

Chapter 2

Study Species, Habitats and Hypotheses

2.1 Study Area

The Nagarahole–Kallahalla–Thitimathi sub-landscape was chosen as our study site after examining other possible sites in the Malenad landscape (Karanth et al. 2011) of the Western Ghats of Karnataka (Das et al. 2006). The study area was found to be the most suitable because it falls under three different forest management regimes and provides a continuum along a gradient of protection levels, human access and resource extraction. It also has a history of social stability with clearly laid down forest protection and management laws.

2.1.1 *Geographic Location, Topography and Soils*

The study area covers the northern part of the Nagarahole National Park (officially designated as Rajiv Gandhi National Park) adjoining Mavukal and Devmachi Reserve Forests (RFs) of Virajpet Forest Division (FD) and a small portion of Anechowkur RFs of Hunsur FD with a total area of 261 km² (12°2′–12°19′ N latitude and 75°56′–76°11′ E longitude) at the foothills of Western Ghats (Fig. 2.1). The study area includes forest blocks called Hatghat RF, Arkeri RF, Kachuvanahalli State Forest (all within Nagarahole National Park) and Mavukal, Devamachi and Anechowkur RF outside of the National Park area (Fig. 2.1).

The terrain is gently undulating with the steep hills in Mavukal RF acting as a barrier to block easy access to villagers to the north of the study area. Mavukal Betta is at the highest point in the region (altitude 1224 m). The study area is well drained with several rivers and streams (Fig. 2.1). The soils are loamy, clay loamy and deep. The precipitation occurs mainly during June to September (south-west monsoons),

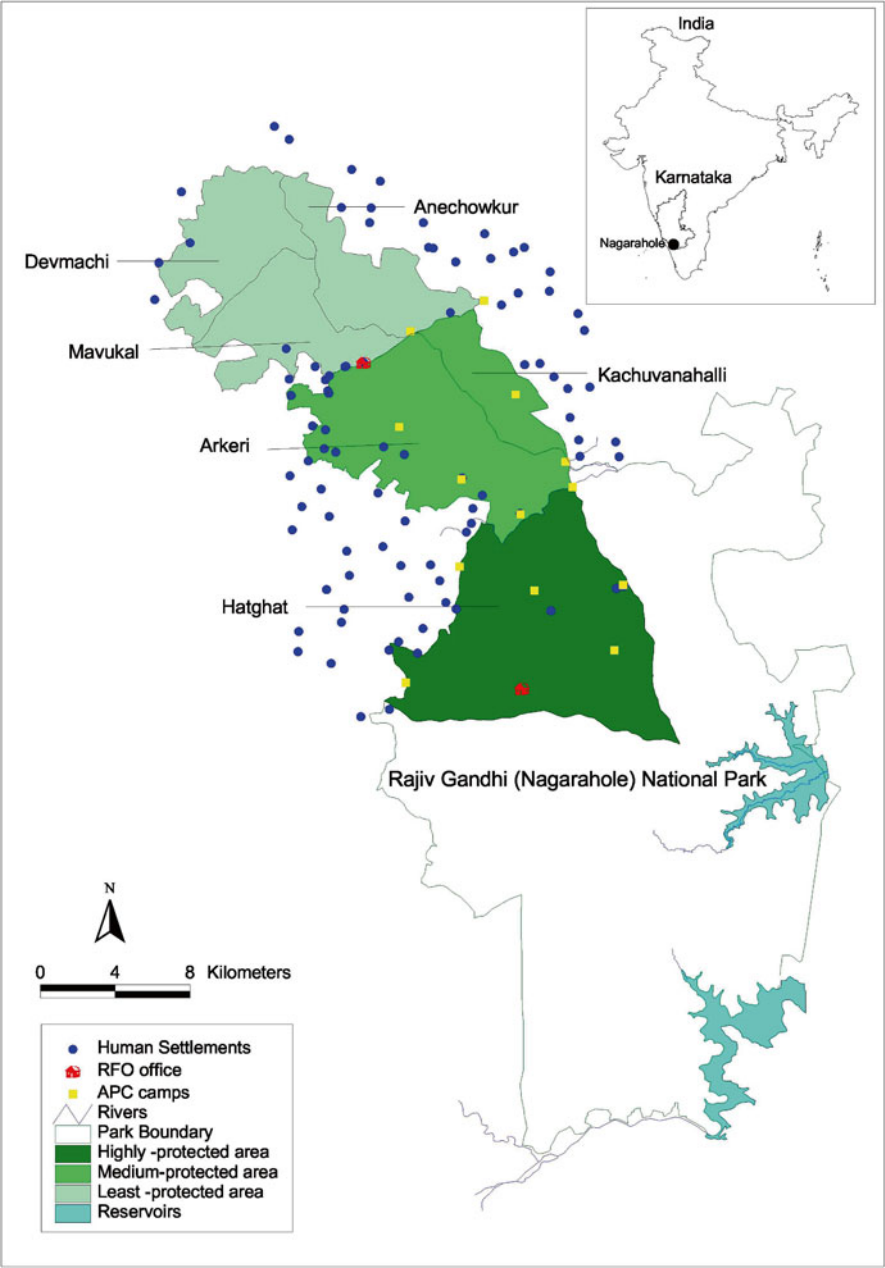


Fig. 2.1 Map showing locations of human settlements and antipoaching camps (APCs) within each of the three management regimes prevalent in the study area. Inset map shows the location of study area within India

and the average rainfall ranges between 1000 and 1500 mm. Annual temperature ranges from a minimum of 10 °C in the winter to the maximum of 35 °C during the summer.

2.1.2 Vegetation of the Study Area

The study area is covered in moist deciduous forests of type 3B/C2 under Champion and Seth (1968) classification. The dominant tree species are generally leafless during February to April. The important tree species found in the study area are *Dalbergia latifolia*, *Terminalia paniculata*, *Terminalia tomentosa*, *Tectona grandis*, *Lagerstroemia lanceolata*, *Toona ciliata*, *Albizia* sp., *Adina cordifolia* and *Anogeissus latifolia*. During the last 60 years of forest management, some of the patches of these natural forests were converted into teak plantations. The middle canopy has *Phyllanthus emblica*, *Grewia tiliifolia*, *Cassia fistula*, *Kydia calycina*, *Gmelina arborea*, *Bauhinia racemosa*, *Butea monosperma*, *Cordia myxa* and the bamboo *Bambusa arundinacea*. Undergrowth species include *Desmodium pulchellum*, *Helicteres isora* and *Cipadessa fruticosa*, but exotic invasive species such as *Lantana camara*, *Eupatorium odoratum* and *Parthenium hysterophorus* are now dominant.

Low-lying swamps, locally named hadlus, are common and form a unique characteristic feature within the study area. These hadlus possess clay soils and get waterlogged during rainy season and retain moisture throughout the year. Because of their high soil moisture content, hadlus have a round the year growth of ungulate forage including grasses and sedges.

The forest vegetation and bioclimatic maps produced by the French Institute, Pondicherry, in collaboration with Karnataka and Kerala Forest Departments (Pascal et al. 1982) show similarity in the composition and structure of vegetation within the study area (Fig. 2.2). The vegetation consists of dense moist deciduous climax forests and degradations with *Lagerstroemia microcarpa*–*Tectona grandis*–*Dillenia pentagyna* type and dry deciduous forests with *Anogeissus latifolia*–*Tectona grandis*–*Terminalia tomentosa* type, thus consisting of both woodlands to savanna woodlands varieties of forests. The study area also has old teak monoculture plantations (Fig. 2.2). This ecological similarity prevalent in the study area enables investigation of the effects of different management regimes within the study area as manifested through various intensities of human pressure.

2.1.3 Wildlife and Biodiversity in the Study Area

Nagarahole National Park is rich in wildlife with 38 species of large mammals, more than 270 species of birds, 32 species of reptiles, many fishes and amphibians (Karanth and Sunquist 1992, 1995; Karanth 1995). The diverse mammalian fauna

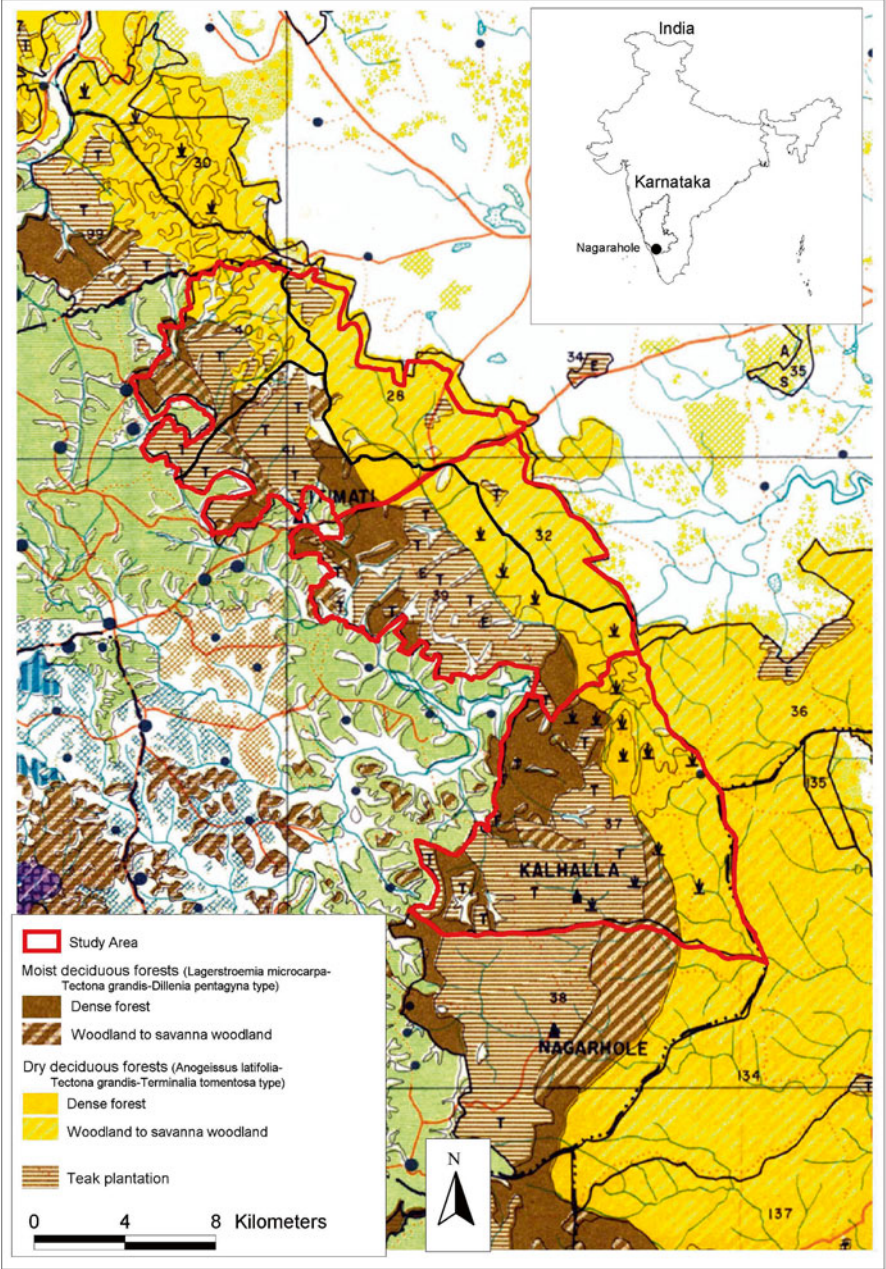


Fig. 2.2 Map showing the main forest vegetation types prevalent within the study area (Source: Pascal et al. 1982)

include seven large terrestrial herbivores and the three arboreal mammals—elephant *Elephas maximus*, gaur *Bos frontalis*, sambar *Rusa unicolor*, chital *Axis axis*, wild pig *Sus scrofa*, muntjac *Muntiacus muntjak* and mouse deer *Moschiola indica* and bonnet monkey *Macaca radiata*, Hanuman langur *Semnopithecus entellus* and Malabar giant squirrel *Ratufa indica* (all scientific nomenclature follows Wilson and Reeder 2005).

Nagarahole National Park is recognised as an Important Bird Area (BirdLife International 2011) in India, with over 270 species of birds recorded. The rare birds include Malabar trogon *Harpactes fasciatus*, Malabar pied hornbill *Anthracoceros coronatus* and the globally vulnerable Nilgiri wood pigeon *Columba elphinstonii*.

2.1.4 Human Impacts on Wildlife and Habitats

Poaching of larger mammals, particularly ungulates, is sometimes a serious problem in the study area. Hunting by local communities for obtaining the meat is the biggest threat to the mammals in the national park (Madhusudan and Karanth 2000).

Other threats include illegal felling of valuable timber tree species, illegal removal of various NTFP, land encroachments on periphery of human settlements, diversion of water flow to nearby coffee plantations and overgrazing by village livestock.

The study area is surrounded by densely populated areas under coffee cultivation to the west and dryland agriculture to the east. There are multiple-use RFs to the north and strictly protected parts of the national park to the south (Fig. 2.1). Furthermore, there are 11 human settlements, with a total population of about 440 families of tribals of Jenu Kuruba, Betta Kuruba and Yerava groups within the study area (Madhusudan and Karanth 2000; Appayya 2001). Traditionally, these tribal families depend on the forests for their needs of fuel wood, timber and a few roots and tubers for consumption. Some illegal hunting is done by them with the meat being shared between the hunters and the accomplices (Madhusudan and Karanth 2000). Sometimes, these tribals also act as guides to illegal hunters from outside who bring in firearms.

As a cumulative consequence, the human settlements within the park and adjoining villages exert varying levels of anthropogenic pressures on the habitat and wildlife. The type and intensity of these pressures vary depending on the proximity of human settlements and access to the forests as well as the population size, village community composition and above all strictness of law enforcement that prevails during any period.

2.1.5 Forest Management History

The entire study area was declared as a Reserved Forest (or State Forest) in the nineteenth century, thus halting the clearing of forests for agriculture. The primary management purpose was revenue generation, timber production and provision of usufructs to the local residents. Therefore, historically these forests in the study area were primarily managed for timber production during early and mid-twentieth century. As the area was quite accessible to transportation, best available timber was removed.

India's first, rather weak law to regulate hunting was enacted in 1955. Under this law, Hatghat and Arkeri RFs (together with Nalkeri RF) were notified as Nagarahole Game Sanctuary in 1955. Legal hunting was forbidden, although the protection was weak. India's strong law, the Wildlife Protection Act, came into force in 1972. Under this law, hunting became an offence with severe punishments and habitat destruction in the form of logging, the collection of forest products was prohibited, and areas could be declared as a National Park, which was the highest level of legal protection possible. Both Hatghat and Arkeri RFs were declared as a part of Nagarahole National Park (together with Kachuvanahalli, Veerana Hosahalli, Nalkeri, Kakana Kote and Metikuppe State Forests). A seriousness on-ground protection began in Hatghat RF, but the lack of management focus, multiple management responsibilities and fragmented configuration with easy human access meant that human impacts continued much more severely in Arkeri RF (and Kachuvanahalli), although they were legally a part of the National Park. However, in the mid-1994, the entire National Park was brought under a unified administration as the Hunsur Wildlife Division based at Hunsur and under the command of a single Deputy Conservator of Forests.

2.1.6 Present Management

The reserved forests of Arkeri and Hatghat (and Kachuvanahalli) are inside the Nagarahole National Park. Here, the main focus is on the protection of wildlife and biodiversity. Therefore, all forms of legal forest exploitation are prohibited. These areas are meant to be intensively patrolled for the protection of the wildlife and habitat. However, the people in settlements located within the park or close to its boundaries continue to do some level of illegal forest exploitation and to a lesser extent an illegal hunting. At strategic locations that are vulnerable for poaching, the park management maintains antipoaching patrol camps. The Hatghat RF, Arkeri RF and Kachuvanahalli SF have a good network of roads useful for patrolling and protection.

The Mavukal and Devmachi RF areas have relatively poor network of roads due to the topography and other reasons. These forest areas were included under teak improvement management circle until mid-1990s and were logged heavily

(Mishra 2001). However, because of legal directions issued by the Supreme Court of India in 1996, all forms of the forest extraction are currently suspended. Unlike inside the national park, however, there are no focused antipoaching patrol camps in these RFs. Although, the hunting is illegal even here, the emphasis of the forest management is not on the protection of wildlife.

2.1.7 Delineation of Management Regimes

Keeping in view this background, we have noted that two broad alternative wildlife conservation models have been advocated in India: (1) a model based on 'preservation' at its core (Karanth 1998; Madhusudan and Karanth 2000) and (2) a model based on 'sustainable resource use by local people' (Gadgil and Guha 1992; Kothari et al. 1996).

However, a practical problem in evaluating such broad generic models of wildlife conservation is that these are not locally context specific and thus not sufficiently evidence based. The effectiveness of these two alternative and contrasting conservation approaches can be compared only by rigorously and quantitatively measuring and comparing the status of biodiversity and wildlife among otherwise ecologically similar sites but with different degrees of human access, uses and impacts. Our study aimed to bridge this gap through a rigorous and quantitative evaluation of biodiversity conservation under different management regimes in the tropical forests of Nagarahole National Park, Karnataka, India.

The three management and access regimes identified to test these hypotheses are briefly described below:

1. Highly protected area (HPA): The Hatghat RF (112.23 km²) falls under this category. This area was declared a multiple-use RF in 1865 (Appayya 2001). Thereafter, it has been a part of a Game Sanctuary declared in 1955 and a National Park in 1974. This category was the most strictly protected area both de facto and *legally*. It has a history of legal wildlife protection since 1955 and effective on-ground law enforcement since 1974.
2. Medium protected area (MPA): The Arkeri RF and Kachuvanahalli SF together (100.84 km²) come under this category. It also had similar history and legal status as Hatghat, but because of its fragmented configuration, greater human access and the lack of focus in wildlife management, it received on-ground protection effectively only from the mid-1990s, when the administratively unified wildlife division was formed. So, its history of wildlife protection is more recent, and its configuration renders the law enforcement difficult.
3. Least protected area (LPA): The Mavukal RF (33.09 km²), Devmachi RF (23.39 km²) and Anechowkur RF (36.76 km²) are covered by this category. Although these areas were declared RFs in 1891, they have been under a multiple-use management regime since then and were never included in the Game Sanctuary notification of 1955 or the National Park notification in 1974.

The right to forest use was available to some local residents, and the forests were managed for timber yield and revenue, rather than conservation.

These three distinct management regimes that prevail within an ecologically similar landscape area (Fig. 2.2) enabled us to spatially demarcate the three management regimes within it and to compare the impacts of human pressures and protection regimes on various forms of biodiversity. They were ecologically comparable in terms of local climate, soils, topography, forest vegetation type, flora and vertebrate fauna, thus providing a suitable study landscape for assessing human impacts on biodiversity (Fig. 2.2).

2.2 Research Hypotheses and Objectives

2.2.1 Objectives

Given the above context, the study aimed to examine human impacts on different forms of biodiversity under different levels of access, strictness of protection and resource extraction regimes that prevailed in a specific conservation landscape. The overall goal was to assess the status of biodiversity in terms of relative abundance and richness patterns for selected taxonomic groups, such as vegetation, birds and large mammals as well as to measure human impacts, such as hunting, biomass collection, grazing, forest fires and related parameters on biodiversity metrics. A key design feature of these measurements was based on rigorous quantitative field surveys using ‘state of the art’ biological sampling methods (see Chap. 3). To develop a set of monitoring protocols for the general use by wildlife managers and to enable their integration into an adaptive management framework was also a related objective of the study.

Specific objectives of the study were:

1. To estimate richness, diversity and abundance of plant species within select groups and to characterise vegetation community composition
2. To estimate population densities of select bird species and foraging guilds as well as to estimate bird species richness
3. To estimate population densities of large mammal species
4. To measure and characterise levels of human access and resulting impacts and disturbances such as hunting, livestock grazing, fires and various forms of forest biomass removal
5. To compare and contrast the status of different forms of biodiversity in three management settings and examine its conservation and management implications

2.2.2 Target Biodiversity Components

Rather than assessing the entire spectrum of biodiversity at risk, we focused on the following clearly discriminated categories of representations of biodiversity to investigate an influence of management and disturbance regimes on the species richness diversity and abundance.

Plants (Scientific Names of Plants Follow Gamble 1935) Plant species were classified into three categories—trees (plants with >30 cm girth at breast height), shrubs (plants with >10 cm and <30 cm girth at ground height) and herbs (plants with <10 cm girth at ground height).

Birds (Scientific Names Follow Rasmussen and Anderton 2005) Bird species have different niche and varying habitat requirements, which in turn determine the distribution pattern and survival of that particular species or guild. The birds can be grouped on the basis of habitat, like forest birds, urban landscape birds, open-forest birds, etc. (Miller and Cale 2000). The type of vegetation determines the food availability, which is, in turn, altered by local disturbance levels, thus affecting the bird species composition (Thiollay 1994). Depending on their body size and food availability, various bird species experience different effects of fragmentation and degradation of habitats (Gaston and Blackburn 1995; Greenwood et al. 1996). Hence, in addition to examining abundance of birds for which we had sufficient sample sizes, we chose food guild assemblage for studying the impact of human pressures, as the human pressures at local level could potentially alter the food resources for birds.

We categorised the species of birds into 19 guilds based on food habits as reported by Grimmett et al. (1999), Kazmierczak and Perlo (2000) and Raman (2003). These guilds were aquatic, frugivorous, frugi-granivorous, frugi-insectivorous, frugi-nectivorous, frugi-omnivorous, gallinaceous, granivorous, grani-insectivorous, insectivorous, insecti-granivorous, insecti-omnivorous, insecti-raptor, nectivorous, necti-frugivorous, necti-insectivorous, omnivorous, raptor and scavenger. For example, gallinaceous birds included Indian peafowl *Pavo cristatus*; grey jungle fowl *Gallus sonneratii* and spur fowl *Galloperdix lunulata*.

Large mammals (Scientific Names Follow Wilson and Reeder 2005) Terrestrial mammals included elephant *Elephas maximus*, gaur *Bos frontalis*, sambar *Rusa unicolor*, chital *Axis axis*, wild pig *Sus scrofa*, mouse deer *Moschiola indica*, muntjac *Muntiacus muntjak* and arboreal mammals included bonnet monkey *Macaca radiata*, Hanuman langur *Semnopithecus entellus* and Malabar giant squirrel *Ratufa indica*. Because of expected lower sample sizes, carnivores were excluded.

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