	0	4	160	45	25	50	1	8	4	0	0	0	0	0	1	0	0	0	0
7	10.44098	76.63424	EG(S)	930	1	0	4	150	45	30	5	1.5	2	10	0	0	0	0	0	1	0	0	0	0
8	10.43976	76.64318	EG(S)	865	0	0	0	250	20	20	50	1	3	7	1	0	1	0	1	0	0	0	1	0
9	10.447951	76.639035	EG(S)	907	0	0	0	210	45	30	70	1	5	8	0	0	0	0	0	0	0	0	0	0
10	10.453732	76.640555	EG(S)	914	1	0	3	130	30	20	30	2	6	5	0	0	0	0	1	0	0	0	1	0
11	10.46841	76.69058	EG(S)	958	1	0	2.5	135	0	21	30	1.5	3	8	0	0	0	0	0	1	0	0	1	0
12	10.47403	76.69353	EG(S)	1028	0	0	0	300	0	40	80	3	8	5	0	0	0	0	0	1	0	0	1	0
13	10.48174	76.69591	EG(S)	1058	0	0	0	100	0	22	50	2	5	4	1	0	1	0	0	0	0	0	0	0
14	10.46296	76.69448	EG(S)	1098	0	0	0	60	0	15	50	3	8	4	0	0	0	0	0	0	0	0	0	0
15	10.45626	76.6957	EG(S)	1069	0	0	0	130	0	30	75	3	3	4	0	1	0	0	0	1	0	0	0	0
16	10.47286	76.65843	EG(S)	1000	0	0	0	100	0	26	75	2.5	9	3	0	0	0	1	0	0	0	0	1	0
17	10.474089	76.655561	EG(S)	999	1	1	1.5	350	0	34	80	4.5	4	8	0	0	0	1	0	1	0	0	1	0
18	10.47799	76.65803	EG(S)	1073	0	0	0	430	30	40	75	3	5	11	0	0	0	0	0	1	0	0	0	0
19	10.48172	76.66058	EG(S)	1091	0	0	0	170	20	36	70	2	4	11	1	0	0	1	0	1	0	0	0	0
20	10.49299	76.64374	EG(S)	1115	0	0	0	140	20	35	70	2.5	1	10	0	0	0	0	0	1	0	0	1	0
21	10.4869	76.65538	EG(S)	1064	1	0	3	120	10	30	70	2	6	8	0	0	0	1	1	1	0	0	0	0
22	10.48077	76.65448	EG(S)	1099	1	2	3	112	45	24	50	2	7	7	0	0	0	0	0	1	0	0	1	0
23	10.477197	76.652898	EG(S)	1104	1	0	4	350	20	34	60	2	6	12	0	0	0	1	1	1	0	0	0	0

24	10.47581	76.65343	EG(S)	1112	1	1	4	230	30	25	30	2	7	6	0	0	0	1	1	0	0	0	1	1
25	10.472083	76.653695	EG(S)	1094	1	0	3	400	20	35	50	2	8	7	0	0	0	1	1	1	0	0	1	1
26	10.4707522	76.653362	EG(S)	949	1	0	3	200	30	25	40	2	7	6	0	0	0	1	1	1	0	0	1	0
27	10.49024	76.63333	EG(S)	1011	1	0	5	190	45	26	80	5	5	8	0	0	1	1	1	1	0	0	1	0
28	10.4808	76.63937	EG(S)	889	1	0	5	250	30	30	60	2	5	11	0	0	0	0	0	1	0	0	1	0
29	10.524491	76.668274	EG(S)	976	0	0	0	230	45	25	60	5	5	6	0	1	0	1	1	0	0	0	1	0
30	10.52119	76.665131	EG(S)	905	0	0	0	150	45	25	60	5	8	6	0	0	0	0	0	1	0	0	0	0

Cam No.	Latitude	Longitude	Altitude	Habitat	CH	CC	LD	SD	TD	CD	B	C	H	WB	Dist WB	Width WB	Rock	Fruit	S	R	L	GBH	Slope	O
1	11.547078	75.9346	801	EG(N)	18	95	5	31	5	0	1	0	0	1	150	200	0	0	0	0	0	84	0	0
2	11.54443	75.934626	746	EG(N)	22	50	1	26	6	28	1	0	1	0	0	0	1	0	0	0	0	211	5	0
3	11.543417	75.936211	762	EG(N)	17	80	2	4	6	0	1		0	1	120	150	0	0	0	0	1	95	5	0
4	11.542736	75.937615	797	EG(N)	23	85	3	0	5	0	1	0	0	1	50	150	1	0	0	1	0	213	5	0
5	11.544722	75.93907	805	EG(N)	18	66	1	0	2	0	1	0	0	1	50	10	0	0	0	0	1	103	5	0
6	11.542093	75.941156	797	EG(N)	15	50	1	50	2	0	2	0	0	1	0	15	1	0	0	0	1	56	5	0
7	11.540352	75.941006	802	EG(N)	13	90	5	16	5	12	0	1	0	1	50	250	0	0	0	0	1	92	5	0
8	11.538937	75.94126	781	EG(N)	15	60	0	0	4	1	1	0	1	1	0	12	1	1	0	1	0	187	5	1
9	11.540908	75.942448	716	EG(N)	0	0	0	0	0	0	0	0	0	1	0	13	0	0	0	0	0	0	0	1
10	11.540098	75.94504	816	EG(N)	22	50	2.1	6	5	0	0	0	0	1	0	10	1	0	0	0	1	132	30	0
11	11.538763	75.947694	836	EG(N)	20	45	1.5	4	10	0	0	0	0	0	0	0	0	1	0	0	1	136	0	0
12	11.537996	75.949025	855	EG(N)	20	30	1.5	4	5	0	0	0	0	0	0	0	0	1	0	0	1	303	0	0
13	11.53711	75.950179	824	EG(N)	22	50	2	6	5	1	0	1	0	0	0	0	0	0	0	0	0	100	0	0
14	11.535825	75.952259	803	EG(N)	16	50	2	9	4	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0
15	11.534853	75.954701	797	EG(N)	29	75	2	4	5	0	1	0	0	0	0	0	0	0	0	0	0	131	0	0
16	11.533304	75.958195	795	EG(N)	16	75	4	60	4	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0
17	11.531669	75.959929	806	EG(N)	25	60	5	8	6	0	0	0	0	1	50	20	0	1	0	0	0	152	45	0
18	11.527813	75.960184	804	EG(N)	25	60	5	6	5	0	1	0	1	1	20	21	0	0	0	0	1	232	45	0

19	11.52446	75.958897	804	EG(N)	30	60	2	5	11	0	0	0	0	1	10	15	1	1	0	0	1	248	30	0
20	11.541535	75.947854	819	EG(N)	26	80	5	5	8	0	0	1	0	1	100	15	1	1	0	0	1	186	45	0
21	11.541659	75.944452	814	EG(N)	25	40	2	7	6	0	0	1	1	1	50	12	1	1	0	0	1	193	30	0
22	11.543112	75.948605	819	EG(N)	32	50	2	8	7	0	0	0	0	0	0	0	1	1	0	0	1	385	20	0
23	11.545566	75.949616	816	EG(N)	25	30	2	7	6	0	0	0	0	0	0	0	1	0	0	0	1	225	45	0
24	11.54367	75.952349	815	EG(N)	24	50	2	7	7	0	0	0	0	0	0	0	1	0	0	0	1	100	10	0
25	11.540879	75.941332	805	EG(N)	15	25	0	0	2	0	0	1	1	1	0	2	1	0	0	0	0	54	0	1

Cam No.	Latitude	Longitude	Altitude	Habitat	CH	CC	LD	SD	TD	CD	B	C	H	WB	Dist. WB	Width WB	Rock	Fruit	S	R	L	GBH	Slope	O
1	10.516827	76.405702	63	MDF(S)	12	75	2	12	1	5	0	0	0	1	3	Reservoir	1	0	0	0	0	78	10	0
2	10.515571	76.409896	98	MDF(S)	18	50	1.5	56	1	3	1	0	0	1	25	Reservoir	1	0	0	0	0	90	5	0
3	10.507823	76.417802	71	MDF(S)	28	80	1	11	5	0	0	0	0	1	30	15	0	0	0	0	0	302	45	0
4	10.522374	76.39494	74	MDF(S)	23	95	0.5	21	4	1	0	0	0	1	30	20	1	1	0	0	0	202	5	0
5	10.510799	76.401909	66	MDF(S)	24	75	2	3	2	4	0	0	0	1	0	9	1	1	1	0	1	86	0	0
6	10.510742	76.405187	75	MDF(S)	15	10	2	6	2	0	0	0	0	1	8	7	0	0	0	0	1	89	0	0
7	10.509243	76.400402	77	MDF(S)	26	60	0.5	8	1	2	0	0	0	1	0	2	1	0	0	0	1	68	0	0
8	10.508967	76.397844	103	MDF(S)	31	60	1	2	4	0	0	0	0	0	0	0	1	0	0	0	1	296	0	0
9	10.506001	76.393001	86	MDF(S)	21	100	1.5	40	4	0	0	0	0	1	0	Reservoir	1	1	1	0	0	196	0	0
10	10.509118	76.389544	54	MDF(S)	20	85	1	0	0	0	0	0	0	1	50	Reservoir	0	0	0	0	0	123	0	0
11	10.51006	76.385531	102	MDF(S)	35	80	1	0	4	0	0	0	0	1	15	4	0	0	0	0	0	266	5	0
12	10.512532	76.386188	103	MDF(S)	11	5	0	2	0	0	0	0	0	1	20	Reservoir	1	0	0	0	0	30	60	0
13	10.526042	76.378008	86	MDF(S)	30	40	2	4	6	0	0	0	0	1	0	Reservoir	1	0	0	1	1	198	0	0
14	10.51499	76.386111	138	MDF(S)	16	40	2	4	6	0	0	0	0	1	0	4	1	0	0	0	1	30	0	0
15	10.516752	76.387376	92	MDF(S)	19	40	2.5	10	2	0	0	0	0	1	0	Reservoir	1	0	0	0	0	112	0	0
16	10.42404	76.463688	125	MDF(S)	18	95	0.5	8	3	11	0	0	0	0	0	0	0	0	0	0	0	65	5	0
17	10.42297	76.462881	154	MDF(S)	35	952	2	32	3	0	0	0	0	0	0	0	0	0	0	0	0	186	0	0
18	10.423512	76.466887	100	MDF(S)	15	85	1	11	3	15	0	0	0	1	20	6	0	0	0	1	0	57	0	0

19	10.4228	76.472044	110	MDF(S)	35	100	2	16	5	0	4	0	0	0	0	0	0	0	0	0	0	149	0	0
20	10.425083	76.471058	120	MDF(S)	29	80	1	14	7	0	2	0	0	0	0	0	0	0	0	0	0	329	0	0
21	10.42418	76.475777	97	MDF(S)	27	90	0.5	25	5	0	0	0	0	1	100	Reservoir	0	0	0	0	0	186	0	0
22	10.454758	76.491829	75	MDF(S)	14	25	1	2	2	7	0	0	0	1	0	5	1	0	1	0	0	117	0	0
23	10.45628	76.489453	89	MDF(S)	16	25	1	1	5	0	2	0	1	1	0	5	1	0	0	1	0	236	15	0
24	10.454652	76.497941	82	MDF(S)	15	80	1	6	4	0	0	0	0	1	8	dam	0	0	1	0	0	130	5	0
25	10.453585	76.493768	85	MDF(S)	18	25	2	10	5	8	0	0	0	1	4	Reservoir	0	0	0	0	0	102	10	0
26	10.438949	76.5124	85	MDF(S)	25	50	1	5	3	0	0	0	1	1	0	8	1	1	0	0	0	143	20	0
27	10.436102	76.512685	87	MDF(S)	30	50	1	14	5	2	1	0	1	1	5	5	1	0	0	0	0	251	0	0
28	10.436897	76.510805	121	MDF(S)	10	35	0	0	0	8	0	1	0	1	25	Reservoir	0	0	0	0	1	205	10	0
29	10.437046	76.504729	70	MDF(S)	23	75	1.5	1	8	1	0	0	0	0	0	0	0	1	0	0	1	200	30	0
30	10.436236	76.502169	75	MDF(S)	20	60	2	5	13	2	0	0	0	1	5	Reservoir	1	1	0	0	1	124	45	0

Cam No.	Latitude	Longitude	Altitude	Habitat	CH	CC	LD	SD	TD	CD	B	C	H	WB	Dist. WB	Width WB	Rock	Fruit	S	R	L	GBH	Slope	O
1	11.923602	75.793843	82	MDF(N)	11	20	5	40	3	10	0	0	0	1	70	12	0	1	0	0	0	95	5	0
2	11.925136	75.796096	90	MDF(N)	18	65	6	20	5	2	1	0	0	1	70	14	0	1	0	0	1	196	5	0
3	11.927756	75.800799	86	MDF(N)	13	100	5	60	3	4	0	0	0	1	30	15	0	1	0	0	0	92	5	0
4	11.931166	75.800371	105	MDF(N)	18	90	45	22	3	4	0	0	0	1	30	15	0	1	0	0	1	63	0	0
5	11.933924	75.801781	111	MDF(N)	25	100	5	10	3	7	0	0	0	1	0	2	0	1	0	0	1	271	0	0
6	11.939097	75.80351	168	MDF(N)	25	90	4	56	1	0	0	0	0	0	0	0	0	1	0	0	0	56	0	0
7	11.935086	75.796952	119	MDF(N)	22	90	6	42	3	3	1	0	0	0	0	0	1	1	0	0	0	212	0	0
8	11.930704	75.794762	98	MDF(N)	20	80	5	22	2	1	0	1	0	1	20	10	0	0	0	0	0	110	0	0
9	11.934034	75.809085	95	MDF(N)	21	60	4	2	5	2	0	0	0	0	0	0	0	1	0	0	0	46	0	0
10	11.931124	75.813958	103	MDF(N)	18	70	3	0	5	4	0	0	0	0	0	0	1	1	0	0	1	85	0	0
11	11.936875	75.814529	100	MDF(N)	23	100	4.5	5	5	12	1	0	0	1	20	10	0	0	0	0	1	94	0	0
12	11.932938	75.818309	119	MDF(N)	24	100	4	10	8	10	0	0	0	0	0	0	0	1	0	1	0	89	5	0
13	11.934225	75.824218	149	MDF(N)	20	100	3	6	4	8	1	0	1	0	0	0	0	1	0	1	0	186	45	0

14	11.928774	75.8229	156	MDF(N)	16	60	4.5	26	3	1	1	1	0	0	0	0	0	0	0	0	0	202	5	0
15	11.930618	75.827576	146	MDF(N)	15	100	5	15	5	0	0	0	0	0	0	0	0	0	0	0	0	58	5	0
16	11.931745	75.83232	140	MDF(N)	18	100	2.5	6	1	9	0	0	1	0	0	0	1	1	0	0	0	72	5	0
17	11.932343	75.837478	161	MDF(N)	21	60	4.5	13	5	8	0	0	0	0	0	0	0	0	0	0	0	216	5	0
18	11.934319	75.84342	270	MDF(N)	23	50	4	22	4	3	1	0	0	0	0	0	0	1	0	0	0	209	5	0
19	11.9362	75.844124	186	MDF(N)	26	80	2	6	2	14	1	0	0	1	0	3	1	1	0	0	1	37	0	0
20	11.936619	75.849465	126	MDF(N)	18	50	2.5	14	3	2	0	0	0	0	0	0	0	0	0	0	0	285	0	0
21	11.931554	75.851037	160	MDF(N)	25	90	1	32	1	3	1	0	0	0	0	0	1	0	0	0	1	79	0	0
22	11.939965	75.80521	136	MDF(N)	23	50	2	54	3	14	0	0	0	1	10	5	0	1	0	0	0	114	0	0
23	11.943047	75.810121	139	MDF(N)	24	100	3	43	1	2	0	0	1	1	10	5	0	0	0	0	0	93	0	0
24	11.946555	75.814177	291	MDF(N)	26	60	0.5	8	1	2	0	0	0	1	0	2	1	0	0	0	0	68	0	0
25	11.947405	75.819049	300	MDF(N)	31	60	1	2	4	0	0	0	0	0	0	0	1	0	0	0	0	296	0	0
26	11.952566	75.819203	282	MDF(N)	21	100	1.5	40	4	0	0	0	0	1	0	0	1	1	1	0	0	196	0	0
27	11.948909	75.82203	320	MDF(N)	20	85	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	123	0	0
28	11.946535	75.824878	240	MDF(N)	35	80	1	0	4	0	0	0	0	1	0	0	0	0	0	0	0	266	5	0
29	11.943005	75.828104	253	MDF(N)	11	5	0	2	0	0	0	0	0	1	0	0	1	0	0	0	0	30	60	0
30	11.938298	75.832494	292	MDF(N)	30	40	2	4	6	0	0	0	0	1	0	0	1	0	0	1	0	198	0	0

Cam No.	Latitude	Longitude	Altitude	Habitat	CH	CC	LD	SD	TD	CD	B	C	H	WB	Dist. WB	Width WB	Rock	Fruit	S	R	L	GBH	Slope	O
1	10.35042	77.222218	433	DDF(S)	25	90	5	15	1	0	0	0	0	1	11	10	1	1	0	0	1	87	5	0
2	10.350447	77.224734	427	DDF(S)	28	60	4	16	2	0	0	0	0	1	10	0	1	1	0	1	1	200	0	0
3	10.34955	77.226502	437	DDF(S)	30	40	7	30	6	2	0	0	0	1	10	15	1	1	0	0	0	300	15	0
4	10.348112	77.228648	431	DDF(S)	22	80	6	0	2	0	0	0	0	1	10	10	1	1	0	1	0	298	5	0
5	10.346023	77.22888	435	DDF(S)	10	50	3	4	3	2	0	0	0	1	10	25	1	1	0	0	0	30	15	0
6	10.343794	77.228137	430	DDF(S)	30	60	4	0	4	1	0	0	0	1	18	15	1	1	0	0	0	400	5	0
7	10.341587	77.226513	437	DDF(S)	18	85	5	0	4	2	0	0	1	1	15	0	1	0	0	0	0	60	0	0

8	10.339941	77.225332	457	DDF(S)	2	0	2	200	0	0	0	0	0	1	15	100	1	0	0	0	0	0	10	0
9	10.338217	77.224023	464	DDF(S)	2	0	0	200	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
10	10.336457	77.221877	447	DDF(S)	8	25	1	200	5	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0
11	10.334763	77.219619	462	DDF(S)	7	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0
12	10.329842	77.219619	465	DDF(S)	3	0	1	0	4	2	0	0	0	0	0	0	0	0	0	0	0	220	0	0
13	10.328855	77.225484	445	DDF(S)	24	85	3	50	1	0	0	0	0	0	0	0	1	0	0	0	0	200	5	0
14	10.550767	77.227827	444	DDF(S)	30	80	5	50	4	0	0	0	0	1	20	0	0	0	0	1	1	250	5	0
15	10.350055	77.230168	445	DDF(S)	35	75	7	10	6	1	0	0	0	1	20	0	1	0	0	1	1	200	5	0
16	10.349856	77.233284	449	DDF(S)	32	60	8	5	4	0	1	0	0	1	20	0	1	1	0	1	0	400	5	0
17	10.35106	77.2358	440	DDF(S)	40	40	5	0	6	0	1	0	0	1	15	0	1	1	0	1	0	50	0	0
18	10.351788	77.233903	462	DDF(S)	25	30	4	0	2	1	0	0	0	1	20	10	0	0	0	1	0	0	30	0
19	10.351978	77.231105	467	DDF(S)	28	60	5	5	2	1	0	0	0	1	10	15	1	0	0	0	1	308	0	0
20	10.352586	77.228343	473	DDF(S)	5	0	4	0	3	1	0	0	0	1	10	0	1	1	0	1	0	0	30	0
21	10.35316	77.225626	483	DDF(S)	3	10	5	20	2	0	0	0	0	1	10	25	1	0	0	0	0	0	0	0
22	10.353479	77.222496	486	DDF(S)	12	10	5	55	1	0	0	0	0	0	0	0	1	0	0	0	0	70	0	0
23	10.353123	77.217286	465	DDF(S)	15	40	5	0	5	1	0	0	1	0	0	0	1	0	0	1	0	76	0	0
24	10.352969	77.214436	454	DDF(S)	18	35	4	0	4	1	0	0	0	1	15	30	0	0	0	0	0	0	0	0
25	10.352948	77.21065	451	DDF(S)	5	10	2	0	1	1	0	0	0	1	15	40	0	0	0	0	0	0	0	0
26	10.353034	77.205779	470	DDF(S)	12	25	3	21	2	0	0	0	0	0	0	0	0	0	0	0	0	64	25	0
27	10.353229	77.20149	493	DDF(S)	16	20	2.5	34	3	0	0	0	0	0	0	0	2	0	0	0	0	80	20	0
28	10.352232	77.196614	583	DDF(S)	15	30	3	16	5	1	0	0	0	0	0	0	0	0	0	0	0	55	20	0
29	10.349415	77.20408	530	DDF(S)	15	10	0	5	2	0	0	0	0	0	0	0	1	0	0	0	0	38	0	0
30	10.346777	77.208464	541	DDF(S)	20	25	1.5	14	4	0	0	0	0	0	0	0	4	0	0	0	0	54	45	0

Cam No.	Latitude	Longitude	Altitude	Habitat	CH	CC	LD	SD	TD	CD	B	C	H	WB	Dist. WB	Width WB	Rock	Fruit	S	R	L	GBH	Slope	O
1	76.810524	10.877082	271	DDF(N)	25	30	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	87	5	0
2	76.808147	10.875418	317	DDF(N)	16	15	2	2	1	0	0	0	0	0	0	0	0	0	0	1	0	43	10	0
3	76.805811	10.875917	347	DDF(N)	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	10	0

4	76.803997	10.876252	423	DDF(N)	2	0	2	110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
5	76.802206	10.878411	450	DDF(N)	8	25	1.5	115	5	4	0	0	0	0	0	0	1	0	0	0	0	32	25	0
6	76.8016	10.87652	446	DDF(N)	3	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	22	25	0
7	76.82042	10.85978	318	DDF(N)	15	20	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	42	45	0
8	76.820601	10.85785	287	DDF(N)	13	20	1.3	25	3	0	0	0	0	0	0	0	0	0	0	0	0	38	45	0
9	76.8199	10.85605	287	DDF(N)	17	40	1.5	12	6	0	0	0	0	0	0	0	0	0	0	0	0	46	45	0
10	76.82099	10.85375	512	DDF(N)	19	40	1.7	10	7	0	0	0	0	0	0	0	0	0	0	0	0	67	45	0
11	76.822908	10.851314	243	DDF(N)	20	30	5	7	7	0	0	0	0	0	0	0	0	0	0	0	0	50	5	0
12	76.821888	10.849934	257	DDF(N)	30	30	5	3	4	0	0	0	0	0	0	0	0	0	0	0	0	60	5	0
13	76.82066	10.848157	280	DDF(N)	5	5	20	3	2	0	0	0	0	0	0	0	1	0	0	0	0	30	45	0
14	76.82078	10.84587	304	DDF(N)	7	10	3	9	2	0	0	0	0	0	0	0	1	0	0	0	0	40	50	0
15	76.816786	10.846945	288	DDF(N)	15	40	5	3	4	0	0	0	0	0	0	0	0	0	0	0	0	85	45	0
16	76.818146	10.844967	281	DDF(N)	25	40	5	11	5	0	0	0	0	0	0	0	0	0	0	0	0	70	20	0
17	76.815996	10.843565	227	DDF(N)	30	50	5	19	6	0	0	0	0	0	0	0	0	0	0	0	0	110	35	0
18	76.813909	10.842599	219	DDF(N)	30	60	5	7	5	0	0	0	0	0	0	0	1	0	0	0	0	140	35	0
19	76.811735	10.842446	233	DDF(N)	15	20	5	17	8	0	0	0	0	0	0	0	1	0	0	0	0	50	20	0
20	76.809592	10.84309	211	DDF(N)	20	40	5	11	9	0	0	0	1	0	0	0	0	0	0	0	0	125	35	0
21	76.807756	10.843329	211	DDF(N)	20	40	5	17	8	0	0	0	0	0	0	0	0	0	0	0	0	120	30	0
22	76.80449	10.86035	299	DDF(N)	30	30	5	7	7	2	0	0	0	0	0	0	0	0	0	0	0	103	50	0
23	76.799462	10.861104	278	DDF(N)	35	60	5	2	1	0	0	0	0	1	0	10	1	0	0	0	0	90	0	0
24	76.801915	10.86136	359	DDF(N)	20	60	5	6	6	1	0	0	0	1	0	2	1	0	0	0	0	210	30	0
25	76.81143	10.83892	380	DDF(N)	31	50	5	14	6	0	0	0	0	1	10	4	0	0	0	0	0	63	10	0
26	76.81435	10.83721	450	DDF(N)	30	80	5	15	5	0	0	0	0	0	0	0	1	0	0	0	1	210	45	0
27	76.81623	10.83421	451	DDF(N)	30.5	80	5	2	5	2	0	0	0	0	0	0	1	0	0	0	0	62	40	0
28	76.82036	10.83548	432	DDF(N)	20	70	5	9	3	0	0	0	0	1	15	3	0	0	1	0	0	120	30	0
29	76.82036	10.83548	570	DDF(N)	26	80	5	10	4	1	0	0	0	1	10	2	0	0	0	0	0	63	0	0
30	76.80989	10.8556	516	DDF(N)	30	80	5	3	4	1	0	0	0	1	200	3	0	0	0	0	0	171	50	0

Cam No.	Latitude	Longitude	Altitude	Habitat	CH	CC	LD	SD	TD	CD	B	C	H	WB	Dist. WB	Width WB	Rock	Fruit	S	R	L	GBH	Slope	O
1	10.217441	77.068192	2208	GL(S)	10	50	3	30	12	5	0	0	1	1	5	3	1	1	1	1	1	106	30	0
2	10.217678	77.07532	2196	GL(S)	8	95	5	26	6	2	0	1	20	5	0	1	1	0	0	0	1	89		
3	10.222407	77.077426	2147	GL(S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	10.221935	77.06388	2162	GL(S)	0	0	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	1
5	10.224232	77.060364	2243	GL(S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	10.233384	77.056216	2208	GL(S)	11	90	5	45	6	0	0	0	0	1	10	2	0	0	1	0	1	155	60	0
7	10.228918	77.05529	2172	GL(S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	10.2395	77.062614	2239	GL(S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	10.229206	77.050764	2089	GL(S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	10.228715	77.085124	1933	GL(S)	9	50	4	36	6	2	2	0	1	1	5	2	1	1	1	0	0	96	50	0
11	10.225622	77.083714	2073	GL(S)	10	95	7	32	6	10	0	0	0	1	100	6	0	0	0	0	1	106	45	0
12	10.220196	77.08786	1964	GL(S)	12	90	2	15	5	2	0	0	0	1	100	5	1	0	0	0	1	111	5	0
13	10.224481	77.088836	1887	GL(S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	10.228259	77.087475	1940	GL(S)	13	80	2	28	4	2	1	0	0	1	0	7	1	0	0	0	1	225	5	0
15	10.230413	77.085895	2017	GL(S)	15	80	2.5	19	4	1	1	0	1	0	0	0	1	1	0	0	1	186	10	0
16	10.233638	77.085553	2003	GL(S)	9	100	3	62	5	10	0	0	1	1	5	2	0	1	1	0	1	123	5	0
17	10.236014	77.086057	1982	GL(S)	16	85	3.5	76	5	1	0	0	0	0	0	0	1	0	0	0	0	165	5	0
18	10.226728	77.087118	1916	GL(S)	11	95	5	21	3	3	0	0	1	0	0	0	1	0	0	0	0	85	5	0
19	10.212102	77.096038	1922	GL(S)	0	0	0	36	1	0	0	0	0	1	0	11	1	0	0	0	0	72	5	0
20	10.206632	77.098579	1915	GL(S)	6	50	2	60	4	0	0	0	0	0	0	0	0	0	0	0	0	98	5	0
21	10.222368	77.090009	1892	GL(S)	5	95	5	40	4	0	0	0	0	0	0	0	0	0	0	0	0	32	5	0
22	10.215195	77.093587	1870	GL(S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	10.218993	77.091336	1877	GL(S)	17	80	5	35	8	1	0	0	0	0	0	0	0		0	0	1	104	5	0
24	10.238098	77.088017	1988	GL(S)	6	20	0	5	1	0	0	0	0	1	0	10	1	1	0	0	0	110	5	0
25	10.240454	77.08935	2002	GL(S)	6.5	10	0	1	2	0	0	0	0	1	0	8	1	0	1	0	0	64	5	1
26	10.240852	77.092342	2085	GL(S)	0	0	0	0	0	0	0	0	0	1	0	7	0	0	0	0	0	0	0	0

Cam No.	Latitude	Longitude	Altitude	Habitat	CH	CC	LD	SD	TD	CD	B	C	H	WB	Dist. WB	Width WB	Rock	Fruit	S	R	L	GBH	Slope	O
27	10.242137	77.093699	2123	GL(S)	0	0	0	0	0	0	0	0	0	1	0	7	0	0	0	0	0	0	0	0
28	10.248483	77.097625	2211	GL(S)	7	80	2	14	5	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0
29	10.250375	77.098895	2264	GL(S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	10.256427	77.102133	1959	GL(S)	6.5	100	6	55	5	0	0	0	0	0	0	0	1	0	0	0	0	36	5	0
1	11.543302	75.931512	880	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	11.540403	75.93372	870	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	11.520225	75.927177	966	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
4	11.518636	75.93165	942	GL(N)	11	90	3	34	5	0	0	0	0	0	0	0	0	0	0	0	1	74	60	0
5	11.506642	75.9353	1007	GL(N)	0	0	0	6	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
6	11.501536	75.937351	1091	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0
7	11.499233	75.940236	885	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0
8	11.518272	75.942005	1090	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0
9	11.518798	75.948584	1203	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0
10	11.519858	75.954071	1230	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0
11	11.520611	75.960245	1035	GL(N)	0	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0
12	11.540197	75.947681	863	GL(N)	8	80	2	65	6	0	0	0	0	0	0	0	0	0	0	0	0	56	10	0
13	11.540056	75.950077	918	GL(N)	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0
14	11.541975	75.949891	1004	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
15	11.548857	75.971866	1407	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	30	0
16	11.545685	75.973358	1342	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
17	11.548367	75.975448	1348	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	10	0
18	11.531941	75.977689	1164	GL(N)	10	80	2.5	45	7	0	0	0	0	0	0	0	0	0	0	3	0	67	10	0
19	11.559491	75.976334	1033	GL(N)	0	0	0	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	45	0
20	11.562639	75.972886	1207	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0
21	11.564754	75.970274	1303	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

22	11.566378	75.967178	1321	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
23	11.569459	75.970701	1405	GL(N)	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
24	11.57081	75.969145	1407	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
25	11.572804	75.966995	1467	GL(N)	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	45	0

(CH = Canopy Height, CC = Canopy Cover (%), LD = Litter Depth (cm), SD = Shrub Density, TD = Tree Density, CD = Climber Density, B = Bole, C = Canes, H = Holes, WB = Water Body, S = Swamp, R = Roots, L = Logs, GBH = Girth at Breast Height, O = Otter Habitat)