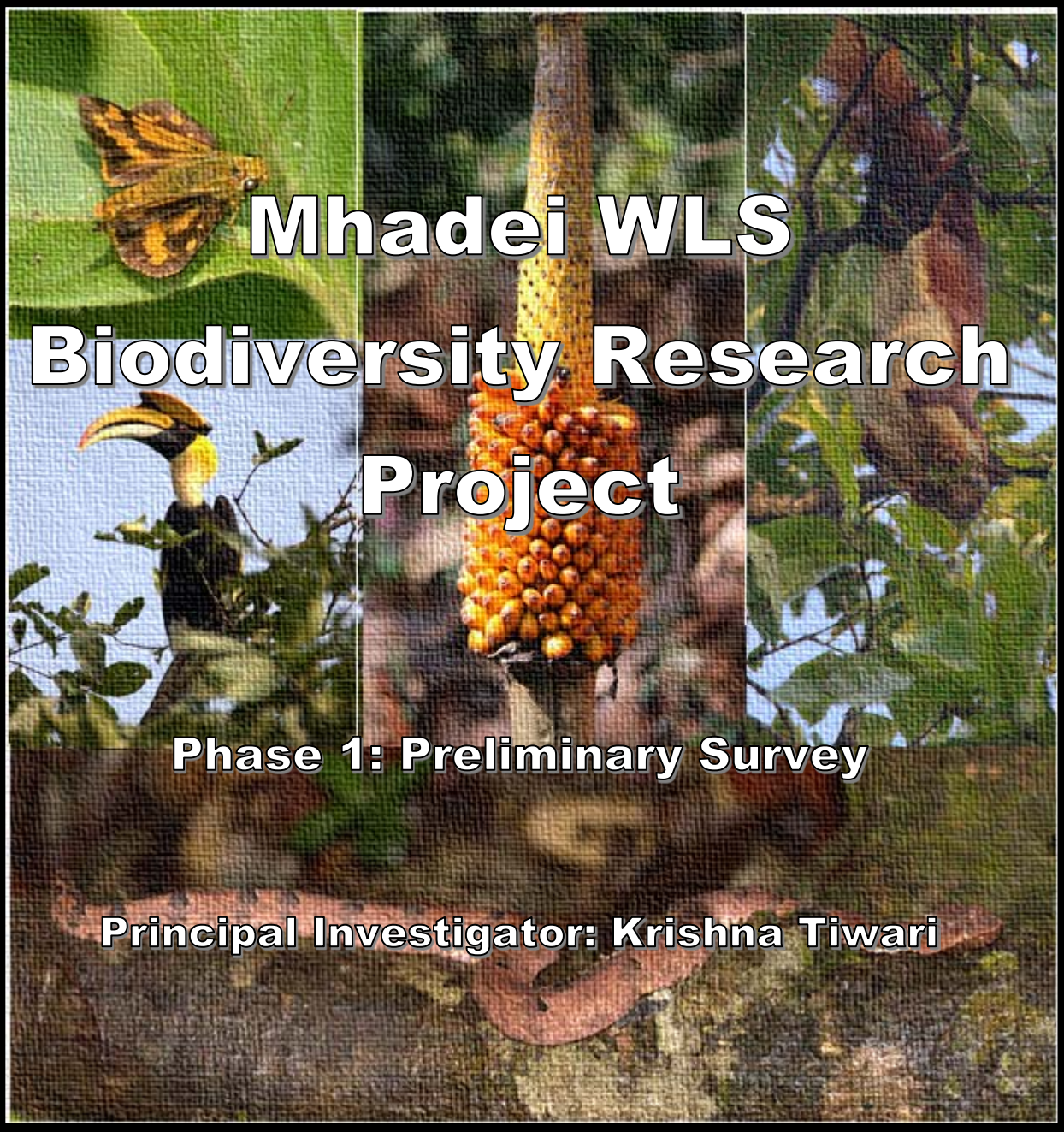
vanashakti



Mhadei WLS Biodiversity Research Project

Phase 1: Preliminary Survey

Principal Investigator: Krishna Tiwari

Table of Contents

Acknowledgements

Thank you to our sponsors for giving all of us the opportunity to explore and study this fascinating area in a lesser-known part of the famous Western Ghats!

Sincere thanks to Vanashakti, Mrs. Meenakshi Menon, Mr. Stalin D., and Ms. Madhavi Sawant for their collaboration and assistance.

Utmost thanks to the following experts who generously contributed their time and efforts in making this project a success: Karunya Prasad, Sandesh Gawas, Hanuman Gawas, Vikram Tiwari, Asif Wadia, Omkar Adhikari, Sumit Kutale, Rushab Chaudhari, Sadanand Gupta, Manir Khan and Dr.Rajdeo Singh, as well as the field assistants Arjun Gurav and Nandu Pednekar.

Special thanks to Mr. Peter Tavares for always being helpful, Junaid and Saddam for their support and cooperation, the locals of Valpoi and Codal for welcoming us to their area, and last but not least, the tea shack Casa Mahaprita for their tasty chai and bites which kept us going!

Abstract

A baseline biodiversity assessment was conducted on a private property in Mhadei Wildlife Sanctuary, a part of the Western Ghats in the state of Goa. The property was identified as a highly biodiverse region, in line with the expected diversity that makes the Western Ghats an area of high endemism and priority for conservation. In the current study carried out over two months, from December 2017 to January 2018, the following numbers of species were identified: 9 snakes; 10 frogs and toads; seven lizards; 15 mammals; 103 birds; 74 butterflies; 12 moths; 10 odonates; 2 spiders; and 147 plants. A research centre was also constructed on site in order to promote further study of the wide diversity of species in the area and encourage their conservation. Proposals of differing budgets have been designed to suggest future use of the research centre. Local field assistants have been trained in research, monitoring and conservation techniques to enable them to maintain and improve the natural integrity of the field site.

Introduction

Goa, a central west-coast state of India, lies in the geographical range of 14051'-15048'N & 73041'-74020'E, and has an area of 3702 kilometres square. Goa contains approximately 2% of the Western Ghats (Sawant, Jadhav & Shyama 2010), a biodiversity hotspot, so labelled as it is a high-priority terrestrial eco-region in need of conservation. It has high species endemism and a low percentage of pristine vegetation and additionally, when examining human population numbers, it is a hotspot with one of the highest elevated risks (Cincotta, Wisnewski & Engelman 2000). Mhadei Wildlife Sanctuary located in the *Sattari* Taluka in North Goa spans an area of 209 square kilometres and is an important protected area within the northern part of the Western Ghats (Sawant, Jadhav & Shyama 2010; Image 1). These important facts related to the field site highlight the vital need for conservation of this region.

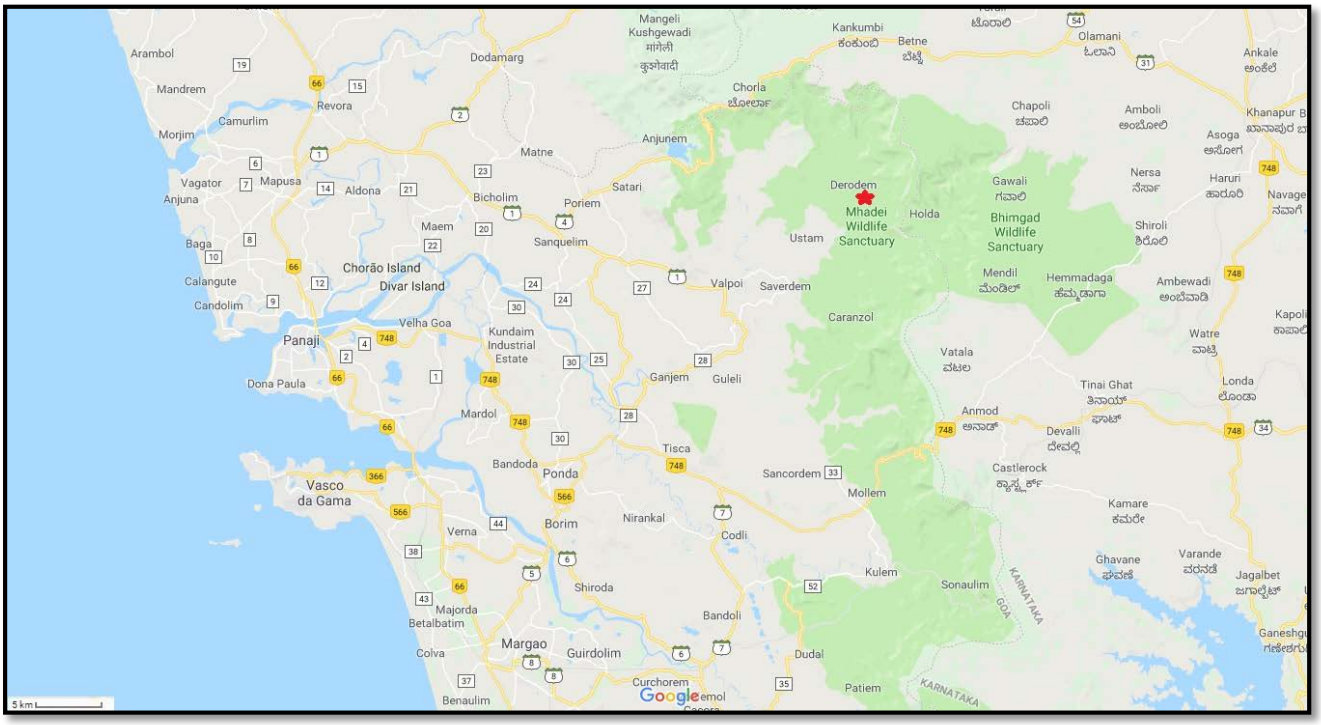


Image 1: Map of Mhadei Wildlife Sanctuary.

Private land measuring 1.5 square kilometres, divided into four plots, was purchased within Mhadei Wildlife Sanctuary and has been the field site for this project (Image 2). Located near the town Valpoi and village Codal, this land consists of tropical evergreen forest. It is largely unmodified land and is therefore ideal habitat for a range of biodiversity including species that are endemic and native to the Western Ghats.

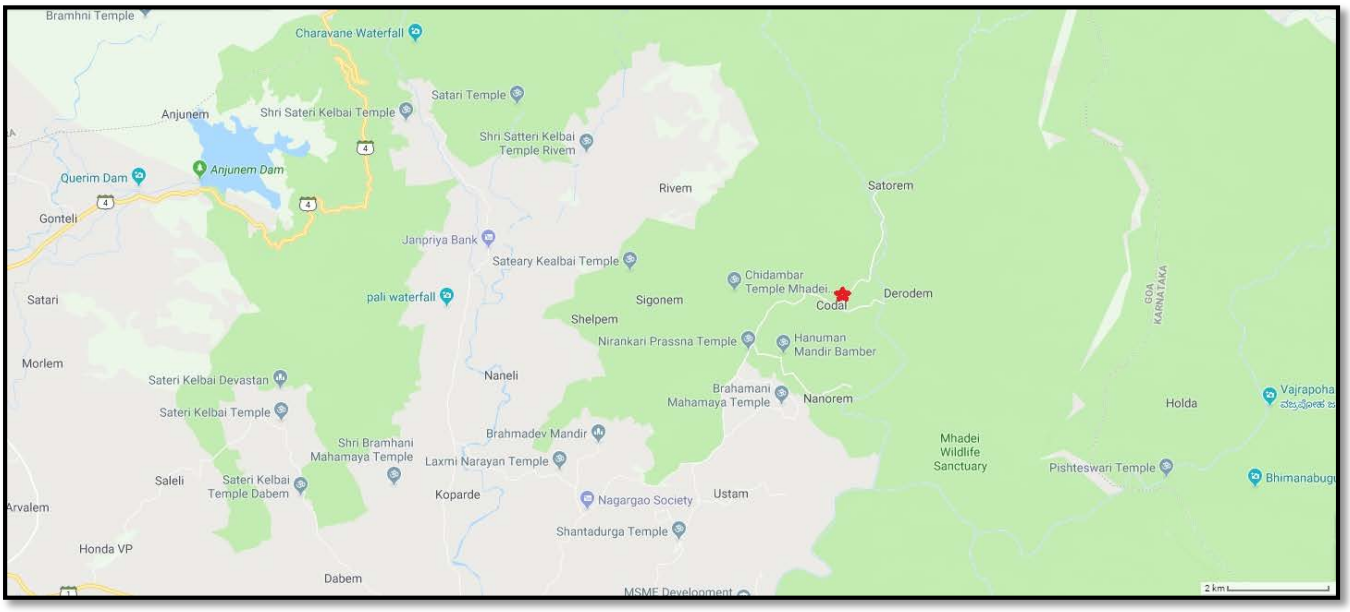


Image 2: Location of property / project site. The red star indicates the location of the field site.

While the rich biodiversity of the general area is well known (Myers et al. 2000), a detailed and thorough assessment of flora and fauna species present on this private land will enable the design and implementation of effective conservation strategies tailored to this site. The study will also help map the importance of Mhadei Wildlife Sanctuary in a scientific and accurate manner.

Additionally, future use and management of this land for research and other purposes requires a thorough understanding of the site including information about the boundaries, fencing, threats of encroachment, presence of illegal activities, and land use in adjacent properties. This study therefore endeavours to gain a detailed preliminary understanding of the private land- its dimensions, condition, inhabitants and potential.

GPS points were taken along the boundaries of the property (Images 3 and 4). A waypoint was taken at every yellow pillar / marker that was installed by the initial surveyors in order to get a detailed understanding of the boundaries of the project site.

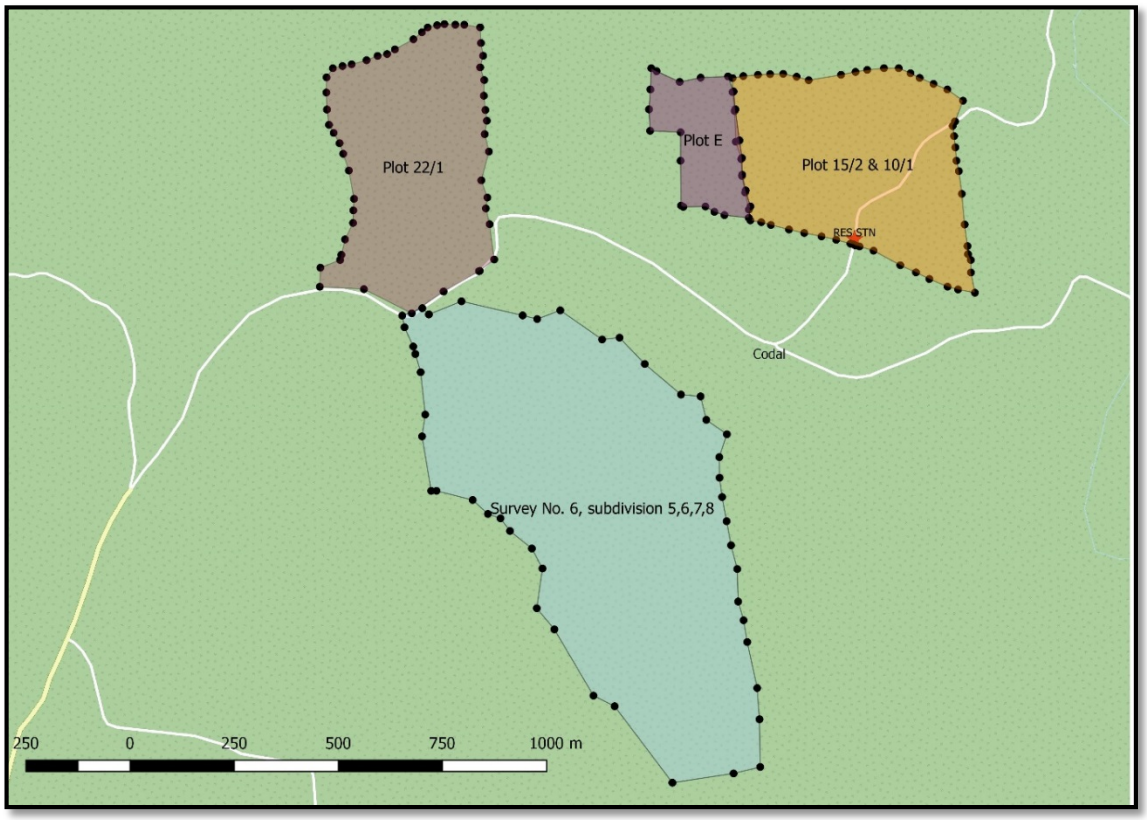


Image 3: Plot boundaries marked with waypoints depicted by black dots.

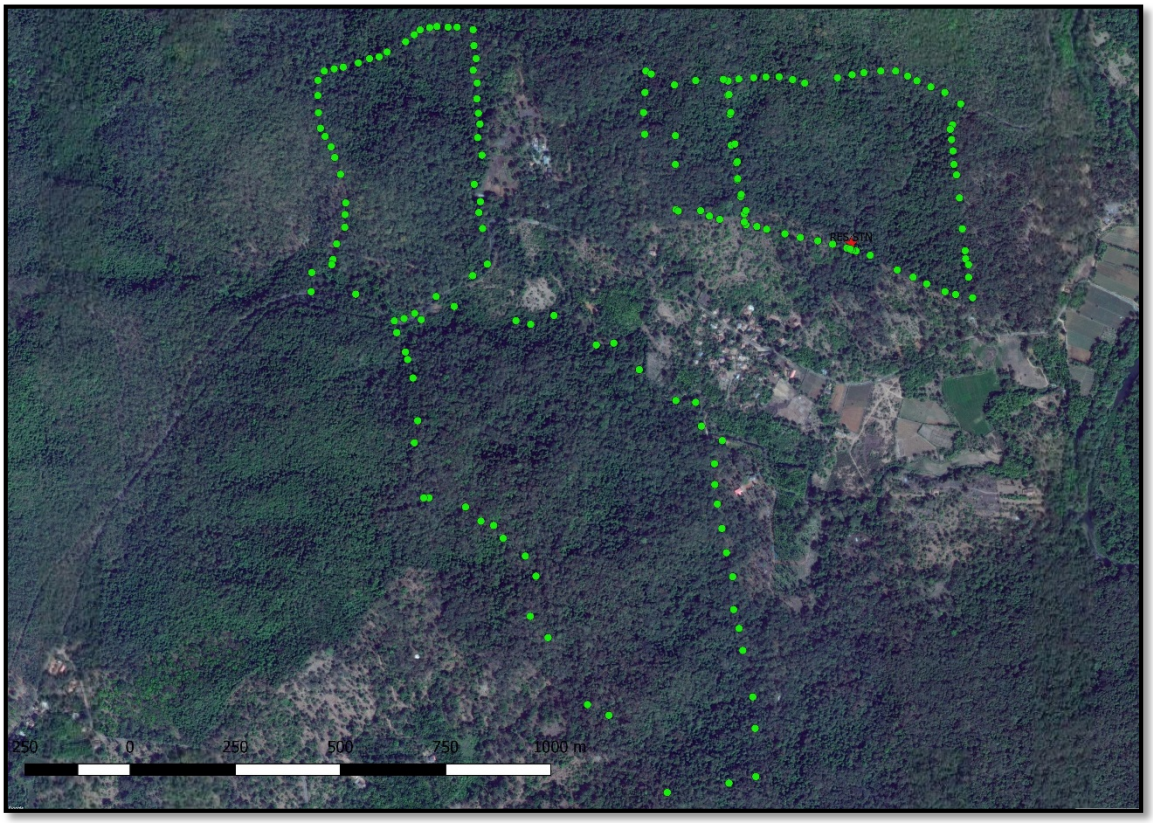


Image 4: Satellite image of plot with boundary waypoints depicted by green dots and the research centre by a red dot.

Aims

1. To conduct a biodiversity assessment of: plants, mammals, birds, insects, amphibians and reptiles.
2. To document the biodiversity through photographs and video recordings.
3. To develop a detailed map of the plot boundaries.
4. To build capacity among the field assistants who will be responsible for the long-term management of the land. This will include training in:
    - Research, monitoring and evaluation of biodiversity levels at regular intervals
    - Maintenance of the research centre.
5. To outline potential uses of the newly established research centre.

Herpetological Survey

Methodology

The herpetological survey was conducted from 27th November to 9th December 2017. Two dry and two wet transects along roads, trails and streams were used to survey reptiles and amphibians in the area. The transects were placed along optimal herpetological habitat within the field site (Image 5). Areas adjacent to the transects were also surveyed on a random basis to account for any animals which may have moved through and then outside of the property. The survey was conducted at various times from evening to dawn, when amphibians and reptiles are most active and easy to discover in their natural environment (Sutherland 2006). Approximately three repetitions were conducted for each transect in Image 4 and multiple repetitions for the random transects displayed in Image 6. A Canon 700D camera with a 90mm macro lens was used for photography during this survey.

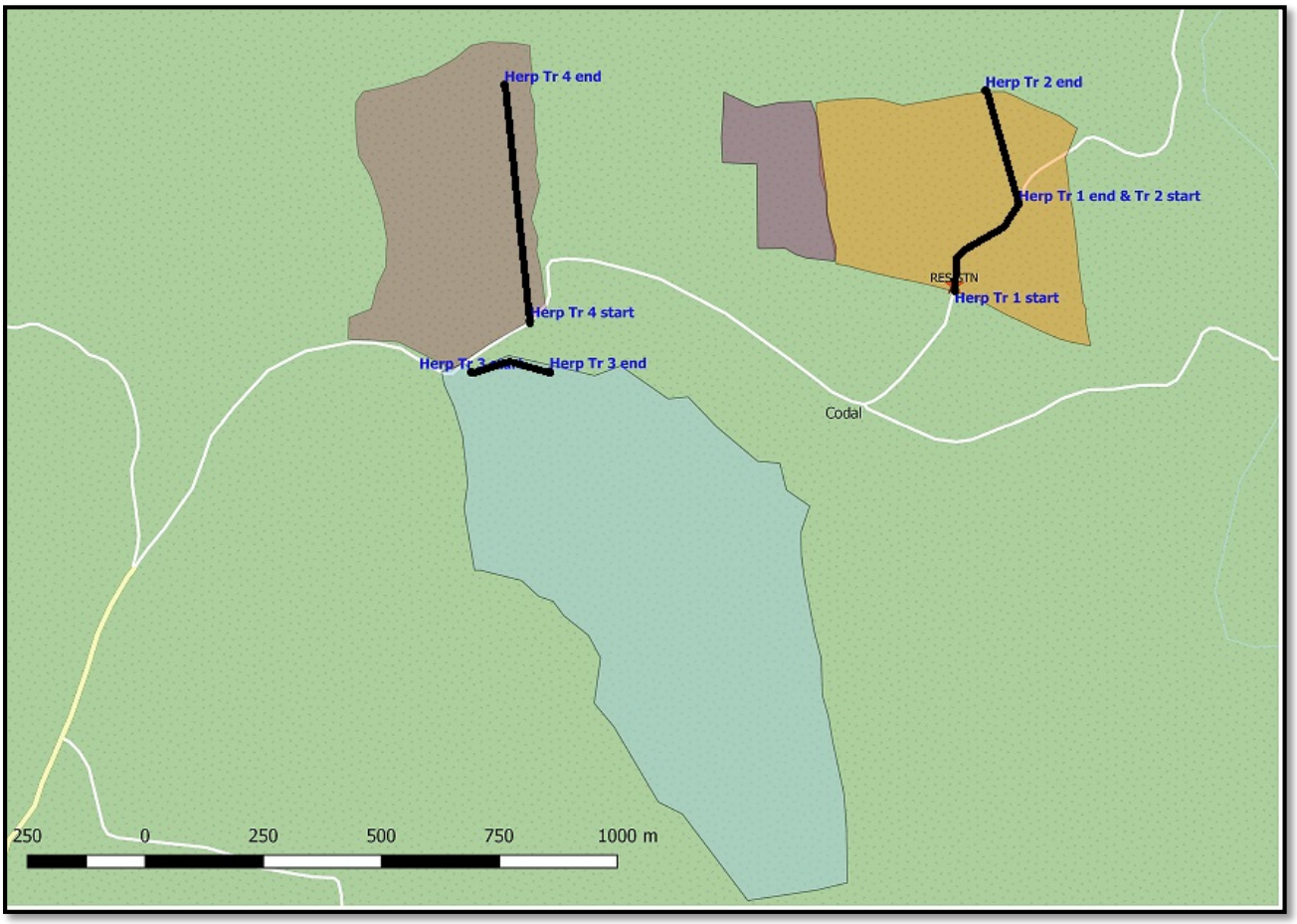


Image 5: Herpetological transects along optimal habitat.

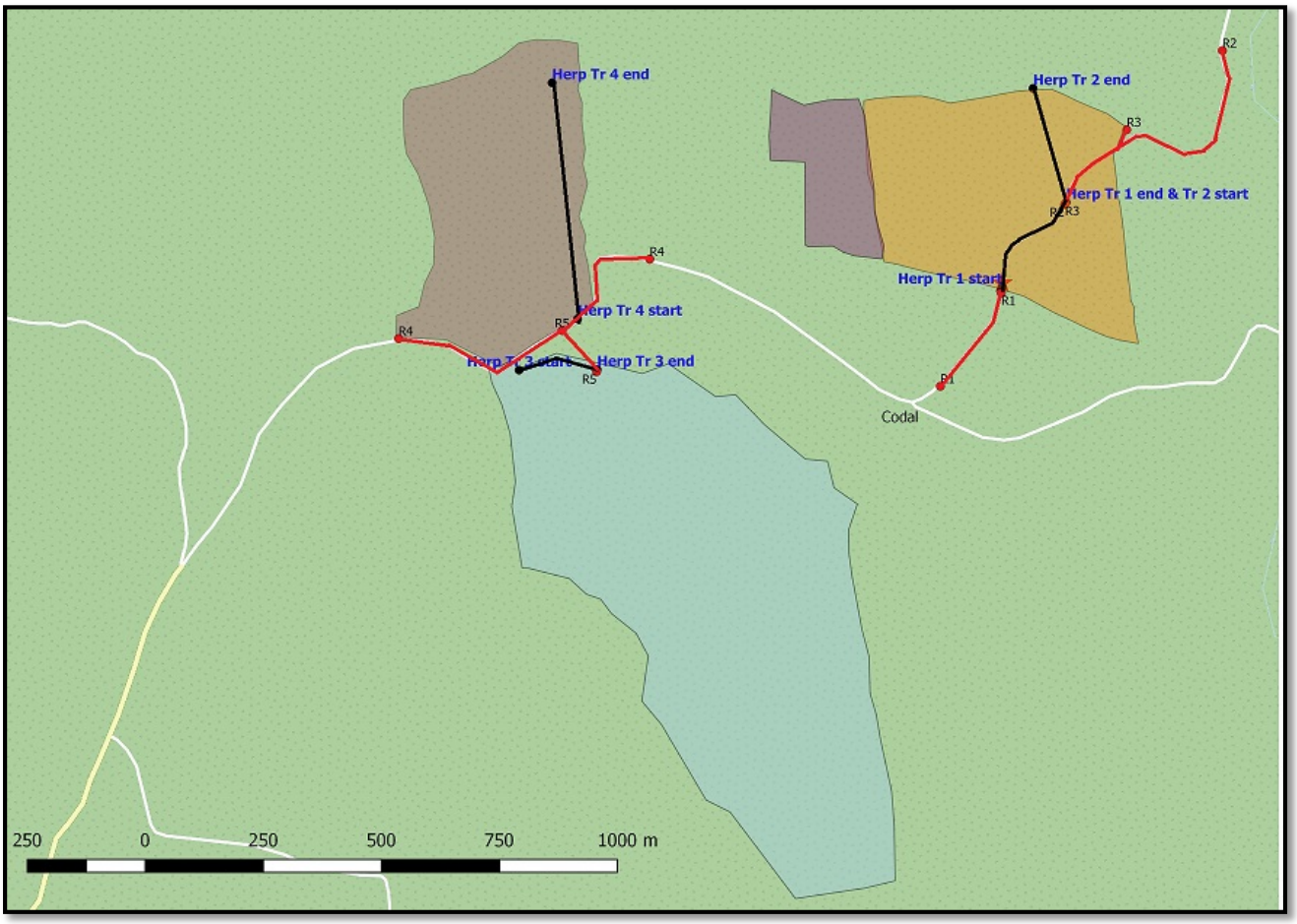


Image 6: Herpetological transects along with random transects.

Results

A total of 10 species of frogs and toads (Table 1), nine species of snakes (Table 2), and seven species of lizards were identified (Table 3). Additionally, unidentified species of *Pseudophilautus*, *Indirana*, *Micrixalus* and *Nyctibatrachus* species of frogs were observed.

Table 1: Frog and toad species identified during the survey.

Scientific name	Common name
Duttaphrynus melanostictus	Common Asian toad
Euphlyctis cyanophlyctis	Indian Skittering Frog
Indirana beddomii	Beddomes Leaping Frog
Indirana salelkari	(A type of Leaping Frog)
Polypedates maculatus	Indian Tree Frog
Pseudophilautus amboli	Amboli Bush Frog
Ramanella mormorata	Marbled Ramanella Frog
Raorchestes bombayensis	Bombay Bush Frog
Rhacophorus malabaricus	Malabar Gliding Frog
Sphaerotheca dobsonii	Mangalore Bullfrog

Table 2: Snake species identified during the survey.

Scientific name	Common name
Ahaetulla nasuta	Green Vine Snake
Amphiesma stolatum	Buff Striped Keelback
Atretium schistosum	Olive Keelback Water Snake
Boiga spp	Cat Snake
Dendrelaphis tristis	Common Bronzeback Tree Snake
Eryx whitakeri	Whitaker's Boa
Hypanale hypnale	Hump-nosed Pit Viper
Lycodon aulicus	Indian Wolf Snake
Xenochrophis piscator	Checkered Keelback

Table 3: Lizard species identified during the survey.

Scientific name	Common name
Calotes rouxii	Roux's Forest Lizard
Calotes versicolor	Oriental Garden Lizard
Cnemaspis goaensis	Goan Day Gecko
Cyrtodactylus albofasciatus	Boulenger's Indian Gecko
Hemidactylus frenatus	Common House Gecko
Hemidactylus prashadi	Bombay Leaf-toed Gecko
Sphenomorphus indicus	Indian Forest Skink

Discussion by the experts

Majority of the frog species identified are endemic to the region as more than 92% of the currently known 225 amphibian species of the Western Ghats are endemic to this biodiversity hotspot (Frost 2016). A large number of amphibians in this region were only discovered recently, over the last decade and a half (Biju 2001), and the diversity is likely to be higher still than current estimates (Biju et al. 2014). For instance, one of the frogs identified in this study, the *Indirana salelkari*, was discovered as recently as 2015 (Modak et al. 2015). Additionally, IUCN assessments of the conservation status of amphibian species was last conducted in 2008, deeming the resulting information to be outdated and in dire need of revision (Nair et al. 2012).

The *Pseudophilautus amboli* is “Listed as Critically Endangered because its Extent of Occurrence is less than 100 km2, all individuals are in a single location, and there is continuing decline in the extent and quality of its habitat” (Biju 2004).

The *Ramanella mormorata* is classified as an endangered frog “because its extent of occurrence is less than 5,000 km², all individuals are in fewer than five locations, and there is continuing decline in the extent and quality of its habitat in the Western Ghats of India” (Biju et al. 2016).

The *Cnemaspis goaensis* is assessed as being endangered because "the areas from where this species is reported have undergone a decline in quality of habitat. The extent of occurrence is less than 1,000 $km^{2"}$ (Srinivasulu & Srinivasulu 2013a).

The *Raorchestes bombayensis* is "Listed as Vulnerable, because its Extent of Occurrence is less than 20,000 km2 and its Area of Occupancy is less than 2,000 km2, its distribution is severely fragmented, and there is a continuing decline in the extent and quality of its forest habitat" (Biju et al. 2004).

Of the lizard species identified, *Cyrtodactylus albofasciatus* and *Hemidactylus prashadi* are endemic to the Western Ghats (Srinivasulu & Srinivasulu 2013b; Srinivasulu & Srinivasulu 2013c).

The survey was conducted in the month of December, which is not the ideal season for herpetological surveys as hibernation is very common in many species of herpetofauna and December is the peak hibernation period. The survey focus was tar roads and streams as they are a preferred habitat for herpetofauna. In the future, this survey should be repeated when reptiles and amphibians are most active, from the end of May, through the whole monsoon period, until the end of October.

A Cat Snake and Rat Snake were observed as they crossed the road as well as many Vine Snakes resting on short vines of shrubs growing adjacent to the road. Two dead specimens of Hump-nosed Pit Vipers and a few dead frogs were also recorded on the road. Roadkill is a major conservation issue for herpetofauna and during the monsoon, which is the mating period for snakes and frogs, local villagers observe many snake deaths on roads. Reducing roadkill within the property by enforcing speed limits through road signage on roads that run through the plots is necessary for the long-term conservation of herpetofauna.

Discussions with villagers, local snake rescuers, and NGO authorities in charge of animal rescues provided some insights on the local level of awareness related to reptile and amphibian conservation. The local villagers worship snakes and indicated interest in protecting them in their natural habitat. They were enthusiastic in conversing about the diversity of snakes in the area, but also had misconceptions about reptiles and believed in common myths related to snakes, such as: 'The Vine Snake punctures humans' skulls'; 'Snakes take revenge'; and 'The Checkered Keelback becomes venomous if it comes on land' (Khaire 2014). Therefore, in order to reverse these beliefs and promote positive ideas related to reptile conservation, education and public awareness programs are required for locals.

In order to conserve and enhance frog diversity, natural canopies with small puddles which offer ideal habitats for frog species need to be identified and protected. If there is data deficiency for the endangered species mentioned, further research is required before species-specific conservation initiatives are implemented to protect those herpetofauna. Further studies using molecular tools and integrated systematic approaches are required for taxonomic revisions of amphibian groups as well as identification of new taxa (Garg et al. 2017).

Ornithological Survey

Methodology

The ornithological survey took place from 9th to 14th December 2017. Two road and three forest trail transects that traverse through optimal bird habitat and have high visibility were selected for the survey (Image 7). Two of the trails were adjacent to streams that act as watering holes for many birds in the area. Most of the transects had at least three repetitions and surveys were conducted in two sessions: from dawn through the morning period, and late afternoon to evening, when birds are actively searching for food. A Canon 700D with a Canon 400mm f5.6lens plus a Canon 5D with Tamaron 150-600mm lens were used during this survey.

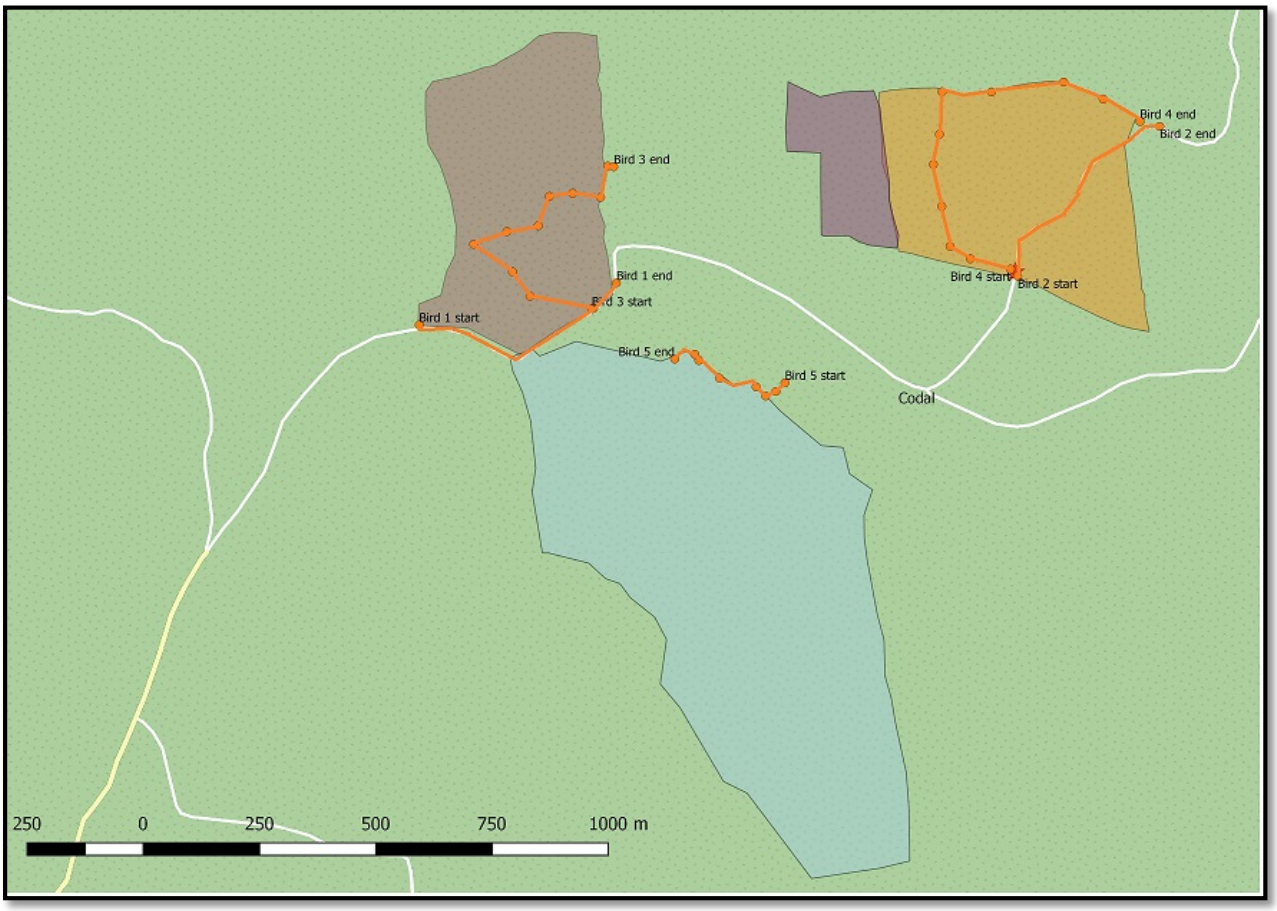


Image 7: Ornithological transects used for the survey.

Results

A total of 103 bird species were identified from 46 families (Table 4). A range of birds were spotted numerous times and these include: Ashy Drongo, Crimson-backed Sunbird, Flame-throated Bulbul, Malabar Grey Hornbill, Malabar Pied Hornbill and Greater Racket-tailed Drongo. Unidentified warblers and raptors were also observed.

Table 4: Bird species identified during the survey.

Common name	Scientific name	Family
Black Eagle	Ictinaetus malayensis	Accipitridae
Black Kite	Milvus migrans	Accipitridae
Brahminy Kite	Haliastur indus	Accipitridae
Crested Serpent Eagle	Spilornis cheela	Accipitridae
Shikra	Accipiter badius	Accipitridae
Blyth's Reed Warbler	Acrocephalus dumetorum	Acrocephalidae
Common Iora	Aegithina tiphia	Aegithinidae
Blue-eared Kingfisher	Alcedo meninting	Alcedinidae
Stork-billed Kingfisher	Pelargopsis capensis	Alcedinidae
White-throated Kingfisher	Halcyon coromanda	Alcedinidae
Cattle Egret	Bubulcus ibis	Ardeidae
Indian Pond Heron	Ardeola grayii	Ardeidae
Malayan Night Heron	Gorsachius melanolophus	Ardeidae
Ashy Woodswallow	Artamus fuscus	Artamidae
Great Hornbill	Buceros bicornis	Bucerotidae
Malabar Grey Hornbill	Ocyceros griseus	Bucerotidae
Malabar Pied Hornbill	Anthracoceros coronatus	Bucerotidae
Bar-winged Flycatcher-Shrike	Hemipus picatus	Campephagidae
Orange Minivet	Pericrocotus flammeus	Campephagidae
Indian Nightjar	Caprimulgus asiaticus	Caprimulgidae
Golden-fronted Leafbird	Chloropsis aurifrons	Chloropseidae
Asian Openbill	Anastomus oscitans	Ciconiidae
Common Tailorbird	Orthotomus sutorius	Cisticolidae
Emerald Dove	Chalcophaps indica	Columbidae
Green Imperial Pigeon	Ducula aenea	Columbidae
Grey-fronted Green Pigeon	Treron (pompadora) affinis	Columbidae
Mountain Imperial Pigeon	Ducula badia	Columbidae
Oriental Turtle Dove	Streptopelia orientalis	Columbidae
Rock Pigeon	Columba livia	Columbidae
Spotted Dove	Stigmatopelia chinensis	Columbidae
House Crow	Corvus splendens	Corvidae
Indian Jungle Crow	Corvus (macrorhynchos) culminatus	Corvidae
Rufous Treepie	Dendrocitta vagabunda	Corvidae
Asian Koel	Eudynamys scolopacea	Cuculidae
Banded Bay Cuckoo	Cacomantis sonneratii	Cuculidae
Nilgiri Flowerpecker	Dicaeum concolor	Dicaeidae

Pale-billed Flowerpecker	Dicaeum erythrorhynchos	Dicaeidae
Thick-billed Flowerpecker	Dicaeum agile	Dicaeidae
Common name	**Scientific name**	**Family**
Ashy Drongo	Dicrurus leucophaeus	Dicruridae
Black Drongo	Dicrurus macrocercus	Dicruridae
Greater Racket-tailed Drongo	Dicrurus paradiseus	Dicruridae
White-rumped Munia	Lonchura striata	Estrildidae
Crested Treeswift	Hemiprocne coronata	Hemiprocnidae
Wire-tailed Swallow	Hirundo smithii	Hirundinidae
Asian Fairy Bluebird	Irena puella	Irenidae
Black-headed Cuckooshrike	Coracina melanoptera	Laniidae
Brown Shrike	Lanius cristatus	Laniidae
Brown-cheeked Fulvetta	Alcippe poioicephala	Leiotrichidae
Brown-headed Barbet	Psilopogon zeylanicus	Megalaimidae
Chestnut-headed Bee-eater	Merops leschenaulti	Meropidae
Green Bee-eater	Merops orientalis	Meropidae
Black-naped Monarch	Hypothymis azurea	Monarchidae
Forest Wagtail	Dendronanthus indicus	Motacillidae
Grey Wagtail	Motacilla cinerea	Motacillidae
Asian Brown Flycatcher	Muscicapa dauurica	Muscicapidae
Asian Paradise-flycatcher	Terpsiphone paradisi	Muscicapidae
Blue-capped Rock Thrush	Monticola cinclorhyncha	Muscicapidae
Blue-throated Blue Flycatcher	Cyornis rubeculoides	Muscicapidae
Dark-sided Flycatcher	Muscicapa sibirica	Muscicapidae
Oriental Magpie-robin	Copsychus saularis	Muscicapidae
Tickell's Blue Flycatcher	Cyornis tickelliae	Muscicapidae
Verditer Flycatcher	Eumyias thalassinus	Muscicapidae
Crimson-backed Sunbird	Leptocoma minima	Nectariniidae
Loten's Sunbird	Cinnyris lotenia	Nectariniidae
Purple Sunbird	Cinnyris asiaticus	Nectariniidae
Purple-rumped Sunbird	Leptocoma zeylonica	Nectariniidae
Vigors' Sunbird	Aethopyga (siparaja) vigorsii	Nectariniidae
Black-hooded Oriole	Oriolus xanthornus	Oriolidae
Black-naped Oriole	Oriolus chinensis	Oriolidae
House Sparrow	Passer domesticus	Passeridae
Grey Junglefowl	Gallus sonneratii	Phasianidae
Indian Peafowl	Pavo cristatus	Phasianidae
Greenish Warbler	Phylloscopus trochiloides	Phylloscopidae
Greater Goldenback	Chrysocolaptes lucidus	Picidae
Heart-spotted Woodpecker	Hemicircus canente	Picidae
Lesser Goldenback	Dinopium benghalense	Picidae
Rufous Woodpecker	Micropternus brachyurus	Picidae
White-bellied Woodpecker	Dryocopus javensis	Picidae
White-naped Woodpecker	Chrysocolaptes festivus	Picidae

Malabar Parakeet	Psittacula columboides	Psittacidae
Plum-headed Parakeet	Psittacula cyanocephala	Psittacidae
Vernal Hanging Parrot	Loriculus vernalis	Psittacidae
Common name	**Scientific name**	**Family**
Flame-throated Bulbul	Pycnonotus (melanicterus) gularis	Pycnonotidae
Red-vented Bulbul	Pycnonotus cafer	Pycnonotidae
Red-whiskered Bulbul	Pycnonotus jocosus	Pycnonotidae
Square-tailed Bulbul	Hypsipetes (leucocephalus) ganeesa	Pycnonotidae
Yellow-browed Bulbul	Acritillas indica	Pycnonotidae
White-breasted Waterhen	Amaurornis phoenicurus	Rallidae
Coppersmith Barbet	Megalaima haemacephala	Ramphastidae
Malabar Barbet	Megalaima malabarica	Ramphastidae
White-cheeked Barbet	Megalaima viridis	Ramphastidae
White-browed Fantail	Rhipidura aureola	Rhipiduridae
Green Sandpiper	Tringa ochropus	Scolopacidae
Velvet-fronted Nuthatch	Sitta frontalis	Sittidae
Indian Eagle Owl	Bubo (bubo) bengalensis	Strigidae
Chestnut-tailed Starling	Sturnia malabarica	Sturnidae
Rosy Starling	Pastor roseus	Sturnidae
Dark-fronted Babbler	Rhopocichla atriceps	Timaliidae
Yellow-billed Babbler	Turdoides affinis	Timaliidae
Malabar Trogon	Harpactes fasciatus	Trogonidae
Malabar Whistling Thrush	Myophonus horsfieldii	Turdidae
Orange-headed Thrush	Geokichla citrina	Turdidae

Discussion by the experts

There are 16 endemic bird species in the Western Ghats and of those, seven have been found in Mhadei Wildlife Sanctuary. Of the seven, three were identified in this study, namely the Malabar Parakeet, Malabar Grey Hornbill, and Crimson-backed sunbird.

The Malabar Pied Hornbill is classified as Near Threatened because “this species probably has a moderately small population, and is likely to have declined as a result of continuing habitat loss” (BirdLife International 2016)

The Great Hornbill is also listed as Near Threatened as “it occurs at low densities and is patchily distributed. It may have a moderately small population and is considered to be declining moderately rapidly to rapidly throughout its range” (BirdLife International, 2017).

A disturbance-free zone throughout the property will ensure continued survival of the large range of species in this region. Additionally, identification and protection of nests, nesting areas, waterholes, perching zones and roosting areas is vital. Children with catapults were commonly noticed harassing birds and other wildlife. An education program to discourage this practice is necessary to reduce human-wildlife conflict.

Periodic surveys are necessary in other seasons, particularly in March, when it is peak breeding season for perching birds, winter migrants are preparing to leave the area and summer visitors are arriving, thus allowing for a maximum range of birds to be visible at any one time.

Vocalisations are important in determining the abundance of birds. During terrestrial bird surveys, the observer generally hears more birds than are seen and counts based on bird songs or calls can be used to survey bird populations. Sound recording devices should therefore be installed in the property because it is an area where bird species richness is high and sound recordings have been suggested by scientists as a useful way of indexing bird abundance and diversity (Dawson & Efford 2009).

Mammalian Survey

Methodology

The mammalian survey was conducted from 19th December 2017 to 31st January 2018. Camera traps were set up at locations within the property where wildlife observations were likely to be captured. These locations were determined based on past sightings by Arjun, the field assistant. Arjun has detailed knowledge of the area, the landscape, wildlife movements and behaviour, and has previously witnessed mammal crossings in various places within the property, which made him a highly suitable candidate for determining camera trap locations. Initially, a survey of scats, scrape marks and urine was also conducted within the property to establish ideal camera trap locations.

Infrared camera traps with passive infrared sensors were used as they do not scare animals away through bright flashes and they are consistent and highly effective at detecting wildlife (Wearn & Glover-Kapfer 2017). One Spypoint Tiny 3 and three Spypoint Force 10 camera traps were used. Four camera traps were set up on trails, at waterholes, along nullahs, near burrows, for a maximum of two nights, with the exception of one trap, which remained at one spot for an extended period, as it was capturing leopard and other large mammal movements. Traps were set up at dusk and removed in the morning to avoid theft of the traps. Data from the camera traps was downloaded and a spreadsheet was filled in daily. Waypoints were taken at camera trap locations, as seen in Image 8 below.

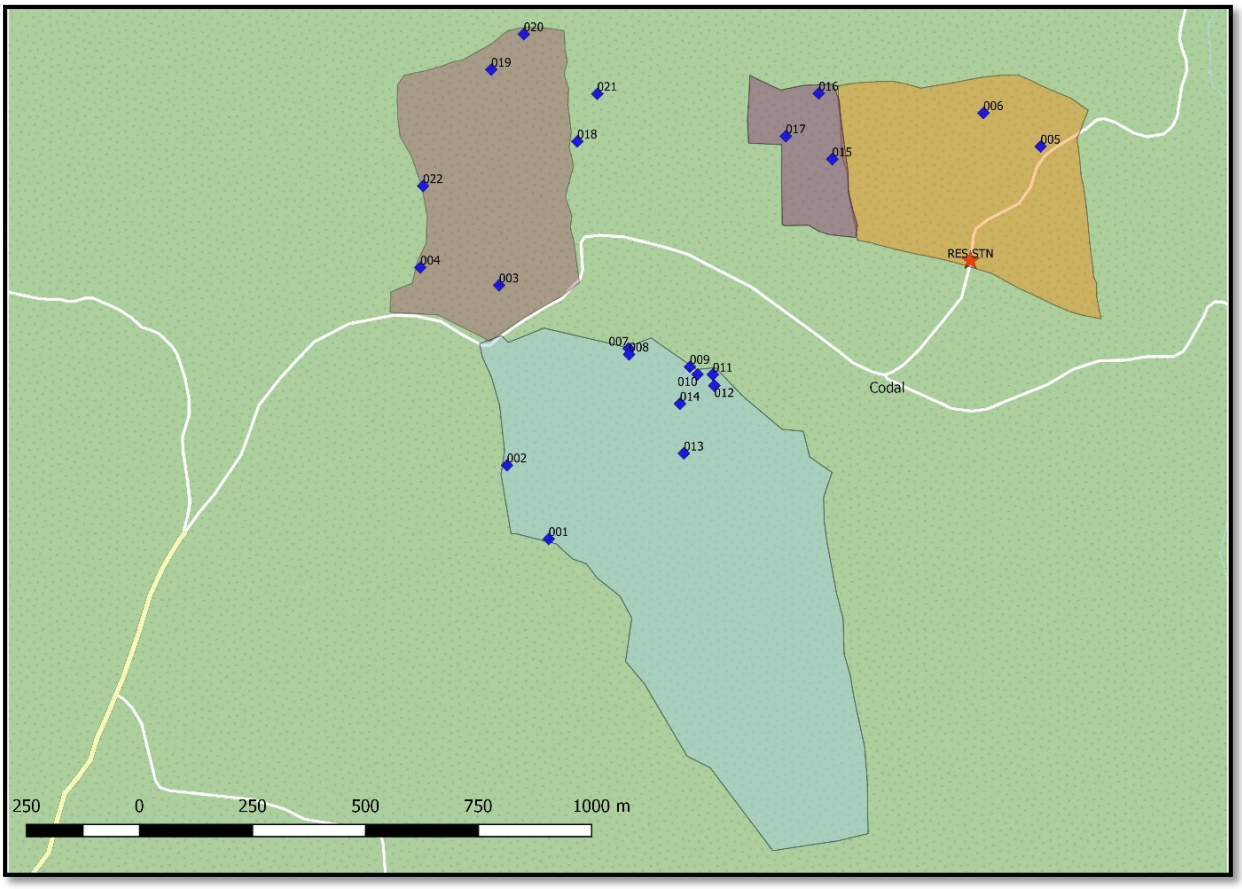


Image 8: Camera trap locations for the mammalian survey.

Results

A total of 15 species of mammals were identified on or near the property (Table 5). Hanuman Langurs, Bonnet Macaques and Palm Squirrels were sighted multiple times but not caught on camera. Unidentified rat and bird images of Jungle Fowl and Peahen with chicks were also captured by the camera traps.

Table 5: Mammalian species found during the survey.

Scientific Name	Common Name
Bos gaurus	Gaur
Funambulus palmarum	Common Palm Squirrel
Herpestes smithii	Ruddy Mongoose
Hystrix indica	Indian Crested Porcupine
Lepus nigricollis	Indian Hare
Macaca radiata	Bonnet Macaque
Moschiola indica	Indian Mouse Deer
Panthera pardus	Leopard
Paradoxurus hermaphroditus	Common Palm Civet
Petaurista philippensis	Indian Giant Flying Squirrel
Ratufa indica	Indian Giant Squirrel
Rusa unicolor	Sambar (male and female)
Semnopithecus dussumieri	Hanuman langur
Sus scrofa	Wild boar
Viverricula indica	Small Indian Civet

Discussion by the experts

Our studies highlight that the property supports a rich diversity of fauna with resident populations of civets, hares, porcupines, mongooses, boars, gaurs and rodents. Giant Squirrels, langurs and macaques can commonly be seen at the research center and other parts of the property.

The Gaur is classified as being Vulnerable by the IUCN because the population decline in parts of its range are over 70% however, in India, the overall decline rate is significantly lower (Duckworth et al. 2016).

The Leopard is listed as Vulnerable as “populations have become reduced and isolated, and they are now extirpated from large portions of their historic range” (Stein et al. 2016).

The “Sambar is listed as Vulnerable through sustained declines across its range” (Timmins et al. 2015).

Long term camera trap studies are required during different seasons in order to achieve a comprehensive checklist of mammalian species present in the area, as well as to get an idea about the abundance and distribution of the different species. The field site is surrounded by hills including the Chorla Ghats. One theory (according to the locals) suggests that currently, the herbivores have migrated to the tops of the hills in search of food and the carnivores have followed them. When the grass and plants dry, animals will return to the forests at the base of the hills to feed on agricultural

crops including cashews and mangoes, and carnivores may follow suit with the migration. The feature of a few water sources within the property would be a valuable attractant and deploying camera traps during the drier months in April / May would enable confirmation of the behavior and migration of the herbivores and carnivores in the area.

Local sources also suggest the presence of Barking Deer, pangolins, tree shrews, loris, bats and otters. Additionally, Gaur were observed stationed in the property for a few days (behind J.K. Farm) before moving further afield, outside the property, suggesting that the property may be used as a 'safe corridor' for travelling or migrating wildlife. Further research is required to investigate these theories. Fencing along property boundaries can be a great obstruction for wildlife movement and any fencing on the properties' boundaries should be removed.

DNA from non-invasive samples such as hair, faeces, urine, shed skin, and saliva can be used for various purposes:

- Discover the presence of rare or elusive species
- Count and identify individuals
- Determine gender
- Study the nutrition or diet
- Assess genetic diversity of a population
- Understand population structure
- Study mating systems (Waits & Paetkau 2005).

Future work related to genetic analysis will be invaluable in understanding the ecology and behavior of the mammals which in turn will guide the development of effective conservation strategies for the animals, particularly for the threatened species.

Furthermore, plant-animal interactions facilitate ecosystem function, whether they are commensal, antagonistic or mutualistic. These connections can be simple- pollination and dispersal, or more complex- the amount of energy that can be gained by a herbivore feeding on different species of plants. The sustainability of ecosystems depend on these elaborate networks of interactions and therefore studying them is a necessary and beneficial exercise (Anderson 2012).

Botanical Survey

Methodology

Extensive field work was carried out by a single field visit from 29th December 2017 to 8th January 2018, with two sessions per day- morning and afternoon. All areas of the property were systematically covered through the guidance of Arjun the field assistant. Plants were recorded along with their phenology, digital images and collection of unidentified plant materials for identification in the laboratory. An SLR Canon SX 50, DSLR Canon EOS 700D with 18-55mm and 55-250mm lenses were used. Waypoints were taken for unique and important plant species such as orchids. Local people were approached to gain ethnobotanical knowledge of the plants in the region, including their medicinal properties, cultural significance and common names of some unidentified plants.

In the data spreadsheet, each plant was given an accepted name, as per the Catalogue of Life website (Hassler 2018), along with the family name, occurrence in Goa, according to the book 'Botanical Survey of India' (Rao 1985), local uses, habit and endemic or introduced status.

N.B.: Status designated to individual plants such as Rare, Occasional, Common, etc. are exclusively made with respect to geographical boundaries as per Rao (1985). It may so happen that the plant is not Rare, Occasional or Common when considering larger geographical boundaries such as other states or entire country.

Results

The forest is dominated by evergreen trees, lianas, climbers, perennial shrubs, epiphytes and herbs, as listed below. A complete list of species discovered can be found in Appendix 10 and Image 9 displays the location of specific, important species of plants.

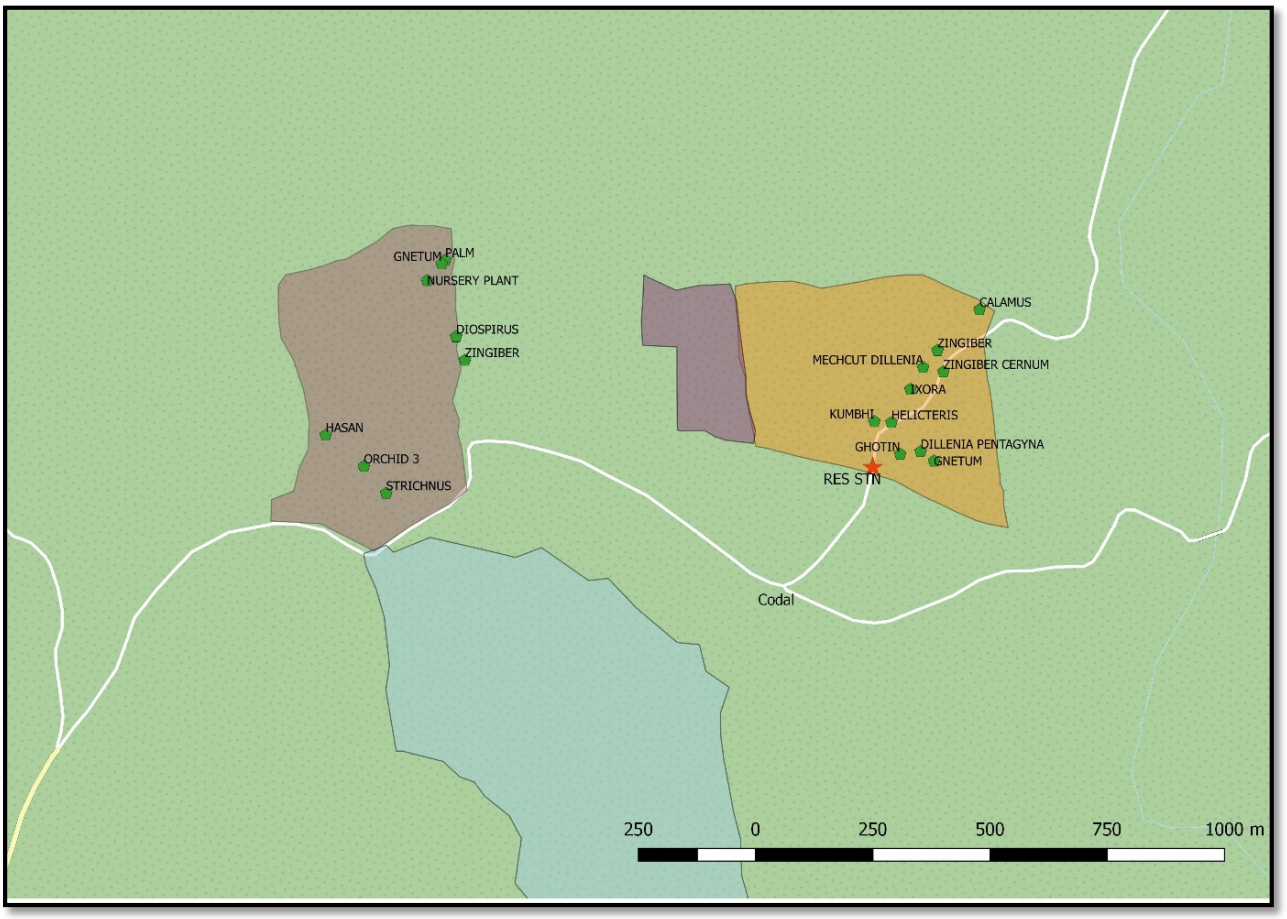


Image 9: Locations of some important botanical species / specimens. (Data from one plot is missing due to file corruption within the GPS hardware.)

Trees - *Terminalia paniculata, Lagerstroemia microcarpa, Actinodaphne* sp.*, Terminalia crenulata, Terminalia bellirica, Terminalia tomentosa, Bombax insigne, Strychnos nux-vomica, Sterculia guttata, Tabernamontana alternifolia.*

Shrubs - *Pshycotria dalzelli, Clerodenrum* sp.*, Leea indica, Bridelia* sp.

Lianas - *Entada* sp.*, Calicopteris floribunda, Gnetum ula.*

Climbers - *Meremia vitifolia, Mucuna* sp.

Aquatic plants (Marginal) – *Pandanus* sp., *Centella asiatica, Torenia bicolor*

Pteridophytes - *Adiantum* sp.*, Pteris quadriaurita, Stenochlaena* sp.

Climbing palm - *Calamus thwaitesii*

Some trees, including *Terminalia paniculata, Sterculia guttata, Strychnos nux-vomica,* and *Terminallia bellirica* were in fruiting stages.

The entire forest is dominated by trees and shrubby vegetation of the moist, deciduous category. *Terminalia* spp. were the most widely distributed and often the *Terminalia* spp. trees harboured epiphytic orchids.

Discussion by the experts

The surveyed area was recorded with one widespread weed- *Chromolaena odorata*. Although this is a rampant weed, the luxuriant flowering of this plant attracts many butterfly species, the most significant of those being the Southern Birdwing (*Troides minos*).

Rauvolfia serpentina is threatened with extinction in India due to indiscriminate collection and over exploitation of natural resources for commercial purposes to meet the requirement of the pharmaceutical industry, coupled with limited cultivation (Dey & De 2010).

The current period of survey is not suitable for floristic survey as the large number of plants were in vegetative condition and only a handful of plants were in the flowering stage. The flowering stage of a plant is crucial for designating the plant to its precise taxonomic classification. Therefore, future floristic survey work should also be carried out in summer, pre-monsoon and post-monsoon periods in order to observe most of the species in their flowering stages.

As this survey was carried out in the winter season, herbaceous flora or ground flora was scanty. Further floral studies should be carried out in the monsoonal period in July and September, during which the growth of herbal flora on the forest floor is at its peak. This could result in the discovery of some interesting plants such as *Ceropegia* spp., Orchids and Ephemerals.

Patrolling of horticultural or monoculture plants from adjacent properties is necessary. Any type of horticultural, ornamental plants, or plants from a monoculture site could enter, establish itself and spread throughout the property rapidly thereby, threatening local, native vegetation.

Entomological and Arachnids Survey

Methodology

The survey for butterflies, moths, odonates and spiders was conducted between 8th and 16th January 2018. The observations were made between 8am and 1pm. Butterflies, odonates and spiders were recorded using direct observations through walks along forest trails and opportunistic sightings. Moths were documented using light traps to attract and photograph the moths for future identification. A Nikon D3100 with Nikkor 55-300mm lens camera was used to photograph insect and arachnid species and were identified using photographic guides by Rangnekar (2007) and Kehimkar (2008 & 2016).

Results

Tables 6 - 9 list the findings of the entomological and arachnids survey. Image 10 displays the observation locations within the property.

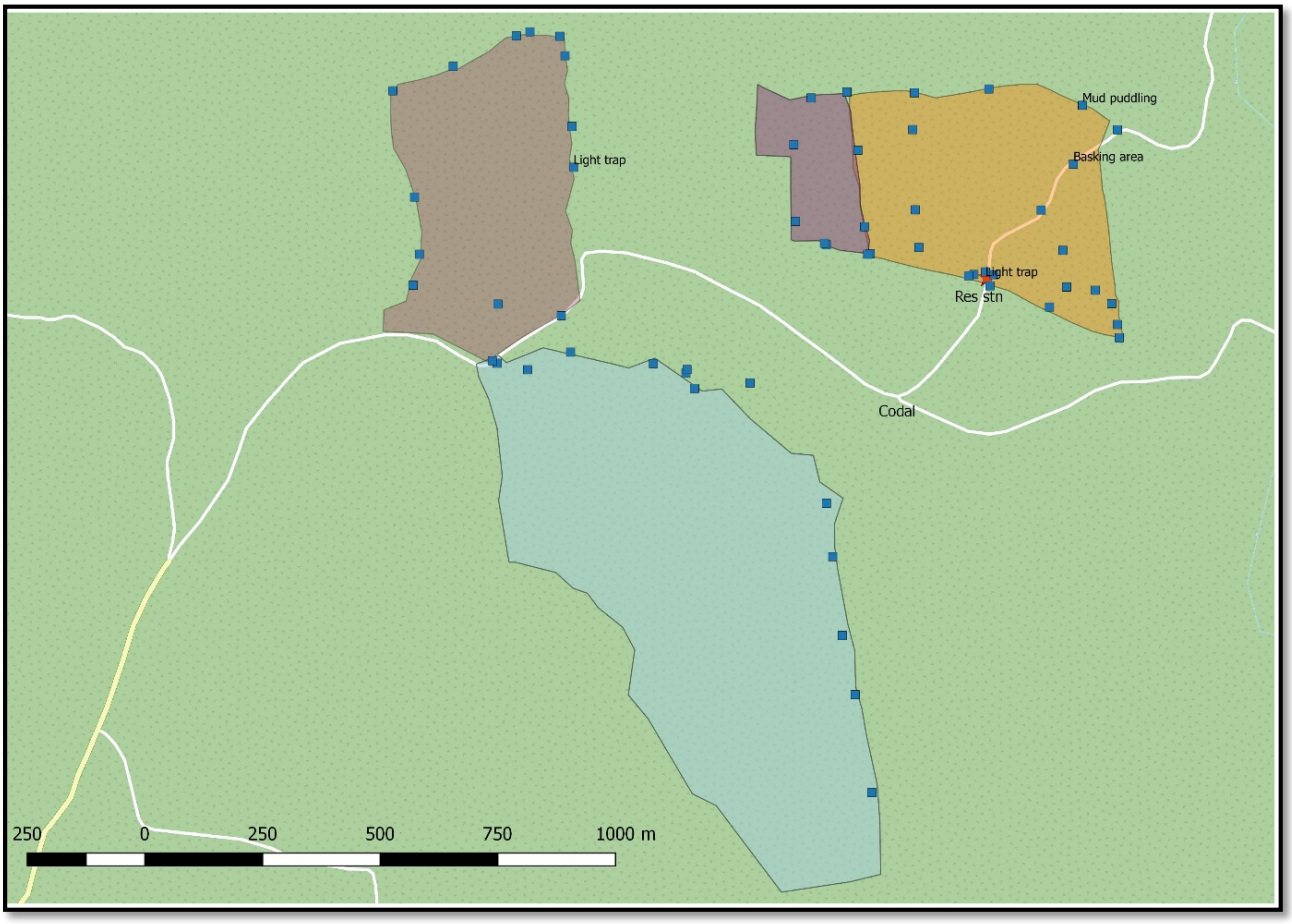


Image 10: Locations of species, light trap and mud puddling observations.

Table 6: Butterfly species recorded, listed by family.

SR. NO	COMMON NAME	SCIENTIFIC NAME	STATUS
		FAMILY: HESPERIIDAE	
1	Awl, Brown	*Badamia exclamationis* (Fabricius)	Common
2	Awl, White Banded	*Hasora taminatus* (Hubner)	Uncommon
3	Bob, Chestnut	*Iambrix salsala* (Moore)	Common
4	Coon	*Psolos fuligo* (Mabille)	Common
5	Dart, Chinese	*Potanthus confucius* (Felder & Felder)	Uncommon
6	Dartlet, Indian	*Oriens goloides* (Moore)	Common
7	Flat, Common Small	*Sarangesa dasahara* Moore	Common
8	Flat, Suffused Snow	*Tagiades gana* (Moore)	Uncommon
9	Scrub Hopper, Pygmy	*Aeromachus pygmaeus* (Fabricius)	Common
		FAMILY: LYCAENIDAE	
10	Cerulean, Common	*Jamides celeno* (Cramer)	Common
11	Ciliate Blue, Pointed	*Anthene lycaenina* (Felder & Felder)	Uncommon
12	Flash, Indigo	*Rapala varuna* (Horsefield)	Uncommon
13	Forget-me-not	*Catochrysops strabo* (Fabricius)	Common
14	Grass Blue, Dark	*Zizeeria karsandra* (Moore)	Common
15	Grass Blue, Lesser	*Zizina otis* (Fabricius)	Common
16	Grass Blue, Tiny	*Zizula hylax* (Fabricius)	Common
17	Grass Jewel, Small	*Freyeria putli* (Kollar)	Common
18	Leaf Blue	*Amblypodia anita* Hewitson	Common
19	Lineblue, Common	*Prosotas nora* (Felder)	Common
20	Lineblue, Dingy	*Petrelaea dana* (de Niceville)	Common
21	Lineblue, Tailless	*Prosotas dubiosa indica* (Evans)	Common
22	Malayan	*Megisba malaya thwaitesi* Moore	Common
23	Monkey Puzzle	*Rathinda amor* (Fabricius)	Common
24	Pierrot, Angled	*Caleta decidia* (Hewitson)	Common
25	Pierrot, Banded Blue	*Discolampha ethion* (Westwood)	Common
26	Pierrot, Common	*Castalius rosimon* (Fabricius)	Common
27	Pierrot, Dark	*Tarucus ananda* (de Niceville)	Uncommon
28	Quaker	*Neopithecops zalmora* (Butler)	Common
29	Tit, Fluffy	*Zeltus amasa*(Hewitson)	Uncommon
		FAMILY: NYMPHALIDAE	
30	Baron, Common	*Euthalia aconthea* (Cramer)	Common
31	Baron, Gaudy	*Euthalia lubentina* (Cramer)	Uncommon
32	Bushbrown, Common	*Mycalesis perseus* (Fabricius)	Common
33	Bushbrown, Gladeye	*Mycalesis patnia* Moore	Uncommon
34	Castor, Angled	*Ariadne ariadne* (Linnaeus)	Uncommon
35	Castor, Common	*Ariadne merione* (Cramer)	Common
36	Count, Grey	*Cynitia lepidea* (Butler)	Common

37	Crow, Common	*Euploea core* (Cramer)	Common
38	Eggfly, Great	*Hypolimnas bolina* (Linnaeus)	Common
39	Evening Brown, Common	*Melanitis leda* (Linnaeus)	Common
40	Lascar, Common	*Pantoporia hordonia* (Stoll)	Common
41	Map, Common	*Cyrestis thyodamas* Boisduval	Common
42	Nawab, Common	*Polyura athamas* (Drury)	Common
43	Nigger	*Orsotrioena medus* (Fabricius)	Common
44	Pansy, Chocolate	*Junonia iphita* (Cramer)	Common
45	Pansy, Grey	*Junonia atlites* (Linnaeus)	Common
46	Pansy, Lemon	*Junonia lemonias* (Linnaeus)	Common
47	Rajah, Black	*Charaxes solon* (Fabricius)	Uncommon
48	Ring, Common Five	*Ypthima baldus* (Fabricius)	Common
49	Ring, Common Four	*Ypthima huebneri* Kirby	Common
50	Ring, Common Three	*Ypthima asterope* (Klug)	Common
51	Rustic	*Cupha erymanthis* (Drury)	Common
52	Sailer, Chestnut-streaked	*Neptis jumbah* Moore	Common
53	Sailer, Common	*Neptis hylas* (Linnaeus)	Common
54	Sergeant, Blackvein	*Athyma ranga* Moore	Uncommon
55	Sergeant, Colour	*Athyma nefte inara* (Westwood)	Uncommon
56	Tiger, Blue	*Tirumala limniace* (Cramer)	Common
57	Tiger, Glassy	*Parantica aglea* (Stoll)	Common
58	Tiger, Striped	*Danaus genutia* (Cramer)	Common
59	Tree Nymph, Malabar	*Idea malabarica* (Moore)	Uncommon
60	Yeoman, Tamil	*Cirrochroa thais* (Fabricius)	Uncommon
FAMILY: PAPILIONIDAE			
61	Jay, Common	*Graphium doson* (Felder & Felder)	Common
62	Lime Butterfly	*Papilio demoleus* Linnaeus	Common
63	Mormon, Common	*Papilio polytes* Linnaeus	Common
64	Raven, Malabar	*Papilio dravidarum* Wood-Mason	Uncommon
65	Rose, Common	*Pachliopta aristolochiae* (Fabricius)	Common
66	Birdwing, Southern	*Troides minos* (Cramer)	Uncommon
67	Mormon, Blue	*Papilio polymnestor* Cramer	Uncommon
FAMILY: PIERIDAE			
68	Grass Yellow, Three-Spot	*Eurema blanda* (Boisduval)	Common
69	Grass Yellow, Common	*Eurema hecabe* (Linnaeus)	Common
70	Emigrant, Mottled	*Catopsilia pyranthe* (Linnaeus)	Common
71	Albatross, Common	*Appias albina* (Boisduval)	Common
72	Jezebel, Common	*Delias eucharis* (Drury)	Common
73	Psyche	*Leptosia nina* (Fabricius)	Common

FAMILY: RIODINIDAE			
74	Judy, Plum	*Abisara bifasciata* Moore	Common

Table 7: List of odonate species.

SR. NO.	COMMON NAME	SCIENTIFIC NAME
DRAGONFLIES		
1	Crimson Marsh Glider	*Trithemis aurora*
2	Fulvous Forest Skimmer	*Neurothemis fulvia*
3	Parakeet Darner	*Gynacantha bayadera*
4	Pied Paddy Skimmer	*Neurothemis tullia*
DAMSELFLIES		
5	Black-tipped Forest Glory	*Vestalis apicalis*
6	Clear-winged Forest Glory	*Vestalis gracilis*
7	Emerald Spreadwing	*Lestes elatus*
8	Pale Slender Dartlet	*Aciagrion pallidum*
9	Stream Glory	*Neurobasis chinensis*
10	Stream Ruby	*Heliocypha bisignata*

Table 8: List of moth species.

SR. NO.	SPECIES
1.	*Dysphania percota*
2.	*Cnaphalocrocis poeyalis*
3.	*Utetheisa* sp.
4.	*Westermannia* sp.
5.	*Pingasa* sp.
6.	*Naarda* sp.
7.	*Nola* sp.
8.	Arctini (Syntomini)
9.	Family Pterophoridae
10.	Subfamily Larentiinae
11.	Family Tineidae
12.	Family Crambidae

Table 9: List of spiders.

SR. NO.	COMMON NAME	SCIENTIFIC NAME
1.	Orb-weaver Spider	*Argiope anusuja*
2.	Wolf Spider	*Hippasa* sp.

Discussion by the experts

The study concluded that the area under investigation has very high insect and arachnid diversity and is home to 74 species of butterflies, 10 species of odonates, 12 species of moths and 2 species of spiders. Five species of butterfly, namely, the *Papilio dravidarum* Wood-Mason, *Troides minos* (Cramer), *Idea malabarica* (Moore), *Mycalesis patnia* Moore, and *Cirrochroa thais* (Fabricius) are endemic to the Western Ghats. 12 species of butterfly are protected under India's Wildlife Protection Act 1972, as listed in Table 10.

Table 10. List of butterfly species protected under the Wildlife Protection Act 1972.

SR. NO.	COMMON NAME	SCIENTIFIC NAME	WPA 1972
1.	Pierrot, Common	*Castalius rosimon* (Fabricius)	Sch I (Part IV)
2.	Sailer, Chestnut-streaked	*Neptis jumbah* Moore	Sch I (Part IV)
3.	Malayan	*Megisba malaya thwaitesi* Moore	Sch II (Part II)
4.	Lineblue, Tailless	*Prosotas dubiosa indica* (Evans)	Sch II (Part II)
5.	Flash, Indigo	*Rapala varuna* (Horsefield)	Sch II (Part II)
6.	Rajah, Black	*Charaxes solon* (Fabricius)	Sch II (Part II)
7.	Nawab, Common	*Polyura athamas* (Drury)	Sch II (Part II)
8.	Sergeant, Blackvein	*Athyma ranga* Moore	Sch II (Part II)
9.	Albatross, Common	*Appias albina* (Boisduval)	Sch II (Part II)
10.	Crow, Common	*Euploea core* (Cramer)	Sch IV
11.	Pierrot, Dark	*Tarucus ananda* (de Niceville)	Sch IV
12.	Baron, Gaudy	*Euthalia lubentina* (Cramer)	Sch IV

Butterflies: Earlier studies have documented 254 species of butterflies (Rangnekar & Dharwadkar 2009) in the state of Goa. The present study recorded 74 species of butterflies, 29% of the total found in the state. Although being a small area, the site has representatives from all 6 families of butterflies: Hesperiidae -9; Lycaenidae – 20; Nymphalidae -31; Papilionidae – 7; Pieridae – 6; and Riodinidae – 1. Nymphalidae was the most abundant family with 31 species and this could be attributed to food availability (Murugesan et al. 2013). Riodinidae was the least abundant family with only 1 species identified. Family-wise abundance follows patterns similar to those shown in earlier studies in the state of Goa (Bowalkar et al 2017, Gaude & Janarthanam 2015, Borkar & Komarpant 2004), with Nymphalidae being the dominant family in all studies.

During the study period one place was identified where butterflies were observed mud puddling (Image 11). Mud puddling is the attraction of adult (generally male) butterflies to moist soil and dirt to suck water and dissolved nutrients. A total of 16 species of butterflies were found using this location for mud puddling, making it a valuable spot for studying and photographing mud puddling in butterflies.

Image 11: Mud puddling spot (N 15°36.005' E 74°12.032', 112 M)

Odonata: 10 species of odonates were documented, of which four are dragonfly species and six are damselfly species and accounts for 11% of the total species (87) found in the state of Goa (Rangnekar & Naik, 2014). The property has many streams, making it ideal habitat for odonates. Further studies are required for getting a complete understanding of the species diversity in the area, especially during the monsoon season, when odonate diversity is very high.

Moths & Spiders: 12 species of moths and two spider species were documented. These species are not identified up to species level as species level identification requires collection of specimens for detailed taxonomic investigation. Identifications are solely based on photographs.

Research during all seasons is required to understand the total species count, seasonal variation, relative species abundance, density and other studies related to population dynamics. Furthermore, as Lepidoptera is a keystone taxa, butterfly studies can be utilised to determine the health of the area under investigation.

Documentation and conservation of larval food plants and nectaring plants utilised by the Lepidoptera order is required for long-term survival of butterflies and moths in the area.

Research centre

The Research Centre was built during the course of this study and is now completely functional (Image 12). It has been designed as a place of work and residence for visiting researchers as well as any scientists or conservationists who may be employed on a more permanent or long-term basis. Detailed proposals including a budget for the functioning of the centre for a year can be found in Appendix I.

Image 12: Research Centre.

Management of the property for the future

This property can be managed with minimal interference and intrusion. This study was a preliminary, phase one project, therefore, further research and studies, as outlined in the Discussion sections of this report, are necessary to better understand the natural systems and equilibrium within which the ecosystems function. Research will also assist with prioritizing management for conservation of threatened species in the region. As mentioned in previous sections, so far, 24 species have been identified as facing threats for their long-term survival and it is imperative for the future of these species that appropriate conservation measures are put into place on the field site.

Certain simple management actions that need to be applied immediately include:

1. Installing sign boards on the roads that pass through the property alerting the public about wildlife crossing and the need to control the speeds at which the locals travel.
2. Patrolling and regular monitoring of illicit logging. Illegal tree felling has been captured on camera traps and it is not unusual to hear sounds of trees being cut, indicating this issue to be a pressing matter of concern. Regular patrolling and monitoring with the aid of CCTV cameras is the only solution for this problem.
3. Invasive species of vegetation threaten the growth of native botanical species and can replace native vegetation at a fast rate. Invasive species are also of little use as food for wildlife, and restrict the movements of animals as well. They therefore need to be removed and replaced with native grasses and trees.

Finally, involving the local community to take responsibility for their natural areas and to work towards protecting them rather than taking advantage of them is a long-term goal that will truly benefit Mhadei Wildlife Sanctuary and its wildlife for many generations to come. This process of developing an interest and appreciation for the local environment can be assisted through community development initiatives that improve the health, wellbeing and livelihoods of the community. At the same time, the anthropogenic dependence and impacts on the forests can be reduced through simple initiatives such as:

1. Building toilet facilities in Codal to stop villagers from defecating and soiling natural forest areas and fields.
2. Providing solar powered stoves to stop villagers from felling trees for firewood for fuel for cooking.
3. Organising medical camps to improve the wellbeing of local citizens. Dry anti-venom can be made accessible at the camps or Centre for use by villagers from Codal or other neighbouring areas.
4. Upgrading the community's religious / cultural facilities by constructing a community centre for instance, to encourage community gatherings and discussions.
5. Opening a tertiary education centre that focuses on ecology, forest management and conservation.

The biodiversity of this study site is extremely valuable both locally and nationally. As a section of the biodiversity hotspot the Western Ghats, it provides habitats to numerous endemic species of wildlife, some of which are threatened and living in unstable and fragmented populations. Conserving this area therefore is vital for the continued survival of the various species that contribute significantly to India's natural heritage.

References

1. Anderson, TM 2012, Plant-Animal Interactions, Berkshire Publishing Group, Berkshire.
2. Biju, SD 2001, A synopsis to the frog fauna of the Western Ghats, India. ISBC—Occasional Publication, 1, pp. 1–24.
3. Biju, SD 2004, *Pseudophilautus amboli*. The IUCN Red List of Threatened Species 2004: e.T58910A11854647. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T58910A11854647.en, viewed on 19 February 2018.
4. Biju, SD, Dasaramji Buddhe, G, Dutta, S, Vasudevan, K, Srinivasulu, C & Vijayakumar, SP 2016, *Uperodon mormorata*. The IUCN Red List of Threatened Species 2016: e.T57987A91601962. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T57987A91601962.en, viewed 20 February 2018.
5. Biju, SD, Garg, S, Gururaja, KV, Shouche, Y, Walujkar, SA 2014. DNA barcoding reveals unprecedented diversity in Dancing Frogs of India (Micrixalidae, Micrixalus): a taxonomic revision with description of 14 new species. Ceylon Journal of Science (Biological Sciences), 43, pp. 37–123.
6. Biju, SD, Shanker, K, Vijayakumar, SP, Srinivasulu, C, Bhupathy, S & Padhye, A 2004, *Raorchestes bombayensis*. The IUCN Red List of Threatened Species 2004: e.T58823A11846015. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T58823A11846015.en, viewed on 19 February 2018.
7. BirdLife International 2016, *Anthracoceros coronatus*. The IUCN Red List of Threatened Species 2016: e.T22682433A92945240. http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22682433A92945240.en, viewed 20 February 2018.
8. BirdLife International 2017, *Buceros bicornis* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22682453A111254552. http://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22682453A111254552.en, viewed 20 February 2018.
9. Borkar, MR & Komarpant, N 2004, Diversity, abundance and habitat associations of butterfly species in Bondla Wildlife Sanctuary of Goa, India. *Zoos' Print Journal,* 19(10), pp. 1648-1653.
10. Bowalkar, D, Michael, NAG, Gaude, K & Pai, IK 2017, A checklist of butterflies (Insecta: Lepidoptera) from Taleigao plateau, Goa, India. *Journal of Threatened Taxa* 9(8), pp. 10626–10630.
11. Cincotta, RP, Wisnewski, J & Engelman, R 2000, Human population in the biodiversity hotspots, *Nature,* 404, pp. 990-992.
12. Dawson, DK & Efford, MG 2009, Bird population density estimated from acoustic signals, *Journal of Applied Ecology,* 46, pp. 1201–1209.
13. Dey, A & De, JN 2010, *Rauvolfia serpentina* (L). Benth. ex Kurz.-A Review. *Asian Journal of Plant Sciences,* 9, pp. 285-298.
14. Duckworth, JW, Sankar, K, Williams, AC, Samba Kumar, N & Timmins, RJ 2016, *Bos gaurus*. The IUCN Red List of Threatened Species 2016: e.T2891A46363646. http://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T2891A46363646.en, viewed 19 February 2018.

15. Frost DR 2016, Amphibian species of the world: an online reference. Version 6.0. New York: American Museum of Natural History. Available at http:// research.amnh.org/ herpetology/ amphibia/index.html, viewed 19 February 2018.
16. Garg, S, Suyesh, R, Sukesan, S & Biju, SD 2017, Seven new species of Night Frogs (Anura, Nyctibatrachidae) from the Western Ghats Biodiversity Hotspot of India, with remarkably high diversity of diminutive forms, PeerJ 5, pp. e3007.
17. Gaude, K & Janarthanam, MK 2015, The Butterfly (Insecta: Lepidoptera) diversity of four sacred groves of Goa, India. *Journal of Threatened Taxa* 7(12), pp. 7927–7932.
18. Hassler M 2018, World Plants: Synonymic Checklists of the Vascular Plants of the World (version Dec 2017). In: Roskov, Y, Abucay, L, Orrell, T, Nicolson, D, Bailly, N, Kirk, PM, Bourgoin, T, DeWalt, RE, Decock, W, De Wever, A, Nieukerken, E van, Zarucchi, J, Penev L, eds. (2018). Species 2000 & ITIS Catalogue of Life, 26th February 2018. Digital resource at www.catalogueoflife.org/col. Species 2000: Naturalis, Leiden, the Netherlands. ISSN 2405-8858.
19. Kehimkar, I 2008, *The book of Indian Butterflies*. Bombay Natural History Society, Mumbai.
20. Kehimkar, I 2016, *Butterflies of India*. Bombay Natural History Society, Mumbai.
21. Khaire, N 2014, *Indian Snakes, A Field Guide*, Jyotsna Prakashan, Delhi.
22. Modak, N, Dahanukar, N, Gosavi, N & Padhye, AD 2015, *Indirana salelkari*, a new species of leaping frog (Anura: Ranixalidae) from Western Ghats of Goa, India. *Journal of Threatened Taxa,* 7(9), pp. 7493–7509.
23. Murugesan, M, Arun, PR & Prusty, BAK 2013, The butterfly community of an urban wetland system - a case study of Oussudu Bird Sanctuary, Puducherry, India. *Journal of Threatened Taxa,* 5(12), pp. 4672–4678.
24. Myers, N, Mittermeier, RA, Mittermeier, CG, da Fonseca GAB & Kent, J 2000, Biodiversity hotspots for conservation priorities, *Nature*, 403, pp. 853-858.
25. Nair, A, Gopalan, SV, George, S, Kumar, KS, Teacher, AGF & Merila, J 2012 High cryptic diversity of endemic Indirana frogs in the Western Ghats biodiversity hotspot, *Animal Conservation*, 15, pp. 489-498.
26. Rangnekar, P & Dharwadkar, O 2009, Three additions to the known butterfly (Lepidoptera: Rhopalocera and Grypocera) fauna of Goa, India, *Journal of Threatened Taxa,* 1(5), pp. 298–299.
27. Rangnekar, P & Naik, R 2014, Further additions to the Odonata (Insecta) fauna of Goa, India, *Journal of Threatened Taxa,* 6(3), pp. 5585–5589.
28. Rangnekar, P 2007, *A Photographic Guide to Butterflies of Goa. (also includes butterflies of other ranges of the Western Ghats & Southern India)*. Mineral Foundation of Goa, Delhi.
29. Rao, RS 1985, As per the Flora of Goa, Diu, Daman, Dadra & Nagarhaveli (Volume 1 and 2) - Botanical Survey of India, New Delhi.
30. Sawant, NS, Jadhav, TD & Shyama, SK 2010, Distribution and abundance of pit vipers (Reptilia: Viperidae) along the Western Ghats of Goa, India *Journal of Threatened Taxa,* 2(10), pp. 1199-1204.
31. Srinivasulu, C & Srinivasulu, B 2013a, *Cnemaspis goaensis*, The IUCN Red List of Threatened Species 2013: e.T172636A1356716. http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T172636A1356716.en., viewed on 19 February 2018.

32. Srinivasulu, C & Srinivasulu, B 2013b, *Geckoella albofasciatus*. The IUCN Red List of Threatened Species 2013: e.T194099A2298523. http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T194099A2298523.en., viewed on 19 February 2018.
33. Srinivasulu, C & Srinivasulu, B 2013c, *Hemidactylus prashadi*. The IUCN Red List of Threatened Species 2013: e.T172638A1357072. http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T172638A1357072.en., viewed on 19 February 2018.
34. Stein, AB, Athreya, V, Gerngross, P, Balme, G, Henschel, P, Karanth, U, Miquelle, D, Rostro-Garcia, S, Kamler, JF, Laguardia, A, Khorozyan, I & Ghoddousi, A 2016, *Panthera pardus* (errata version published in 2016). The IUCN Red List of Threatened Species 2016: e.T15954A102421779. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T15954A50659089.en., viewed on 19 February 2018.
35. Sutherland, WJ 2006, *Ecological census techniques: a handbook*, Cambridge, U.K.
36. Timmins, R, Kawanishi, K, Giman, B, Lynam, A, Chan, B, Steinmetz, R, Sagar Baral, H & Samba Kumar, N 2015, *Rusa unicolor* (errata version published in 2015). The IUCN Red List of Threatened Species 2015: e.T41790A85628124. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T41790A22156247.en., viewed on 19 February 2018.
37. Waits, LP & Paetkau, D 2005, Noninvasive genetics sampling tools for wildlife biologists: a review of applications and recommendations for accurate data collection, *Journal of Wildlife Management* 69(4), pp. 1419–1433.
38. Wearn, OR & Glover-Kapfer, P 2017, Camera-trapping for conservation: a guide to best-practices, WWF Conservation Technology Series 1 (1).

Appendix

Appendix I: Research Centre Proposals

Lower budget proposal

Component	Cost (Rs)
Nature Information Centre	
Painting the research center with the Vanashakti logo; information boards; photo galleries of wildlife species and conservation; signboards of local area including 3D maps.	100,000/-
Caretaker	
Live-in caretaker to ensure cleanliness, maintenance and security of the research centre and its contents. Salary of Rs10,000 per month x 12 months	1,20,000/-yr
Local field assistant	
Local person with knowledge about the property, wildlife, local issues. Assist with educating visiting researchers, maintaining the property, patrolling for threats and implementing conservation initiatives. Salary of Rs12,000 per month x 12 months	1,44,000/-yr
Researcher	
Passionate, active researcher and conservationist with knowledge about the Western Ghats. Responsible for leading basic conservation initiatives (such as monitoring of flora and fauna). Conducting and assisting with biodiversity research / studies. Salary of Rs25,000 per month x 12 months (Salary is a minimum estimate and may vary.) Travel, food, stationery, and other supplies needed for the centre, field staff, and researchers are as 'as actuals'. An estimate of Rs1,50,000 has been calculated.	3,00,000/-yr 1,50,000/- yr
Total	**8,14,000/- yr**

Higher budget proposal

Component	Cost (Rs)
Nature Information Centre	
Library with local guide books, journals, maps, etc. to assist researchers during their stay.	10,000/-
Additional local field assistant	
Additional field assistant if required to assist visiting researchers. Salary of Rs12,000 per month x 12 months	1,44,000/- yr
Researchers / Experts / Consultants	
Conduct biodiversity surveys for a full year, through all seasons, in order to develop a comprehensive checklist of species on the property. Conduct further research as per the suggestions made in this report and meeting held on 18/02/18 for Phase 2 of the project. More specifically, focus on endemic and threatened species that are discovered during the biodiversity surveys in order to devise species-specific conservation strategies. Consultation from experts required at this stage for conducting research, data analysis and report writing. Approximate consultation fees for research and equipment costs provided.	75,000/- for equipment 4,00,000/- for consultants
Sub-total	6,29,000/-
Total from lower budget proposal	8,14,000/-
Total	**1,443,000/- yr**

Appendix II: Photographic list of amphibians and reptiles

SNAKES

Hypnale hypnale

Ptyas mucosa

Ahaetulla nasuta

Amphiesma stolatum

Dendrelaphis tristis

FROGS & TOADS

Duttaphrynus melanostictus

Duttaphrynus melanostictus

Raorchestes bombayensis

Polypedates maculatus

Euphlyctis cyanophlyctis

Indirana salelkari

Indirana bedomii

Indirana spp.

Indirana spp. 2

Pseudophilautus amboli

Pseudophilautus spp.

Pseudophilautus spp. 2

Ramanella mormorata

Sphaerotheca dobsonii

LIZARDS

Cyrtodactylus albofasciatus

Hemidactylus prashadi (juvenile)

Hemidactylus prashadi

Cnemaspis goaensis

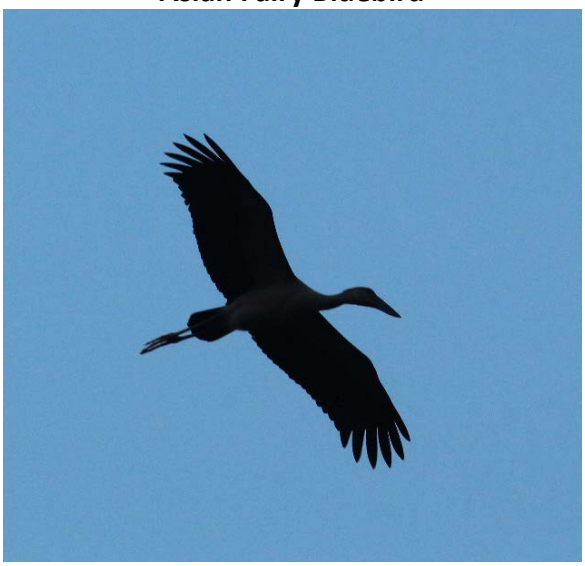
Hemidactylus frenatus

Appendix III: Photographic list of birds

Ashy Woodswallow

Asian Fairy Bluebird

Asian Koel



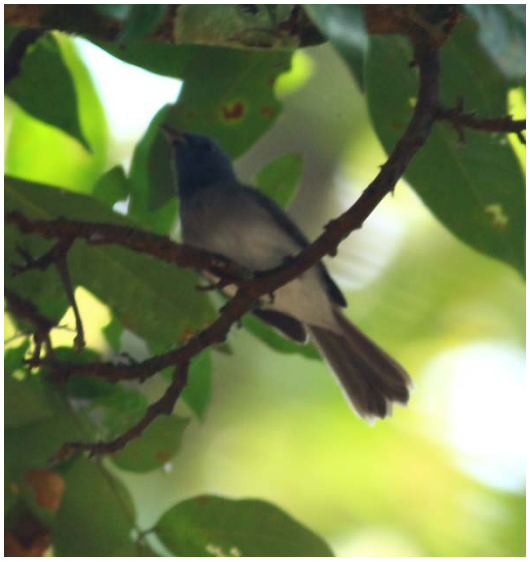
Asian Openbill

Asian Paradise-flycatcher (female)

Asian Paradise-flycatcher (male)

Bar-winged Flycatcher-Shrike

Black Drongo



Black-naped Monarch

Black-naped Oriole

Blue-capped Rock Thrush

Blue-eared Kingfisher

Brahminy Kite

Brown-cheeked Fulvetta

Brown Shrike

Chestnut-headed Bee-eater

Chestnut-tailed Starling

Common Iora

Crested Serpent Eagle

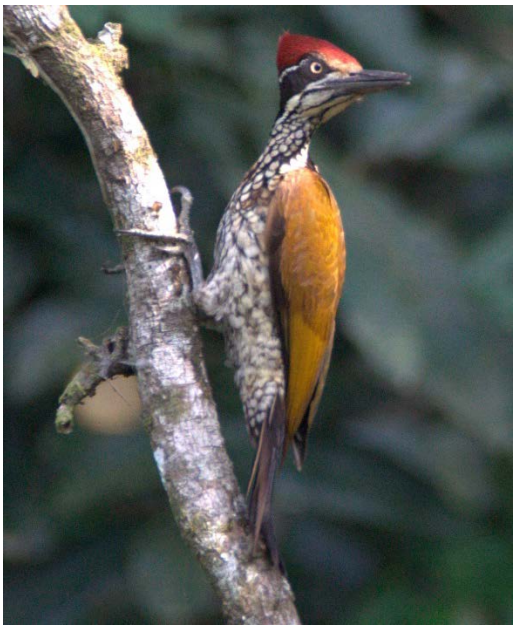
Crimson-backed Sunbird (female)

Crimson-backed Sunbird (male)

Flame-throated Bulbul

Golden-fronted Leafbird

Great Hornbill



Greater Goldenback

Greater Racket-tailed Drongo

Green Bee-eater

Grey-fronted Green Pigeon

Heart-spotted Woodpecker

Indian Jungle Crow

Indian Pond Heron

Lesser Goldenback

Loten's Sunbird

Malabar Barbet

Malabar Grey Hornbill

Malabar Parakeet

Malabar Pied Hornbill

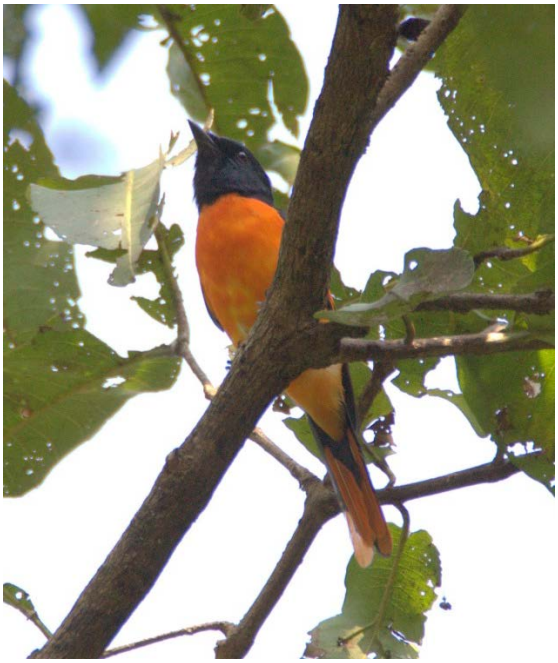
Malabar Trogon (female)

Malabar Trogon (male)

Mountain Imperial Pigeon

Nilgiri Flowerpecker

Orange Minivet (female)



Orange Minivet (male)

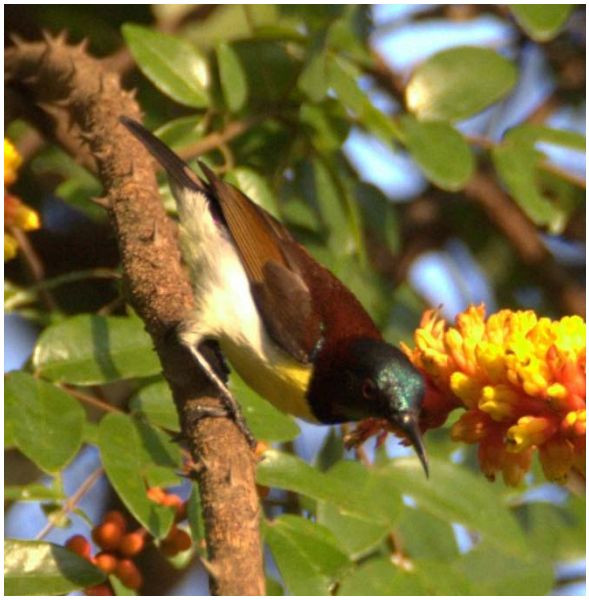
Oriental Magpie-robin

Oriental Turtle Dove

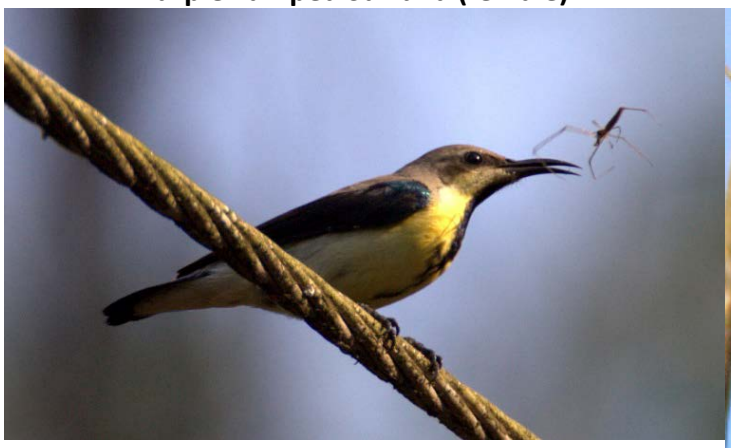
Pale-billed Flowerpecker

Plum-headed Parakeet

Purple-rumped Sunbird (female)



Purple-rumped Sunbird (male)



Purple Sunbird (female)

Purple Sunbird (male)

Red-vented Bulbul

Red-whiskered Bulbul

Rock Pigeon

Rosy Starling

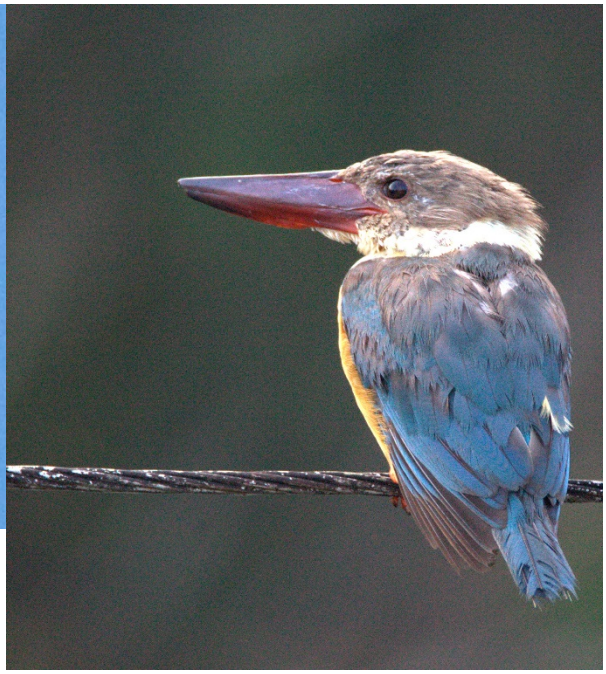
Rufous Treepie

Rufous Woodpecker

Shikra

Spotted Dove

Square-tailed Bulbul



Stork-billed Kingfisher

Tickell's Blue Flycatcher (female)

Tickell's Blue Flycatcher (male)

Velvet-fronted Nuthatch

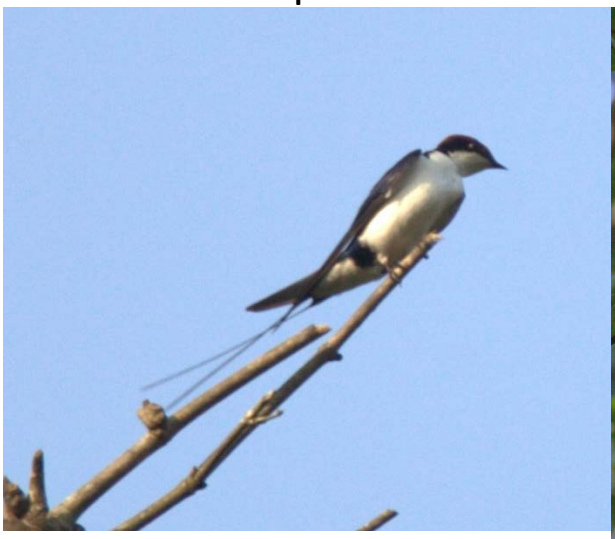
Verditer Flycatcher

Vernal Hanging Parrot

White-cheeked Barbet

White-rumped Munia

White-throated Kingfisher



Wire-tailed Swallow

Yellow-browed Bulbul

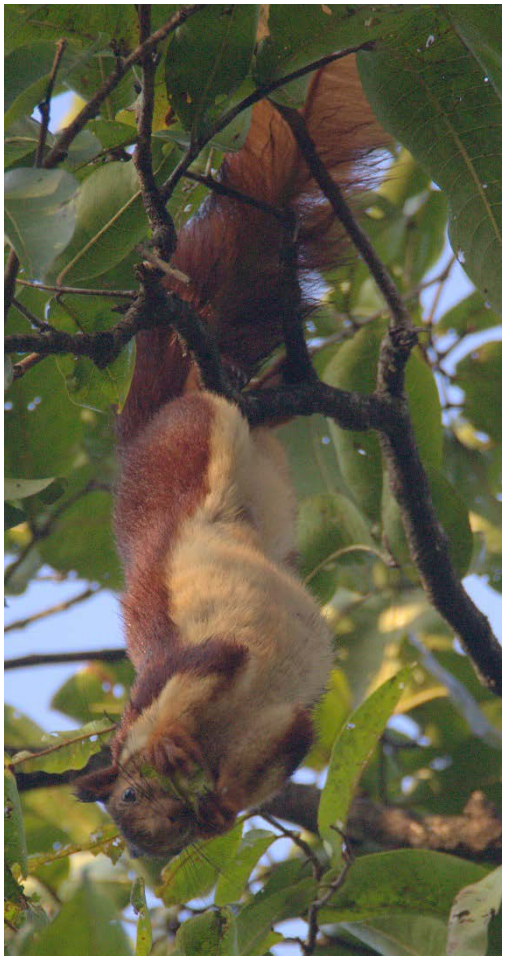
Appendix IV: Photographic list of mammals

Common Palm Civet

Gaur

Indian Crested Porcupine

Indian Giant Flying Squirrel



Indian Giant Squirrel

Indian Hare

Indian Mouse Deer

Leopard

Ruddy Mongoose

Sambar

Small Indian Civet

Wild boar

Appendix V: Photographic list of plants

Anacardium occidentale

Sterculia guttata

Chromolaena odorata

Hibiscus furcatus

Crotalaria calycina

Flemingia semialata

Moullava spicata

Merremia vitifolia

Torenia bicolor

Adenostemma lavenia

Dicliptera foetida

Helicteres isora

Tabernaemontana alternifolia

Canscora diffusa

Canscora perfoliata

Mimosa pudica

Rungia repens

Leucas cilliata var. cilliata

Xantolis tomentosa

Strobilanthes ixiocephalous

Staurogyne zeylanica

Nothopegia sp.

Mucuna sp.

Pepromia pellucida

Haplanthodes tentaculatus

Terminalia paniculata

Callicarpa tomentosa

Bombax insigne

Calamus twaitesii stemh

Bixa orellana

Catunaregam spinosa

Piper nigrum

Crotalaria pallida

Calamus thwaitesii

Tabernaemontana alternifolia

Strychnos nux-vomica

Sterculia guttata

Zingiber cernuum

Xylia xylocarpa

Entada rheedei

Psychotria dalzellii

Gnetum ula

Paramignya monophylla

Elaeagnus conferta

Sterculia guttata

Fungi

Dacryopinax

Bracket fungi

Bracket fungi

Bracket fungi

Bracket fungi

Bryophytes , Algae and Lichens

A crustose lichen

Sporophytic stage of a bryophyte

Thallus of a bryophyte

Fern

Patches of Algae

Stenochlaena

Appendix VI: Photographic list of insects and spiders

FAMILY: HESPERIIDAE

Aeromachus pygmaeus
(Pygmy Scrub Hopper)

Iambrix salsala
(Chestnut Bob)

Hasora taminatus
(White Banded Awl)

Badamia exclamationis
(Brown Awl)

Oriens goloides
(Indian Dartlet)

Potanthus confucius
(Chinese Dart)

FAMILY: HESPERIIDAE

Sarangesa dasahara
(Common Small Flat)

Tagiades gana
(Suffused Snow Flat)

Psolos fuligo
(Coon)

FAMILY: RIODINIDAE

Abisara bifasciata
(Plum Judy)

FAMILY: LYCAENIDAE

Amblypodia anita
(Leaf Blue)

Athene lycaenina
(Pointed Ciliate Blue)

Caleta decidia
(Angled Pierrot)

Catochrysops strabo
(Forget-me-not)

Discolampa ethion
(Banded Blue Pierrot)

Freyeria putli
(Small Grass Jewel)

FAMILY: LYCAENIDAE

Jamides celeno
(Common Cerulean)

Megisba malaya thwaitesi
(Malayan)

Neopithecops zolmora
(Quaker)

Petrelaea dana
(Dingy Lineblue)

Prosotas dubiosa indica
(Tailless Lineblue)

Prosotas nora
(Common Lineblue)

FAMILY: LYCAENIDAE

Rapala varuna
(Indigo Flash)

Tarucus ananda
(Dark Pierrot)

Zeltus amasa
(Fluffy Tit)

Zizeeria karsandra
(Dark Grass Blue)

Zizina otis
(Lesser Grass Blue)

Zizula hylax
(Tiny Grass Blue)

FAMILY : NYMPHALIDAE

Ariadne ariadne
(Angled Castor)

Athyma nefte inara
(Colour Sergeant)

Athyma ranga
(Blackvein Sergeant)

Charaxes solon
(Black Rajah)

Cirrochroa thais
(Tamil Yeoman)

Cupha erymanthis
(Rustic)

FAMILY: NYMPHALIDAE

Cynitia lepidea
(Grey Count)

Cyrestis thyodamas
(Common Map)

Danaus genutia
(Striped Tiger)

Euploea core
(Common Crow)

Euthalia aconthea
(Common Baron)

Euthalia lubentina
(Gaudy baron)

FAMILY: NYMPHALIDAE

Hypolimnas bolina
(Great Eggfly)

Idea malabarica
(Malabar Tree Nymph)

Junonia atlites
(Grey Pansy)

Junonia iphita
(Chocolate Pansy)

Melanitis leda
(Common Evening Brown)

Mycalesis patnia
(Gladeye Bushbrown)

FAMILY: NYMPHALIDAE

Mycalesis perseus
(Common Bushbrown)

Neptis hylas
(Common Sailer)

Neptis jumbah
(Chestnut streaked Sailer)

Orsotrioena medus
(Nigger)

Parantica aglea
(Glassy Tiger)

Polyura athamas
(Common Nawab)

FAMILY: NYMPHALIDAE

Tirumala limniace
(Blue Tiger)

Ypthima asterope
(Common 3 Ring)

Ypthima baldus
(Common Five Ring)

Ypthima huebneri
(Common Four Ring)

FAMILY: PIERIDAE

Appias albina
(Common Albatross)

Catopsilia pyranthe
(Mottled Emigrant)

Delias eucharis
(Common Jezebel)

Eurema blanda
(Three Spot Grass Yellow)

Eurema hecabe
(Common Grass Yellow)

DAMSELFLIES

Aciagrion pallidum
(Pale Slender Dartlet)

Heliocypha bisignata
(Stream Ruby)

Lestes elatus
(Emerald Spreadwing)

Neurobasis chinensis
(Stream Glory)

Vestalis apicalis
(Black-tipped Forest Glory)

Vestalis gracilis
(Clear-winged Forest Glory)

DRAGONFLIES

Gynacantha bayadera
(Parakeet Darner)

Neurothemis fulvia
(Fulvous Forest Skimmer - Female)

Neurothemis fulvia
(Fulvous Forest Skimmer - Male)

Trithemis aurora
(Crimson Marsh Glider)

Neurothemis tullia
(Pied Paddy Skimmer)

Trithemis aurora
(Crimson Marsh Glider)

MOTHS

Dysphania percota
(Blue Tiger moth)

Cnaphalocrocis poeyalis

Utetheisa sp.

Westermannia sp.

Pingasa sp.

Naarda sp.

MOTHS

Nola sp.

Arctini (Syntomini)

Family Pterophoridae

Larentiinae

Family Tineidae

Family Crambidae

SPIDERS

Argiope anusuja
(Orb-weaver spider)

***Hippasa* sp.**
(Wolf Spider)

Appendix VII: Data sheet for amphibians and reptiles

Date	Start time	End time	Transect	Scientific name	Common name	Number
27-Nov-17	10:00 PM	11:00 PM	1	*Ahaetulla nasuta*	Green vine snake	2
27-Nov-17	10:00 PM	11:00 PM	1	*Frog (Roadkill)*		1
27-Nov-17	10:00 PM	11:00 PM	1	*Indirana spp*		1
27-Nov-17	10:00 PM	11:00 PM	1	*Pseudophilautus amboli*	Amboli bush frog	3
28-Nov-17	7:00 PM	8:00 PM	1	*Ahaetulla nasuta*	Green vine snake	1
28-Nov-17	7:00 PM	8:00 PM	1	*Boiga spp*	Cat snake	1
28-Nov-17	7:00 PM	8:00 PM	1	*Cyrtodactylus albofasciatus*	Boulenger's Indian gecko	1
28-Nov-17	7:00 PM	8:00 PM	1	*Dendrelaphis tristis*	Common bronzeback tree snake	1
28-Nov-17	7:00 PM	8:00 PM	1	*Duttaphrynus melanostictus*	Common Asian toad	1
28-Nov-17	7:00 PM	8:00 PM	1	*Hemidactylus prashadi*	Bombay leaf-toed gecko	4
28-Nov-17	7:00 PM	8:00 PM	1	*Indirana spp*		3
28-Nov-17	7:00 PM	8:00 PM	1	*Pseudophilautus amboli*	Amboli bush frog	2
28-Nov-17	8:00 PM	9:00 PM	2	*Cnemaspis goaensis*	Goan day gecko	1
28-Nov-17	8:00 PM	9:00 PM	2	*Pseudophilautus amboli*	Amboli bush frog	2
28-Nov-17	8:00 PM	9:00 PM	2	*Sphenomorphus indicus*	Indian forest skink	1
30-Nov-17	10.30 PM	11.30 PM	2	*Cnemaspis goaensis*	Goan day gecko	1
30-Nov-17	10.30 PM	11.30 PM	2	*Cyrtodactylus albofasciatus*	Boulenger's Indian gecko	1
30-Nov-17	10.30 PM	11.30 PM	2	*Duttaphrynus melanostictus*	Common Asian toad	1
30-Nov-17	10.30 PM	11.30 PM	2	*Euphlyctis cyanophlyctis*	Indian skittering frog	1
30-Nov-17	10.30 PM	11.30 PM	2	*Hemidactylus frenatus*	Common house gecko	1
30-Nov-17	10.30 PM	11.30 PM	2	*Indirana beddomii*	Beddomes leaping frog	2
30-Nov-17	10.30 PM	11.30 PM	2	*Pseudophilautus amboli*	Amboli bush frog	3
30-Nov-17	10.30 PM	11.30 PM	2	*Sphenomorphus indicus*	Indian forest skink	1
2-Dec-17	4:00 AM	5:00 AM	1	*Ahaetulla nasuta*	Green vine snake	1

2-Dec-17	4:00 AM	5:00 AM	1	*Duttaphrynus melanostictus*	Common Asian toad	1
2-Dec-17	4:00 AM	5:00 AM	1	*Indirana beddomii*	Beddomes leaping frog	6
2-Dec-17	4:00 AM	5:00 AM	1	*Indirana salelkari*	A type of leaping frog	3
2-Dec-17	4:00 AM	5:00 AM	1	*Pseudophilautus spp*		5
2-Dec-17	4:00 AM	5:00 AM	1	*Pseudophilautus spp*		2
2-Dec-17	4:00 AM	5:00 AM	1	*Sphenomorphus indicus*	Indian forest skink	1
3-Dec-17	2.30 AM	3.30 AM	2	*Duttaphrynus melanostictus*	Common Asian toad	1
3-Dec-17	2.30 AM	3.30 AM	2	*Indirana beddomii*	Beddomes leaping frog	2
3-Dec-17	2.30 AM	3.30 AM	2	*Pseudophilautus spp*		1
4-Dec-17	10.30 PM	11.30 PM	3	*Euphlyctis cyanophlyctis*	Indian skittering frog	27
4-Dec-17	10.30 PM	11.30 PM	3	*Hypanale hypnale*	Hump-nosed pit viper	1
4-Dec-17	10.30 PM	11.30 PM	3	*Pseudophilautus spp*		3
4-Dec-17	10.30 PM	11.30 PM	3	*Raorchestes bombayensis*	Bombay bush frog	1
4-Dec-17	10.30 PM	11.30 PM	3	*Sphaerotheca dobsonii*	Mangalore bullfrog	1
5-Dec-17	7:00 PM	8:00 PM	3	*Cnemaspis goaensis*	Goan day gecko	2
5-Dec-17	7:00 PM	8:00 PM	3	*Duttaphrynus melanostictus*	Common Asian toad	2
5-Dec-17	7:00 PM	8:00 PM	3	*Euphlyctis cyanophlyctis*	Indian skittering frog	32
5-Dec-17	7:00 PM	8:00 PM	3	*Hypanale hypnale*	Hump-nosed pit viper	2
5-Dec-17	7:00 PM	8:00 PM	3	*Indirana beddomii*	Beddomes leaping frog	1
5-Dec-17	7:00 PM	8:00 PM	3	*Polypedates maculatus*	Indian tree frog	2
5-Dec-17	7:00 PM	8:00 PM	3	*Pseudophilautus spp*		17
5-Dec-17	7:00 PM	8:00 PM	3	*Pseudophilautus spp*		13
5-Dec-17	7:00 PM	8:00 PM	3	*Raorchestes bombayensis*	Bombay bush frog	7
5-Dec-17	7:00 PM	8:00 PM	3	*Sphaerotheca dobsonii*	Mangalore bullfrog	1
5-Dec-17	7:00 PM	8:00 PM	3	*Sphenomorphus indicus*	Indian forest skink	2
7-Dec-17	2.30 AM	3.30 AM	3	*Cyrtodactylus albofasciatus*	Boulenger's Indian gecko	1
7-Dec-17	2.30 AM	3.30 AM	3	*Euphlyctis cyanophlyctis*	Indian skittering frog	12
7-Dec-17	2.30 AM	3.30 AM	3	*Pseudophilautus spp*		7
7-Dec-17	2.30 AM	3.30 AM	3	*Pseudophilautus spp*		2

7-Dec-17	2.30 AM	3.30 AM	3	*Raorchestes bombayensis*	Bombay bush frog	6
7-Dec-17	2.30 AM	3.30 AM	3	*Sphaerotheca dobsonii*	Mangalore bullfrog	1
7-Dec-17	2.30 AM	3.30 AM	3	*Sphenomorphus indicus*	Indian forest skink	2
8-Dec-17	6.30 PM	7.30 PM	4	*Amphiesma stolatum*	Buff striped keelback	1
8-Dec-17	6.30 PM	7.30 PM	4	*Polypedates maculatus*	Indian tree frog	1
8-Dec-17	6.30 PM	7.30 PM	4	*Pseudophilautus spp*		14
8-Dec-17	6.30 PM	7.30 PM	4	*Pseudophilautus spp*		1
8-Dec-17	6.30 PM	7.30 PM	4	*Sphaerotheca dobsonii*	Mangalore bullfrog	1
8-Dec-17	6.30 PM	7.30 PM	4	*Sphenomorphus indicus*	Indian forest skink	2
8-Dec-17	6.30 PM	7.30 PM	4	*Xenochrophis piscator*	Checkered keelback	1
9-Dec-17	12:00 AM	1.00 AM	4	*Polypedates maculatus*	Indian tree frog	1
9-Dec-17	12:00 AM	1.00 AM	4	*Pseudophilautus spp*		52
9-Dec-17	12:00 AM	1.00 AM	4	*Pseudophilautus spp*		7
9-Dec-17	12:00 AM	1.00 AM	4	*Raorchestes bombayensis*	Bombay bush frog	2
9-Dec-17	12:00 AM	1.00 AM	4	*Sphaerotheca dobsonii*	Mangalore bullfrog	1

Appendix VIII: Data sheet for birds

Date	Time	Observer	Transect	Species
9/12/2017	Evening	VT	1	Black Drongo
9/12/2017	Evening	VT	1	Brown-headed Barbet
9/12/2017	Evening	VT	1	Chestnut-headed Bee-eater
9/12/2017	Evening	VT	1	Coppersmith Barbet
9/12/2017	Evening	VT	1	Crimson-backed Sunbird
9/12/2017	Evening	VT	1	Emerald Dove
9/12/2017	Evening	VT	1	Great Hornbill
9/12/2017	Evening	VT	1	Indian Jungle Crow
9/12/2017	Evening	VT	1	Loten's Sunbird
9/12/2017	Evening	VT	1	Malabar Barbet
9/12/2017	Evening	VT	1	Malabar Grey Hornbill
9/12/2017	Evening	VT	1	Purple Sunbird
9/12/2017	Evening	VT	1	Purple-rumped Sunbird
9/12/2017	Evening	VT	1	Red-whiskered Bulbul
9/12/2017	Evening	VT	1	Rock Pigeon
9/12/2017	Evening	VT	1	Vernal Hanging Parrot
9/12/2017	Evening	VT	1	White-cheeked Barbet
9/12/2017	Evening	VT	2	Bar-winged Flycatcher-Shrike
9/12/2017	Evening	VT	2	Black-hooded Oriole
9/12/2017	Evening	VT	2	Blue-throated Blue Flycatcher
9/12/2017	Evening	VT	2	Chestnut-headed Bee-eater
9/12/2017	Evening	VT	2	Forest Wagtail
9/12/2017	Evening	VT	2	Black Kite
9/12/2017	Evening	VT	2	Heart-spotted Woodpecker
9/12/2017	Evening	VT	2	Indian Nightjar
9/12/2017	Evening	VT	2	Indian Peafowl
9/12/2017	Evening	VT	2	Malabar Grey Hornbill
9/12/2017	Evening	VT	2	Malabar Pied Hornbill
9/12/2017	Evening	VT	2	Orange Minivet
9/12/2017	Evening	VT	2	Thick-billed Flowerpecker
9/12/2017	Evening	VT	2	White-bellied Woodpecker
10/12/2017	Morning	AW	1	Asian Fairy Bluebird
10/12/2017	Morning	AW	1	Bar-winged Flycatcher-Shrike
10/12/2017	Morning	AW	1	Black Drongo
10/12/2017	Morning	AW	1	Black-naped Oriole
10/12/2017	Morning	AW	1	Brown-cheeked Fulvetta
10/12/2017	Morning	AW	1	Common Iora
10/12/2017	Morning	AW	1	Grey-fronted Green Pigeon
10/12/2017	Morning	AW	1	Orange Minivet
10/12/2017	Morning	AW	2	Nilgiri Flowerpecker

10/12/2017	Morning	AW	2	Red-whiskered Bulbul
10/12/2017	Morning	AW	2	Velvet-fronted Nuthatch
10/12/2017	Morning	VT	3	Ashy Drongo
10/12/2017	Morning	VT	3	Asian Fairy Bluebird
10/12/2017	Morning	VT	3	Bar-winged Flycatcher-Shrike
10/12/2017	Morning	VT	3	Black-naped Oriole
10/12/2017	Morning	VT	3	Brown Shrike
10/12/2017	Morning	VT	3	Crimson-backed Sunbird
10/12/2017	Morning	VT	3	Dark-fronted Babbler
10/12/2017	Morning	VT	3	Golden-fronted Leafbird
10/12/2017	Morning	VT	3	Grey-fronted Green Pigeon
10/12/2017	Morning	VT	3	Loten's Sunbird
10/12/2017	Morning	VT	3	Mountain Imperial Pigeon
10/12/2017	Morning	VT	3	Nilgiri Flowerpecker
10/12/2017	Morning	VT	3	Orange Minivet
10/12/2017	Morning	VT	3	Purple-rumped Sunbird
10/12/2017	Morning	VT	3	Vernal Hanging Parrot
10/12/2017	Morning	VT	3	Vigors' Sunbird
10/12/2017	Morning	VT	3	White-naped Woodpecker
10/12/2017	Morning	VT	3	Wire-tailed Swallow
11/12/2017	Morning	AW	1	Ashy Drongo
11/12/2017	Morning	AW	1	Bar-winged Flycatcher-Shrike
11/12/2017	Morning	AW	1	Black-headed Cuckooshrike
11/12/2017	Morning	AW	1	Brown Shrike
11/12/2017	Morning	AW	1	Flame-throated Bulbul
11/12/2017	Morning	AW	1	Golden-fronted Leafbird
11/12/2017	Morning	AW	1	Nilgiri Flowerpecker
11/12/2017	Morning	AW	1	White-browed Fantail
11/12/2017	Morning	AW	2	Black-hooded Oriole
11/12/2017	Morning	AW	2	Blyth's Reed Warbler
11/12/2017	Evening	AW	2	Chestnut-headed Bee-eater
11/12/2017	Evening	AW	2	Indian Jungle Crow
11/12/2017	Evening	AW	2	Malabar Parakeet
11/12/2017	Morning	AW	2	Purple-rumped Sunbird
11/12/2017	Morning	AW	2	Red-whiskered Bulbul
11/12/2017	Evening	AW	2	Shikra
11/12/2017	Morning	AW	2	Square-tailed Bulbul
11/12/2017	Morning	AW	2	Vernal Hanging Parrot
11/12/2017	Morning	AW	2	Wire-tailed Swallow
11/12/2017	Morning	AW	2	Yellow-browed Bulbul
11/12/2017	Morning	VT	3	Crimson-backed Sunbird
11/12/2017	Morning	VT	3	Dark-fronted Babbler
11/12/2017	Morning	VT	3	Flame-throated Bulbul
11/12/2017	Morning	VT	3	Malabar Grey Hornbill

11/12/2017	Morning	VT	3	Malabar Pied Hornbill
11/12/2017	Morning	VT	3	Orange-headed Thrush
11/12/2017	Evening	VT	4	Asian Fairy Bluebird
11/12/2017	Evening	VT	4	Brahminy Kite
11/12/2017	Evening	VT	4	Crimson-backed Sunbird
11/12/2017	Evening	VT	4	Dark-fronted Babbler
11/12/2017	Evening	VT	4	Great Hornbill
11/12/2017	Evening	VT	4	Grey Junglefowl
11/12/2017	Evening	VT	4	Malabar Grey Hornbill
11/12/2017	Evening	VT	4	Malabar Whistling Thrush
11/12/2017	Evening	VT	4	Mountain Imperial Pigeon
11/12/2017	Evening	VT	4	Pale-billed Flowerpecker
11/12/2017	Evening	VT	4	Velvet-fronted Nuthatch
12/12/2017	Evening	AW	1	Ashy Drongo
12/12/2017	Evening	AW	1	Asian Openbill
12/12/2017	Evening	AW	1	Chestnut-tailed Starling
12/12/2017	Morning	AW	1	Chestnut-tailed Starling
12/12/2017	Morning	AW	1	Flame-throated Bulbul
12/12/2017	Morning	AW	1	Golden-fronted Leafbird
12/12/2017	Morning	AW	1	Greater Racket-tailed Drongo
12/12/2017	Morning	AW	1	Grey-fronted Green Pigeon
12/12/2017	Morning	AW	1	Heart-spotted Woodpecker
12/12/2017	Evening	AW	1	Indian Pond Heron
12/12/2017	Evening	AW	1	Malabar Barbet
12/12/2017	Morning	AW	1	Malabar Trogon (female)
12/12/2017	Morning	AW	1	Malabar Trogon (male)
12/12/2017	Morning	AW	1	Rufous Treepie
12/12/2017	Morning	AW	1	Shikra
12/12/2017	Morning	AW	1	Verditer Flycatcher
12/12/2017	Evening	AW	2	Greenish warbler
12/12/2017	Evening	AW	2	Grey-fronted Green Pigeon
12/12/2017	Evening	AW	2	Malabar Grey Hornbill
12/12/2017	Evening	AW	2	Mountain Imperial Pigeon
12/12/2017	Evening	AW	2	Purple Sunbird
12/12/2017	Evening	AW	2	Purple-rumped Sunbird
12/12/2017	Evening	AW	2	Raptor
12/12/2017	Evening	AW	2	Rock Pigeon
12/12/2017	Evening	AW	2	Yellow-browed Bulbul
12/12/2017	Morning	VT	4	Black-naped Oriole
12/12/2017	Morning	VT	4	Blue-throated Blue Flycatcher
12/12/2017	Morning	VT	4	Crimson-backed Sunbird
12/12/2017	Morning	VT	4	Flame-throated Bulbul
12/12/2017	Morning	VT	4	Greater Racket-tailed Drongo
12/12/2017	Morning	VT	4	Grey Junglefowl

12/12/2017	Morning	VT	4	House Sparrow
12/12/2017	Morning	VT	4	Rufous Woodpecker
12/12/2017	Morning	VT	5	Asian Brown Flycatcher
12/12/2017	Morning	VT	5	Asian Paradise-flycatcher
12/12/2017	Morning	VT	5	Crimson-backed Sunbird
12/12/2017	Morning	VT	5	Dark-fronted Babbler
12/12/2017	Morning	VT	5	Dark-sided Flycatcher
12/12/2017	Morning	VT	5	Malabar Barbet
12/12/2017	Morning	VT	5	Malabar Grey Hornbill
12/12/2017	Morning	VT	5	Stork-billed Kingfisher
12/12/2017	Night	VT	Research centre	Indian Eagle Owl
13/12/2017	Morning	AW	1	Ashy Woodswallow
13/12/2017	Morning	AW	1	Bar-winged Flycatcher-Shrike
13/12/2017	Morning	AW	1	Black Drongo
13/12/2017	Morning	AW	1	Black-naped Monarch
13/12/2017	Morning	AW	1	Black-naped Oriole (female)
13/12/2017	Morning	AW	1	Blue-capped Rock Thrush
13/12/2017	Morning	AW	1	Brown-cheeked Fulvetta
13/12/2017	Morning	AW	1	Dark-sided Flycatcher
13/12/2017	Morning	AW	1	Greater Racket-tailed Drongo
13/12/2017	Morning	AW	1	Green Bee-eater
13/12/2017	Morning	AW	1	Grey-fronted Green Pigeon
13/12/2017	Morning	AW	1	Indian Jungle Crow
13/12/2017	Morning	AW	1	Lesser Goldenback
13/12/2017	Morning	AW	1	Malabar Barbet
13/12/2017	Morning	AW	1	Malabar Pied Hornbill
13/12/2017	Morning	AW	1	Malabar Trogon
13/12/2017	Morning	AW	1	Oriental Magpie-robin
13/12/2017	Morning	AW	1	Oriental Turtle Dove
13/12/2017	Morning	AW	1	Purple Sunbird (female)
13/12/2017	Morning	AW	1	Rosy Starling
13/12/2017	Morning	VT	2	Flame-throated Bulbul
13/12/2017	Morning	VT	2	Malabar Trogon
13/12/2017	Morning	AW	2	Red-vented Bulbul
13/12/2017	Morning	AW	2	Spotted Dove
13/12/2017	Morning	AW	2	Tickell's Blue Flycatcher
13/12/2017	Morning	AW	2	Velvet-fronted Nuthatch
13/12/2017	Morning	AW	2	White-rumped Munia
13/12/2017	Morning	AW	2	White-throated Kingfisher
13/12/2017	Morning	AW	2	Yellow-billed Babbler
13/12/2017	Morning	AW	2	Yellow-browed Bulbul
13/12/2017	Morning	VT	3	Crimson-backed Sunbird
13/12/2017	Morning	VT	3	Heart-spotted Woodpecker
13/12/2017	Morning	VT	3	Malabar Pied Hornbill

13/12/2017	Morning	VT	3	White-cheeked Barbet
13/12/2017	Morning	VT	3	White-throated Kingfisher
13/12/2017	Morning	VT	5	Asian Openbill
13/12/2017	Morning	VT	5	Cattle Egret
13/12/2017	Evening	VT	5	Cattle Egret
13/12/2017	Morning	VT	5	Crimson-backed Sunbird
13/12/2017	Evening	VT	5	Crimson-backed Sunbird
13/12/2017	Morning	VT	5	Flame-throated Bulbul
13/12/2017	Morning	VT	5	Green Sandpiper
13/12/2017	Morning	VT	5	Grey Wagtail
13/12/2017	Evening	VT	5	Indian Pond Heron
13/12/2017	Morning	VT	5	Loten's Sunbird
13/12/2017	Morning	VT	5	Malayan Night Heron
13/12/2017	Morning	VT	5	Red-whiskered Bulbul
13/12/2017	Morning	VT	5	Stork-billed Kingfisher
13/12/2017	Morning	VT	5	White-breasted Waterhen
14/12/2017	Morning	VT	2	Ashy Drongo
14/12/2017	Evening	VT	2	Ashy Drongo
14/12/2017	Morning	VT	2	Asian Fairy Bluebird
14/12/2017	Evening	VT	2	Asian Fairy Bluebird
14/12/2017	Evening	VT	2	Crested Serpent Eagle
14/12/2017	Evening	VT	2	Crimson-backed Sunbird
14/12/2017	Evening	VT	2	Asian Koel
14/12/2017	Morning	VT	2	Flame-throated Bulbul
14/12/2017	Evening	VT	2	Flame-throated Bulbul
14/12/2017	Morning	VT	2	Flame-throated Bulbul
14/12/2017	Evening	VT	2	Flame-throated Bulbul
14/12/2017	Morning	VT	2	Greater Racket-tailed Drongo
14/12/2017	Evening	VT	2	Greater Racket-tailed Drongo
14/12/2017	Morning	VT	2	Malabar Pied Hornbill
14/12/2017	Morning	VT	2	Malabar Trogon
14/12/2017	Evening	VT	2	Malabar Trogon
14/12/2017	Evening	VT	2	Mountain Imperial Pigeon
14/12/2017	Morning	VT	2	Red-whiskered Bulbul
14/12/2017	Morning	VT	3	Ashy Drongo
14/12/2017	Morning	VT	3	Black-naped Oriole
14/12/2017	Morning	VT	3	Dark-fronted Babbler
14/12/2017	Morning	VT	3	Flame-throated Bulbul
14/12/2017	Morning	VT	3	Banded Bay Cuckoo
14/12/2017	Morning	VT	3	Great Hornbill
14/12/2017	Morning	VT	3	Common Tailorbird
14/12/2017	Morning	VT	3	Grey Junglefowl
14/12/2017	Morning	VT	3	House Crow
14/12/2017	Morning	VT	3	Malabar Pied Hornbill

14/12/2017	Morning	VT	4	Crimson-backed Sunbird
14/12/2017	Morning	VT	4	Flame-throated Bulbul
14/12/2017	Morning	VT	4	Black Eagle
14/12/2017	Morning	VT	4	Great Hornbill
14/12/2017	Morning	VT	4	Greater Goldenback
14/12/2017	Morning	VT	4	Green Imperial Pigeon
14/12/2017	Morning	VT	4	Crested Treeswift
14/12/2017	Morning	VT	4	Plum-headed Parakeet
14/12/2017	Morning	VT	4	Rufous Treepie
14/12/2017	Morning	VT	4	Vernal Hanging Parrot

Appendix IX: Data sheet for mammals

ID	Camera	Date	Location- waypoint reference	Photo / Video	Image description	Timestamp on image
1	1	19/12/2017	6	V	Rat	16:14:41
2	2	19/12/2017	20	V	Wild Boar	16:29:58
3	1	23/12/2017	19	V	Sambar (female)	12:57:49
4	1	27/12/2017	9	V	Small Indian Civet	8:53:42
5	2	27/12/2017	11			
6	3	27/12/2017	7			
7	4	27/12/2017	8			
8	1	28/12/2017	9			
9	2	28/12/2017	11			
10	3	28/12/2017	7			
11	4	28/12/2017	8			
12	1	11/01/2018	3			
13	2	11/01/2018	17			
14	3	11/01/2018	16			
15	4	11/01/2018	14			
16	1	12/01/2018	3			
17	2	12/01/2018	12			
18	3	12/01/2018	16			
19	4	12/01/2018	14			
20	1	13/01/2018	3			
21	2	13/01/2018	12			
22	3	13/01/2018	13	V	Rat	13:35:50
23	4	13/01/2018	14			
24	1	14/01/2018	3			
25	2	14/01/2018	12			
26	3	14/01/2018	10	V	Common Palm Civet	16:38:48
27	4	14/01/2018	18			
28	1	15/01/2018	3	P & V	Ruddy Mongoose	
29	1	15/01/2018	3	P & V	Leopard	10:48:40
30	2	15/01/2018	22	P		9:07:04
31	3	15/01/2018	10			
32	4	15/01/2018	18			
33	1	16/01/2018	3	V	Small Indian Civet	15:06:12
34	2	16/01/2018	22			
35	3	16/01/2018	10			

36	4	16/01/2018	18			
37	1	17/01/2018	3	V	Wild Boar	13:54:22
38	2	17/01/2018	22			
39	3	17/01/2018	5	V	Indian Mouse Deer	19:51:20
40	4	17/01/2018	18			
41	1	18/01/2018	3	V	Bird	19:34:02
42	2	18/01/2018	21	V	Indian Crested Porcupine	16:47:38
43	3	18/01/2018	5			
44	4	18/01/2018	18			
45	1	19/01/2018	3			
46	2	19/01/2018	21			
47	3	19/01/2018	5			
48	4	19/01/2018	18			
49	1	20/01/2018	3			
50	2	20/01/2018	21	V	Small Indian Civet	7:33:06
51	3	20/01/2018	5			
52	4	20/01/2018	18			
53	1	21/01/2018	3		Small Indian Civet	11:00:24
54	2	21/01/2018	21			
55	3	21/01/2018	5			
56	4	21/01/2018	18			
57	1	22/01/2018	3			
58	2	22/01/2018	21	V	Indian Crested Porcupine	14:18:30
59	3	22/01/2018	5	V	Sambar (male)	10:06:34
60	4	22/01/2018	15			
61	1	23/01/2018	3	V	Indian Hare	
62	1	23/01/2018	3	V	Small Indian Civet	11:48:56
63	1	23/01/2018	3	V	Indian Crested Porcupine	13:15:38
64	1	23/01/2018	3	V	Wild boar	16:56:26
65	2	23/01/2018	21			
66	3	23/01/2018	5			
67	4	23/01/2018	15			
68	1	24/01/2018	3	V	Indian Hare	11:14:42
69	1	24/01/2018	3	V	Leopard	10:05:36
70	2	24/01/2018	21			
71	3	24/01/2018	5			
72	4	24/01/2018	15			
73	1	25/01/2018	3	V	Bird	18:31:28

74	2	25/01/2018	21			
75	3	25/01/2018	5			
76	4	25/01/2018	15			
77	1	26/01/2018	3			
78	2	26/01/2018	21			
79	3	26/01/2018	5			
80	4	26/01/2018	15			
81	1	27/01/2018	3	V	Indian Hare	14:01:52
82	1	27/01/2018	3	V	Indian Hare	18:11:26
83	2	27/01/2018	2			
84	3	27/01/2018	1			
85	4	27/01/2018	4			
86	1	28/01/2018	3			
87	2	28/01/2018	2			
88	3	28/01/2018	1	V	Sambar (male)	11:44:42
89	3	28/01/2018	1	V	Ruddy Mongoose	20:27:50
90	4	28/01/2018	4			
91	1	29/01/2018	3	V	Indian Hare	12:39:29
92	2	29/01/2018	19			
93	3	29/01/2018	19	V	Rat	17:01:20
94	3	29/01/2018	19	V	Bird	20:44:32
95	4	29/01/2018	4			
96	1	30/01/2018	3			
97	2	30/01/2018	19			
98	3	30/01/2018	19			
99	4	30/01/2018	4			
100	1	31/01/2018	3	V	Small Indian Civet	8:14:14
101	2	31/01/2018	19			
102	3	31/01/2018	19			
103	4	31/01/2018	4			

Appendix X: Data sheet for plants

Botanical name	Common name	Family	Occurrence in Goa	Local uses	Habit	Natural range
Ichnocarpus frutescens (L.) W. T. Aiton		Apocynaceae	Frequent		Climber	Native
Pothos scandens L.		Araceae	Occasional		Climber	Native
Hemidesmus indicus (L.) R. Br.	Anant vel	Asclepiadaceae	Not mentioned		Climber	Native
Moullava spicata (Dalzell)Nicolson		Fabaceae	Occasional in forest		Climber	Native
Calycopteris floribunda (Roxb.) Lam.	Uski	Combretaceae	Common		Climber	Native
Camonea vitifolia (Burm.f.) A.R.Simões & Staples		Convolvulaceae	Occasional		Climber	Native
Mucuna pruriens (L.)DC.		Fabaceae	Common		Climber	Native
Teramnus labialis (L.f.)Spreng.		Fabaceae	Common		Climber	Native
Gnetum ula Brongn.		Gnetaceae	Occasional,woody climbers		Climber	Native
Lygodium flexuosum (L.) Sw.		Lygodiaceae	***		Climber	***
Anamirta cocculus (L.) Wight & Arn.		Menispermiaceae	Rare		Climber	Native
Diploclisia glaucescens (Bl.) Diels		Menispermiaceae	Sparse		Climber	Native
Piper nigrum L.		Piperaceae	Escape from cultivation		Climber	Native
Stenochlaena sp.		Pteridaceae	***		Climber	***
Paramignya monophylla Wight.		Rutaceae	Occasional in forest		Climber	Native
Cissus sp.		Vitaceae	***		Climber	***
Tragia involucrata L.		Euphorbiaceae	Occasional		Climber	Native
Bridelia montana (Roxb.) Willd.		Phyllanthaceae	Not mentioned		Climbing shrub	Native
Aerides sp.		Orchidaceae	***		Epiphyte	***
Eria sp.		Orchidaceae	***		Epiphyte	Native
Rhynchostylis sp.		Orchidaceae	***		Epiphyte	Native
Drynaria sp.		Pteridaceae	***		Epiphyte	***
Dicliptera foetida (Forssk.) Blatter		Acanthaceae	Occasional		Herb	Native
Eranthemum roseum (Vahl) R. Br.		Acanthaceae	Common		Herb	Native
Haplanthodes verticillatus (Roxb.) R.B. Majumdar		Acanthaceae	Rare		Herb	Native
Justicia micrantha (Oersted) V.A.W. Grah.		Acanthaceae	Not mentioned		Herb	Native
Justicia pectinata L.		Acanthaceae	Common		Herb	Native
Justicia sp.		Acanthaceae	***		Herb	***
Justicia wynaadensis (Nees) Heyne		Acanthaceae	Not mentioned		Herb	***
Nelsonia canescens (Lam.) Spreng.		Acanthaceae	Rare, found in cleared areas		Herb	Introduced
Rungia repens (L.) Nees		Acanthaceae	Common in moist, open fields and forest undergrowth		Herb	Native

Staurogyne zeylanica (Nees) Kuntze		Acanthaceae	Rare		Herb	Native
Celosia argentea L.		Amaranthaceae	Common weed		Herb	Introduced
Dracaena terniflora Roxb.		Asparagaceae	Not mentioned		Herb	Native
Acmella radicans (Jacquin) R.K. Jansen		Asteraceae	Not mentioned		Herb	Introduced
Blumea oxyodonta DC.		Asteraceae	***		Herb	***
Blumea sp.		Asteraceae	***		Herb	***
Cyathocline purpurea (Buch.-Ham. ex D. Don) Kuntze		Asteraceae	Common		Herb	Native
Elephantopus scaber L.		Asteraceae	***	Dried inflorescence is used against fever as a necklace pendant	Herb	Native
Synedrella nodiflora (L.) Gaertn.		Asteraceae	Rare		Herb	Naturalised
Crotalaria calycina Schrank		Fabaceae	***		Herb	Native
Crotalaria pallida Aiton		Fabaceae	Common		Herb	Native
Smithia sp.		Fabaceae	***		Herb	***
Funaria sp.		Funariaceae	***		Herb	
Canscora diffusa (Vahl) R. Br. ex Roem. & Schult.		Gentianaceae	Common in moist, sandy, shady, area		Herb	Native
Pogostemon benghalensis (Burm.f.) Kuntze		Lamiaceae	Rare		Herb	Native
Sida rhombifolia L.	Sadeda, Sahadeva	Malvaceae	Common weed		Herb	Endemic to Western Ghats
Urena lobata L.		Malvaceae	Common		Herb	Introduced
Mimosa pudica L.		Mimosaceae	Common		Herb	Native
Peperomia pellucida (L.) Kunth		Piperaceae	Common in moist places		Herb	Native
Adiantum sp		Pteridaceae	***		Herb	***
Pteris quadriaurita		pteridaceae	***		Herb	***
Pteris sp.		Pteridaceae	***		Herb	***
Spermacocce ocymoides Burm.f.		Rubiaceae	***		Herb	Native
Spermacoce sp.		Rubiaceae	***		Herb	Native
Torenia bicolor Dalz.		Scrophulariaceae	Occasional		Herb	Native
Selaginella sp.		Selaginellaceae	***		Herb	***
Zingiber cernum Dalzell		Zingiberaceae	Not mentioned		Herb	Native
Centella asiatica (L.) Urb.	Brahmi	Apiaceae	Occasional in moist places		Herb	Native
Desmodium triflorum (L.)DC.		Fabaceae	Common		Herb	Native
Canscora perfoliata Lam.	Motha kilwar	Gentianaceae	Rare		Herb	Native
Leucas ciliata Benth.	Burumbi	Lamiaceae	Occasional		Herb	Native
Entada rheedei Spreng.		Fabaceae	Occasional		Liana	Native
Loranthus sp.		Loranthaceae	***		Parasitic shrub	***

Tolypenthus sp.		Loranthaceae	***	Parasitic shrub	***
Strobilanthes integrifolius (Dalz.) Kuntze	Karvy	Acanthaceae	Rare	Shrub	Native
Strobilanthes ixiocephalus Benth.	Karvy	Acanthaceae	Common in forest undergrowth	Shrub	Endemic
Chromolaena odorata (L.) R.King & H.Rob.		Asteraceae	Abundant	Shrub	Naturalised
Bixa orellana L.		Bixaceae	Not mentioned	Shrub	Introduced
Senna tora (L.)Roxb.		Fabaceae	Common	Shrub	Native
Cajanus lineatus (Wight & Arn.)Maesen		Fabaceae	***	Shrub	Native
Flemingia semialata Roxb.		Leguminoceae	Occasional	Shrub	Native
Melastoma malabathricum L.		Melastomataceae	Common	Shrub	Native
Senegalia rugata (Lam.) Britton & Rose		Mimosaceae	Not mentioned	Shrub	Native
Pandanus sp.	Kewda	Pandanaceae	Rare	Shrub	Native
Meyna laxiflora Robyns		Rubiaceae	Fairly common in ghat areas	Shrub	Native
Glycosmis pentaphylla (Retz.) DC.	Panchi	Rutaceae	Common in forest undergrowth	Shrub	Native
Clerodendrum infortunatum L.		Verbenaceae	Common	shrub	Introduced
Leea indica (Burm. fil.) Merr.		Vitaceae	Very Common	Shrub	Native
Dendrolobium triangulare (Retz.)Schindl.		Fabaceae	Common	Shrub	Native
Rauvolfia serpentina (L.) Benth. ex Kurz	Sarpagandha	Apocynacae	Common	Shrub	Native
Carissa carandas L.	Karanda	Apocynceae	Common in forest undergrowth	Shrub	Native
Homonoia retusa (Graham ex Wight) Müll.Arg.	Sharan	Euphorbiaceae	Occasional	Shrub	Native
Gliricidia sepium (Jacq.)Walp.	Grishmi	Fabaceae	Not mentioned	Shrub	Introduced
Hibiscus furcatus Roxb.		Malvaceae	Common	Shrub	Native
Flemingia strobilifera (L.)W.T.Aiton		Papilionaceae	***	Shrub	Native
Mussaenda frondosa L.		Rubiaceae	Common in open forest edges	Shrub	Native
Psychotria dalzellii Hook.f.		Rubiaceae	Common	Shrub	Native
Helicteres isora L.	Murud sheng	Sterculiaceae	Common	Shrub	Native
Triumfetta rhomboidea Jacq.		Tiliaceae	Common on hill slopes.	Shrub	Native
Vitex negundo L.	Nirgundi	Verbenaceae	Common	Shrub	Native
Hydnocarpus pentandrus (Buch.-Ham.) Oken	Kadu kavath	Achariaceae	Common	Tree	Native
Anacardium occidentale L.	Kaju	Anacardiaceae	Cultivated	Tree	Introduced
Holigarna sp.		Anacardiaceae	***	Tree	Native
Mangifera indica L.	Aamba	Anacardiaceae	Common	Tree	Native

Nothopegia castaneifolia (Roth) Ding Hou	Ameeti	Anacardiaceae	Occasional in deciduous forest	Sap is used against blunt trauma by touching the cut part of stem on affected areas.	Tree	Native
Spondias pinnata (L. fil.) Kurz	Ran amabada	Anacardiaceae	Occasional in deciduous forest		Tree	Introduced
Alstonia scholaris	Satoon	Apocynaceae	Rare	Bark decoction on empty stomach is used to induce vomitting.	Tree	Native
Holarrhena antidysentrica		Apocynaceae	Common on hilltops		Tree	Native
Tabernaemontana alternifolia L.	Nag kuda	Apocynaceae	Common		Tree	Native
Calamus thwaitesii Becc.	Vet	Arecaceae	Common		Tree	Native
Caryota urens L.	Bherli mad	Arecaceae	Common	Pith region is used for making *roti*	Tree	Native
Heterophragma quadriloculare (Roxb.) K.Schum.		Bignoniaceae	Rare		Tree	Native
Radermachera xylocarpa (Roxb.) Roxb. ex K.Schum.		Bignoniaceae	Rare		Tree	Native
Bombax ceiba L.	Kate savar	Bombacaceae	Common		Tree	Native
Bombax insigne Wall.		Bombacaceae	Not mentioned		Tree	Native
Garcinia indica (Thouars) Choisy	Bhiran, Kokam	Clusiaceae	Frequent	Used in cooking	Tree	Native
Terminalia bellirica (Gaertn.) Roxb.	Ghotim	Combretaceae	Common		Tree	Native
Terminalia crenulata (Heyne) Roth	Ain, Kindal	Combretaceae	Common		Tree	Natice
Terminalia paniculata Roth.	Kindal	Combretaceae	Common		Tree	Native
Terminalia tomentosa Wight & Arn.	Matti	Combretaceae	Common		Tree	Native
Dillenia pentagyna Roxb.	Karmal	Dilleniaceae	Frequent		Tree	Native
Hopea ponga(Dennst.) D.J. Mabberley		Dipterocarpaceae	Common		Tree	Native
Elaeagnus conferta Roxb.		Eleagnaceae	Occasional		Tree	Native
Aporosa cardiosperma (Gaertn.) Merr.	Salai	Euphorbiaceae	Common, in forest interior	Bark largely eaten by Indian Giant Squirrel	Tree	Native
Falconeria insignis Royle		Euphorbiaceae	***		Tree	Native
Hevea brasiliensis (Willd. ex A.Juss.) Müll.Arg.	Para Rubber Tree	Euphorbiaceae	Common		Tree	Introduced
Macaranga peltata (Roxb.) Mull. Arg.	Chanada	Euphorbiaceae	Occasional	Sap is used by locals for clotting blood; leaves used for making plates	Tree	Native
Malotus phillipensis (Lam.) Mull. Arg.		Euphorbiaceae	***		Tree	***
Phyllanthus sp.	Jangali aamla	Euphorbiaceae	***		Tree	***
Bauhinia sp.		Fabaceae	***	Bark decoction taken with milk induces vomitting	Tree	***
Dalbergia sissoo DC.	Shisam	Fabaceae	***	Used for woodwork	Tree	Native

Actinodaphne sp.		Lauraceae	***		Tree	Native
Careya arborea Roxb.		Lecythidaceae	Not mentioned		Tree	Native
Lagerstroemia microcarpa	Nana	Lythraceae	Common	Wood is used for construction	Tree	Native
Memecylon pauciflorum Bl.		Melastomataceae	***		Tree	Native
Xylia xylocarpa (Roxb.)Taub.	Jamba	Mimosaceae	Common in open forest		Tree	Native
Artocarpus heterophyllus Lam.	Phanas	Moraceae	Occasional		Tree	Native
Artocarpus lacucha Buchanan-Hamilton ex D. Don	Otam	Moraceae	***	Fruits are cut and used in vegetable dishes	Tree	Native
Ficus sp.	Pimpli (Payari)	Moraceae	***		Tree	***
Syzygium sp.		Myrtaceae	***		Tree	Native
Bridelia retusa (L.) A.Juss.	Kacha-Koch	Phyllanthaceae	Very common		Tree	Native
Bambusa sp.		Poaceae	***		Tree	***
Ziziphus rugosa Lam.		Rhamnaceae	Common in open forest		Tree	Native
Zizyphus mauritiana Lamk.		Rhamnaceae	***		Tree	Native
Catunaregam spinosa (Thunb.) Tirveng.	Geli	Rubiaceae	***	Used as fish poison	Tree	Native
Ixora brachiata Roxb.		Rubiaceae	***		Tree	Native
Schleichera oleosa (Lour.) Oken	Hasan	Sapindaceae	Occasional		Tree	Native
Mimusops elengi L.		Sapotaceae	Rare		Tree	Native
Xantolis tomentosa (Roxb.) Raf.		Sapotaceae	Occasional on hill slopes		Tree	Native
Tetrameles nudiflora R. Br.		Tetramelaceae			Tree	***
Grewia sp.		Tiliaceae	***		Tree	***
Callicarpa tomentosa (L.) L.		Verbenaceae	Common in open forest		Tree	Native
Tectona grandis L.f.		Verbenaceae	Occasional		Tree	Native
Ficus benghaliensis L.		Moraceae	***		Tree	Native
Cyclea peltata Hook. & Thoms.		Moraceae	***		Tree	Native
Sterculia guttata Roxb.		Sterculiaceae	***		Tree	Native

Appendix XI: Data sheet for insects and spiders

Location details where observations were made.			
SR. NO.		LAT-LONG	ELEVATION
1	Start	N 15°35.870' E 74°12.294'	108 m
	Area between JK farm and Research Centre	N 15°35.957' E 74°12.292'	158 m
		N 15°36.018' E 74°12.355'	168 m
		N 15°36.018' E 74°12.355'	168 m
		N 15°35.951' E 74°12.368'	133 m
		N 15°35.864' E 74°12.376'	126 m
		N 15°35.833' E 74°12.383'	122 m
	End	N 15°35.843' E 74°12.330'	127 m
2	Start	N 15°35.547' E 74°12.33'	77 m
	Inside village after Arjun's house	N 15°35.486' E 74°12.338'	116 m
		N 15°35.395' E 74°12.350'	110 m
		N 15°35.328' E 74°12.365'	128 m
	End	N 15°35.216' E 74°12.384'	135 m
3	Start	N 15°35.685' E 74°12.240'	65 m
	Behind Arjun's house	N 15°35.678' E 74°12.174'	87 m
		N 15°35.696' E 74°12.163'	92 m
		N 15°35.707' E 74°12.125'	94 m
		N 15°35.720' E 74°12.026'	97 m
		N 15°35.700' E 74°11.975'	99 m
	End	N 15°35.707' E 74°11.939'	109 m
4	Start	N 15°35.809' E 74°12.530'	91 M
	Area opposite Research Centre	N 15°35.796' E 74°12.525'	105 M
		N 15°35.772' E 74°12.596'	101 M
		N 15°35.737' E 74°12.679'	99 M
		N 15°35.725' E 74°12.676'	99 M
		N 15°35.776' E 74°12.670'	91 M
		N 15°35.791' E 74°12.650'	93 M
		N 15°35.795' E 74°12.616'	95 M
		N 15°35.830' E 74°12.612'	99 M
	End	N 15°35.883' E 74°12.586'	108 M
5	Start	N 15°35.808' E 74°12.500'	107 M
	Behind Research Centre	N 15°35.840' E 74°12.441'	108 M
		N 15°35.883' E 74°12.436'	112 M
		N 15°35.975' E 74°12.433'	144 M
		N 15°36.017' E 74°12.435'	150 M
		N 15°36.021' E 74°12.523'	134 M
		N 15°36.003' E 74°12.035'	112 M
	End	N 15°35.975' E 74°12.676'	109 M

6	Start	N 15°35.762' E 74°12.015'	109 M
	Bridge before JK farm	N 15°35.775' E 74°11.940'	115 M
		N 15°35.797' E 74°11.839'	111 M
		N 15°35.832' E 74°11.846'	120 M
		N 15°35.897' E 74°11.841'	133 M
		N 15°36.019' E 74°11.815'	122 M
		N 15°36.047' E 74°11.887'	111 M
		N 15°36.082' E 74°11.962'	123 M
		N 15°35.870' E 74°11.978'	122 M
		N 15°36.082' E 74°12.014'	116 M
	End	N 15°35.978' E 74°12.028'	104 M
7	Basking place (Bridge) King Cobra	N 15°35.710' E 74°11.933'	108 M
8	Basking place (Research Centre)	N 15°35.932' E 74°12.619'	108 M
9	Mud puddling	N 15°36.005' E 74°12.032'	112 M