Chapter 1

INTRODUCTION

1.1 Introduction

Small carnivores of tropical forests represent an ecologically diverse and influential guild of forest vertebrates playing key roles as predators and seed dispersers. Small carnivores, as referred to generally small body sized carnivore species, have varied life histories showing highly species-specific responses to habitat and human-induced habitat changes, and attain varied conservation status. Lesser carnivores far outnumber large carnivores in species richness and are much more diverse in their behavior and ecology. These species can be solitary to highly social, frugivorous to hypercarnivorous, and habitat specialists of climax communities or generalists that live in close proximity to humans. Given their smaller size and ability to thrive in diverse habitats, they are usually more abundant than large carnivores, yet their impact within communities is generally assumed to be relatively minor. Indeed, where large carnivores have been lost or where lesser carnivores have been introduced, there are important examples of them driving the community structure. There are also instances in which lesser carnivores fill ecological role such as dispersers of seeds, that large, hypercarnivorous carnivores cannot. In most cases, lesser carnivores are not the top, or apex predators in an ecosystem, but there are instances, such as on islands or where they have been introduced, where they can fill the role of apex predator and perhaps cause community level cascades. In these unique circumstances, their collective ecological impact may be similar to and as profound as that of larger carnivores.

In species-rich communities, complex interactions among predators and their prey may emerge (Sih et al., 1998). Predators can act in an additive fashion, such that the summation of their effects on their prey is greater than that of any single predator alone. The widespread ascendency of lesser carnivores to the role of apex predator is a relatively recent phenomenon engendered by anthropogenic driven extinctions and range contractions of large carnivores (Laliberte and Ripple 2004).
Small carnivore (herpestids, mustelids, viverrids) diversity is centered in three major regions in the Indian sub-continent, in the Eastern Himalaya, North-east Hills and the Western Ghats (Sterndale 1884, Pocock 1939, Nowak 1999). There are 33 species of small carnivores in India including a unique assemblage in the Western Ghats. Seventeen species of small carnivores (excluding members of Family Canidae) that belong to mammalian Families; Felidae (small cats), Mustelidae, Viverridae and Herpestidae are known to occur in the Western Ghats. They are as follows; jungle cat (*Felis chaus*), leopard cat (*Prionailurus bengalensis*), rusty spotted cat (*Prionailurus rubiginosus*), fishing cat (*Prionailurus viverrinus*), Eurasian otter (*Lutra lutra*), smooth coated otter (*Lutra perspicillata*), small-clawed otter (*Amblonyx cinerus*), Nilgiri marten (*Martes gwatkinsi*), honey badger (*Mellivora capensis*), small Indian civet (*Viverricula indica*), common palm civet (*Paradoxurus hermaphroditus*), brown palm civet (*Paradoxurus jerdonii*), Malabar civet (*Viverria civettina*), grey mongoose (*Herpestes edwardsii*), ruddy mongoose (*Herpestes smithii*), brown mongoose (*Herpestes brachyurus*) and stripe-necked mongoose (*Herpestes viticollis*). Behavioural and ecological studies of most small carnivores through direct observation in tropical forests is difficult because of their rarity and nocturnal habits. Deriving meaningful estimates of their abundance is a challenging task. As national parks and sanctuaries become subjected to greater human use, carnivores are severely affected by developmental activities, wildlife trade and hunting (Johnsingh 1986, Ashraf et al., 1993, Gupta 1997). There is a large void in the information available on the ecology of most of the small Indian carnivores (Mukherjee 1989, Mukherjee 1998). They are in urgent need of a focused conservation program which can achieve many successes with many challenges and identify a range of future work. They suffer from common issues of lack of awareness of their plight and the deficiency of reliable data on their distribution and conservation requirements.

To best plan landscape conservation strategies within the context of Mudumalai Tiger Reserve, it is critical to understand the population ecology of India’s IUCN-listed small carnivores. The population status of these carnivores and their feeding ecology are of considerable interest as India’s forests shrink, fragment, and degrade due to increasing demands from the growing human population. The outstanding rate of forest loss in India is dramatically changing the landscape composition through fragmentation, leaving many species of carnivores and their prey threatened with extinction. Without careful consideration of population dynamics
across species and habitats, conservation efforts may be poorly applied, thus delaying species recovery. This will critically improve our state of knowledge to protect lesser carnivores and aid the development of theory on their social structure, behavior, and evolution. The study will help in suggesting localized monitoring mechanisms wherever necessary as this is very important in minimizing surprise cases of extinction. A new generation of camera traps with the use of well-developed population deriving models has led to an increase in the use of remote surveying and monitoring methodologies for elusive species from which population estimates and relative abundance indices can now be made (Karanth 1995, Carbone et al., 2001). Camera traps have also enabled more accurate estimates of species richness, diversity and spatial distribution of small mammals. With long-term use, these tools will enable monitoring changes in populations over time. Habitat features may determine spatial distribution of small carnivores in an area since they exploit a variety of habitats and resources where resource partitioning is the outcome of species coexistence (MacArthur 1972, Cody 1974, Diamond 1978, Tilman 1982) especially for sympatric species. This study aimed to examine the abundance and occupancy of small carnivores with the application of photographic captures using camera traps and diet composition of small carnivores through faecal analysis. I also investigated seasonal species-habitat relationships from microhabitat (non-spatial) and remotely sensed features (spatial) to understand how habitat variables govern their occurrence pattern. I also predicted the distribution of small carnivores in the intensive area of Mudumalai Tiger Reserve (hereafter called Mudumalai).

1.2 Small felids

In palaeogeological terms, the Felinae radiated relatively recently and rapidly in the late Miocene 13–14 million years ago, with extinct and extant genera of the family Felidae derived from a common ancestor 27 million years ago (Macdonald 1992). Cats can be classified on basis of their body size and body weight (large ≥20 kg, medium 10-20 kg and small ≤ 10 kg). India’s six species of small cats; jungle cat (*Felis chaus*), Palla’s cat (*Octocolobus manul*), desert cat (*Felis silvestris*), leopard cat (*Prionailurus bengalensis*), fishing cat (*Prionailurus viverrinus*), rusty spotted cat (*Prionailurus rubiginosus*) are up against odds. Basic knowledge on their biology and ecology is scarce. Small cats are hypercarnivores-obligate meat eaters. Much about
the behavior of small cats could be learnt from their tail morphology. Interesting anecdotes of lesser cats in India provide little concrete evidence on their population status (Parihar 1989, Haque and Vijayan 1993, Patel and Jackson 2005, Manakadan and Sivakumar 2006, Patel 2006, Vyas et al., 2007). This is likely because of the extreme difficulty in physically observing them and the inaccessibility of their habitat. This is a common issue in conservation because the smaller elusive species are often the most difficult to study. Schauenberg (1978) reported jungle cat reproduction, Dal (1954) and Rathore and Thapar (1984) gave notes on its feeding behaviour. Habitat selection and seasonal changes in jungle cat body weight were outlined by Haptenr and Sludskii (1972) and Roberts (1977). Density estimates of small cats ranged from 0.07 to 1 individual/km² (Gardner et al., 2010, Oliveira et al., 2010, Gupta 2011, Reppucci et al., 2011). Kiltie (1988) examined jaw lengths in regional assemblages of felids and found that female jaw length was closely related to modal prey weight. Since felids use a killing bite to dispatch prey, species that feed upon larger prey should have concomitantly wider jaw gapes hence, jaw lengths (and probably other morphological parameters) appear to have evolved to maximize efficiency in handling and killing common prey species and to minimize overlap with adjacent sized species within the assemblage. Evenness in distribution of jaw lengths in regional assemblages of felid species may possibly indicate partitioning of resources within the felid guild. While this may well be an evidence of character displacement, jaw lengths could equally have evolved as a response to size distribution of available prey. In South America, margay, jaguarundi, oncilla (Leopardus tigrinus) and Geoffroy’s cat (L. geoffroyi) occur at higher densities in the absence of larger ocelots, suggesting that ocelots may compete directly or indirectly with the smaller cats (Oliveira et al., 2008). Black-footed cats and African wild cats may benefit from the removal of larger competitors such as caracals and jackals (Canis mesomelas) (Sliwa 2006). Caracals have been observed killing and partly eating even African wildcats suggesting interspecific competition (Caro and Stoner 2003).

Worldwide, small cats inhabit specialized habitats. The pampas cat thrives in open habitats, ranging north through the dry forests and scrub grasslands of Bolivia, Paraguay, and Brazil, and up the Andes mountain chain from Chile to Ecuador and possibly marginally into southwestern Colombia (Silveira 1995). The Geoffroy’s cat is distributed throughout the pampas grasslands and dry Chaco shrub and woodlands, and around the alpine saline desert of north-western Argentina to 3300 m in the Andes.
(Nowell and Jackson 1996). Most of its range is arid or semi-arid (Pereira et al., 2006), but it also occurs in wetlands (Sunquist and Sunquist 2002). The guina (Leopardus guigna) is the smallest felid in the Americas, having a constricted distribution, occurring only in central and southern Chile and marginally in adjoining areas of Argentina. Although the guina is forest-dependent, selecting areas of thicket understory, they use a variety of more open scrub habitat types (Dunstone et al., 2002). In Central America and parts of northern South America the oncilla (Leopardus tigrinus) may be most common in montane cloud forest, it is mostly found in lowland areas of Brazil, being reported from rainforests to dry deciduous forest, savannahs, semi-arid thorny scrub, and degraded secondary vegetation in close proximity to human settlement (Oliveira et al., 2008). The margay (Leopardus wiedii) reaches its greatest abundance in lowland rainforest (Oliveira et al., 2008). It also occurs in dry deciduous forest (Nowell and Jackson 1996), but seems to be absent from the semi-arid caatinga scrub of Brazil, with the possible exception of some evergreen forest enclaves. The jaguarundi (Puma yagouaroundi) ranges from Mexico through Central America and the Amazon basin to central Argentina and Uruguay, occurring in closed primary rainforests to open desert, scrubs, and grasslands, although in open areas it sticks towards dense cover (Nowell and Jackson 1996). The sand cat (Felis margarita) which occurs exclusively in the desert is highly fossorial and is known to Saharan nomads as ‘the cat that digs holes’ (Dragesco-Joffé 1993). Sand cat scats contained the remains of Cairo spiny mouse (Acomys cahirinus) and gecko (Stenodactylus spp.). Sand-dwelling rodents made up the majority (65–88%) of its stomach contents from carcasses collected in Turkmenistan and Uzbekistan (Schauenberg 1974). The black-footed cat (Felis nigripes), Africa’s smallest felid, is endemic to the short grasslands of South Africa. The sex-specific difference in prey size consumption by this species could help reduce intraspecific competition between them (Sliwa 2006). The wildcat (Felis silvestris) has the widest distribution of any felid being found throughout the drier regions of Africa into Europe (including Scotland), southwest and central Asia, and Russia (Nowell and Jackson 1996). The Palla’s cat (Otocolobus manul) has a strong association with rocky, steep areas and rarely found in open grasslands. The flat-headed cat (Prionailurus planiceps) is closely associated with wetlands, to a greater degree than the fishing cat, with a much smaller distribution, found only on the islands of Borneo and Sumatra and the Malayan peninsula. Most collection records for the flat-headed cat are from swampy
areas, oxbow lakes, and riverine forest (Nowell and Jackson 1996), peat-swamp forest and logged forest (Bezuijen 2003). Fishing cats are strongly associated with wetland, swamps and marshy areas, oxbow lakes, reed beds, tidal creeks, and mangrove areas, along watercourses at elevations up to 1525 m, lowland areas, near degraded habitats and aquaculture ponds in Calcutta (Nowell and Jackson 1996). The Andean cat (*Leopardus jacobita*) occurs only in association with rocky outcrops in the arid zones of the high Andes, typically above 4200 m, a specialist predator of chinchillids (*Lagidium spp*; Marino et al., 2011). Basic reproductive studies, using fecal hormone and semen analysis, have been initiated in small cat species to broaden our knowledge on species specific reproductive physiology to help improve their captive-breeding success (Swanson 2006). Small cats are considered to be dietary generalists with small mammals commonly comprising a major proportion of their food.

Wildcats are well adapted to live near human habitations probably because of the abundance of natural prey (rodents), and people noted that their presence was useful in killing rodents and protecting their grain stocks. European farmers benefit from colonies of feral cats around their barns, and treasured in their homes. Though it may seem like such cats are performing a great service to humanity, it is virtually at the cost of eradicating native wild prey. Fur trade is a serious threat to small cats, especially those with attractively marked pelts, such as the leopard cat, fishing cat and rusty spotted cat in India, and the South American species. Nevertheless, small scale trade continues, usually 'under the counter', and particularly in tourism zones. Seizures of large numbers of skins in various places in India from time to time are evidence of this clandestine trade. Given the secrecy of their lives, and the few records confirming their presence in various regions in the country, planning conservation measures for small cats presents considerable difficulty. Moreover, since they lack the glamour of the big cats, it is difficult to persuade governments to set aside areas only for small cats. However, they share the habitats of the big cats, and like their bigger cousins, their real habitats are natural areas of forest, grasslands and wetlands. Protection of these ecosystems is therefore an essential element in ensuring the future of small cats. It is essential that once the required information is gathered on these species, long term studies along with necessary conservation initiatives will ensure the survival of these cats. Efforts to study the lesser cats have not been made enough and there is a lot of work to be done before any conclusion can be made about their status in India. It is still not certain where and how many of them still exist.
Efforts should be made to identify and suggest localized monitoring mechanisms to track and monitor lesser cats.

1.3 Viverrids

The Viverridae consists of 13 genera and 35 species (Gaubert et al., 2005a, Gaubert et al., 2005b, Wozencraft 2005), about 50% of which are IUCN red-listed and/or poorly known (http://www.iucnredlist.org; Schreiber et al., 1989). The members of the family Viverridae are characterized by the presence of scent glands external to the anal region (Wozencraft 1989). Viverridae are confined to the Old World tropics. They were the only carnivores to reach Madagascar. They do not even occur as fossils, in the New World. They differ from the family Herpestidae in the sense that their anus is not enclosed in the glandular pouch and they have a peneal gland in the genital region (Pocock 1941). Most of the members have retractile claws. Their ears are comparatively larger with well developed bursa on the external margin. They are distinguished in the external characters from the members of the family Felidae by the hind foot being five toed, the retention of the inter-ramal tuft of facial vibrissae and typically elongated muzzle. Many of the members have spots or stripes on the body and the tail has ring like marks (Pocock 1939). In viverrids, the total length (head, body and tail) varies from 320 to 1850 mm, where as body weight varies from around 600 gm in the case of African linsang (Poiana richardsoni) to 20 kg in the case of binturong (Arctitis binturong). They are either terrestrial or arboreal in nature and have wide variety of diet including small mammals, birds, insects and fruits. Viverrids are mostly solitary and nocturnal. They have diversified into a variety of biological roles: some, such as palm civets (Paradoxurinae), are chiefly frugivores. Little precise knowledge is available on the ecological role of this diverse carnivore fauna, but it is certain to be significant. Viverrids retain a number of phylogenetically primitive characteristics which are of great scientific interest. The African civet (Civettictis civetta) is known for its valuable source of a musk-like substance called “civet”. This yellowish secretion has the consistency of butter and is a product from scent glands located near the civet’s anus. Civet musk mainly comes from Ethiopia, where “civet farmers” keep up to 60 wild-caught male civets in cylindrical cages made of branches. Musk is collected every 9-12 days with a horn spatula, each collection amounting to 10-15 gms per animal. There are an estimated
180 civet farmers in Ethiopia, holding a total of over 2700 animals (Schreiber et al., 1989). An animal produces about 800 gm civet per year, representing a value of 350 U.S. dollars (in early 1988). During 1975-1978, Ethiopia exported a total of 5830 tons of musk, mainly to France, where it was used as a raw substance in the perfume industry. As the animals were not captive-bred, the possible vast increases in production of this valuable substance appear to be limited.

The family Viverridae is divided into four subfamilies Cryptoproctinae, Viverrinae, Hemigalinae and Paradoxurinae (Wozencraft 1989). They are found only in tropical and subtropical Africa and Asia. Of the six subfamilies, the viverrids in India are represented by two subfamilies Viverrinae and Paradoxurinae with nine species. They represent small to medium-sized, nocturnal, solitary predators, often inhabiting inaccessible areas (Nowak 1999). Viverrids show more ecological diversification in trophic specialization and substrate use than any other family of carnivores (Eisenberg 1981). They are widely distributed throughout Europe, Asia, East Indies, Africa, and Madagascar, with up to eight species occurring sympatrically in tropical habitats (Medway 1977). Despite the large number of species of viverrids within the order Carnivora (13%) (Wemmer and Watling 1986) and their wide distribution throughout the Old World tropics, the basic biology of most species is unknown (Joshi et al., 1995). Most studies indicate that viverrids feed primarily on fruit and forage exclusively at night. Researches hypothesize that the social organization and activity patterns of these civets are shaped by the distribution of food resources. The palm civet is more arboreal than the small and large Indian civets (Bartels 1964). Palm civets are distributed throughout southern and eastern Asia in a wide variety of habitats (Lekagul and McNeely 1977). Rabinowitz (1991) reported home-range size of the palm civet from mixed-deciduous and dry, evergreen forest at Huai Kha Khaeng Wildlife Sanctuary, Thailand which was 12 times larger than that found in Chitwan National Park. More home-range overlap was observed when ripe fruiting trees were at low density or clumped in distribution (Joshi et al., 1995). The Malabar civet (Viverra civettina) is one of the several mammalian endemics in the evergreen rainforest belt of southwest India. The large Indian civet (Viverra zibetha) is quite common in the Terai belt along Himalayan foothills, and in the Eastern and Northeastern parts of India (Prater 1971, Acharjyo and Patnaik 1987, Choudhury 1997, 1999, Menon 2003, Peter 2003) and the Malabar civet which is a critically endangered species is restricted to the lowland (coastal) Western Ghats (Jerdon 1874,
Ashraf et al., 1993, Rai and Kumar 1993). It was earlier regarded as a subspecies of *Viverra megaspila* (Ellerman and Scott 1951, Honacki et al., 1982), but Lindsay (1928) and Pocock (1941) reviewed its taxonomic position and considered it as a separate species *V. civettina*. It is also the only viverrid listed in Schedule I of the Indian Wildlife (Projection) Act, 1972. Its closest relative, the large-spotted civet (*Viverra megaspila*), sometimes regarded conspecific with *V. civettina*, ranges widely from Burma eastwards through southeast Asia. There were only two possible sight records by Karanth (1986) in the Kudremukh area in Chikmagalur district, Karnataka, and another one by Kurup (Zoological Survey of India) at Thiruvalla in Pathanamthitta district, Kerala, in the 1970s. *Viverra civettina* has probably disappeared from most of the coastal tracts and its continued existence in various parts of the Western Ghats needs confirmation. The only indication of a captive Malabar civet was provided by Pocock (1941) who described a skin obtained from Trivandrum Zoo. Dead wild specimens were confirmed by Kurup (Zoological Survey of India). The spotted linsang (*Prionodon pardicolor*) is distributed over a considerable part of southeast Asia but seems to be rare everywhere. The golden palm civet, (*Paradoxurus zeylonensis*) is indigenous to Sri Lanka, but closely related to the brown palm civet (Groves et al., 2009). The Malay civet (*Viverra tangalunga*) is found on the Malay Peninsula, Sumatra, Borneo, Sulawesi, Maluku Islands and the Philippines (Corbet and Hill 1992, Kanchanasakha et al., 1998, Suyanto et al., 1998) where it occurs in a wide variety of habitats including forests, secondary habitats, cultivated land and the outskirts of villages (Wemmer and Watling 1986, Nowak 1999). The large-spotted Civet (*Viverra megaspila*) occurred widely in mainland south-east Asia from southern China and Myanmar, through Indochina and Thailand south to Peninsular Malaysia (Corbet and Hill 1992), Myanmar, Thailand, Vietnam and Malaysia primarily in lowland forest (Holden and Neang 2009), Lao PDR and China. The most distinctive subspecies of the small-toothed palm civet (*Arctogaeidia trivirgata*) occurs in moist west Java, from the south coast up to 1700 m. The Mentawai palm civet (*Paradoxurus lignicolor*) is a part of the unique plant and animal community in the Mentawai islands. There are no confirmed records of this species in the wild apart from only museum records. The Mentawai Islands are the only small islands where the banded palm civet (*Hemigalus derbyanus minor*) occurs. It is otherwise known from the larger land masses of Sumatra, Borneo, Peninsular Malaysia, and Thailand. The Hose’s palm civet (*Diplogale hosei*) is endemic to a few
mountain ranges in Sarawak and Sabah (East Malaysia). The Sulawesi palm civet (*Macrogalidia musschenbroekii*) a monotypic genus, occurs mainly in primary forest from sea level to montane rain forest and cloud forest. Lowland populations of the Sulawesi palm civet could be adversely affected by timber cutting and cultivation. The Owston’s palm civet (*Chrotogale owstoni*) is the sole living representative of its genus. It may be largely terrestrial, and prefers habitats in the vicinity of rivers in primary and secondary forests. The genus *Cynogale* contains only two species (usually treated as subspecies), the otter civet (*C. bennettii*) and Lowe’s otter civet (*C. lowe*). They are semi-aquatic with specialized morphological adaptations such as broad, webbed feet and muscles which close the nose and ears. The Abyssinian genet (*Genetta abyssinica*) appears to have a wide altitudinal and ecological range, from coastal plains and open dry lowlands to montane heather moorlands and Afro-alpine grassland. Behrens and Rompaey (2002) provided records of this species in montane dry forest (dominant species; tree heath (*Erica arborea*), curry bush (*Hypericum revolutum*) and Abyssinian rose (*Rosa abyssinica*), and recorded them at 3750 m. The giant genet (*Genetta victoriae*) is the largest species of its genus occurring in forests between the Zaire, Lualaba and Oubangi rivers and the rift valley in northeast Zaire. The aquatic genet (*Osbornictis piscivora*), “Africa’s rarest viverrid,” is the sole living representative of its genus. The species is thought to hunt in water, but presumably unlike the otter civets, which are reported to lie in ambush, it is discontinuously distributed within its range, and there seems to be a correlation between its occurrence and large homogeneous stands of *Gilbertiodendron* forests (Schreiber et al., 1989). The Leighton’s linsang (*Poiana richardsoni liberiensis*) is one of the carnivores with a very restricted range in parts of the Upper Guinea rainforest belt, demonstrating the importance of this region as one of the core areas for viverrid conservation in Africa.

The level of coverage of species suitable ranges by existing and proposed IUCN reserves was low, and it is suggested that the total surface of protected areas be substantially increased in Africa and Asia (Papes and Gaubert 2007). These animals generally have a restricted distribution, so options in choosing prime habitats for preservation are limited. Great extents of the areas identified as suitable protected areas should be augmented to conserve these small carnivores.

Published research (Guan et al., 2003) has so far implicated the masked palm civet (*Paguma larvata*), as possible sources of SARS-like coronaviruses. The masked
palm civet, common palm civet and small Indian civet are the species most commonly found in wildlife restaurants across the southeast Asia, but all nine species are eaten under the generic label of ‘civet meat’ (Bell et al., 2004). It is also worth noting that within the three subfamilies of viverrids represented across Indochina, there are a further 14 African species that are exploited within the African bushmeat trade (Schreiber et al., 1989). In common with a range of other species across this region, several of these small carnivore species are now threatened with extinction as a result of overexploitation at unsustainable levels by an expanding international trade in wildlife. Seven out of 11 viverrids are listed as threatened in the 2000 Vietnam Red Data Book (the large spotted civet, the spotted Linsang, the small-toothed palm civet, the binturong, Owston’s palm civet, Lowe’s otter civet and the Taynguyen civet). The IUCN Species Survival Commision Action Plan for the conservation of viverrids 15 years ago highlighted habitat loss and fragmentation, particularly of tropical moist forests and wetland ecosystems, as the major threats (Schreiber et al., 1989). That important collation of information on the status and conservation requirements of these small carnivore groups flagged the urgent need for population surveys and research into the ecological requirements of these little-studied species. The Action Plan also warned that ‘the impact of hunting was growing with the rapid increase in human populations’, which ‘results in a decrease in habitat quality and the fragmentation of Viverrid population, and that this problem appeared to be greatest in the Upper Guinea rainforests and parts of Asia, such as China, Taiwan and Vietnam (Schreiber et al., 1989). The important point is that 20 years ago, even in Africa, while other ‘more important’ wildlife species were often sold by hunters at local markets, these small carnivore species tended to be consumed at home and were therefore regarded as opportunistically hunted subsistence food. Whether viverrids will survive in degraded or alternative habitats is of crucial importance for further conservation planning.

1.4 Herpestids

The members of the family Herpestidae are characterized by the uniquely derived nature of their anal sac and the structure of the auditory bulla (Wozencraft 1989). They are distinguished from the members of the family Viverridae by the presence of a naked glandular pouch around the anus, with the anal glands opening
into the pouch. They have long non-retractile and fossorial claws. The ears have no marginal bursa. The penis, which although short as compared to viverrids, has a well developed baculum and is without penile glands (Pocock 1939). In Herpestids, the total length (head, body and tail) varies from 200 to 1600 mm and the weight varies from around 340 gm. Mongooses are among those that are able to open hard-shelled food such as eggs, mollusks and crustaceans. The striped-necked mongoose (*Herpestes vitticollis*) is the largest Asiatic mongoose. Mongooses are terrestrial in nature and have a diverse diet including small mammals, birds, reptiles, crabs, fish and insects. They are mostly gregarious and a few are solitary too. The family Herpestidae is divided into three subfamilies Galiiinae, Herpestinae and Mungotinae (Wozencraft 1989). They occur in most of Africa and Asia. In India the family Herpestidae is represented by subfamily Herpestinae with seven species. Most ecological information on mongooses is available from North America and Madagascar, where introductions resulted in the species becoming invasive where densities can be expected to be fairly high. Mongooses were introduced to a variety of islands which lacked suitable predators to control agricultural pests or snakes; in several cases, especially on some Caribbean islands, they demonstrated the risks of biological pest control by not only killing selected pest targets, but also devastating native endemic species not adapted to coping with efficient predators. Ancient Egyptians kept the ichneumon (*Herpestes ichneumon*) to kill snakes. *Herpestes* had a great impact on ancient Egyptian thinking. The advent of poultry breeding to which mongooses were detrimental and thought to be the cause for the decrease in the numbers of ichneumons kept in the houses of north Africa. Mongooses also featured prominently in the Middle and Far Eastern religions, frequently as guardians of wealth.

The collared mongoose (*Herpestes semitorquatus*) is brightly coloured and occurs only in Sumatra and Borneo, small Indian mongoose (*Herpestes javanicus*) in Mauritius was found to have a mean home range of 0.77 km² (0.25–1.10) (Roy et al., 2002). Cape grey mongoose home range was found between 0.21-0.63 km² (Cavallini and Nel 1990). *Herpestes auropunctatus*, had a large proportion of fruits, vegetation and insects in the diet (0.85), with home ranges of 0.31 km² (Gittleman and Harvey 1981). Mean estimated density is only available for introduced populations of the small Indian mongoose, and as a result are likely to be higher than densities in range habitats. However, since density estimates from range countries are lacking, these
may prove to be helpful priors: 6.4 animals per hectare in St. Croix, 2.4/ha in Jamaica and 4.6/ha in Puerto Rico (Horst et al., 2001) or 1.8 animals/ha using capture-recapture estimates in the West Indies (Corn and Conroy 1998). The yellow mongoose (Cynictis penicillata) dens together with conspecifics in groups ranged between two to 13 individuals in size, but individuals typically forage alone or in pairs (Rasa et al., 1992, Cavallini 1993). Females are polyestrous, occasionally giving birth to two litters per season, and young typically disperse during spring (Rasa et al., 1992). In South Africa yellow mongooses occupy large number of bolt-holes and burrows (Manser and Bell 2004).

1.5 Study species

1.5.1 Jungle cat

_Distribution and status_

_Felis chaus_ is listed as Least Concern in the IUCN Red List of Threatened Species as it is widespread and common particularly in India. Once thought it to be closely related to the lynx, which share its characteristic traits of tufted ears, long limbs and a short tail (Sunquist and Sunquist 2002), but it is actually a close relative of the domestic cat. A wide range of subspecies (recognized nine) have been proposed by Wozencraft (2005).

The jungle cat has a broad but patchy distribution. Population decline and range contraction are of concern, particularly in Egypt, in the Caucasus, and in the southwestern, central and Southeast Asia. In India, it is the most common small cat (Mukherjee and Groves 2007). They inhabit savannas, tropical dry forests and reedbeds along rivers and lakes in the lowlands and are rare in rainforests. Although they are adaptable animals, being found even in dry steppe, they prefer wetland environments with tall grasses or reeds in which to hide. They do not survive well in cold climates, and are not found in areas where winter snowfall is common (Sunquist and Sunquist 2002). They have been observed from sea levels to altitudes of 8000 ft (2400 m) or perhaps higher in the Himalayas. They frequent jungles or open country, and are often seen in the neighborhood of villages (Blanford 1888–91). They live in altitudes up to 2500 m (8200 ft), but are more common in the lowlands.
Even though jungle cats were known to be absent from the Malayan peninsula, south of the Isthmus of Kra, the possibility of occurrence of the species was reported from a highly fragmented forest in the Malaysian state of Selangor (Sanei and Zakaria 2010). In the 1970s, Southeast Asian jungle cats still used to be the most common wild cats near villages in certain parts of northern Thailand and occurred in many protected areas of the country (Lekagul and McNeely 1988). But since the early 1990s, jungle cats are rarely encountered and have suffered drastic decline due to hunting and habitat destruction. Today, their official Thai status is critically endangered (Lynam et al., 2006). In Cambodia, Laos and Vietnam, jungle cats probably once occurred widely in the secondary habitats, which is easily accessible to hunters and where hunting pressure is now very heavy. Due to unselective trapping and snaring, jungle cats appear quite rare nowadays in comparison to sympatric small cats. Skins are occasionally recorded in border markets, and live individuals, possibly taken from Myanmar or Cambodia, occasionally turn up in the Khao Khieo and Chiang Mai zoos of Thailand (Duckworth et al., 2005).

Jungle cats are rare in the Middle East. In Jordan, they are highly affected by the expansion of agricultural areas around the river beds of Yarmouk and Jordan rivers, where they are hunted and poisoned by farmers for attacking poultry (Abu-Baker et al., 2003). In Afghanistan they are also considered rare and threatened (Habibi 2003). In Europe, it is of marginal occurrence, with small populations in Cis-Caspian region and the Caucasus along the Caspian Sea. The European population has been rapidly declining since the 1960s. There was no record of this species in Astrakhan State Reserve (Russian Federation) since the 1980s. Marked population fluctuations are characteristic of this species in this region, probably because of absence of adaptations to cold winters. Despite these fluctuations the long-term trend in Europe is of decline in both population and area of occupancy. Data from Russia suggest that there are about 500 animals left in the wild (Prisazhnyuk and Belousova 2007). A very small population persists in Georgia (Duckworth et al., 2008a). This species is considered threatened in a number of range states in Europe and the Caucasus, and is included in the Red Books of the Russian Federation, Armenia, Azerbaijan and Georgia (IUCN 2007).
Ecology and behavior

Jungle cats are generally solitary in nature. They rest in abandoned burrows, tree holes, and humid caves under swamp rocks, or in areas of dense vegetation. Although often active at night, they are less nocturnal than many other cats, and in cold weather may even bask on a sunny day. Allayarov (1964) detected and identified two jungle cat burrows as small holes inside dense reed thickets lined with old cane leaves and fur along rivers in Uzbekistan. They have been estimated to travel between 3 and 6 km (1.9 and 3.7 mi) per night, although this likely varies depending on the availability of prey. There is a striking difference in body size of jungle cats in the west and the east of their distribution, with Israeli cats being 43% heavier than Indian cats (Mukherjee and Groves 2007). Territories are maintained by urine spraying and scent marking (Sunquist and Sunquist 2002). Tehsin (1996) reported that in Rajasthan, a sick jungle cat approached the bushes, ripped the leaves of Eclipta alba (Compositae), swallowed them and then walked some distance away, stretched and puked the food. Besides it is noted in Indian medical records this plant was used in liver disorders, regulating gall bladder glands, hepatitis and digestion. Tehsin and Tehsin (1988) also reported that in Rajasthan, it was observed hiding inside bushes, waiting for a jungle fowl’s arrival, caught one of them and disappeared inside the dense bushes.

Somewhat larger than domestic cats, jungle cats range from 55 to 94 cm (22 to 37 in) in length, plus a relatively short 20 to 31 cm (7.9 to 12 in) tail, and stand about 36 cm (14 in) tall. Weight varies across the range from 3 to 12 kg. In Uzbekistan, they are known to travel 5 to 6 km (Allayarov 1964). In captivity pregnancy period is about 63-68 days (Green 1991), the birth interval is 93-131 days (Schauenberg 1979). Vertical bars are visible on the fur of kittens, which disappear in adult cats, although a few dark markings may be retained on the limbs or tail.

Areas with extensive deciduous Dipterocarp forest and at least scattered surface water are the species predominant known habitat in Indochina. However, areas such as the Nakai Plateau which support other forms of savanna-like vegetation may support the species. It is probably rare from all closed canopy forests like rainforest. The species may make use of agricultural areas with a low intensity of human use and which retain patches of scrub (Duckworth et al., 2005). In sandy and
Jungle cats have adapted well to irrigated cultivation, having been observed in many different types of agricultural and forest plantations throughout their range, such as sugar cane plantations in India (Tikader 1983, Khan and Beg 1986). In Israel they can be found around pisciculture ponds and irrigation ditches. Vereschagin (1959) noted that the jungle cat's use of the semi-arid plains of Azerbaijan increased with the development of a local irrigation system and decreased with its abandonment. However, moving the seasonally flooded riverine tugai vegetation (trees and shrubs with dense stands of tall reeds and grasses) of this region for livestock fodder, as well as plowing it under for agriculture, is known to be associated with the decline of jungle cat populations in the European-central Asian parts of its range (Nowell and Jackson 1996).

Jungle cats feed mainly on prey that weighs less than a kilogram. Small mammals, principally rodents, are the prey most frequently found in fecal contents (Gupta 2011). An earlier study in India's Sariska Tiger Reserve estimated that jungle cats eat three to five rodents per day (Mukherjee et al., 2004). Birds rank second in importance, but in southern Russia waterfowl are the main prey of jungle cat diet in the winter. With overwintering populations of waterfowl congregating in large numbers on unfrozen rivers and marshes, the jungle cat hunts among reed beds and along edges of wetlands, searching for injured or weakened birds. Other prey species are taken more opportunistically, including hares, nutria, lizards, snakes, frogs, insects, and fish (Heptner et al., 1992). In India, they have been seen scavenging over kills of large predators such as the Asiatic lion (Duckworth et al., 2008a). In a study in southern Uzbekistan, fruits of the Russian olive made up 17% of their diet in winter (Sunquist and Sunquist 2002). While jungle cats specialize on small prey, they are large and powerful enough to kill even young swine, sub-adult gazelles, and chital fawn (Sunquist and Sunquist 2002, Gupta 2011).

In the reed beds of the Nile delta they hunt water voles, frogs, fish and waterfowl, while in drier habitats they feed on everything from hares, gerbils and house mice to birds, snakes, lizards, and domestic poultry. Known to be active by day and by night, they are often spotted amidst human settlements, denning in old buildings. Their predators even include larger felines and canids such as tiger, leopard and dhole (Ramesh 2010). Jungle cats most often, hunt rodents, birds and frogs. They
have been observed to be capable of swimming as much as 1.5 km at a stretch (Hinde and Hunter 2005). Near human settlements, they may feed on domesticated chicken and ducks. They also exhibit arboreal habits (Heptner et al., 1992). Like most other cats, they hunt by stalking and ambushing their prey, and they use reeds or tall grass as cover. They are adept at leaping, and sometimes attempt to catch birds in flight. Although they can run at up to 32 km/hr (20 mph), they rarely pursue prey that escapes their initial pounce (Sunquist and Sunquist 2002). Water and dense ground cover can be found in a variety of habitats, ranging from desert (where the cat is found near oases or along riverbeds) to grassland, shrubby woodland and dry deciduous forest, as well as cleared areas in moist forest (Nowell and Jackson 1996). Density estimates from natural tugai habitat in central Asia range from 4-15 individuals per 10 km², but where this vegetation type has declined due to development and their density may not exceed two cats per 10 km² (Nowell and Jackson 1996).

Females are sexually mature at the age of 11 months and give birth to litters of one to six kittens, although more than three are relatively unusual. Jungle cats sometimes raise two litters in a year (Heptner et al., 1992). Gestation lasts 63–66 days and is remarkably short for an animal of this size. Birth generally takes place between December and June, depending on the local climate, although females can sometimes give birth to two litters in a year. Before birth, the mother prepares a den in an abandoned animal burrow, hollow tree, or reed bed (Sunquist and Sunquist 2002). Kittens weigh 43 to 160 gms (1.5 to 5.6 oz) at birth, tending to be much smaller in the wild than in captivity. Initially blind and helpless, they open their eyes at ten to thirteen days of age, and are fully weaned by around three months. Males usually do not participate in the raising of kittens, but in captivity have been observed to be very protective of their offspring, more than the females, or males of other cat species. Kittens begin to catch their own prey at around six months, and leave the mother after eight or nine months (Schauenberg 1979, Sunquist and Sunquist 2002).

Principal threats

Unselective trapping, snaring and poisoning around agricultural and settled areas have caused population declines in many areas throughout its range (Abu-Baker et al., 2003, Duckworth et al., 2005). India formerly exported large numbers of jungle
cat skins before the species came under legal protection (over 300,000 were declared as being held by traders from Kashmir there when export was banned in 1979) (Sunquist and Sunquist 2002), as well as in Egypt and Afghanistan (Habibi 2003). Jungle cat skin is used for making hats, locally called ‘’over chamo’’ in Arunachal Pradesh (Solanki and Chutia 2004). This species is often assessed as being in no danger and has therefore been ignored as a rare species. Jungle cats can do well in cultivated landscapes (especially those that lead to increased numbers of rodents) and artificial wetlands. However, reclamation and destruction of natural wetlands, ongoing throughout its range but particularly in the arid areas, still pose a threat to the species, as density in natural wetlands is generally higher (Nowell and Jackson 1996). In fact, in recent years a clearer picture has showed that this species could well be among the rarest of the small cats in Asia, and definitely the rarest one for which there is no protection within most of its current distribution since it is assumed to be common.

**Conservation measures**

The jungle cat is listed on CITES Appendix II. It is protected from hunting in some range states (India), but in many it receives no legal protection outside protected areas (Nowell and Jackson 1996). The species now receives legal protection from all hunting and trading within Afghanistan after being placed on the country’s 2009 Protected Species List. Furthermore, given the amount of habitat loss occurring in riparian and wetland areas in Afghanistan, this species should be considered a research priority.

The ecology and status of the jungle cat is still poorly known (Nowell and Jackson 1996, Sunquist and Sunquist 2002). In Southwest and Southeast Asia, where it is considered rare and declining, more research needs to be undertaken to gain knowledge of current distribution, both in and outside Protected Areas (Abu-Baker et al., 2003, Duckworth et al., 2005). The jungle cat would also benefit from improved protection of natural wetlands and reed-beds, particularly in the more arid parts of its range, and improved legislation prohibiting fur trade. Some farmers consider the jungle cat a pest since it takes away poultry (Abu-Baker et al., 2003), hence conservation measures should include protection for domestic fowl and halting of indiscriminate poisoning and trapping of jungle cat. It is imperative to observe
feeding habits of the jungle cat to find out the reasons for their dependency on domesticated animals, when in reality there could be plenty of prey available.

1.5.2 Rusty-spotted cat

**Distribution status**

The Rusty-spotted Cat (*Prionailurus rubiginosus*) is Felidae’s smallest member and found only in India and Sri Lanka (Pocock 1939). It has been listed as Vulnerable by IUCN in 2002 as the total effective population size is below 10,000 mature individuals with a declining trend due to habitat loss, and no subpopulation containing more than 1,000 mature breeding individuals (Khan and Mukherjee 2008). The Indian population is listed on CITES Appendix I. The Sri Lankan population is included in CITES Appendix II. The species is fully protected over most of its range, with hunting and trade banned in India and Sri Lanka (Khan and Mukherjee 2008). The rusty-spotted cat rivals the black-footed cat as the world's smallest wild cat. It is smaller than a domestic cat. It is 35 to 48 cm (14 to 19 in) in length, with a 15 to 30 cm (5.9 to 12 in) tail, and weighs only 0.9 to 1.6 kg (2.0 to 3.5 lb). Males weigh about 1.5 to 1.6 kg, and females weigh 1.1 kg (Phillips 1935). The short fur is grey over most of the body, with rusty spots over the back and flanks, while the underbelly is white with large dark spots. The darker colored tail is thick and about half the length of the body, and the spots are less distinct. The tail averages about 50% of head-body length (Pocock 1939). There are six dark streaks on each side of the head, extending over the cheeks and forehead (Sunquist and Sunquist 2002). Rusty-spotted cats have been observed frequently by researchers (Kittle and Watson 2004, Manakadan and Sivakumar 2006, Patel 2006, Vyas et al., 2007).

Rusty-spotted cats have a relatively restricted distribution. They mainly occur in moist and dry deciduous forests as well as scrub and grassland, but are likely to be absent from evergreen forest (Nowell and Jackson 1996). They prefer dense vegetation and rocky areas (Kittle and Watson 2004, Patel 2006). It is difficult to say whether distribution is continuous throughout India because the species’ habitat preferences are poorly understood. In Sri Lanka, Phillips (1935) stated that “it is rarely seen far away from jungles”, while De Alwis (1973) terms it “the ubiquitous wildcat of Ceylon” equally comfortable in the high montane forests of Horton Plains.
(2135 m) or the sizzling sandy wastes of the Hambantota coastline”. In India, Prater (1971) described its habitat as grassland, scrub and forest. Similarly, residents of 45 villages in the Dangs semi-evergreen forest described its habitat as rocky areas and hill slopes, but not forest edges (Worah 1991).

Perhaps these seeming inconsistencies can be explained in terms of interspecific competition or ecological separation, although this subject has scarcely been investigated for the small tropical Asian cats. The closely related leopard cat is found throughout much of India, but is absent from Sri Lanka. It is possible that the rusty-spotted cat is the more common of the two species in the drier, more open vegetation types of India (Athreya 2010), while the leopard cat predominate moist forests. This would explain the concentration of rusty-spotted cat records in southern India, and the infrequent and seemingly isolated reports from more northern regions. Rusty-spotted cats can tolerate modified habitats; females with kittens have been found denning in tea plantations of Sri Lanka (Phillips 1935), and in the attics of houses in southern India, areas surrounded by paddy fields and coconut plantations. In the latter case, it was noted that the species was virtually unknown to local residents. A rusty-spotted cat was photographed in 1993 in an old farm house in a mango plantation in Bansa National Park in Gujarat. It was also observed on a tree in Gir Wildlife Sanctuary (Mitra 2005). According to Karanth (1993), these cats can be found in farmland throughout southern India’s Deccan Plateau, and in the outskirts of Bangalore city.

In India, they were long thought to be confined to the south, but records have established that they are found over much of the country (Kittle and Watson 2004). They were observed in Gir Wildlife Sanctuary and National Park, Tadoba-Andhari Tiger Reserve in Maharashtra, on India's east coast, and in eastern Gujarat (Pathak 1990, Dubey 1999, Manakadan and Sivakumar 2006, Patel 2006). Camera trapping revealed their presence in the Pilibhit Tiger Reserve in the Indian Terai and the Nagzira Wildlife Sanctuary in Maharashtra (Anwar et al., 2010, Patel 2010). In western Maharashtra, there is a breeding population of rusty-spotted cats in a human dominated agricultural landscape, where rodent densities are high (Athreya 2010).

In Sri Lanka, there are a few records from montane and lowland rainforest. There are two distinct populations, one in the dry zone and the other in the wet zone (Deraniyagala 1956). As indicated by the patchy and infrequent nature of collections
and observations this remains speculative until basic natural history studies have been carried out.

**Ecology and behaviour**

Very little is known of the rusty-spotted cat’s behavior in the wild. They are apparently nocturnal (Chakraborty 1978, Pathak 1990) and partly arboreal, spending the day resting in dense cover or shelter such as hollow logs. It feeds mainly on rodents, birds, lizards, frogs, or insects. The diet of the rusty-spotted cat has not been properly documented; Phillips (1935) reported without elaboration that it feeds upon small mammals and birds. Local people in both Sri Lanka and India have reported that they are most visible after heavy rain, when they emerge to feed on rodents and frogs (de Alwis 1973, Worah 1991). They are known to prey on domestic poultry (Phillips 1935, Pocock 1939).

While dense vegetation and rocky areas are preferred (Worah 1991, Kittle and Watson 2004, Patel 2006), rusty-spotted cats have been found in the midst of agricultural and settled areas (Nowell and Jackson 1996, Mukherjee 1998, Nekaris 2003). They are highly arboreal (Sunquist and Sunquist 2002), and Patel (2006) observed cats pouncing down from tree branches when hunting prey. Most observations were in the night (Mukherjee 1998, Nekaris 2003, Kittle and Watson 2004, Patel 2006, Vyas et al., 2007). Once it was seen hunting frogs, but small rodents as the main prey were reported from a series of observations by Patel (2006) and Nekaris (2003); seeking out such prey is likely why the cats venture into cultivated areas. The animal was sighted in Nugu, at 1950 hrs, on a fig tree (*Ficus bengalensis*) at a height of about 5 m, the tree was 16 m tall and another sighted in Bandipur National Park and one in Sira of Tumkur (Kumara and Singh 2007). The other sighting at three and a half kilometers from Sira town in Karnataka was near a roadside Tamarind tree (*Tamarindus indica*) at 23:30 hrs (Kumara and Singh 2007). It was at a height of about 2 m, the tree was about 6 m tall. The cat remained on the tree for about 5 min until it moved to another branch, due to disturbance. The sighting locality was close to human habitations, which was adjacent to a reserved forest. The general forest type of the region is dry scrub or dry deciduous.

Oestrus usually lasts for five days. The mother prepares a den in a secluded location, and gives birth to one or two kittens after a 65-70 day gestation. At birth, the
kittens weigh just 60 to 77 g (2.1 to 2.7 oz), and are marked with rows of black spots. The cat reaches sexual maturity at around 68 weeks, by which time it has developed the distinctive adult coat pattern of rusty blotches. Adults weigh about 0.9 kg (Sunquist and Sunquist 2002). Rusty-spotted cats have lived for twelve years in captivity, but their lifespan in the wild is unknown (Pocock 1939).

**Principal Threats**

Habitat loss and the spread of cultivation are serious problems for wildlife in both India and Sri Lanka. Although there are several records of rusty-spotted cats from cultivated and settled areas, it is not known to what degree cat populations are able to persist in such areas. There have been occasional reports of rusty-spotted cat skins in trade (Nowell and Jackson 1996). In some areas, they are hunted for food or as livestock pests (Sunquist and Sunquist 2002).

Deforestation and the spread of cultivation are serious problems for wildlife in both India and Sri Lanka. As far as rusty-spotted cats are concerned, it is not known if populations can persist in cultivated landscapes, and individuals taking poultry are vulnerable to persecution. A long coat made of rusty-spotted cat fur was found for sale in Kathmandu, Nepal (Van Gruisen and Sinclair 1992). Early reports on rusty-spotted cats refer to hybridization with domestic cats as common occurrences, but they have not been substantiated.

1.5.3 **Leopard cat**

**Distribution and status**

The leopard cat is a widespread and relatively common species (Nowell and Jackson 1996, Sunquist and Sunquist 2002), although some island subspecies are included in the Red List. Although there is a declining population trend in parts of its range due to habitat loss and hunting, the species is stable in many areas, even thriving in some altered habitats including oil palm and sugar cane plantations (IUCN 2007).

The leopard cat is a widespread in Asia (Nowell and Jackson 1996, Duckworth et al., 1999, Holden 2001, Duckworth et al., 2005, Lynam et al., 2006,
Yasuda et al., 2007). It is found throughout most of India, west into Pakistan and Afghanistan (Habibi 2003), through the Himalayan foothills, across most of China, and north to the Korean peninsula and into the Russian Far East (Nowell and Jackson 1996). It is found throughout Southeast Asia, and on the islands of Sumatra, Java, Borneo and Taiwan. It is found on numerous small offshore islands of mainland Asia (Nowell and Jackson 1996, Sunquist and Sunquist 2002). The leopard cat is the only wild felid found in Japan, where it occurs on the small islands of Tsushima and Iriomote, and the Philippines, where it occurs on the islands of Palawan, Panay, Negros and Cebu. In the Philippines, there are recent (2007) unconfirmed reports from the island of Masbate.

Higher survival rates (92%) of this species were recorded in a protected area with little human influence, compared with lower rates in areas with greater human activity (53-82%) (Haines et al., 2004). The small population (approximately 100) of leopard cat on Japan's 710 km² Tsushima Island, considered the subspecies as occurs in northeastern mainland Asia, has decreased over the last 30-40 years (Izawa et al., 2007). It has been reported to occur in some reserves of Karnataka (Karanth 1986). It was sighted in Sharavathi Valley Wildlife Sanctuary, Bandipur Tiger Reserve, Talakavari Wildlife Sanctuary, Pushpagiri Wildlife Sanctuary and in a coffee estate in Virajpet adjacent to Brahmagiri Wildlife Sanctuary in Kodagu district (Kumara and Singh 2007). The species was quite common in Kodagu and fringes of coffee estate adjacent to Bhadra Wildlife Sanctuary in Chikmagalur.

**Ecology and behaviour**

The species can range up to 3000 m in parts of its range which extends into the Himalayas along river valleys. It occurs in a broad spectrum of habitats, from tropical rainforest to temperate broadleaf and marginally, coniferous forest, as well as shrub forest and successional grasslands. The northern boundaries of its range are limited by snow cover; the leopard cat avoids areas where snow is more than 10 cm deep. It is not found in the cold steppe grasslands, and generally does not occur in arid zones, although there are a few records from relatively dry and barren areas of Pakistan. Leopard cats occur commonly in dense secondary growth, including logged areas, and have been found in agricultural and forest (rubber tree, oil palm, sugarcane) plantations. The species can live close to rural settlements. Leopard cats are excellent
swimmers, and have successfully colonized offshore islands throughout their range (Nowell and Jackson 1996, Sunquist and Sunquist 2002).

In the most comprehensive study, based on a large sample size of 20 radio-collared cats in Thailand's Phu Khieu Wildlife Sanctuary, mean home range size (95% MCP) was 12.7 km², larger than in other areas of Thailand (4.5 km²) (Grassman et al., 2005), Borneo (3.5 km²: Rajaratnam 2000), or on Japan's Iriomote island (Schmidt et al., 2003). There was no significant difference between male and female home range size. Males weigh (mean ± SD) 2.9 ± 0.38 kg and females weigh 2.3 ± 0.27 kg in Thailand (Grassman et al., 2005). Open and closed forest habitats were used in proportion to their occurrence, and activity patterns showed crepuscular and nocturnal peaks. In Borneo, Rajaratnam et al., (2007) found that leopard cats hunted rodents in oil palm plantations, and used forest fragments for resting and breeding. Murids dominated the diet (85-90%: Grassman et al., 2005, Rajaratnam et al., 2007). Other small mammals, eels and fish have also been reported in their diet as well as occasional scavenging on carrion (Nowell and Jackson 1996).

**Principal threats**

Until banned in 1988 leopard cat skins were widely exported from China to Western Europe, after which they were exported to Japan. Between 1984 and 1989 China exported c. 2,00,000 skins a year and stockpiles were estimated at over 8,00,000. Collected by specialist hunting tribes, the skins were usually sent to Kashmir to be fashioned into garments for export and for Indian markets. Following violent political unrest in Kashmir, traders established a market in Kathmandu which benefits from tourism. Although commercial trade is much reduced, the species continues to be hunted throughout most of its range for fur, food, and as pets. They are also widely viewed as poultry pests and killed in retribution. Island populations are small and seriously threatened in the Philippines and Japan. Leopard cats can hybridize with domestic cats, as is shown by the popular domestic breed, the "safari cat". Hybridization in the wild has been reported, but is not considered a significant threat. Although the species is less dependent on forest cover than others, habitat loss and fragmentation is still a major threat across most of its Asian range (Nowell and Jackson 1996).
Conservation measures

Included on CITES Appendix II; populations in Bangladesh, India and Thailand are included on Appendix I. The species is protected at the national level over part of its range, with hunting prohibited in Bangladesh, Cambodia, Hong Kong, India, Indonesia, Japan, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Russia, Thailand and Taiwan, and hunting and trade regulations in place in South Korea, Lao PDR and Singapore (Nowell and Jackson 1996). The species is on Afghanistan’s 2009 Protected Species List, banning all hunting and trading of this species within the country.

1.5.4 Small Indian civet

Distribution and status

The Small Indian Civet (*Viverricula indica*) is found across south and Southeast Asia as well as in the Indonesian archipelago. This species is listed as Least Concern due to its widespread geographical distribution and habitat use, with evidence from many range states of healthy populations in agricultural/secondary landscapes. Some populations may be locally depressed by snaring/hunting but not to the extent of threatening the species. It persists in the face of heavy hunting that has wiped out some other ground-dwelling species, and it is mainly an open-forest and edge species, so that it has probably benefited from the rampant forest conversion of the last century in Southeast Asia. There are no recent records for Sumatra, but it is possible that the species was not native there.

This species is currently known to occur in south and central China (Wang and Fuller 2001, 2004), Hong Kong (Suen 2002), most of India (Mudappa 2002), Lao PDR (Duckworth 1997), Myanmar (Su Su 2005), Thailand (Rabinowitz 1991, Austin and Tewes, 1999), Vietnam (Roberton 2007), Cambodia and Sri Lanka (Duckworth et al., 2008b). It was formerly known from Singapore but its current status there is unclear. Corbet and Hill (1992) include all of Sumatra for the species' distribution range, but only four individuals are known, all from one locality in the far north. Other records from Sumatra have not been seen, and it is suggested to restrict its range to the north, and the lack of recent records from Sumatra is still puzzling.
(Duckworth et al., 2008b). It has been introduced to Madagascar (Lekagul and McNeely 1977), Socotra (Pocock 1939) and Zanzibar. The current status of these introduced populations is also poorly known.

The population status of this species is less well known than other Southeast Asian small carnivores, because recent survey efforts have not been appropriate for assessing the species. This is best shown by records from Myanmar. Su Su (2005) found that it was the second most common species of small carnivore recorded in Hlawga Wildlife Park in Myanmar, a secondary small isolate of semi-natural habitat in the outskirts of Yangon, a former capital city, subject to barely controlled snaring and other forms of encroachment, where only one other species of small carnivore persists in significant numbers. The habitat degradation and hunting patterns in Myanmar where the species is common are representative of much of non-Sundaic Southeast Asia, and incidental records from various other sites (Duckworth and Robichaud 2005) imply large populations in total, although it is likely that in Vietnam and Lao at least populations will have been somewhat depleted by snaring. In Cambodia, where more camera-trapping has taken place in deciduous forest areas, it is commonly camera trapped. The same factor was suspected to be responsible for the relatively few recent records from Lao PDR (Duckworth et al., 1999), and may also have generated earlier remarks such as in Thailand, this species is rather rare (Lekagul and McNeely 1977); in fact, it is common in the degraded parts of Khao Yai national park. It is also abundant over large areas of India. It is common in deciduous forests of Dak Lak, Vietnam (Le Xuan Canh et al., 1997) and more widely in the country (Roberton 2007). No information has been sought for the Sundaic populations except for Sumatra, where the species status has always been unclear.

**Ecology and behaviour**

This species has been recorded in semi-evergreen and deciduous, mixed deciduous, bamboo, scrubby areas, grasslands and riverine habitat (Duckworth 1997, Le Xuan Canh et al., 1997, Mudappa 2002, Su Su 2005). The species measures 100 cm in body length (including a tail length of 38 cm) and 2.5 kg in body weight (Kumar and Umapathy 1999). This species is nocturnal and mostly terrestrial (Mudappa 2002). An adult male was radio-tracked in Thailand and had a home range of 3.1 km² (Rabinowitz 1991). The niche of *V. indica* in Myanmar is that of a solitary,
nocturnal predator of small vertebrates and arthropods, that forages widely at ground level in different habitat types and rests during daytime in dense shrubbery near the ground (Su and Sale 2007). In Lao PDR, this species is found in semi-evergreen and deciduous forest including adjacent degraded areas (Duckworth et al., 1999). In other countries it is tolerant of habitat degradation and lives in proximity to human communities (Lekagul and McNeely 1988) and an active avoidance of closed evergreen forest was shown in Myanmar (Than Zaw et al., 2008). In Thailand, it is mostly found in long grass or scrub habitat, particularly in areas near villages, where it may live in drains, outhouses, and roofs, eating domestic poultry (Su Su 2005) as well as rats, mice, birds, snakes, fruit, and roots, as well as carrion (Lekagul and McNeely 1988). It produces a litter of three to five, and the life span is eight to nine years (Lekagul and McNeely 1988). In Myanmar this species was recorded from both mixed deciduous forest and bamboo forest (Su Su 2005). This species was rarely seen in the undisturbed rainforests of Kalakad-Mundanthurai Tiger Reserve (KMTR) in India, and was mostly seen near garbage dumps (Mudappa 2002). In KMTR they were not camera-trapped frequently in rainforests, but were the most camera-trapped species in grasslands and riverine habitat (Mudappa 2002, Ramesh et al., 2012). This species is nocturnal, and mostly terrestrial and insectivorous. Wang and Fuller (2001) conducted a study on the ecology of this species near Taohong Village in northern Jiangxi Province, southeastern China, from April 1993 to November 1994. Wang and Fuller (2003) conducted a study on the food habits of this species in a rural agricultural area of southeastern China (Taohong Village, Jiangxi Province) by analyzing its scats, the study was conducted between June 1992 and November 1994, and reported that this species ate mostly mammals, with moderate insects and plants.

**Principal threats**

The extent to which extensive habitat loss and degradation are a threat to this species remains unclear as in most or all of its range areas it is more common in altered landscapes than in closed-canopy old-growth evergreen forest. This species is hunted for its meat and scent (Gupta 2004) in some portions of its range which potentially might reduce populations. Ground-dwelling small carnivores are exposed to hunting, particularly with snares. This is occurring in much of its range, including Lao PDR (Duckworth 1997) and Thailand, with snaring found even in some protected
areas. There has been an increased demand for civet meat in Chinese and Vietnamese markets (Bell et al., 2004, Lynam et al., 2006). In India animals are in captivity for collection of ‘civet’, a fixative used internationally in the perfume industry and domestically for various purposes; even in areas of heavy collection, the animals remain common in the degraded forest, scrub and agricultural landscapes covering most of peninsular India. The converse seems to be true: it remains more common than most other species of small carnivores in heavily encroached areas of southern China, than Myanmar (Su Su 2005).

**Conservation measures**

In Myanmar, this species is totally protected under the Wildlife Act of 1994 (Su Su 2005). This species is listed in Category II of the China Wildlife Protection Law (1988) (Li et al., 2000) and as ‘Vulnerable’ in the China Red List (Wang and Xie 2004). It is listed on CITES Appendix III (India). It has been recorded in many Protected Areas (Duckworth 1997, Mudappa 2002, Su Su 2005).

**1.5.5 Common palm civet**

**Distribution and status**

It is normally found in Ceylon, Bangladesh, Brunei Darussalam, Singapore, Myanmar, India and Pakistan, Burma and Southern China, south to Sumatra and Java, east to the Philippines, Borneo, Celebes and the Lesser Sunda Island. In Malaysia, the common palm civets are wide spread on the mainland, in Langkawi, Pulau Penang, and Pulau Tioman. Kumara and Singh (2007) sighted 32 animals; the sightings included two animals each in Brahmagiri-Makut and Sirsi-Honnavara, nine animals in Nagarahole, five animals in Chamundi hill, three animals each in Sharavathi Valley Wildlife Sanctuary and Bandipur National Park, and four animals each in Talakaveri Wildlife Sanctuary and Pushpagiri Wildlife Sanctuary. Although 15 animals were sighted in the Western Ghats region, the sightings were mostly from moist deciduous or deciduous forests.
Ecology and behavior

*Paradoxurus hermaphroditus* live in tropical forests, plantations, fruit orchards and often finds its way into human settlements. This species often colonizes the eaves of houses or outbuildings. During the day, palm civets most often rest in trees covered with heavy vines; they also rest in tree cavities and occasionally in tall trees (Joshi et al., 1995). Palm civets forage exclusively at night. The likelihood of encountering predators during the day may favour nocturnal foraging behavior. They are also expert climbers and spend most of their lives in trees. Palm civets choose the tallest and largest tree in the immediate area. It exhibits considerable overlap of ranges among conspecifics. Social organization and activity patterns of these civets are shaped by the distribution of food resources and the activities of larger mammalian predators. This species is more arboreal than the larger Indian civet. Non-overlapping territories often occur when food resources are evenly distributed and defense is uneconomical when food resources are superabundant. When foraging in the same area, civets repeatedly use the same resting trees. Resting trees with vines and holes, preferred by the civets, are used for several consecutive days. When they are threatened, they usually hiss and spit like cats. They have often been observed to breed in house roofs in coastal plains of Udupi, and also in dry plains, such as Bidar district in Karnataka with little forest, however, they are very rare or absent in areas completely bare and without any vegetation (Kumara and Singh 2007). Pillay (2009) sighted two pairs of common palm civet in Anamalai Tiger Reserve on the road from Anamalai town to Valparai, three pairs at different locations in Chinnar Wildlife Sanctuary, while driving along the road from Marayoor town to Chinnar; all these sightings occurred in dry deciduous habitats.

They are identified by the three dark stripes along the back, on a creamy or dark grey background, and by the dark mask across the eyes and muzzle. It weighs from 4 to 11 pounds (1.8 to 5 kg). Their head and body length is approx. 17 to 28 inches (43.2 to 71cm). Pinnae are small and faintly pointed muzzle. It has a long body with short legs. They have coarse grayish to brown coat with black-tipped guard hairs. Three rows of black spots run along each side of its body. This species is known to occur in secondary forests, fruit orchards, near villages or in the tops of trees close to human habitation, indeed it sometimes inhabits the roof spaces of rural properties. They usually nest, however, in hollow trees where they raise two or three young.
Palm civets are primarily frugivorous, feeding on berries and pulpy fruits, including those of *Ficus* trees and palms (Shanahan et al., 2001). The niche of *P. hermaphroditus* in a regenerated degraded forest in Myanmar is summarized as that of a small, solitary, nocturnal frugivore which mostly feeds and rests in the canopy of trees typical of mixed deciduous forest (Su and Sale 2007). They generally eat small vertebrates, insects and ripe fruits. Besides that, they are very fond of palm sap, therefore their common name is also called the Toddy cat for its apparent fondness for sucking the sap from palm trees; the same sap is used to make the alcoholic drink called 'toddy'.

The sap is used by natives to make sweet liquor called “toddy”, which gives the palm civet its common name – Toddy Cat. The palm civet is also fond of coffee cherries. They eat the outer fruit and the coffee beans pass through their digestive tract. Palm civet’s natural diet includes flesh and large number of wild fruits. Toddy cat reproduce throughout the year although it has been recorded that kittens are mostly found from October to December. During the brief periods of mating and when the females have their young, the civets occupy resting trees together. Normally, kittens are born in a litter of 2 to 5 young. They are usually born in a hollow tree, boulder crevices or a space among the rocks. Their eyes are closed at birth. Sexual maturity is attained at 11 – 12 months. In captivity, the common palm civet can live up to 22 years.

**Principal threats**

The common palm civets are often killed by fruit agriculturalists. In south India they are often live trapped since they are considered as pests in coconut plantations, coffee estates and orchards. The civets produce secretion that is sweet, musky and pleasant to human nose. Therefore, civets are hunted for their musk which is gathered by scraping the civets’ anal sac. This species is also prized for their meat in South-east Asia.

**Conservation measures**

The habitat of palm civets can be saved by preventing over-logging activities in rainforests. Local hunting and habitat loss are the major factors affecting the status
and distribution of small carnivore species. The government must continue to monitor logging activities. Understanding utilization of wild natural food will allow better maintenance of species in captivity, with breeding populations to reduce the potential pressure on natural populations (Balakrishnan 2000). The economic importance of civets is yet to be explored in India. In addition, road network with busy traffic in forest areas has led to many road kills of civets (Sheshadri and Ganesh 2011). Habitat disturbance and illegal hunting by the local tribes (Kani and Kurumba) in south India should be investigated in detail. This is an adaptable species that seems to thrive in a variety of environmental conditions from a gradient of disturbed habitats to pristine intact forests.

1.5.6 Brown palm civet

Distribution status

This species is listed as Least Concern because in view of its abundance within highly disturbed and fragmented areas, with many animals living in plantation-dominated landscapes, and its large population known from surveys in several areas. However this species has a restricted distribution, and there is continuing habitat loss and conversion of coffee/cardamom plantations (which hold substantial numbers of the species) into tea (which does not support it), but not at rates nearly sufficient to drive habitat-based population declines even for Near Threatened. Brown palm civets are considered to be restricted to the evergreen forests and the adjacent forests of the Western Ghats, ranging from Brahmagiri in the south to Khanapur (Belgaum district) in the north. These factors mean that the species ought to be monitored may warrant concern in the future; the role of the remaining tall forest fragments as sources for the animals living in artificial habitats is still not clear. Although the species does not currently qualify for Near Threatened there is some concern that it may be declining in some portions of its range. This species is endemic to southern India (Wilson and Reeder 2005), where it is found in the Western Ghats (Pocock 1939, Corbet and Hill 1992, Mudappa 1998). The distribution of this species has been poorly documented due to its nocturnal and arboreal habits. Its population status is poorly known. It is not as rare as it was previously generally believed to be, at least in relatively undisturbed rainforest (Mudappa 2002). It was the most frequently sighted small carnivore in
Kalakad-Mudanthurai Tiger Reserve (KMTR) between May 1996 and December 1999 (Mudappa 2002). Ryley (1913) found them to be fairly abundant in Coorg, though not nearly as common as Paradoxurus hermaphroditus (Rajamani et al., 2002). It appears to be fairly common in Kakachi-Upper Kodayar (Ganesh 1997) and other areas above 1,000 m within KMTR in the Agasthyamalai hills and Anamalai hills (Mudappa 2001). It was most common in altitudes above 1000 m, though they were seen as low as even 700 m (Mudappa 2002).

**Ecology and behaviour**

It is largely arboreal, nocturnal, and mainly frugivorous, feeding on nearly 40 rainforest trees and liana fruit species, though it does supplement its diet with birds, rodents, and insects (Pocock 1939). It is often found in coffee plantations and elevated (above 500 m) moist forests (Ashraf et al., 1993). Occasionally it will feed on the ground, as indicated by success in live-trapping and camera trapping in KMTR (Mudappa 2002). It is known mostly from tropical rainforests but has also been recorded from coffee estates in Coorg and Anamalais (Ryley 1913, Mudappa 2001). The animal weighed (mean ± SD) 2.4 ± 0.8 kg in KMTR (Mudappa 2001). In a survey conducted in the Western Ghats in 2001-02, 23 sightings of this species were in evergreen forests, including five in high altitude montane evergreen forest or sholas (Rajamani et al., 2002). It was recorded in both undisturbed, large patches of contiguous forest, as well as in fragments surrounded by tea plantations and human habitations. They were recorded on forest trails and along main roads, often exposed to traffic. Rajamani et al., (2002) found that this species may be more dependent on the structure and floristics of forests, rather than altitude.

**Principal threats**

Populations may be threatened by habitat destruction due to mining activities in Kudremukh (which has since been closed by the government), hydroelectric projects in Anamalais, and large-scale plantations of coffee, cardamom, and tea in and around Protected Areas (Ashraf et al., 1993). Hunting is unlikely to be a major threat to this species; however, illegal hunting is still common in privately owned plantations. As it is strictly frugivorous and arboreal, rainforest fragmentation is a
likely threat to this species (Mudappa 2002). It is able to survive in heavily encroached areas provided some fragments remain with relatively unbroken canopy and adequate food resources, such as coffee and cardamom, but not tea, Eucalyptus, or teak (Rajamani et al., 2002).

Conservation measures

This species is listed on CITES Appendix III (Wilson and Reeder 2005), as well as Schedule II part II of the Indian Wildlife (Protection) Act, 1972. This species is likely to be found in 25 protected areas within its distribution (Ashraf et al., 1993). More surveys are needed to determine the abundance and distribution of this species, due to concern about threats from commercial plantations of coffee, tea, *Eucalyptus spp.*, and teak, as well as other development activities (Menon and Bawa 1997). Long-term protection of primary rainforests, both large tracts as well as fragments, is imperative to the conservation of this species. More surveys are urgently needed to determine the true abundance and distribution of this species. More information about possible threats would allow more certainty over its status.

To further our understanding of this species and its current status there is a need to increase the intensity of camera trapping and night surveys in identified areas. Equally important areas will require constant interactions with local communities living to gather information regarding possible sightings. Other methods of increasing information relating to the brown palm civet include creating awareness among the local masses.

1.5.7 Stripe-necked mongoose

Distribution and status

This species is listed as Least Concern due to its wide distribution, presumed large population, occurrence in a number of Protected Areas, tolerance to some degree of habitat modification, and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category. The stripe-necked mongoose is found in Southwest India (Mudappa 1998) and Sri Lanka (Santiapillai et al., 2000). In India, this species is found particularly in the Western Ghats and other hill tracts in
the Nilgiris from Coorg (now Kodagu) to Travancore (Pocock 1939, Prater 1971, Medway 1978, Phillips 1984, Corbet and Hill 1992, Mudappa 1998), and Dharwar, as well as near Bombay (Blanford 1888-1891) to Cape Comorin (Van Rompaey and Jayakumar 2003). In Sri Lanka it is found across a range of elevations from high hills to lowlands, being most common between 400 and 1400 m (Van Rompaey and Jayakumar 2003). Population assessments for the stripe-necked mongoose have been made but these are not recent (Van Rompaey and Jayakumar 2003); nevertheless, the species appears to be relatively common in many areas of its range. In India, it is rare in the northern part of its range, and most abundant in Travancore (Jerdon 1874). It is also common in the Nilgiri and Palni plateaus in the High Wavy Mountains (Hutton 1949), and on the Valparai Plateau in the Anamalai Hills. It is not uncommon in Coorg, although less common than *Herpestes edwardsii* (Van Rompaey and Jayakumar 2003). In Sri Lanka, it used to be fairly common in the higher hills of the Central Provinces, but seems to be declining (Van Rompaey and Jayakumar 2003). It is relatively common in the Sri Lankan interior and is "moderately plentiful" in the Horton Plains area and around Gamaduwa (Van Rompaey and Jayakumar 2003). The species is not uncommon in the low-country dry zone along the banks of the Menik Ganga (Van Rompaey and Jayakumar 2003), and is present, but not common in the wet zone in the Kalutara District (Phillips 1984).

**Ecology and behaviour**

The stripe-necked mongoose has been recorded in deciduous and evergreen forest, swampy clearings, plantations, open scrub and along watercourses (Webb-Peploe 1947, Van Rompaey and Jayakumar 2003). In deciduous forests it is usually found in swampy clearings, along watercourses, and in open scrub (Krishnan 1972) as well as in rice fields. Of the 11 sightings in Protected Areas, seven were in dry deciduous forest, three in moist deciduous forest, and one in a teak plantation. In Valparai, Anamalai Hills, there were a dozen sightings between April and December of 2002, with animals seen foraging along streams in riverine forests and swamps, and also in tea plantations. In Sri Lanka, its distribution may encompass lowland dry zone forest and it is rarely sighted in disturbed areas or close to human settlements however, the species is adaptable and can tolerate relatively high disturbance.
It is more common in the hills than in the lowlands (Hill 1939), and has been found up to 2200 m (Van Rompaey and Jayakumar 2003). It is diurnal and feeds on small mammals, birds, birds' eggs, reptiles, fish, insects, grubs, and roots (Van Rompaey and Jayakumar 2003). The typical litter size is two to three and an animal in captivity was recorded as living for nearly 13 years (Van Rompaey and Jayakumar 2003). Measurements for Indian males (n = 4) are as follows; mean length of head and body is 52.9 cm, mean length of tail is 31.5 cm; weighs upto 1 kg while females (n = 3): mean length of head and body is 47.4 cm, mean length of tail is 29.7 cm weighs 2.7 kg (n = 1) (Pocock 1941). Usually solitary but it’s often observed in pairs. It was often sighted in the early mornings and late evenings along stream beds. Most of the time it was observed digging out grubs from the soft damp soil/mud (Phillips 1984). A stripe necked mongoose has been observed chasing even a small chital (Axis axis) fawn (Krishnan 1972), mouse deer (Moschiola indica) (Johnsingh 1983) or even scavenge on large predator kills (Ramachandran 1985).

**Principal threats**

There are no major threats to the global population of the stripe-necked mongoose, although major threats are present at the local scale in the form of hunting, trade and road kills. This species is hunted for meat that is eaten by several tribes and for its hair that is used for making shaving brushes, paint brushes, and good luck charms (Hanfee and Ahmed 1999). They are also regularly killed by hunting dogs (Webb-Peploe 1947). All mongoose species are in demand for the wildlife trade (Van Rompaey and Jayakumar 2003), however, this threat is regional in scale. The loss of habitat is a threat however, there is likely to be no significant level of population decline at the species scale.

**Conservation measures**

The stripe-necked mongoose is on Schedule IV of the Indian Wildlife (Protection) Act, 1972, and has been recorded from many protected areas throughout its range (Van Rompaey and Jayakumar 2003). The Indian population is listed on CITES Appendix III.
1.5.8  Ruddy mongoose

*Distribution and status*

This species is listed as Least Concern in view of its wide distribution, presumed large population, and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category. The impacts of habitat loss, degradation and hunting on populations are unknown but the population is not suspected to be declining at a rate sufficient to qualify for Near Threatened. This species not only has a wide geographical distribution, but it also occurs in varied vegetation types from arid regions in the plains of northern and western India to high altitudes (> 2000 m) of southern India, as well as in human-dominated agricultural landscapes. More information is needed to determine the true status of this species and there is a need to monitor its trends. The ruddy mongoose is found in southern India: Nilgiri Biosphere Reserve (Yoganand and Kumar 1995), central India and Sri Lanka. There are recent records in northern India from Madhav National Park, Madhya Pradesh, Sariska Tiger Reserve, and Rajasthan. The population status of the ruddy mongoose is unknown, but the species is believed to be common in some forests of central India. Ruddy Mongoose is thought to be absent in coastal and evergreen forests of the Western Ghats. They occur in dry forests and forests with rocky outcrops, and are absent in completely barren areas. Kumara and Singh (2007) sighted five animals in Nagarahole, three in Bandipur National Park, one in Hasanur forests in Chamarajnagar and Savandurga forests in Magadi of Bangalore district, and six in Daroji Bear Sanctuary in Bellary district. All sightings were either in the morning or in the evening, in dry forests or rocky areas. Animals were often seen in pairs. They were sighted frequently in Bhadra and Bandipur (Karanth 1986, 1988).

*Ecology and behavior*

The ecology of the ruddy mongoose remains to be studied. Most records of this species are from forested areas including dry forests, dry thorn areas, and disturbed forests, although there are also fewer records from open areas and secluded rice paddy fields. In India, this species was found exclusively in dry forests, and was never sighted near human settlements. The elevation range is 50 to 2200 m in South
India. The ruddy mongoose is crepuscular, hunting by day as well as by night as it hunts, feeds, and rests in trees. In India, it is frequently sighted scavenging road kills. This species is large (1.7 kg; weight of a road-killed animal) and resembles the grey Mongoose but is reddish-brown with a grizzled appearance and a black-tipped tail (Prater 1971). It has the habit of walking with the tip of its tail turned upwards, a distinctive behavioural trait (Menon 2003).

**Principal threats**

Little is known of direct threats to the ruddy mongoose but there appears to be no major threats to the global population. Local-scale major threats include hunting and snaring by tribes and villagers.

**Conservation measures**

The Indian population is listed in CITES Appendix III (Wozencraft 2005), and Schedule IV of Indian Wildlife (Protection) Act, 1972. In central India people consider the mongoose to be sacred, and thus it is not killed there. The species occurs in numerous protected areas.

1.5.9 **Grey mongoose**

**Distribution and status**

The common grey mongoose (*Herpestes edwardsii*) is listed as Least Concern in view of its wide distribution, presumed large population and adaptability to human-dominated landscapes, and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category. This species is mainly found in southern Asia mainly India, Pakistan, Nepal, Sri Lanka and some other parts of Asia. It is commonly found in open forests, scrub lands and cultivated fields, often close to human habitations.
**Ecology and behavior**

It lives in burrows, hedgerows and thickets, among groves of trees, taking shelter under rocks or bushes and even in drains. Usually found singly or in pairs. It preys on rodents, snakes, birds’ eggs and hatchlings, lizards and variety of invertebrates. Their tail length equals their body length. Body length: 14 to 17 inches (36 to 45 cm) Tail length: 17 inches (45 cm), weight: 2 to 4 lb. (0.89 to 1.4 kg). The habitat and ecology of the Indian Grey Mongoose is known from few studies, however, it has been recorded in disturbed areas, in dry secondary forests, and thorn forests, but seems to be a commensal with humans as well. This species was often recorded near human settlements in central India, where it was seen near garbage bins, garbage dumps, scavenging on carrion, and on roads (Choudhury et al., 2011). The species seems to be most common in disturbed areas, in dry secondary forests and thorn forests. This species has been found up to 2100 m (Corbet and Hill 1992) and feeds on insects and snakes (Santiapillai 2000). Home range estimates for Indian grey mongoose (*Herpestes edwardsii*) from the Nilgiri Biosphere Reserve (single individual for a period of four months) was found to be 3.4 to 4.9 hectares (0.039 to 0.049 km$^2$), and an overall range of 0.15 km$^2$ (Kumar and Umapathy 1999).

**Principal threats**

This species has no major threats occurring across the whole of its range, however, it does experience some regional threats. Kalle (2011) notes that the grey mongoose is often captured and sold as a pet. This species is very common in Nagapattinam and often local farmers trap them in cages and sold for meat. Gypsies from northern India use hook snares to capture individuals for skins, which are then sold in local markets in Nepal (Choudhury et al., 2011). All mongoose species are in demand for the wildlife trade (Van Rompaey and Jayakumar 2003): the meat is eaten by several tribes and the hair is used for making shaving brushes, paint brushes, and good luck charms (Hanfee and Ahmed 1999).
Conservation measures

The Indian Grey Mongoose is listed on CITES Appendix III in India (Wozencraft 2005). In 2002 in India, the government upgraded the Mongoose species, to Part II of Schedule II of Wildlife (Protection) Act 1972. This species is found in numerous protected areas. Field surveys, ecological studies, habitat protection and monitoring of threats are needed.

1.6 Justification of study

Effective conservation of small carnivores requires detailed knowledge of their current distribution, population status and ecological requirements. Although our understanding on their distribution and ecology has increased, comprehensive information at a regional scale in most parts of the country is still lacking. The extreme difficulty in physically observing them and the inaccessibility of their habitat is one of the common issues in small carnivore research due to their elusive behavior and rarity which makes it most difficult to study in the wild. There is deficiency in reliable field data on their distribution and conservation requirements. All that is left of them is interesting anecdotal information providing little concrete evidence on their population status. Keeping the aforementioned caveats in mind, this study was initiated from 2009 to 2011 in Mudumalai Tiger Reserve.

1.7 Study objectives

1. To determine the abundance and occupancy of small carnivores in Mudumalai Tiger Reserve.
2. To study the dietary pattern of small carnivores.
3. To determine spatial and non-spatial variables governing the occupancy of small carnivores and
4. To predict the distribution pattern of small carnivores through habitat suitability modeling in Mudumalai Tiger Reserve.
1.8 Organization of the thesis

The thesis is structured into six chapters, each chapter consists of an introduction to the topic, elaboration on methods and analysis used, results arrived at and discussion of the results. First chapter deals with the study species; small cats, civets and mongooses, scope of the study and its objectives. Chapter 2 describes the study area, Mudumalai Tiger Reserve. Chapter 3 deals with the occupancy and abundance of small carnivores. Chapter 4 deals with the dietary pattern of small carnivores. Chapter 5 deals with the differences in spatial and non-spatial variables governing the occupancy of small carnivores and Chapter 6 deals with predicting distribution pattern of small carnivores in and around Mudumalai Tiger Reserve.