FORESTS, WILDLIFE & PEOPLE ON THE MARGINS: PERMEABLE LANDSCAPES IN THE EASTERN GHATS, INDIA

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ABSTRACT OF THE DISSERTATION

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Wildlife and human needs are often enmeshed within discursive representations and praxis of wildlife conservation in the Global South. In India, more than three quarters of forested area is "unprotected." These spaces are categorized as Reserve Forests and support diverse flora and fauna within complex landscapes of human settlement and agricultural fields. Much of this biodiversity remains understudied and underrepresented. This dissertation explores how biophysical and social factors coproduce space to create a conducive landscape for wildlife in the semi-arid Eastern Ghats of South India.

I employ a mixed-methods approach to respond to calls for more integrated research in conservation, and use a range of data sources such as semi-structured interviews, household surveys, faunal surveys and satellite imagery. The findings illustrate how livelihood diversity and everyday practices of rural communities living on the periphery of four Reserve Forests shape both landscape composition and structure. Species distribution models that assess relative likelihoods of distribution of the Sloth Bear, Four-horned Antelope, Wild boar and Leopard in the study area provide insight

into the socio-ecological conditions under which shared spaces are created and maintained. This allows me to untangle the relationships mediating wildlife presence in unprotected forests. By drawing on lifeworlds of a marginalized forest dependent community, I argue that representations of Reserve Forests need to be contextualized based on actual vegetation characteristics and the relations between people, wildlife and forests. The results show that heterogeneity in land-use/cover produces a permeable landscape that resists precise classification.

This dissertation attempts to disrupt traditional conservation paradigms by showing that wildlife persists in human-dominated landscapes through a complex intersection of landscape composition and structure, forest management policies, everyday practices of rural communities and mutual adaptations between wildlife and people. Thus wildlife conservation in Reserve Forests should understand the landscape matrix, take into consideration diverse land uses and acknowledge the value of forests to rural communities.

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Chapter 1: Introduction

This dissertation began with a need to examine the curious absence of the Eastern Ghats in conservation discourse in India, despite wildlife presence. This discourse which until recently mostly focused on Protected Areas, biodiversity hotspots (in the Western Ghats, Himalayas and North-East of India), charismatic and endangered mammals in the subcontinent. The question that drove my research project initially asked, why were representations of the Eastern Ghats, a critical biogeographic region, so sparse in available literature.[1] This led me to explore how "conservation value" was determined, by whom, with what objectives and to what ends.

Wildlife conservation in India is complicated because the underlying premise delimits space, and requires deliberation on human and wildlife needs. Other than the ethics of making a choice, conservation implicates a much larger politics of state, society and institutions at multiple scales. This raises issues regarding sustainability, justice and both human and nonhuman rights. Locational specificities further complicate the issue based on the local political economy of resource access as well as national and international politics. In addition, subjective and situated sciences facilitate and dominate the choice of species, location, research and funding priorities. In this dissertation, I argue that wildlife in human-dominated landscapes need to be protected through a landscape approach with a consideration of both diverse land uses and the value of forests to rural communities.

[1] "The Eastern Ghats (EGs), a chain of ancient, low hill ranges adjoining the east coast of India, support a diverse array of tropical forests and have great conservation significance…many remnant patches of evergreen, semi-evergreen and moist deciduous forests." (Rawat 1997, 307). Further, scholars have reported unique floral associations in these ranges, wild rice varieties and immense floral diversity in the form of more than 2600 plant species (Rawat 1997; Ramachandran et al. 2018).

In the next section, I elaborate on the research problem and context. Then I turn to the research questions, literature review, methodology and the overall structure of the rest of the dissertation.

1.1. Research Problem & Context

Protected Areas (PAs) are one of the first documented and dominant models of wildlife conservation adopted globally. This involves setting areas aside for the sake of conservation and management. However, historical and even current empirical accounts across different places and cultures show that conservation is not simply a result of scientific rationality and modernism. Communities have reserved areas to conserve flora and fauna for sociocultural and religious reasons for centuries. For instance, sacred groves in parts of South Asia, Africa and Australia have been part of local land management practices that form critical gene pools (Bhagwat and Rutte 2006). Yet, conservation today tends to be defined by the exclusion of people from forests. This approach is also known as the fortress approach. This modus operandi continues despite acknowledgment that:

1. A large percentage of biodiversity exists outside PAs
2. It is not possible to isolate PAs from influences within the larger landscape matrix
3. Wildlife movement is not constrained by political or physical boundaries, making the effectiveness of PAs questionable

Such an understanding has prompted diverse scholars—from natural resource scientists (DeFries et al. 2005; Ostrom and Nagendara 2006) and agro-ecologists (Altieri 2002) to ecologists (Brooks et al. 2009; Porter Bolland 2011)—to advocate for the need to look beyond protected areas and other traditional conservation spaces to protect

biodiversity. My own scholarship and case study emerges from similar theoretical and practical concerns about the current limitations of conservation models and assumptions. As I will show later in this dissertation, scholarly critiques of PAs are abundant, but the concept or the idea of a PA has deep roots in policy and practice, globally. This separation of nature from society has practical implications that are evident in resource management policies, in forest management, climate change and even urban studies.

In India one of the consequences of this separation is evident in both forest and wildlife management policy. Wildlife outside PAs occupy a liminal space, unprotected and unacknowledged. Common explanations to wildlife presence yield terms like "unexpected" or "stray", and in ecological terms wildlife outside PAs are hypothesized as "sink populations". These terms are clearly misleading and possibly ill-informed as Rangarajan and Sivaramkrishnan (2014) suggest among other scholars who work on the environmental history of India. The authors state, "The socio-ecological fabric has often been remade via contest with the fluidity of environments and occupations being a major long-term feature of the past, with relationships fragmenting and coalescing in close conjunction with changing ecological milieus." (Rangarajan and Sivaramkrishnan 2014, 29). Hence, wildlife and humans have shared the landscape and their existence continues through different permutations and combinations. These historical connections are gradually eroding because of changing livelihoods, pressures of modernization and development agendas (Ghotge 2016; Ramdas 2014; Sundar 2014). This makes the need for research and conservation efforts in India to shift the focus away from PAs and adopt spaces that have and continue to support wildlife, even in unintended ways.

A focus on PAs, biodiversity hotspots and charismatic species have negated wildlife found outside these boundaries.[2] Conservation research and funding priorities tend to concentrate on endangered species, keystone species, protected areas etc. and this leads to a progressive marginalization of other areas and species (Ghosal et al. 2013; Martin, Blossey and Ellis 2012). India is a mega-diversity country contributing to 7.8% of the world's known biodiversity. Its tropical location and varied climatic zones ranging from the Himalayas to Deserts and Mangroves are classified into seven biomes and 19 sub biomes (Roy et al. 2006). The most well-known faunal species include the Asian Elephant, Bengal Tiger, Asiatic Lion, and Indian Rhinoceros to name a few. Other than mammals, India also has 13% of the world's birds (Rahmani) and a whole suite of other organisms. Protected Areas cover approximately five percent of the total geographic area of the country.

Over the past two decades there is a growing recognition of wildlife outside PAs and deliberations on human-animal coexistence. These contributions push towards and compel one to think beyond the fortress approach among other top-down methods of conservation practice. My approach contributes to this more recent discourse on conservation in India and examines the coproduction of rural people's land use practices, wildlife habitat and the landscape matrix. The aim is not to undermine the value of PAs, but to examine wildlife habitats in a lived landscape. I analyze the complex intersection of landscape composition and structure, policies, everyday practices of rural communities

[2] "Biodiversity hotspots" gained popularity after a seminal publication by Myers (1988) and continue to define conservation priorities. This is despite a call for a need to consider ecological processes and "biodiversity coldspots" (Bøhn and Amundsen 2004; Carolan 2009; Kareiva and Marvier 2003; Marchese 2015). The reason to consider coldspots is because they contain species diversity, are habitats to rare and endangered species, and perform critical ecological functions.

and mutual adaptations by wildlife and people. This differs from the theoretical underpinnings of current conservation practice and policy (as practiced today) and builds towards new frameworks that emphasize a landscape approach to conservation. To make my case, I examine an unprotected area in the Eastern Ghats in India by considering the landscape matrix, species distributions, forest management, rural people's practices and perceptions.

1.2. Research Questions

I proposed two overarching and several sub-questions, that will initiate a discussion on conservation in lived landscapes in India. The research questions are addressed in more detail in the chapters that follow. The chapters are split across three simple yet fundamental aspects that form the basis of conservation: the landscape, the wildlife and the forests. Each chapter considers the practices, livelihoods and lifeworlds of rural communities and characteristics of the biophysical landscape.[3] Indisputably, conservation also depends on specific policies, institutions and the meta-narrative that it is built on. Although I do not dwell into the theoretical basis of these aspects, they deeply contribute to my understanding of wildlife in human-dominated or lived landscapes.

1. How does the spatial heterogeneity of land-use/cover around the fragmented Reserve Forests (RFs) provide suitable habitat for Four-Horned Antelope (*Tetracerus quadricornis*), Sloth Bear (*Melursus ursinus*), Leopard (*Panthera pardus*) and Wild Boar (*Sus scrofa*)?

[3] The OED defines lifeworlds as "All the immediate experiences, activities, and contacts that make the world of an individual or corporate life".

2. How do everyday practices and livelihoods of local communities shape the landscape matrix to facilitate wildlife habitat and movement in the absence of formal conservation mechanisms?

The following sub-questions emerged from data gathered in the field and correspond to the chapters in this dissertation. Each sub-question attempts to contribute to the broader questions through an investigation into the biophysical and/or social characteristics of the study area.

- What is the composition of the landscape matrix and how does it influence the presence of the Sloth Bear, Four-horned Antelope, Wild boar and Leopard? How do everyday practices of the local communities' influence landscape composition in articulation with biophysical properties?
- What is the structural pattern of the matrix and how does it affect wildlife habitat and dispersal? How is matrix structure a consequence of a coproduction between natural processes and land-use practices?
- How is wildlife perceived by the local communities and how do people adapt to wildlife presence?
- What is the likelihood of species distributions in the study area and what are the potential adaptations made by wildlife to human presence?
- How do official representations of Reserved Forests (RFs) differ from perceptions of rural communities and vegetation composition in semi-arid landscapes?
- How is forest use and management affected by differential access regimes and the relation forest dependent communities share with the forest?

These questions demand an integrated analytic framework. I use political ecology and land-change science because these approaches contribute to scholarship that addresses human-environment dynamics and sustainability (Turner and Robbins 2008).

1.3. Conceptual Framework

The benefits and challenges of applying political ecology and land change science to investigate human-environment relationships are well documented (Brannstorm and Vadjunec 2013; McCusker 2013; Turner and Robbins 2008). Both political ecology (PE) and land change science (LCS) share intellectual legacies and seek to explain "real-world problems relating to livelihoods and resources" (Brannstorm and Vadjunec 2013, 2). In addition, the tools and techniques used in PE and LCS overlap to an extent (Rindfuss et al. 2004). Combining the two parallel approaches helped me frame my research process, and examine the physical and social aspects of this working/lived landscape through different angles.

Political ecology frameworks question the social, cultural, economic, political and historical production of nature by dominant economic systems, the implications of scientific predictors and issues pertaining to environmental and livelihood practices that help shape land-use. Robbins (2012) explains the field as one that "seeks to unravel the political forces at work in environmental access, management, and transformation (3). In the process, PE seeks to inform development with an emphasis on disadvantaged communities. Scholars explore how control, knowledge and access to resources leads to an increase/decrease in vulnerability and ecosystem sustainability (Turner and Robbins 2008).

Land change science on the other hand aims to understand the complexity of interactions (patterns and processes) in human-environment systems, the causal factors of land-use/cover change and the potential implications of changing scenarios on the landscape. This approach considers feedback loops within the biophysical and social environment (Schneider 2008). For instance, LCS focuses on how local land management effects structure and function of the landscape. A focus on drivers that influence land-use and management decisions explicates the multiple pathways and institutions that influence decisions. This contributes to broader understandings of global environmental change and sustainability (Brannstorm and Vadjunec 2013; Turner and Robbins 2008).

Linking PE and LCS to examine my research questions allows me to understand the geographically situated biophysical processes and environmental politics of resource use. Other scholars have also used PE and LCS together with diverse objects of analysis. These include examining impacts of economic reforms in coffee producing regions, vulnerability to snow storms, impacts of access to electricity on deforestation rates etc. (Hausermann 2014; Tanner and Johnston 2017; Yeh et al. 2014). In my research, I show how livelihood diversity and land use decisions work as proximate drivers that shape landscape structure, and unintentionally contribute to a facilitative matrix for wildlife. Further, combining these results with tactics undertaken by farmers to reduce crop raids by Wild Boars helps grasp how wildlife and humans coexist.

However, combining LCS and PE has its share of challenges too as mentioned earlier. One of the critical issues based on a fundamental epistemological difference is how LCS and PE interpret causality (Brannstorm and Vadjunec 2013). The IPAT (Impact, Population, Affluence, and Technology) model persists in LCS, despite critiques

to its postulation of correlations between environmental degradation and human population (Lambin et al. 2001). In fact, LCS scholars discuss how neither poverty nor population are sole determinants to understanding land-cover change (Lambin et al. 2001). The authors suggest a need for more contextual analyses and broader understandings of human-environment relationships to establish which conditions drive land-use/cover change (Lambin et al. 2001). Alternatively, PE scholars favor political economy explanations to environmental change (Brannstorm and Vadjunec 2013). My research shows that the Neo-Malthusian position on population effects on the environment continues to be ubiquitous in conservation studies. In fact, the use of human population density as a variable in statistical models is illustrative of this bias (DeFries, Karanth and Pareeth 2010; Karanth, Curran and Reuning-Scherer 2006). In Chapter 2, I show how this move recirculates the separation between nature and society. An *a priori* assumption on the effect of human population on wildlife leads to an unlikelihood for conservationists to acknowledge wildlife in lived landscapes. Hence, this tension between LCS and PE also helps me to develop my case where wildlife and humans share spaces and find ways to mutually adapt.

More specifically, this research contributes to three interconnected issues: a need to rethink wildlife spaces, importance of the landscape matrix and the coproduction of nature and society. Further, I also provide a justification for the use of mixed methods in this dissertation.

1.3.1. Beyond the Norm: Rethinking Wildlife Spaces

Within political ecology conservation provides an ideal point to explore and analyze issues of place making, territorialization, control, access, rights, ecological and

social objectives involving matters related to ethics and justice.[4] The multifarious and multiscalar involvement of a host of actors constituting different networks to conserve the "world's biodiversity" is staggering and is uncovered by several studies situated across the globe (Brockington, Duffy and Igoe 2008; Lele et al. 2010; Neumann 2004; Peluso 1993; Schroeder 1999; West 2006). What makes conservation a particularly different (and political) resource management issue is the relationality of scale it deals with, or the intrinsic link between the local pastoralist, the state, global organizations like IUCN and the ecosystem/species central to the issue. For instance, in my study area state representations of forests use the term "degraded" as a descriptor for the state of forests. This representation does not define the term or situate it in within a historical timeline. Instead, universal definitions used by global organizations are used to characterize the state of forests as I show in Chapter 4. Hence, the relational aspect of what should be protected or conserved, how and where involves multiple actors with distinct priorities.

This dissertation focuses on the absence of conservation (as intention) in a lived landscape or in other words wildlife presence in forests that are not PAs. Hence, aspects like territorialization, rights and place making do not feature directly in my context. Instead, I use a political ecology lens to examine how knowledge, representation, access and subject making intersect in my study area. I use multiple methods to explore the rhetoric used by the State Forest Department and juxtapose these with the ways local communities value the same forests. As the results show representations of secondary forests by the state stand in contrast to how rural communities access and benefit from

[4] Particularly in context of Protected Areas (PAs)- In India as in other countries, people are excluded from areas after a PA is demarcated. This leads to conflict due to resettlement (and the lack of resettlement or just compensation), as well as a denial of access to resources which impact livelihoods of the rural communities.

the resource. Finally, these land cover categorizations also influence management practices on the ground. The spatial and temporal diversity of forest policy outcomes in India is discussed extensively by several authors (Lele 2007; Rai 2014; Ramdas 2014). Blaikie and Springate-Baginskie (2007) state and as my research will show "Facts are malleable…and there is a remarkably wide gap between rhetoric, the intention of the law, guidelines, policy documents and what really goes on in the field" (5).

The question that remains unsatisfactorily answered is how does one first assess and then propose conservation measures for forests where wildlife presence is unacknowledged. The focus of conservation on primary forests ("pristine natures") globally has led to the neglect of secondary forests and other ecologically complex landscapes (Hecht 2004; Putz and Redford 2010). Though secondary forests are being reconsidered over the past decade (Chazdon et al. 2009; Gardner et al. 2009; Hecht and Cockburn 2004; Putz and Redford 2010), along with a recent re-evaluation of degraded forests (Goldstein 2014) their value to wildlife conservation is still largely under represented. There is no doubt that much biodiversity exists outside PAs (Gorenflo and Brandon 2006; Rodrigues et al. 2004), but the economics of conservation have led to data paucity in other areas.

In addition to PE methodologies, LCS offers an alternate way to frame the biophysical and social characteristics of my study area as I show in the next section.

1.3.2. Finding Value in the Landscape Matrix

The Eastern Ghats in India consist of discontinuous hill ranges that run parallel to the east coast of India. The study area as I will elaborate on later consists of a patchwork of forests, and village commons that are interspersed with agricultural lands and rural

settlements. Hence conservation strategies that require and prioritize large "untouched" tracts of land for wildlife protection are unrealistic in this area. A more realistic approach looks beyond traditional conservation norms and sees humans as embedded in the landscape, thus integrating social and ecological systems (Ellis and Ramankutty 2008). Anthropogenic biomes" or "anthromes" provide a framework for carrying out research in couple socioecological systems (Ellis and Ramankutty 2008).

An acknowledgement that wildlife conservation involves both human and ecological systems, helps integrate the entire landscape matrix and consequently its participants into this research project. While the importance of anthropogenic landscapes to wildlife has been discussed earlier (Rahmani 2005), anthromes provide a theoretical framework that is useful in unprotected landscapes as I show in Chapter 2. Agricultural landscapes are also favorable to existing wildlife habitats and species ranging from birds to carnivores (Nogeire et al. 2013; Troupin and Carmel 2014; Wright, Lake and Dolman 2012). In addition, research also shows cases where man-made interventions like irrigation ditches have been found to be critical habitats for endangered species (Crifasi 2007).[5] Further, Hecht (2004) shows in the case of El Salvador, the patchiness of the habitats, anthropogenic forests, coffee farms, and secondary vegetation in pastures contribute to the biodiversity and biotic complexity of the region. The Eastern Ghats and its landscape matrix are an ideal setting to study the matrix because of the heterogeneity in the land-use/cover and wildlife presence.

[5] Crifasi (2007) takes the case of the Preble's meadow jumping mouse and its shifting listing under the Endangered Species Act, and the implications that follow with regard to riparian conflicts, land-use decisions and urban sprawl.

Wildlife habitats the world over are changing, and fragmented landscapes are conceivably more the rule than an exception. Hence, researchers urge conservation biologists and wildlife managers to re-conceptualize efforts towards functional connectivity, matrix quality and developing ways towards habitat retention and restoration (Brady et al. 2009; Franklin and Lindenmayer 2009; Prugh et al. 2008; Villard and Metzger 2014). Based on the shrinking habitat for wildlife, Franklin and Lindenmayer (2009) state that, "matrix management matters because formal reserve systems will never cover more than a small fraction of the globe" (349). My research aims to fill this gap by first examining the land-use/cover of the matrix, its patterns and the everyday practices of rural communities that shape it.

1.3.3. Co-producing the Landscape: Nature and Society

Scholarship in nature-society geography identifies ways human and nonhuman entities and processes combine to co-produce landscapes and environmental conditions (Lorimer 2012; Rocheleau 2011; Sundberg 2011; Whatmore 2002). In this context, a focus on everyday land-use and environmental practices of rural people in Chittoor west, allows me to examine how humans and non-humans coproduce a heterogeneous landscape. For instance, in my study area the presence of Sloth Bears and their breeding season determines if shepherds and other livestock herders take the animals to graze on the foothills, uplands or wasteland hillocks. Similarly, when the Leopard is in the area, grazing domestic animals is restricted to fallow agricultural lands and other areas close to settlements. In a more complex setting on the US-Mexico border, Sundberg (2011) demonstrates how non-human actors like cats, deserts and rivers shape boundary enforcement and politics. Reframing "agency" as "collective performance, rather than the

product of individual intention", Sundberg (2011, 332) shows how the relationality between human and nonhumans constitute landscape. This calls for a more collaborative understanding of relations and everyday practices that co-produce the world. The durability of emergent associations in time and space is the subject of empirical analysis in this scholarship, with a focus on the *relations* and *practices* that bring them into being (Whatmore 2002; Hinchliffe et al. 2005; Latour 2005; Haraway 2008). One of the central actors in my research appears to be drought because it regulates not only livelihoods of people but also their perceptions towards wildlife and the forests. Further, recurrent drought leads to drying of water holes in the forests and increased wildlife movement in agricultural fields. This also points at the temporality of these associations and subsequently the likelihood of interaction between humans and wildlife.

I explore these performative conservation networks where wildlife, state practices, everyday land-uses and other human and nonhuman elements interact by accounting for "situated knowledges" (Haraway 1988; Rocheleau 2011; Sundberg 2004; Whatmore 2002) of different actors that constitute this diverse landscape. This brings in responsibility and accountability to the production of knowledge as well as acknowledges individual standpoints and subject positions that exist within networks. Further, the situated knowledges of farmers and forest dependent communities combine to co-produce biodiverse and heterogeneous landscapes that are wildlife habitats to several species.

Conservation is characterized by complicated connections between unpredictable non-human actors, rural people, state officials, international organizations (e.g. IUCN) and other intermediary actors. The number and diversity of actors constituting different networks to conserve biodiversity (Brockington, Duffy and Igoe 2008; Neumann 2004;

Peluso 1993; West 2006), and the linkages with specific histories and geographies makes conservation a particularly complex resource management issue. As Lorimer (2012) states, “Conservation inherits complex assemblages of theories, technologies, laws, territories and practices from past eras with different politics and ecologies” (606). Echoing similar concerns, Whatmore (2002) shows how the circulation and reinscription of wilderness continues, not only in popular imagination, but also among “experts”. To conclude, the landscape matrix in my study area in a way resists current conservation norms and signifies a need to incorporate multiple spaces, species and people.

1.4. Why Mixed Methods?

Conservation research in lived landscapes where human presence is critical to landscape patterns and processes is under-researched. Several studies on wildlife conservation mention anthropogenic pressure and most often human presence is considered to be a deterrent. Conversely, studies on community participation in conservation assess the lacunas in management, implications on lives and livelihoods and fall short because they do not engage with wildlife. Nevertheless, a few scholars attempt to consider both humans and wildlife (Athreya 2013; Carter and Linnell 2016; Dorresteijn et al. 2014). The primary reason for this disconnect rests on the different methodological requirements and the contrary epistemological and ontological assumptions used to interrogate the physical and the social aspects of conservation (Bennett and Roth 2015; Newing 2011).

Disciplinary boundaries raise practical problems and knowledge specializations further intensify the divide (Bennett and Roth 2015). The conservation discourse is also split between those who advocate for human free spaces, or as Guha (2005) classifies it

as “The Authoritarian Biologist and the Arrogance of Anti-humanism”, as opposed to those who see a longer history of shared space between wildlife and rural communities (Athreya 2013; Carter and Linnell 2016; Dorresteijn et al. 2014; Rangarjan 2005). However, there is now a wide recognition for conservation to engage with the human as part of the landscape (Bennet et al. 2016; Büscher and Wolmer 2007; Newing 2011; Sandbrook et al. 2013). This is an attempt to bring social scientists and conservation biologists on the same page. (Bennett and Roth 2015; Madden 2004; Newing et al. 2011).[6] To overcome the limitations and the historic disconnect between the natural and social sciences, scholars recommend using integrated and pluralistic approaches (Büscher and Wolmer 2007; Sandbrook et al. 2013).

For instance, in Chapter 3 I use species distribution models to map the likelihood of species distributions and combine this with an investigation into people’s interactions with wildlife. The maps generated are based on environmental variables and species presence data. This output largely corresponds with responses from the community. But there are certain forested patches within the study area that show a likelihood of species presence although according to the communities the species are absent there. An interdisciplinary method allows one to explore such discrepancies. Local knowledge and experience indeed can contribute to biological inquiries. And if we assume that the landscape is coproduced then we have to take into account local knowledge on presence or absence of species. As much as this does not suggest that this is the whole truth, neither is a mathematical model without bias or error. And transferring authority to any

[6] Since 2003 the Society for Conservation of Biology (SCB), which is an international organization dedicated to promoting conservation research and practice has established a Social Science Working Group. The SCB was established in 1985 and it has taken close to two decades for a recognition of social science perspectives in conservation.

one of these methods over the other is what Hulmes (2011) terms as an “epistemological slippage”. Thus, while it may well be that based on the scale of the study that most of the patches that have certain vegetation cover are fundamental niches for species, the realized niche in a lived landscape also depends on everyday practices of humans.

Next, in Chapter 4, I look at official categories of the RFs that determine value and management using official reports. I juxtapose these with the different forms of value the forest takes for the village community. As expected official land cover categories are unknown to people, but positioning these different ways of knowing provides interesting results. To this I add a third way of knowing, by calculating NDVI or the vegetation index for the RFs. Each one of these methods constructs its own definition of value as I show in this chapter. Knowing these different constructions of value is critical to my project as it allows for a richer understanding of how RFs are valued.

I thus turn to political ecology to guide my methods and frame my research because it offers a way to use multiple approaches. Political ecologists among other social scientists have provided evidence to the problems associated with conservation across the global north and south. As discussed earlier, this critical insight has brought the social construction of nature and power politics defined by structures, gender, race, caste and class to the forefront. All these insights point at a need for cross-scale analyses to conservation in addition to methodological pluralism.

Merging the biophysical and social is challenging. I attempt methodological pluralism in my research for the following reasons: First, the object of inquiry is wildlife in a lived landscape. This demands examination of both biophysical and social aspects rather than taking an either/or approach. Second, since the study area is understudied and

unrepresented (within conservation research) it is essential to answer the “what” question. In other words, what species are there, what kind of a forest is this, what are the attributes of the physical environment and what inferences can we draw from this data regarding the potential for wildlife presence or suitability of the area as potential wildlife habitat. Third, when discussing areas that lie outside protected areas, one must ask the “how” question: how do the everyday practices and perspectives of the local communities influence wildlife habitat.

Mixed methods are usually used with the following intentions: triangulation, complementarity, development, initiation or expansion (Greene 2007). For this study, I use mixed methods with an aim to expand the understanding around wildlife spaces in unprotected forests in the Eastern Ghats. The idea behind it is to expand the scope of the study and generate a better understanding through engagement with different ways of knowing. Greene (2007) states that, "In an *expansion* mixed methods study, different methods are used to assess *different phenomena*." (103). The use of mixed methods within political ecology has shown the need to respect different epistemological traditions and accept the partial nature of knowledge and contradictions within (Dolittle 2015; Turner 2015). More importantly mixing methods, allow for “the silences and incompatibilities…(to) become evident when data sets produced by diverse methodologies are brought together” (Nightingale 2003, 80). My research shows that mismatched data sets point not only at the data itself, rather the incompatibility lies in the disciplinary boundaries that the conservation discourse is embedded in, and this allows the separation to perpetuate.

To conclude using mixed methods also corresponds with an integration of LCS and PE as discussed earlier. It further allows me to incorporate different actors and their situated knowledges.[7] This aids in identifying how livelihood diversity and land-use decisions in this semi-arid area are responsible for the ways in which humans shape the landscape. Further, the integration opens up space to consider lived experiences and also consider changing livelihoods and social dynamics within rural communities. The species distributions, calculations of the vegetation index and the structural pattern in the landscape matrix all contribute to a richer understanding of the dynamics within the study area. I thus draw from multiple data sources: faunal surveys, semi-structured interviews, household surveys, satellite imagery, official reports from the State Forest Department and my experience in the study area over the past few years, and more specifically between June-December 2015. Details on data used and analytic methods are in individual chapters.

1.5. Study Area

The Eastern Ghats located in peninsular India extend over 1750 kms between 11°30’ and 22°0’N latitude and 76°50’ and 86°30’ E longitude (Ramachandran et al. 2017). Broken hill ranges encompass this biogeographic region, and run through Orissa, Telengana, Andhra Pradesh tapering off in northern Tamil Nadu (Figure 1.1). The study area is located in western Chittoor district (Andhra Pradesh) and covers a section of the Eastern Ghats.

[7] “Situated knowledges” is a term attributed to Donna Haraway (1988) who discusses the impossibility of objectivity and instead points at the “embodied nature of all vision”. As a result, knowing emerges from a particular vision and the power to see, thus it is always a partial perspective.

Elevations range from 650-1350m and undulating topography defines western Chittoor, unlike the eastern part which is relatively flatter. This area receives an average rainfall of 650mm from both the southwest and northeast monsoon, and is drought prone. Dry deciduous, scrub and thorn forests, subsistence farms, grazing lands and rural settlements constitute the land cover in this semi-arid landscape. Seasonal streams and water bodies referred to locally as tanks have been the mainstay of the population's water requirements. Granite rocks dominate the area.

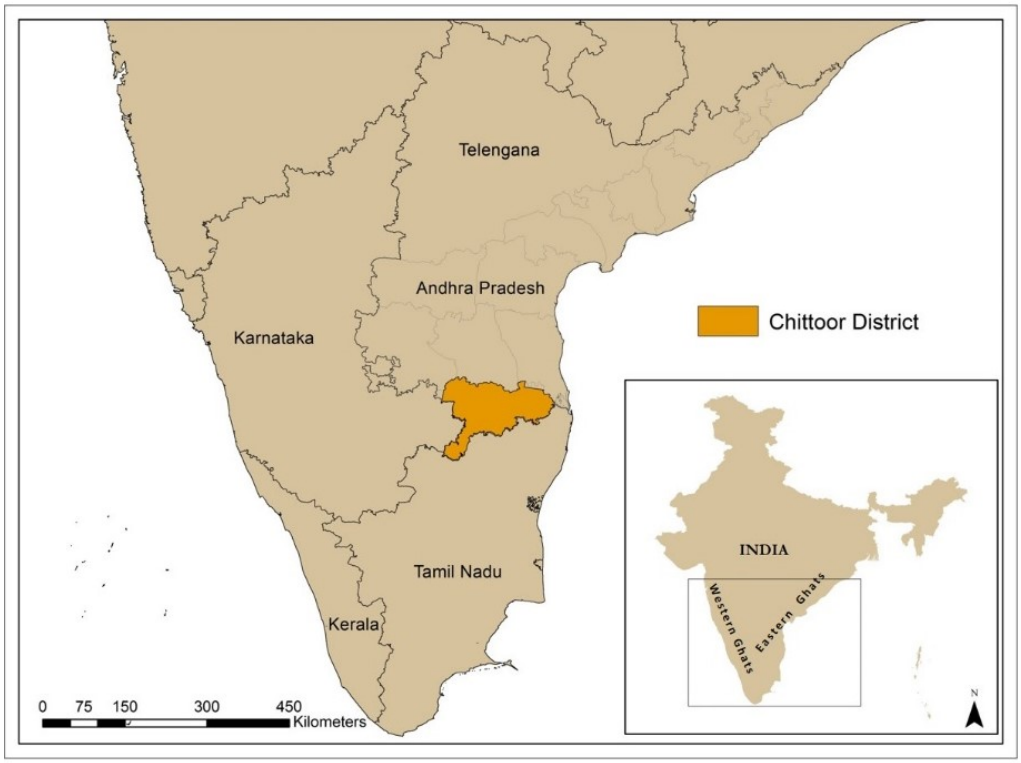

Figure 1.1. Chittoor District, Eastern Ghats India

Due to the combination of poor soils and unreliable rainfall, dry land farming for subsistence was traditionally practiced (e.g. groundnuts, dry land rice, millets and horse gram). However, this has changed over the past few decades with availability and access to irrigation (borewells) through government subsidies. Market pressure is also resulting

in a larger percentage of farmers making the shift to irrigation intensive cash crops (e.g. tomato, irrigated rice, vegetables and sugarcane).

The forests in this part of the district are classified as Reserve Forests (RFs) and managed by the state Forest Department (Figure 1.2). Forest area in Chittoor covers 27% of the geographical area, but only one percent is protected under three PAs (APSFR 2013). In western Chittoor, there are no PAs or wildlife conservation initiatives, yet unusually high levels of species diversity at low density exist. The diversity of available habitats within relatively small forest patches provides niches to several species but the area and limited resources curbs the population. This includes several endemic and vulnerable species of both flora and fauna (APSFR 2013; FES 2008). The dominant tree species in the RFs in the study site (*Noorukuppalakonda*, *Tavalam*, *Kanduru* and *Madirimalai* West Reserve Forest) consist of *Acacia sundra, Anogeissus latifolia, Albizzia amara, Diospyros montana, Dalbergia paniculate* and *Vitex altissima* in addition to other fruit bearing trees and several shrub species. A recent study in the Eastern Ghats on rare, endangered and threatened plant species also points at the need to prioritize areas outside PAs, based on high species richness found by the authors (Ramachandran et al. 2018). Critical wildlife in the area includes the Slender Loris, Rusty Spotted Cat, Four-horned Antelope, Indian Pangolin, Sloth Bear, Striped Hyena, Yellow-throated Bulbul and the Indian Wild Dog (APSFR 2013; FES 2008) among others.[8] These factors make it an ideal location to identify both social and ecological factors that contribute to the production and persistence of spaces where high species diversity exists outside protected areas.

[8] Wildlife population surveys have not been undertaken in the area. I use "high species diversity" based on (qualitative estimates) documentation by the state and NGOs working in the region.

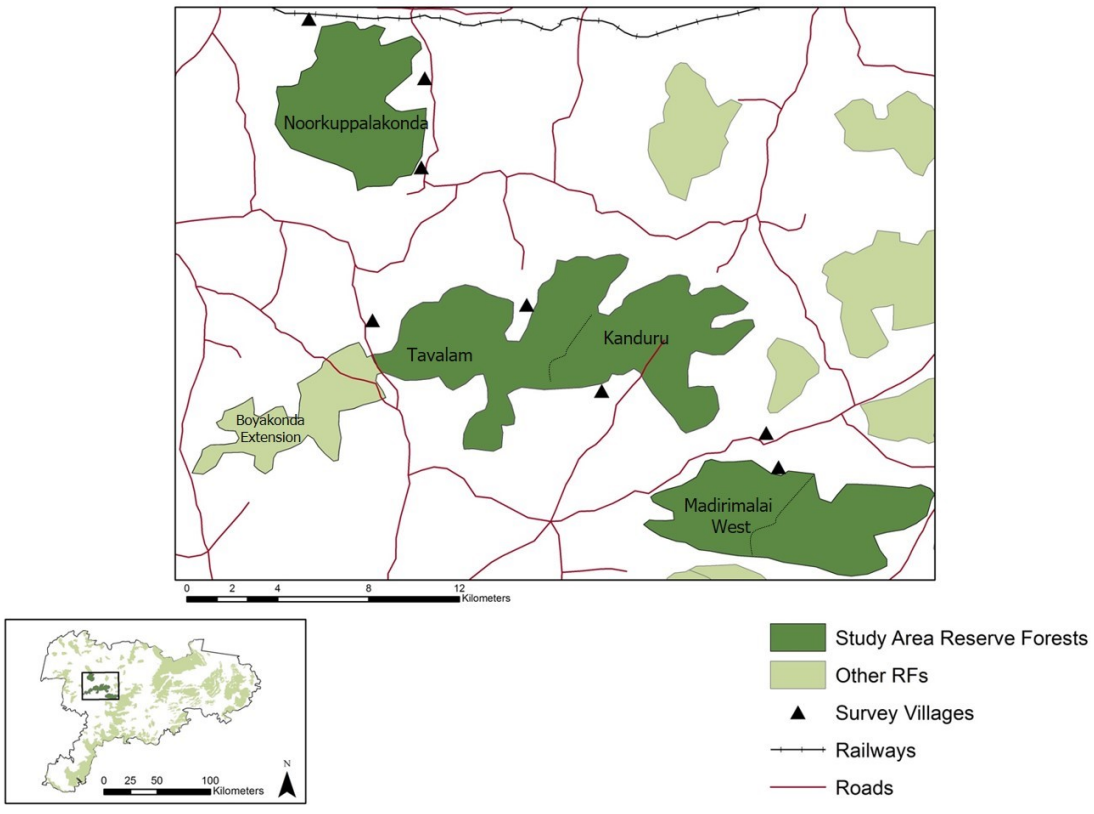

Figure 1.2 Study Area: Reserve Forests & Survey Villages

Although rich in biodiversity, Chittoor district has a high poverty rate and is considered one of the "most backward districts" (Ministry of Panchayati Raj 2009) in the country. High levels of poverty, drought and fluctuating prices for agricultural commodities compel local communities to maintain diverse livelihoods that involve livestock rearing, collecting non-timber forest produce, and seasonal migration for wage labor. Hence, the combination of changing land-use practices and functions makes this research timely as it investigates the patterns and processes operational in this landscape matrix through intersections of land-use, everyday practices and social networks to understand how wildlife persists within this complicated landscape in Chittoor district.

The villages in the study area consist of a mix of communities with diverse livelihoods. I do not name the villages or respondents to maintain anonymity as per IRB guidelines. I detail the sampling methods used to select the villages and respondents in each chapter. The sample for 191 household surveys included 99 women and 92 men. The semi-structured interviews included 18 women and 33 men. [9]

1.6. Dissertation Structure

The rest of this dissertation is organized under three primary analytical chapters based on data collected from June-November 2015; followed by a conclusion. Each analytical chapter uses different methods hence these are explained within the chapter itself. I provide chapter outlines for each chapter here.

In Chapter 2, "Permeable Landscapes: Why the Matrix Matters" I characterize the landscape matrix in my study area through the patterns and processes shaped by biogeography and the everyday practices of the rural communities living around four reserved forests (RFs). The composition and structural connectivity within the matrix helps establish why a landscape-centric approach to conservation using anthromes is necessary. I further argue that livelihood diversity and land use decisions work as key drivers to explain how humans shape the landscape and unintentionally contribute to wildlife habitat in this area.

In Chapter 3, "People and Wildlife: Shared Spaces & Mutual Adaptations" I claim that shared spaces between humans and wildlife are a result of a complex intersection of the biophysical and socially constructed world that include government

[9] With regard to education levels, among respondents to the household survey 27% had attended high school, 5% had been to college, 17% stopped their education after primary school and 51% did not have access to formal education. The respondents to the semi-structured interviews had largely not been to school and the quarter who had said they stopped going at some point in primary school.

policies and everyday practices of local communities. The species distribution models provide relative likelihoods of distribution of the Sloth Bear, Four-horned Antelope, Wild boar and Leopard in the study area. The results provide an insight into the socio-ecological conditions under which shared spaces are maintained, untangling the relationships mediating the presence of biodiversity in places that we do not expect.

In Chapter 4, "Fringe Forests: Perceptions, Representations and Access" I trace the plurality of discourse surrounding forests. I show how the social landscape is characterized by embodied experiences and changing perceptions towards the forest at the collective level. Further I explore how differential access to village commons and forests result from intersections of social diversity and the state's ways of knowing and managing Reserved Forests (RFs). Finally, I argue that state representations of reserved forests determine management, but these representations are contradictory to local community perceptions and benefits gained. This chapter also highlights the lifeworld of a marginalized forest dependent community living in the study area and uncovers their shifting subjectivities in relation to the forest, its management and the larger village community.

The last Chapter 5, "Conclusions" provides an overview of my findings with an emphasis on the relevance to wildlife conservation in lived landscapes. I also use this space to make a case for a landscape scale approach to conservation and one that integrates biophysical and social aspects. Through an analysis of the landscape, wildlife, forests, the livelihoods and lifeworlds of people in this part of the Eastern Ghats I explain the potential of human wildlife cohabitation and offer an altered framework for conservation that can be adapted to similar scenarios.

Chapter 2. Permeable Landscapes: Why the Matrix Matters

2.1 Introduction

Wildlife conservation is often spoken of in "crisis" mode and precautionary principles guide the underlying basis of conservation. The need to prevent further extinction and endangerment of biodiversity and ecosystems alike, is the recurring justification provided. A relatively recent approach promoted primarily in the global North is restoration, based on the notion that we can restore ecosystems and wilderness to what it once was, provided the "original" actors are introduced[10](Holmes 2015; Lorimer et al. 2015). Although restoration appears to provide an ecological solution on the face of it, more in-depth analysis shows that it is challenging and can be impractical particularly given the potential socio-political, economic and cultural implications of this model. In the previous chapter, I describe how protected area models of conservation are totalizing and fail to consider the reality of landscapes. More specifically, the protected area (PA) model set into motion the good, bad and ugly of conservation policies and practices at a global scale (Lele et al. 2010; Neumann 2004; Schroeder 2008; West 2006). Literature on the topic reveals the shortcomings and the failings of the PA model of conservation realized in the 1970s and modified thereon. The changes involved including communities in conservation with varying degrees of success, techniques to militarize conservation, integrating conservation and development etc. Yet, what these critiques/reviews fail to provide is an alternative, that considers human and biophysical aspects equally. One also finds scathing critiques of the PA model in development literature exposing the problems

[10] Rewilding is a term used to restore wilderness or critical ecosystem functions through the introduction of critical flora and fauna (Lorimer et al. 2015). Selection of “original” actors is contested as is the “baseline” used when assessing ecological functions both spatially and temporally.

resulting from PAs (Dressler and Roth 2011; Li 2007; Treves et al. 2005). While there is no doubt that biodiversity conservation is a priority, there is also no doubt that conservation at the cost of the lives and livelihoods of people is not the way forward.

In the global South and in India, wildlife conservation studies often use human population density as a variable to prove or/and predict the detrimental influence of humans on wildlife (Agarwala et al. 2016; DeFries, Karanth and Pareeth 2010; Karanth, Curran and Reuning-Scherer 2006). This strengthens the underlying basis for fortress conservation models. The problem with these studies is the a priori bias that assumes human population density will be negatively correlated with wildlife occupancy/presence. This logic persists despite a growing body of research that shows biodiversity is higher outside PAs in several locations, and wildlife including large predators like leopards inhabit human-dominated landscapes (Athreya et al. 2013; Carter and Linnell 2016; Dorresteijn et al. 2015). Further, according to Rangarajan (2015) the concept of "stray animals" outside parks is found to be both "inappropriate and misleading…[because] these animals are peripatetic and their home ranges are in areas outside reserves" (12). At the same time, I do not suggest that high human population density is good for wildlife. Instead, I argue that the use of population density as an inhibiting factor for wildlife in India reiterates the notion that humans and wildlife cannot coexist, and wildlife conservation should be within borders of national parks and other designated areas.[11] Political ecologists have underscored the unreliability of considering demography as the sole driver for environmental change (Hecht et al. 2014; Robbins and Smith 2016). They

[11] In Chapter 3, I use data collected in the field to show the presence of four species (Sloth Bear, Four-Horned Antelope, Leopard & Wild Boar) in reserved forests, that are not protected areas. A discussion on human-animal cohabitation is also taken up in this chapter.

show how demographic changes can also be facilitative, as in the case of forest transitions where population declines have led to reforestation. Conversely, other studies show that population declines can lead to a decrease in biodiversity (Robson and Nayak 2010). Yet the Malthusian influence and the ingrained cause-effect models lead conservationists to disregard human presence. The PA model or the exclusionary model is valuable undoubtedly, but research on wildlife in lived landscapes or human dominated landscapes continues to be limited. This gap is a result of the intersection between funding priorities, policy and a focus on charismatic megafauna and biodiversity hotspots, both at national and international levels. But the use of population density or the number of villages around a forest is problematic both for the assumptions it makes, and because it rarely considers the livelihood and everyday practices of local communities.[12] The PA model and related studies tend to ignore areas outside its borders and instead focus on aspects within the park or reserve boundaries. Some studies document and investigate buffer zones and areas immediately outside PAs (DeFries et al. 2007; Karanth et al. 2013) yet do not go beyond. Given that human-dominated landscapes are a norm in large parts of the world, how then can conservation so easily exclude the value of humans.

An alternate framework that recognizes humans as embedded in the landscape considering both social and ecological systems is the concept of "anthropogenic biomes" or "anthromes" (Ellis and Ramankutty 2008). Grounded in the idea that humans have a significant influence on most of the world's terrestrial landscape, anthromes facilitate the

[12] Studies that include human population density as a variable in their models, do not dwell into details on the local communities, their livelihoods, interactions with forests and wildlife or find out the level of dependence on the resource.

process of normalizing the discourse on conservation in human-dominated landscapes. Admittedly, anthropogenic biomes are not equivalent to human dominated landscapes yet the acknowledgment that humans are part of the terrestrial landscape aids in the process of moving away from concepts of "pristine" and "untouched" nature that the PA framework often builds on. In this chapter, I characterize the landscape matrix in my study area through an evaluation of the patterns and processes shaped by both biogeography and the everyday practices of the rural communities living around four reserved forests (RFs). I highlight the importance of land use decisions at the household level and livelihood diversity as key drivers that explain how humans shape the landscape and unintentionally contribute to wildlife habitat in this area. Analysis of the physical landscape identifies the structural connectivity and complexity that facilitates wildlife movement between the four reserved forests and the matrix. This helps establish the need for a landscape-centric approach to conservation that uses anthromes explicitly rather than as an afterthought. The landscape matrix that I look at comprises of heterogeneous land-use/cover that includes rain-fed and irrigated agriculture, dry deciduous, open and dense scrub forests, areas covered with grass and human settlements. It is bound by the limits of my study area and covers an extent of approximately 660 sq.km. Land is owned and managed by the state Forest Department, Revenue Department and individual farmers. Further, wildlife and forest related policies do not consider farmlands because farming policies are most often independent of ecological considerations (Sundar 2015). Hence, taking this complex scenario of heterogenous land-use/cover, multiple management institutions and diverse local communities this chapter unpacks unexpected wildlife presence in lived landscapes. This allows me to explain why and how

conservation needs an alternate approach in human-dominated landscapes. In the next section, I review literature and present the specific research questions that guide my research.

2.2 Literature Review & Research Questions

A review of literature suggests that the landscape matrix approach is critical to understanding the presence of wildlife in human-dominated landscapes. This is because in most cases PAs are impractical and unnecessary (Bhagwat et al. 2008; Brunckhorst 2010). There is thus a need to think beyond PAs, to integrate working landscapes and focus on improving matrix quality (Franklin and Lindenmayer 2009; Ruffell et al 2010). Parameters of matrix quality usually depend on the focal species, but more broadly and within a landscape approach, one has to consider both biophysical and social aspects. More specifically, a high-quality matrix will have structural and functional connectivity between forest patches for different species in addition to a level of coexistence between humans and wildlife, which facilitates safe wildlife movement through the matrix for forage or dispersal, and a low risk factor for human lives and livelihoods. Conceptually, agricultural landscapes are integrated into conservation in many parts of North America and Europe through land sharing and land sparing, both debated widely in conservation and development literature (Fischer et al. 2014).[13] But similar efforts are not yet popular in South Asia, although they are slowly gaining traction (Sundar 2015). Given the predicted prospects of climate change and increasing threats from development in India, there is reason for concern regarding areas that do not fit the normative parameters of

[13] Land-sharing is designed for less intensive agricultural landscapes where biodiversity if maintained within. It is also referred to as wildlife friendly farming. While land sparing targets intensified production within a section of the agricultural landscape while leaving the remaining area for biodiversity conservation (Renwick and Schellhorn 2016)

wildlife conservation. The Eastern Ghats are one of many underrepresented and unassuming regions within India and conservation activities in the study area are few and far between. I draw upon literature from landscape ecology, conservation and agroecosystems to answer the following questions:

1. What is the composition of the landscape matrix and how does it influence the presence of the Sloth Bear, Four-horned Antelope, Wild boar and Leopard? How do the everyday practices of rural communities' influence landscape composition in articulation with biophysical properties?

2. What is the structural pattern of the matrix and how does it affect wildlife presence? How is matrix structure a consequence of a coproduction between the natural processes and land-use practices?

Landscape ecology attempts to describe the relationship between landscape structure and function or ecological processes (Turner 1989). I focus on characterizing landscape structure to understand how the composition as well as spatial configuration of the landscape leads to a permeable landscape for wildlife and people. I estimate composition using land cover and this allows me to estimate the heterogenous land covers in the matrix (Griffith 2004). Although not spatially explicit, composition is an important prerequisite in characterizing the matrix. Metrics developed to evaluate landscape composition also include richness, evenness and diversity (McGarigal 1995), but for this study I use only the proportional abundance of each class within the study area. Identifying landscape composition builds towards an understanding of matrix quality and consequently its spatial heterogeneity. The second aspect of landscape structure analysis involves the physical distribution or the "spatial character of patches

within a landscape" (Griffith 2004, 6). A large variety of metrics have been developed to calculate landscape configuration at different scales (cell, patch and landscape level). These metrics assess size, shape, orientation, density, connectivity, contagion etc. in the landscape (Mc Garigal 1995; Turner 2005). I focus on the spatial arrangement of the matrix in terms of its land-use/cover to explain how structural configuration of landscape enables movement and dispersal of medium to large size mammals in the study area.[14] Landscape structure influences biodiversity through a range of aspects that include patch size, patch shape, distance between patches, type of cover, probability of connectivity etc.

Since the emergence of the field of landscape ecology, research on landscape structure and processes has been extensive and has taken many directions. One area of research concentrates on landscape structure assessing composition and configuration, while others focus on functional connectivity.[15] Studies assessing landscape structure or function are often species specific, but there are numerous others that calculate the same metrics more generally or at broader scales. Fahrig et al. (2011) provide a framework to assess functional landscape heterogeneity using composition and configuration of the landscape and highlight the need to develop functional land cover maps based on species perspectives rather than human.[16] The authors point at the need for "development of a landscape scale understanding of the relationship between landscape heterogeneity and

[14] Though there are no population estimates of the four species in my study area or data on faunal movement patterns it is difficult to establish this definitively. Yet, based on discussions with local communities I believe wildlife moves through the matrix between forest patches and through agricultural fields.

[15] Studies show that composition and configuration can be highly correlated, and there is a need to distinguish between the two (Duflot et al. 2017; Mimet et al.2016).

[16] Rather than define patches in the matrix using satellite imagery and land cover data the authors propose that a patch should be defined based on species resource needs and that "cover types that we can distinguish are not necessarily functionally different for that species group and vice versa" (Fahrig et al. 2011, 103).

biodiversity" (Fahrig et al. 2011,109) and further state that this must be integrated with information from farmers on their agricultural practices. The importance of agricultural landscapes within wildlife conservation literature has also been growing albeit at a slow pace. The different approaches involve assessing the role of informal protected areas within the landscape matrix (Bhagwat et al. 2005), the potential of conservation in human modified landscapes (Koh and Gardner 2010), ecoagriculture landscapes (Scherr and McNeely 2008), carnivore use across agricultural-wildland gradients (Nogeire et al. 2013), agroecosystems as complementary spaces to PAs (Troupin and Carmel 2014) and more recently a proposal to apply anthromes to landscape scale conservation (Gibson and Quinn 2017). All these studies argue that agricultural landscapes should be considered in conservation planning and implementation. Hence, anthromes offer a more realistic framework to integrate an understanding of the composition and configuration of the landscape matrix through both its physical and social variables. However, this coupling of human and ecological systems is not novel since several other disciplines are cognizant of the coproduction of socioecological systems, and the manifold intersections between environmental, economic, social and political decisions.[17] Yet the use of anthromes as a framework in wildlife conservation is a unique opportunity to question the assumptions and inputs that form the basis of traditional conservation paradigms that separate nature and society.[18] In my study I make the role of human systems explicit and do not make a priori assumptions on population density as an inhibiting factor. Instead,

[17] For instance, scholars in political ecology, land change science and science and technology studies like Robbins 2009; Rocheleau 2001, Jasanoff 2004 etc.

[18] As Gibson and Quinn summarize several authors and state, "… traditional framing of conservation efforts and targets as starting with or grounded in potential vegetation i.e. biomes, is not working and the role of human systems needs to be more explicit" (2017, 1).

after estimating the proportion of land-use/cover in the matrix, I ask how does the agricultural practices of local communities' shape landscape composition. This also brings out the importance of temporality particularly in semi-arid landscapes, where land-use practices are closely related to rainfall and its lack (Altieri and Toledo 2005).

In human dominated landscapes the type and quality of the intervening matrix between patches affects species occupancy more than simply patch size and isolation. Research shows that, patch area and isolation proved to be "poor predictors of occupancy across species" (Prugh et al. 2008, 20770). The authors undertake a meta-analysis to determine if patch area and isolation are good predictors of occupancy in fragmented animal populations (Prugh et al. 2008). In this analysis, the authors compile occupancy data from 1015 studies carried out on vertebrate and invertebrate populations across six continents. The authors note the value of patch metrics depend on the species under study, and the scale considered but also point to two other critical aspects that are integral to understanding the presence of wildlife in anthropogenic landscapes: first, that species surviving in fragmented landscape matrices are "survivors" and second, "patches are not islands" (Prugh et al. 2008, 20773).[19] This is in response to a dominant framework used to justify the PA approach, island biogeography theory (IBT). Often referred to as the habitat-matrix paradigm, this framework has been deliberated and critiqued since the 1970s. Even though IBT has its share of supporters and detractors, numerous studies emerging from it continue to justify the method's explanatory force (Franklin and Lindenmayer 2009). The concept of habitat-matrix in island biogeography assumes that the patch is habitat and non-patch area is the matrix which usually defined as an

[19] Similar findings were reported by Bender and Fahrig (2005) and Umetsu et al (2008).

inhospitable barrier between patches. Even though IBT combined with metapopulation theory is a strong argument made by wildlife conservationists, the inherent weakness of this approach has been discussed extensively. Mimet et al. (2016) illustrate how use of the habitat-matrix model has led to oversimplifications in understanding landscape processes, and show how composition is more important than configuration when understanding biodiversity patterns. Given the nature of a lived landscape and that too one where forests are used regularly by local people, wildlife presence implies a level of adaptability to human activity. Unlike islands, a forest patch in a lived landscape can either face a benign or hostile environment around it. Thus, considering the adaptive capacity of wildlife and the relatively low level of human-animal conflict in the study area, this study aims to contribute to understanding the attributes of the matrix and evaluate its permeability.

Landscape permeability is a measure of landscape structure that considers "the hardness of barriers, the connectedness of natural cover and the arrangement of land uses. It is defined as the degree to which regional landscapes, encompassing a variety of natural, semi-natural and developed land cover types, will sustain ecological processes and are conducive to the movement of many types of organisms" (Anderson and Clark 2012, 2). Unlike landscape connectivity, which assesses the capacity of individual species to move between habitats, permeability estimates the degree that the whole landscape can sustain wildlife needs and ecological processes. In other words, connectivity is critical when examining wildlife movement patterns across areas where habitat destruction has occurred (or was never there) between two or more suitable habitat patches. Whereas, permeability detaches the analysis from specific patches taking a more holistic or

landscape level approach. Hence taking a multiscale and multispecies approach, permeability allows one to hypothesize the quality of the matrix in other words, for both wildlife use and movement (Singleton et al. 2002; Gray et al 2016). Conservation in fragmented forests often use landscape connectivity metrics to estimate nodes and linkages. Connectivity is important not only for genetic dispersal and migration but also when wildlife uses the matrix as a resource for foraging.[20] Typically, functional connectivity depends on the species, habitat quality within the connectors and the landscape matrix. Apart from species behavior and preference, the remaining variables are broadly quantified through an assessment of structural elements in the landscape (Vogt et al. 2009). But, structural and functional connectivity are not the same thing as they can exist independent of each other. In the sense, in fragmented landscapes certain species may have the ability to move between the fragments through the matrix in the absence of structural connections. Conversely, structural connectivity can facilitate movement, but it does not guarantee that species will use the corridor or stepping stone connectors. Research also shows that corridors can turn into sinks and ecological traps (Brodie et al. 2016) and this can prove to be more detrimental to wildlife in areas where hunting and poaching are threats. On the other hand, a landscape approach to conservation that considers the matrix in its entirety does not create such identifiable sinks for the species. While this study does not look at evolutionary or animal dispersal, it is important to acknowledge that the boundaries between forest versus non-forest can matter for species survival. As my results show, boundaries between land categorized as forests and wastelands are permeable. Further vegetation composition in both these land

[20] In my study area, data from household surveys and interviews with the local communities confirms the hypothesis that wildlife uses the matrix.

categories is similar. Other structural connections also exist and evolve due to heterogenous land-use/cover and changing land use and management practices.

Boundary crossing, species evolution and adaptive capacity to cross boundaries is studied in wildlife biology and related sciences. The findings of such studies are relevant to my research questions. For instance, Martin and Fahrig (2015) carry out a simulation to assess evolution of species behavior with regard to dispersal and habitat boundaries. They state "... habitat amount and habitat fragmentation have weaker effects on the evolution of boundary crossing than matrix quality or disturbance frequency" (5797). Although many studies on matrix quality and concepts of dispersal are species specific, one can infer that analyzing matrix quality is significant for fragmented forests and more so, in the case of anthropogenic landscapes. Further, matrix quality in the study area can be potentially improved, whereas increasing forested area is not an option or even a possibility. Based on land ownership patterns that involve multiple actors and management practices, and dependence of rural communities on agroecosystems increasing forest area is impractical presently. Whereas, matrix quality can be improved through community involvement in forest conservation and a consideration of the agricultural systems that support and maintain wildlife habitat. As Villard and Metzger (2014) state, "maintaining habitat quality, habitat configuration and matrix composition may represent valuable alternatives to maintain a species in landscapes where a significant increase in habitat amount is impossible over the short term." (7). This makes analyzing the quality and consequently the permeability of the matrix important to justify why a landscape approach to forest and wildlife conservation is critical in lived landscapes.

Indicators used to measure matrix quality include species-specific habitat quality and distance among habitat patches in fragmented landscapes particularly in human dominated tropics (Umetsu et al 2008). These indicators increase the explanatory power of species distribution models as seen in a study of small mammals in the Atlantic forest of Brazil (Umetsu et al 2008). In the same study, the authors find that for generalist species one has to consider more than just the forest as habitat because generalist species have a tendency to interact with different land cover types (Umetsu et al 2008). This corresponds with my argument that the Four-horned Antelope, Sloth Bear, Leopard and Wild Boar all use the landscape matrix despite its variegated land-use/cover. All four species are categorized as habitat generalists (Dutta et al. 2013; Allwin et al. 2016), which suggest that they can and do adapt to a variety of vegetation and forest cover types, despite their particular niches. This is another reason for species survival and persistence in these unexpected spaces. Unfortunately, metrics used to estimate matrix quality and permeability involve species level movement data which I do not have. Thus, I use proxy metrics that provide insight into the structure of the landscape which allows drawing inferences on the potential of the matrix as a biodiversity conservation target. The paucity of data on wildlife in unprotected forests leads to barely any work done on lived landscapes or heterogenous matrices, making the findings of this research significant. In the next section, I discuss the methods I use to analyze the landscape matrix followed by the results.

2.3 Methods

2.3.1 Data Used

Land-use/cover Map

A land-use/cover map was developed for the study area using remote sensed imagery and ground truth data collected over six months (May-December 2015).[21] I used Landsat 8 data which was downloaded from USGS[22] with a resolution of 30m for May 2015, Path 143, Row 51. Classification was carried out using image processing software: ERDAS Imagine and Idrisi Terrset. The steps involved: pre-processing the satellite imagery or converting the raw data/digital numbers to reflectance; data processing through a segmentation tool that uses spectral similarity to facilitate classification; creating training sites for land-use/cover based on ground truth data (with 25 points on average for each class) and finally use of the maximum likelihood classifier to develop the map. The land-use/cover classification was based on field observations of the following types of land-use/cover: dryland agriculture, irrigated agriculture, dry deciduous forest, open scrub, dense scrub and exposed/bare rocks.[23]A final step in developing a land-use/cover map is accuracy assessment. This involves assessing the accuracy of a classified image compared to a reference or base image that is assumed to be a true representation of the land cover. In this case, the classified image was compared

[21] Ground truth data includes taking geographic coordinates and identifying land cover types, which was collected during field visits to the agricultural lands, forests and wastelands.

[22] United Stated Geological Survey (http://earthexplorer.usgs.gov)

[23] These land-use/cover categories are based on observations I made during field visits in 2015 (June to November), and shorter trips made in 2013 and 2014. I also try to focus on the preferred habitat pertinent to the four species in this study. Land covered by grass is significant for the Four-horned Antelope. However, due to the complex nature of this landscape and lack of finer spatial resolution satellite imagery classifying grass as a separate cover was difficult. On the other hand, since exposed/bare rocks were clearly identifiable on the landscape during field surveys using the data to identify this type of cover was possible. Inclusion of exposed/bare rocks as a cover type is not common practice, but in this landscape, it is important because of the Sloth Bear's preference to use areas in and around large granite boulders as denning sites.

through a set of 35 randomly generated points (stratified) to compare the classified image of May 2015 to locations using Google Earth.

Household Surveys

191 household surveys using stratified random sampling were undertaken in eight villages located on the periphery of the four Reserve Forests between June-November 2015 (Figure 2.1). The surveys were stratified based on the dependence the local villages have on the Reserve Forests.[24] Hence, 40% of the sample represent those dependent on *Noorkuppalakonda*, 30% are dependent on *Tavalam*, 12% on *Kanduru* and 18% on *Madirimalai* West Reserve Forests.[25]

The household surveys generated data on the diverse livelihood patterns, land holding size, livestock rearing practices, use of forests, presence of and interactions with wildlife in agricultural fields and within forests. The surveys also included questions on perceptions towards wildlife to understand human-wildlife relations in the area. These villages were selected based on prior visits made to the study area in June 2013 and 2014. All surveys were conducted in Telegu and translated to English. The survey protocol was approved by Rutgers University's IRB in 2015.

[24] In each village the surveys covered 25-30% of the total number of households
[25] I describe the composition of each RF in Chapter 4

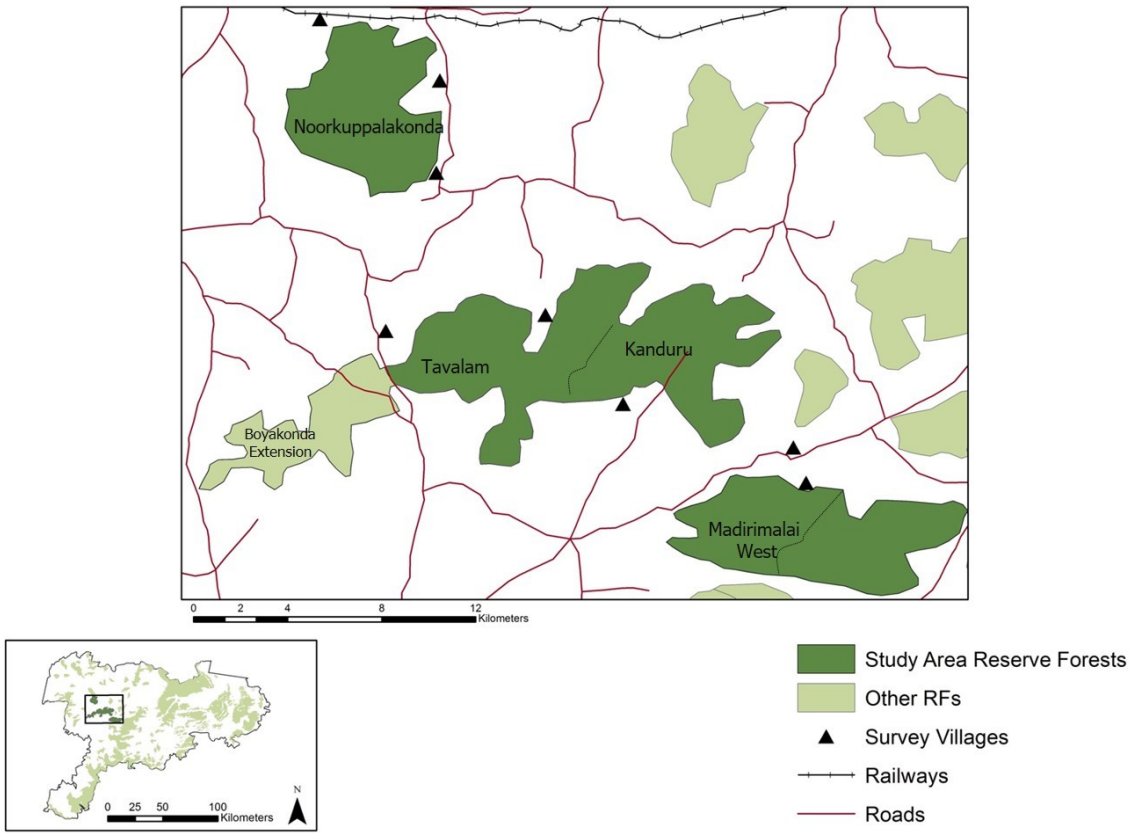

Figure 2.1. Study Area: Reserve Forests & Survey Villages

Faunal Surveys

Field surveys were carried out from June-November 2015 to record the presence of four wild mammalian species in the study area. The species selected are the Four-Horned Antelope (*Tetracerus quadricornis*), Sloth Bear (*Melursus ursinus*), Leopard (*Panthera pardus*) and Wild Boar (*Sus scrofa*). I focus on these mammals as the first three are listed as "vulnerable" in IUCN's Red List, and the Wild Boar is considered a problem by farmers. I discuss the habitat requirements of these species in the results section. Faunal evidence included animal scat/droppings (for the Four-horned Antelope, Leopard and Sloth Bear), dug up mounds in the forest and tank beds (for Sloth Bear and Wild Boar), and tracks (for all four species). Geographic coordinates and elevation were

recorded at the site of evidence along with a basic description of the land cover and a qualitative estimation of anthropogenic pressure in the area. This was estimated using categories of low, moderate and high based on the visible cut branches, goat and sheep pellets and evidence of fuel wood collection that included fuelwood bundles and visibly cut tree branches.

The terrain, access routes into the forest and the inability to access certain areas made opportunistic sampling the only way to record species data although equal stratified sampling based on environmental variables defining the species niche was planned. Guided walks over six months were carried out to the four reserve forests in the study area.[26] These walks covered at least 50% of the area of each RF and ensured the sampling of diverse micro and macro habitats.[27] Repeat visits were also made to at least half the sites to record additional presence data to ensure suitability of the data collected (Franklin 2009). This included using different approach routes to record wildlife evidence and avoid environmentally biased samples. Imperfect detection can distort the relationships/outcomes of the modeling process. According to Guillera-Arroita et al. (2015) if the same observer carries out all the surveys i.e. there is constant detectability and a lesser chance of sampling bias. Since I was the only one recording data this aspect was taken into consideration.

[26] The guided walks were undertaken with a field guide and a naturalist local to the area. Both individuals are familiar with the forests and the species of interest.

[27] Micro habitats refer to a description of the location where the sign was recorded i.e. foothills, stream bank, plateau, ridge or ravine. Macro habitat includes the vegetation type i.e. dry deciduous forest, open scrub, dense scrub or mixed.

2.3.2 Data Analysis Methods

Landscape Composition

The land-use/cover map was used to estimate landscape composition in the study area. Using ERDAS Imagine I calculated area covered by each land-use/cover classification and the percentage contribution of each cover type to the matrix. A richer understanding of the agricultural or non-forested cover was gained through data from household surveys. This included knowing crop diversity and land-use patterns, which further allowed for an explanation of fallow lands, increasing trends towards irrigated agriculture and other practices that I detail in the results section.

Landscape Configuration

To characterize and identify patterns in the landscape matrix I use a spatial pattern analysis software from the Guidos 2.1 software package (Vogt 2010). Morphological Spatial Pattern Analysis (MSPA) is based on a geometric approach and uses a binary map to analyze the spatial arrangement and connectivity in an image. The binary map was generated from the land-use/cover map, taking dryland and irrigated agriculture as the background, and the rest of the categories formed the foreground. MSPA assesses the level of functional connectivity by analyzing the structural configuration of a landscape using the binary map and carries out a segmentation analysis of the foreground objects in the image. It describes the level of connectivity based on the foreground which in this case are all the areas covered by non-agricultural land cover. The foreground is classified into different thematic categories that include: Cores, Bridges, Islets, Loops, Perforations, Branches and Edges (Vogt et al. 2008). Cores are defined as forest areas surrounded by

forest pixels[28]; Bridges are forest pixels that connect two or more core areas; Islets are those pixels that are not connected to cores and are too small to contain cores themselves; Loops are essentially pixels that connect cores to themselves; Branches are those pixels that extend from core areas but do not connect to other cores; and Edges are pixels formed between the forest and non-forest area in the landscape[29] (Vogt et al. 2008; Soile and Vogt 2009). I use an eight-neighbor connectivity rule[30], and an edge width of one which is the minimum possible. The edge width is defined based on the resolution of the data, which is 30m, hence using one allows the detection of the maximum amount of core area. Based on the shape and rough edges of each RF allowing for maximum detection of core area seems most advantageous.

In lieu of a permeability index for the matrix, I use entropy and a fragmentation analysis to estimate how the structure can influence movement of wildlife. Entropy in MSPA helps quantify spatial heterogeneity through a per-pixel analysis and provides a normalized indicator that goes "beyond describing fragmentation as perceived by faunal species…" (Vogt and Riiters 2017, 355). Entropy represents fragmentation in a landscape and measures the degree of spatial disorder (Vogt 2015). It is based on the second principle of thermodynamics where a high level of entropy means a high level of randomness, or disorder. A single compact object will have a minimum entropy value whereas, a checkerboard pattern represents maximum entropy (Vogt 2017). Further, I calculate two measures of fragmentation, one uses the foreground (forest cover which includes all non-agricultural categories) and the second uses the background (non-forest

[28] This definition of cores, is not connected to the concept of "core areas" within PAs.
[29] Using a pixel level classification method as opposed to a patch or landscape level allows for more accuracy in determining spatial patterns in a landscape (Vogt et al. 2007).
[30] Includes pixel connected by pixel borders and a pixel corner (Vogt et al.2008).

cover which includes both dryland and irrigated agriculture) based on a moving window analysis that uses window lengths of 7, 13, 27, 81 and 243. The images presented in the results are a summation of these five observation scales.

Summary statistics are calculated based on data on land-use practices generated from household surveys. These include responses to questions on soil and water conservation, non-agricultural land cover in and around the fields and other everyday practices pertaining to land-use decisions at the household level. This also provides an insight to the intersections between agricultural, animal husbandry and forest ecosystems in the study area.

2.4 Results

2.4.1 Landscape Composition

As argued earlier, a resource patch or species specific habitat is critical to its survival (in this case the Reserve Forests), but in a lived landscape both forests and non-forests are important. The table below shows the composition of the landscape matrix in terms of the abundance of each land-use/cover class. This analysis is based on the land-use/cover map created for the study area using remote sensing imagery and ground truth data (Figure 2.2). The land-use/cover of the matrix as evident from Table 2.1 appears under the broad (simplified) category of forests and non-forests.[31]

[31] Although this binary is disputed by several scholars among whom Prugh et al (2008) state, "The patch/non-patch dichotomy appears to be a gross oversimplification for many species in fragmented landscapes." (20773), it is still worthwhile to get an overall picture of the landscape.

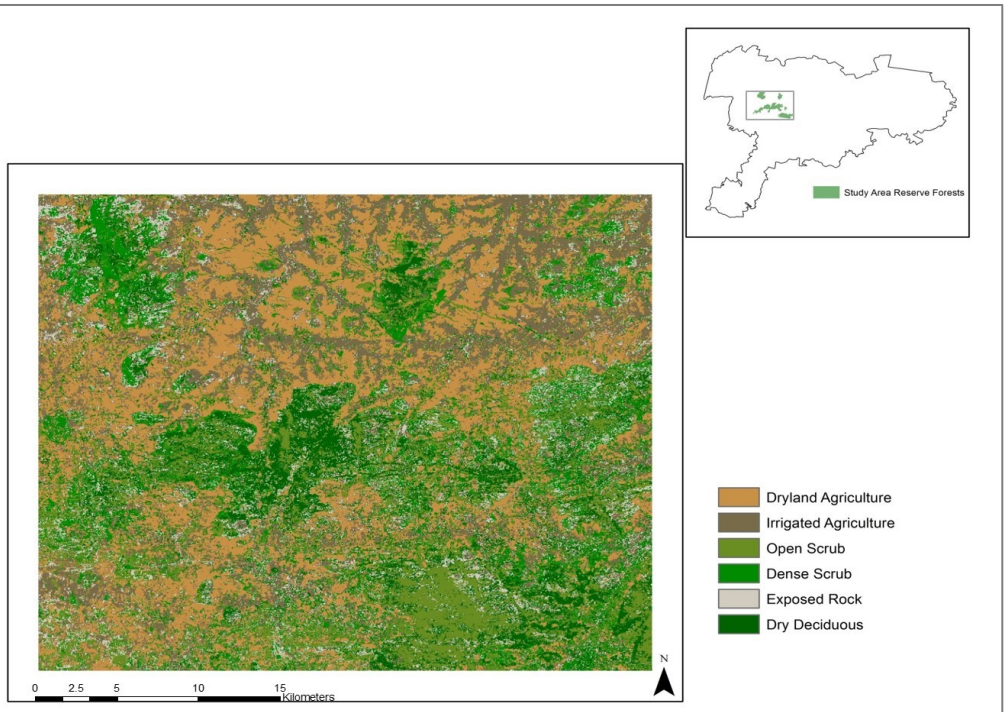

Figure 2.2. Land-Use/Cover in the Study Area

The proportion of area under agriculture (48%), and non-agriculture or forest cover (52%) makes it clear that the matrix is divided almost equally with forest cover cumulatively exceeding agriculture by 4 percent.[32]

Table 2.1: Composition of Land-Use/Cover in the study area

Land-Use/Cover	Area (in hectares)	Percentage contribution to the matrix
Dry Land Agriculture	15695	26.94
Irrigated Agriculture	12450	21.38
Dry Deciduous Forest	7029	12.08
Dense Scrub	10715	18.42
Open Scrub	7071	12.14
Sheet Rocks	5258	9.03

[32] I include exposed rocks within forest cover because almost all the points collected and used to develop the land-use/cover map were located inside the RF boundaries. Open and Dense Scrub are also recorded as forest cover based on field observations, and scrub is critical to the livelihood of shepherds and goat herders.

I use this dichotomy to get an estimate of land-use/cover in the matrix and infer its use to the species under study rather than distinguish between habitat and non-habitat. This is based on the hypothesis that the Four-horned Antelope, Sloth Bear, Wild Boar and Leopard all use the matrix for foraging and dispersal. I first discuss the composition of the forested landscape, correlate this with findings from the faunal surveys and then pursue an inquiry into the agricultural landscape.

The Forested Landscape

The dominant species under dry deciduous forests are *Wrightia tinctoria*, *Anogeissus latifolia*, *Dolicandrone atrovirens*, *Dalbergia paniculata* and *Vitex altissima*. Dense scrub includes species like *Zizyphus oenoplia*, *Chomelia asiatica* and *Canthium parviflora*; while open scrub vegetation is characterized by species like *Dodonea viscosa*, *Cassia auriculata*, and *Randia dumetorum*. The Reserve Forests are used on a regular basis by the local communities for fuel wood collection, grazing livestock and collection of non-timber forest produce. In this scenario, a logical consequence of this lived landscape is that open scrub vegetation is predominantly at the foothills. As elevation increases patches of dense scrub interspersed with dry deciduous trees becomes more frequent.[33]

Data from faunal surveys also compare with these observations (Figure 2.3). For instance, geographic coordinates recorded for Four-Horned Antelope middens are in areas adjoining dry deciduous and dense scrub cover, which are open and have grass. This is similar to the habitat characteristics observed in other locations where the

[33] This is because a large majority of the community prefers to use the foothills unless they have livestock to graze. Women in particular said that using the foothills to collect fuel wood allows them to return home quickly to take care of other household chores.

antelope shows a preference for short grass, sparse stunted trees and open canopy areas.[34] 75% of the middens were located in areas with grass patches (*Cymbopogan* spp.) with a higher presence in areas with grass and *Anogeissus latifolia* trees. Areas of higher elevations, undulating slopes, hill tops and plateaus typically have this land cover in the study area.

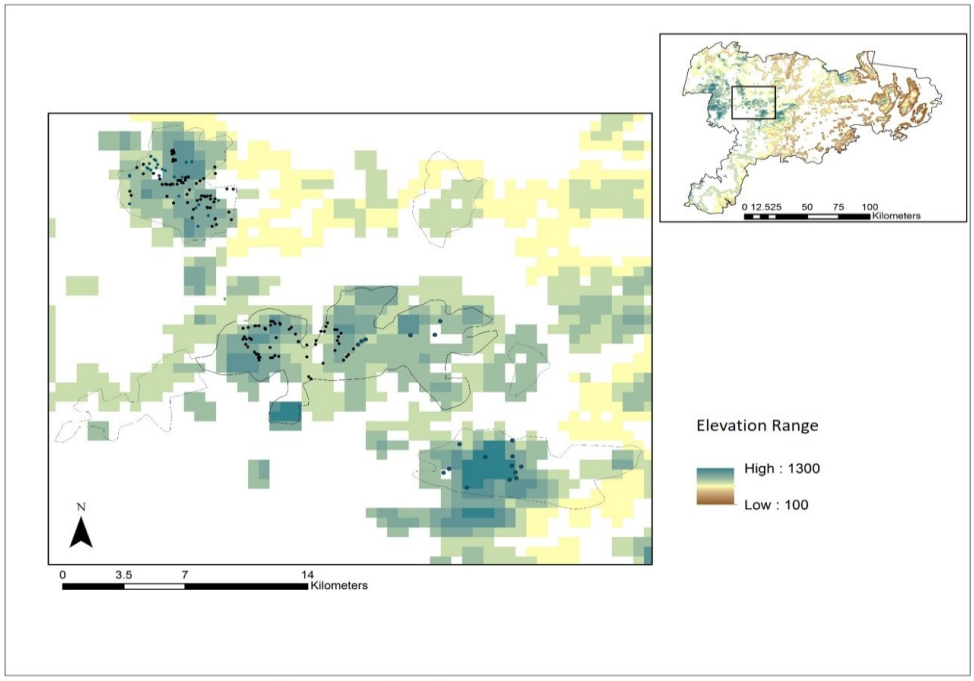

Figure 2.3 Elevation and Faunal Data Points in the Four Reserve Forests

Unlike the Four-Horned Antelope, Sloth Bear scat and termite digs are found across all three forest cover types (open scrub, dense scrub and dry deciduous), and at different elevations. 95% of Wild boar tracks were recorded in stream beds, tanks or/and water holes in the RFs. The 15 leopard signs recorded were in areas covered by dense scrub and dry deciduous trees, at both mid and high elevations. The correlation between elevation and species presence in the study area thus has to be interpreted through the

[34] Baskaran et al. 2011

lens of anthropogenic pressure instead of a purely physical phenomenon

The land-use/cover map also shows the fluidity/permeability of land categories in the study area.[35] Forest cover in most cases is a result of natural regeneration dotted with patches of old growth which makes it difficult to discern where dense scrub ends and dry deciduous begins. This heterogeneity in landscape composition and configuration challenges the definition of edge effects in different species. As other scholars have shown heterogeneous habitats effect both species occupancy and movement, as well as the ability to delineate habitat patches (Prugh et al. 2008; Resasco et al. 2017. Besides this RFs do not have physical boundaries around them, instead a part of the boundary has trenches, and other parts may have markers, as simple as a large rock. Curiously despite the missing physical evidence or easily identifiable markers, everyone in the villages know where the forest boundary starts. This traditionally Indian and local forest management and boundary making technique is conducive to connectivity for wildlife. Several texts dealing with forest management particularly in the colonial and post-colonial context discuss the permeability between forests and agricultural land. In my study area, it is difficult even for a discerning observer to know where the forest starts and where the "wasteland" ends because the difference in composition is not visually evident. An important point to note here is that the proportion of forest cover in the matrix includes the RFs, the Revenue Wastelands and other village commons.

The forested area provides habitat and key resources to wildlife, yet the surrounding matrix also emerges as a critical place for foraging and movement. The agricultural landscape comprises of rain-fed/dry land and irrigated agriculture, covering

[35] In addition to field notes, photographic documentation and observations made during the faunal surveys.

27% and 21% of the matrix respectively. In the next sub section, I query agricultural practices in the study area to find out how local communities shape the composition of the matrix. This will provide further insight into coproduction of the matrix by physical and social elements of the landscape.

Querying the Agricultural Landscape

Agriculture in the study area dates back to the Neolithic age (Krishna and Morrison 2009; Singh 2013). Archaeological evidence suggests that agriculture and pastoral farming evolved to suit the ecological conditions, and South Indian Neolithic settlers domesticated several crops including cereals and legumes (Krishna and Morrison 2009). Today a bird's eye view of the non-forested part of the matrix (48% of land-use/cover) shows patches of red soil of different shapes and sizes in the midst of rocky hillocks, interspersed with bright green fields with irrigated rice cultivation. In the distance, one also sees mango plantations and other trees distributed across the landscape. The study area receives an average annual rainfall of 650-700mm and it appears like a complex interspersion of land-use/cover. Small farm plots are the norm ranging from 0.5 acre to 2 acres. Farmers traditionally cultivated groundnut, millets and horse gram, but now the most visible crops are tomato and paddy (See Figure 2.4).[36] In the past, millets namely foxtail millet, pearl millet, little millet and finger millet were the primary crops, along with groundnut and horse gram. These crops are well suited to the semi-arid climate because scanty rainfall is sufficient. The farmers say that the agricultural landscape has changed over the past three decades. The area has always been drought

[36] The matrix and particularly the agricultural landscape corresponds to the concept of traditional farming systems as opposed to intensive agricultural systems (Fahrig et al. 2011).

prone and farm-based livelihoods depend on the will of the "rain gods", who according to the farmers is becoming more and more "close-fisted" with each passing year. Through six months of field work a common refrain from the landless, small, marginal and large farmers was that the area had missed the monsoon again.

As an outsider, I was unable to understand the logic of tomato and irrigated rice cultivation in this drought prone region. Both tomato and irrigated rice are water and labor intensive, unlike groundnuts and millets that are sowed and require weeding once or twice through the season. Irrigation has become accessible to anyone who can get resources (government loans and/or subsidies) to drill a borewell.[37] In the past, many farmers cultivated rain fed rice, while irrigated rice cultivation was restricted to those farmers whose fields were located close to traditional water harvesting structures known as tanks.

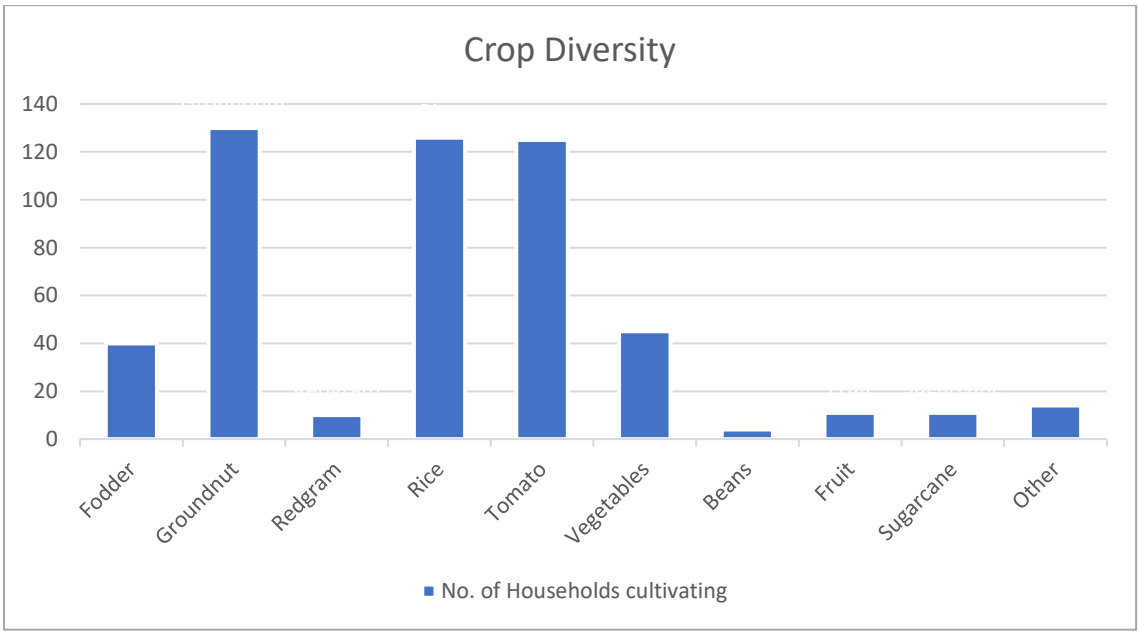

Figure 2.4. Crop Diversity in the study area based on household surveys

[37] Either a farmer should have the money or the leverage/contact with government employees in the chain of command to easily get a loan and permission to drill a borewell.

Tomatoes on the other hand do not require as much water as rice, yet they do need irrigation at regular intervals. Both crops also necessitate application of pesticides and chemical fertilizers, which in turn effect the ecosystem.[38] During conversations with the farmers I was often told that tomatoes and rice carry a higher risk in terms of market prices.[39] The risk is apparently worthwhile, as the market price of tomatoes determines if a household has a good year or migrates for labor in summer. On trying to investigate more and understand the logic, I learned that access to irrigation has increased due to government subsidies and loans. Farmers do not have to depend on the rain to cultivate their land, and incurring profits is not limited to those who have traditionally enjoyed the benefits of the location of their lands, close to the tanks. Unsurprisingly, recurrent drought years, over extraction of groundwater and poor watershed management has led to a situation where most tanks are dry. Hence, brilliant green fields of paddy in this dry landscape seems odd. The dry tanks or inability to access irrigation also spurred a further need to drill for borewells by large and small farmers alike. According to government data, area under irrigated rice/ paddy cultivation in Chittoor district has quadrupled in the last two decades (Andhra Pradesh Agriculture Department Online Portal). Similarly, the number of farmers willing to take a risk on tomatoes has increased manifold. Though tomatoes have been part of the agricultural landscape since the 1970s, the number of

[38] As one farmer said, "There used to be foxes here, we heard them howl at night. But the pesticides have killed them all. The crops we grow these days need pesticides, and in large quantities. These are consumed by rodents and smaller mammals which the foxes depend on. The foxes have been eliminated, at least locally." (Respondent 24, 2015).

[39] There have been seasons when some farmers dump their crops on the road because it is not worth carrying the crop to the market. While, smaller famers leave the ripe fruits on the land and choose to not harvest as spending on labor is not worth it.

farmers growing it has increased.[40] The communities are aware that the water table has fallen, bore wells are becoming unreliable, traditional dug wells have been dry for the past decade or more, like the tanks, and farming is more precarious each year. In every village, there are more than a handful of people who migrate to towns and cities for labor annually. On probing the issue of crop diversity with women, they concede that food insecurity is a concern as cash crops do not provide subsistence for the household. Yet, women seemed to go down a fatalistic route if queried more on the subject. The precarious nature of life in semi-arid areas dependent on the land and rain, has compelled communities to diversify their livelihoods. Everyone does not necessarily see the long-term disadvantages of reducing the water table or the potential food insecurity they are leading themselves into. Further, with the focus on the next generation as educated and (optimistically) gainfully employed, approximately 60% of the respondents foresee a future where they are not dependent on the land/rains.

One of the unintended consequences of the market driven agricultural landscape and increasing number of irrigated fields is the increase in water sources for wildlife. Most natural water holes in the RFs are seasonal, barring one or two in each RF which have water through the year.[41] This makes the matrix a necessity for wildlife survival. The Four-horned Antelope, Spotted Deer, Sloth Bear, Porcupine, Wild Boar and other small mammals visit agricultural fields particularly those that are located close to forest edges, according to the farmers. In general, the communities do not have a problem with

[40] According to one farmer in his early 50s, "There were no tomatoes when I was a child. When a few people planted it, we children went and stole from their fields to eat. I got a thrashing from my mother. She said we shouldn't eat tomatoes because we did not know what they were and eating them could harm us. Now everyone plants tomato and puts it into every meal." (Respondent 13, 2015)

[41] When the perennial water holes run dry the communities believe it signifies “bad times”.

wildlife. Although the Wild Boar shares a different relation with the farmers because it does not simply come for water, but causes crop damage too.[42] Further, as the composition of the agricultural landscape has changed over the past three decades, the wild boar has effectively adapted to every crop. As one farmer said "Earlier the wild boar did not touch millets, it only caused problems in the groundnut fields. Now, it eats everything from tomatoes to eggplants and sugarcane." (Respondent 31, 2015). The ungulates on the other hand may browse on crops but do not cause damage to the extent as the Wild Boar.

Farmers often explain crop choice based on the market, but the influence of social, political, cultural and natural factors that play into a household's decision are also important. My entire sample said that they spoke with their elders and the family prior to taking a decision on what to cultivate or even if they should cultivate. The larger village community and sociocultural practices determine when to sow the seeds. As one older farmer explained,

> Agricultural seasons are divided into 66 *kartis*, some can be for a few days while others run into weeks. We have a tradition called *Molakala Punnami*, it is undertaken at the beginning of the kharif season before the full moon. Traditionally we used to plant a variety of seeds including millets, pulses and oil seeds in an earthen pot. This was a community level practice. After nine days, the seed that sprouted best was chosen for cultivation that season. We still do *Molakala Punnami* but there is not much agricultural diversity left, everyone wants to cultivate groundnut, tomato and paddy. We have other practices related to agriculture too- For instance if it rains in Molakala karti we sow groundnut otherwise we do not. If a *karti* is over, you cannot sow groundnut. But the younger generation does not particularly care… (Respondent 13, 2015).

Hence, although it is simple to point at market forces (which are largely responsible) these decisions are not simply based on the economic. Social practices and traditional

[42] I discuss strategies farmers in the study area use to cope with wild boar crop raids in the next chapter.

customs continue to influence how, when and what is cultivated. In addition, the presence of the state through its multiple arms is also a factor that must be considered when looking at the composition of the matrix. For instance, the Agricultural Department promotes certain seeds based on its priorities, the Horticultural wing provides saplings to plant on private and common lands, the Forest Department has its own agenda with plantations in and around the forest. To add to this complexity, the Revenue Department undertakes plans to regenerate wastelands or in some cases provide land to the landless through one of many government poverty eradication schemes.[43] These messy linkages have direct and indirect implications on the landscape composition in the matrix.

Beyond land ownership and management, the changing agricultural practices correspondingly effect all the other systems.[44] This chapter queries the agricultural system primarily as the others are discussed in detail in the following chapters. The interactions between crop choice, animal husbandry and forestry are dynamic. For instance, in the past when farmers cultivated millets crop residue was stored and used during the dry season as fodder, reducing pressure on forests. Now, with an increase in the number of stall fed cattle (as discussed in detail in Chapter 4) several farmers cultivate fodder, while the rest resort to buying it or get access to government supplied fodder in summer. Another change that farmers point to is the way small livestock played an important role in agricultural fields. In the past sheep and goat owners regularly corralled their animals for 3-4 nights in agricultural fields for enrichment. With the

[43] Several landless households receive legal access to cultivate on "wastelands" based on their status (living Below the Poverty Line). While at least half my sample suggested that they had cultivated (usually groundnut) small parcels on wastelands, illegally.

[44] Typically, when imagining a rural agricultural landscape matrix in India and other parts of the global south agriculture, forests and animal husbandry are critical components (Altieri and Toledo 2005; Negi et al. 2012).

number of livestock reducing, there is a shortage of farmyard manure which compels buying farmyard manure from the market. Another interaction between the systems is produced by tomato cultivation. Tomatoes require sticks for support and farmers with large land holdings procure these from the market whereas, the small farmers collect branches from the forest and wastelands. At least half of the respondents in the household survey claim that they buy the sticks while others admit to the subterfuge involved in getting it from the forest.[45] Historic connections exist between agriculturists, pastoralists and farmers (Ghatge and Ramdas 2015), which make understanding the diversity of livelihoods and the intersections critical to an examination of landscape composition.

The fluidity in livelihood choices also shapes landscape composition through the permutations it creates and differential pressure on agricultural and forest resources. In semi-arid areas people are compelled to diversify their income options to survive. This diversity supports the poorest households as it allows them to distribute their risks. In my study area, all 191 respondents depend on more than one source of income that involves a mix of farming, animal husbandry, daily wage labor and other kinds of jobs to make ends meet (Figure 2.5).

[45] Local communities are allowed to gather fuelwood in Reserved Forests as long as it is “dry wood” for their own sustenance but do not permit cutting or lopping branches termed as “green wood or fresh wood” by the respondents.

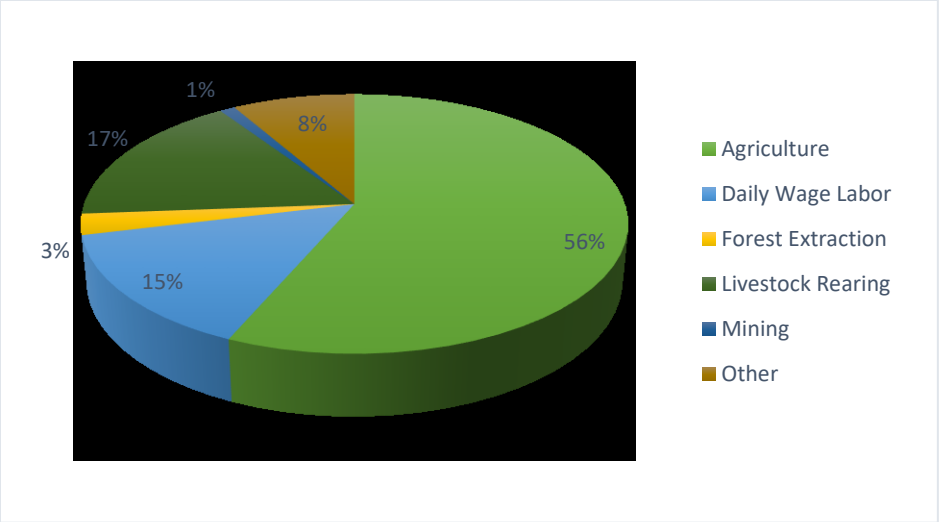

Figure 2.5. Primary income source for households (n=191)

As a result of this, it would be inaccurate to assume that simply the presence of people, population density or the number of settlements determine the amount of anthropogenic pressure on forests. For example, farmers with large land holdings usually do not depend on forests to supplement their income or for fuelwood. In most cases they have an adequate supply of fuel wood from trees around their farms. Further, they are also the first households to avail of cooking gas. Similarly, it is not necessary that the landless exploit the forest. Based on changing energy use patterns in both villages and towns, demand for fuelwood has decreased. Poverty itself is not a strong indicator of forest degradation as Lambin et al. (2001) suggest and my data shows. The poorest households in the village may be more forest dependent, but the vegetation does not lend itself to logging or large-scale extraction of any kind. Daily wage labor is usually undertaken on farms belonging to large land owners provided rains are timely and borewells have not dried up. The landed and landless are interdependent but recurring drought years force many families to the nearest town or city to look for work. Farmers with small plots of land often supplement their income by working on larger farms or find other options for

wage labor.

Livestock rearing once an activity demarcated based on caste, has changed over the past three decades. Earlier the *Golla* or shepherd community primarily reared goats and sheep. Presently, there is no caste-based distinction with regard to livestock rearing. Other than changing practices the government encouraged households to invest in small ruminants like goat and sheep, through poverty alleviation programs a few years back. Cattle on the other hand were and continue to be reared by farmers and others, for milk and as draught animals.[46] According to the shepherds, the number of households who either own or lease goats or sheep has decreased due to recurrent drought, over the past five years. Goat and sheep populations effect the composition of forest cover more than cattle. The change from native breeds of cattle to hybrid varieties has drastically reduced the number of cattle that graze in the Reserve Forests and wastelands. Resource dependent communities shape the landscape through their agricultural practices and diverse livelihoods.

2.4.2 Landscape Configuration

The previous section showed that analysis of composition determines what is the land-use/cover and how much there is but does not necessarily provide a spatial picture. In this section, I analyze configuration of the matrix through the structural patterns present and assess how these patterns effect wildlife. I take the structural analysis further by combining household level data on the everyday practices of local communities, to analyze how biophysical and social characteristics interact.

The spatial pattern analysis using MSPA displays the matrix based on the user's

[46] I discuss the changes in livestock rearing practices in more detail in Chapter 4.

classification of foreground, which in this case was the combination of all non-agricultural land cover. As discussed in the methods section, the geometric analysis divides the landscape into cores, edges, islets and bridges. In this matrix, patches determined as core areas covered 55% which is significant as it means that based on the 8 pixels connectivity rule more than half the forest cover within the study area forms a patch. A more detailed analysis of the structures identified as cores, divides them into small, medium and large. [47]

As evident from Table 2.2 the number of patches classified as small cores are very high, while the largest patches are only four. These four large patches/cores correspond to the reserve forests and the 25 medium cores correspond to the revenue wastelands (except in one case, where a core identified under medium size is a RF) in the matrix.

Table 2.2: Number of core areas in the matrix

Core Size	**Frequency**	**Percentage of Foreground** (Includes all forested or non-agricultural land-use/cover categories)
Core (small)	2876	6.04
Core (medium)	25	6.82
Core (large)	4	42.06

[47] Ranging from 300 to 11000 pixels

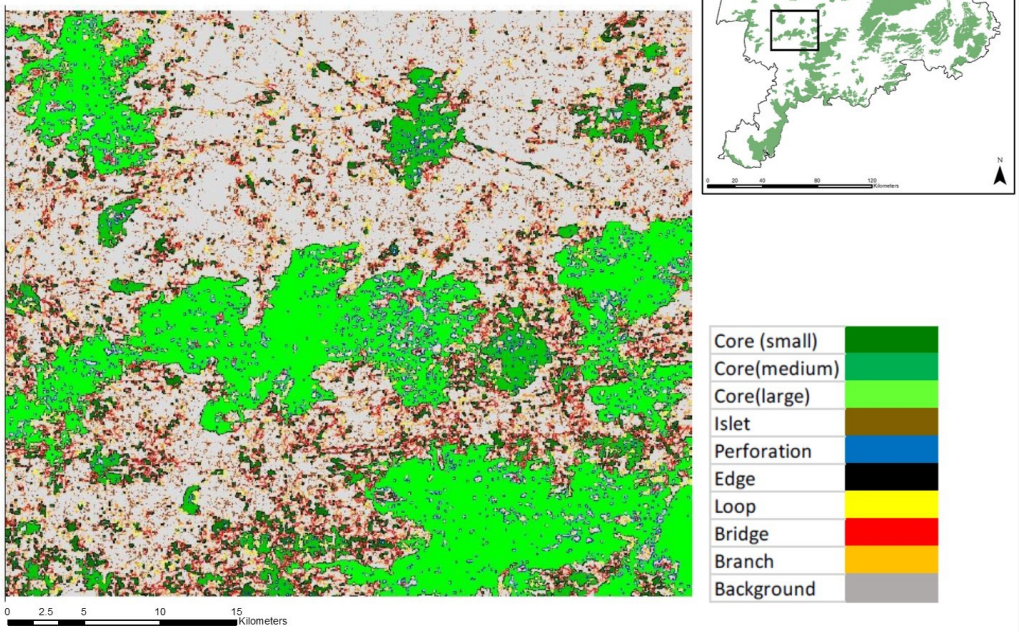

Figure 2.6. Thematic Classification of the Spatial Pattern Analysis for the Landscape Matrix

The percentage of foreground (forested) covered by all the connectors is 26%. This explains the composition of the matrix discussed earlier, where forest cover is approximated at 52% of the entire cover. Given the size of the RFs it is obvious that the entire forest cover is not within the RF but a quarter of the forest cover in the matrix forms bridges, loops and islets and the rest is in small and medium cores. This can further be investigated to determine their use for multiple species at different scales.

The small core areas on the map (Figure 2.6) draw attention to the matrix heterogeneity, that are dependent on the social practices that shape these patterns. I first make a few observations on the spatial pattern analysis followed by results from the household surveys that add to understanding how people shape the structural patterns.

Spatial Patterns: Cores & Connectors

- There is an association between medium cores with areas of higher elevation. The rocky slopes and poor soil quality do not support agriculture, because of which this area has historically been part of village commons and grazing grounds.[48]
- The wastelands or medium cores are distributed across the matrix, with several larger (in area) wasteland hillocks located close to the RF patch, almost as (unintended) buffers. These patches have similar mixed vegetation to the forests and that explains why they are considered forested in the land-use/cover map. Based on my field observations the quality of vegetation on the wastelands is variable across the matrix. Some wastelands have higher percentage of area covered with grass, while others have more scrub and thorn vegetation. Similarly, anthropogenic pressure in wastelands is also variable across the landscape. In addition, there are a few areas where granite mining is happening.
- The smaller cores do not necessarily form linear connections between the larger cores although they do in some cases.[49] The concentration of bridges and islets between *Tavalam/Kanduru* and *Madirimalai* RFs is also evident. The islets make up 6% of the cover, and these are clearly agricultural lands which have a mix of trees/shrubs planted to encourage soil and water

[48] These are now under the category of wastelands, identified and assessed during colonial rule in the process of land surveys. Presently, the Revenue Department manages wastelands in the state.
[49] As discussed earlier, *Bridges* are forest pixels that connect two or more core areas; *Islets* are disconnected from cores and are too small to contain cores themselves; *Loops* connect cores to themselves.

conservation.

- In some cases, the small cores correspond to plantations. These plantations are often fruit trees, which makes them an ideal resource for mobile species like macaques and birds.
- The small cores are connected to each other locally in several locations. In other words, there are bridges within each cluster of these cores.
- The inclusion of exposed rock as a type of land cover increased the potential of the MSPA to locate smaller cores and islets. Sheet rocks are of no practical use to farmers unless they are close to the settlement and are used as a space to thresh grains. Vegetation grows around the sheet rocks and in its crevices undisturbed, in a way increasing linkages in the landscape.

An ideal conservation plan will need to identify the cores and connectors in more detail based on ground realities. Yet this spatial pattern analysis highlights the heterogeneity of the matrix, the way in which different sized cores are distributed across the landscape and the presence of a diversity of connections/links. Calculating entropy based on the foreground and background, determines the amount the background is fragmented by the foreground and vice versa, thus giving a single index to interpret the spatial pattern. The entropy for the landscape matrix is 48.41%, which implies that the forest is fragmented by the non-forest by 48%. This index suggests an average level of fragmentation, since it is neither very low nor high. A more robust interpretation of this is apparent in the moving window analysis that calculates the area density of foreground pixels. I calculated the metrics for this twice, first using forest as foreground (Figure 2.7) and second, using non-forest as foreground (Figure 2.8).

The first image (Figure 2.7) shows the level of fragmentation with forest cover as foreground. The index uses five observation scales to calculate the proportion of foreground pixels classified into six fragmentation classes. These classes are: Rare (<10%), Patchy (10% to 40%), Transitional (40% to 60%), Dominant (60% to 90%), Interior (90% to 100%) and Intact (100%).

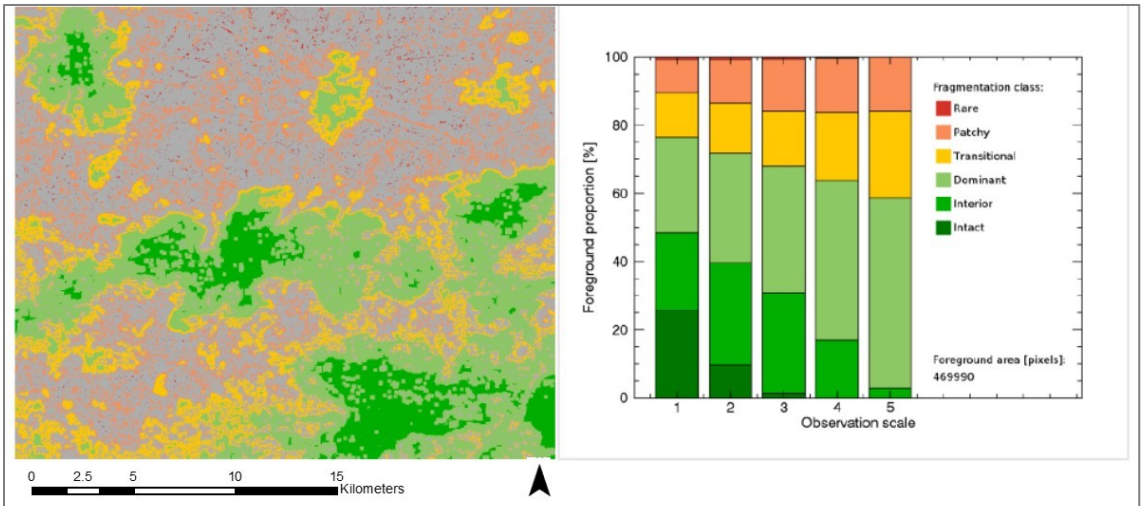

Figure 2.7. Foreground Area Density based on Forest Cover
Observation scale are moving window lengths of 7, 13, 27, 81 and 243

From Figure 2.7 it is evident that the RFs are the only areas classified as having an *interior*, and that Madirimalai RF (in the south-east corner of the figure) has the maximum amount of unfragmented forest cover.[50] Moving beyond the RFs in Figure 2.7 the *transitional* area in yellow is also noteworthy because it brings to focus the forest edges and a high density of *transitional* areas at the edges. In a majority of cases, these *transitional* areas represent the wastelands, which corresponds with my field observations on the quality of vegetation on these patches. Additionally, the density of transitional areas corresponds with the observation made earlier regarding the lack of hard boundaries

[50] Madirimalai RF hence also has the largest core area in terms of forest core versus edges.

in the matrix. Although forest boundaries are discernible the high density of transitional areas around suggests that there are linkages in the landscape. This analysis also correlates with the links identified in the spatial pattern analysis, the areas marked as *patchy* are the bridges, islets and loops we saw earlier. As the observational scale increases (in the bar plot), the proportion of forest pixels under *intact and interior* classes reduces.

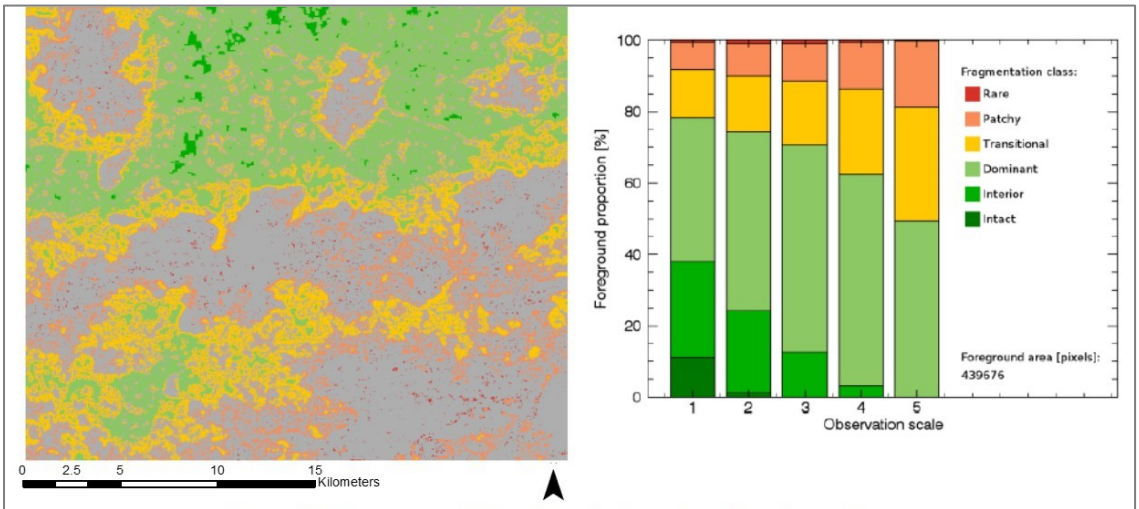

Figure 2.8. Foreground Area Density based on Non-Forest Cover
Observation scale are moving window lengths of 7, 13, 27, 81 and 243

The second image (Figure 2.8), which seems like a mirror image of Figure 2.7 shows a relatively patchy non-forest cover at this scale.[51] Since the object of my analysis is the matrix, using non-forest cover allows one to make observations on the area outside the forested patches. The *dominant* area in this image (light green) is concentrated in the north and north-east sections of the image and the only *interior* areas are also within this

[51] As mentioned earlier, majority of private land holdings are relatively small ranging from 0.5 to 2 acres. Further, although there may be cases of land consolidation in some areas based on the surveys the percentage of this is very low. For instance, in each village I surveyed there were one or two large farmers who has more than 5 acres of land. In addition, the handful of cases across the study area where land had been consolidated and converted to plantations was also not larger than 5-7 acres. Thus, the dominant land holding size and management unit continues to be small.

area. The *transitional* areas (in yellow) or areas with 40% to 60% cover are more obvious in this image and border the edges of both forest and wastelands. A large part of agricultural area both north and south of Tavalam and Kanduru RFs is also under the *transitional* class. As the observational scale increases (in the bar plot), the proportion of foreground pixels under *intact and interior* classes completely disappear. In the next section, I continue to analyze the spatial pattern discussed here through the practices of local communities that lead to coproduction of these spaces.

Shaping Landscape Structure Through Everyday Practices

Based on household surveys carried out in eight villages 80% of land owners have some form of soil and water conservation (SWC) measure on their property.[52] These measures consist of primarily planting trees/shrubs (51%) that demarcate the property, field bunds (29%) that help hold the water and soil on their lands and a smaller percentage of individuals who use rock fences to demarcate the plot. All these soil and water conservation strategies help in recharging ground water and reducing soil erosion. The remaining 20% of the sample either have no visible measures due to the land being fallow and tend to use dried thorn bushes to bound the property when they cultivate. Although these SWC measures are not intended to facilitate wildlife movement their functional purpose leads to an increase in favorable vegetation and potential stepping stones. Scholars date similar soil and water conservation practices back to the medieval period, between the1350s to 1600A.D. and state, "Soil erosion control measure such as mulching and contour bunding was in vogue" (Krishna and Morrison 2009, 46). Prior to this period, irrigation projects were undertaken by various rulers through rivers, canals

[52] A minuscule number of individuals who do not live locally and have changed their land-use by establishing plantations, fruit trees or eucalyptus have fenced their property.

and tanks. In the study area, as mentioned earlier tanks were and continue to be the most important water resource. Thus, the landscape has been coproduced by local communities through adaptations of local terrain and climate historically.

Similarly, another aspect of the physical landscape combines with social practices to produce both cores and linkages is dikes.[53] I use a small subsection of the matrix to show the way in which dikes otherwise considered of little use to farmers, make the landscape structurally more connected (Figure 2.9). The area selected is the portion between Kanduru and Madirimalai RFs, and the large density of small cores, bridges and islets is visible.

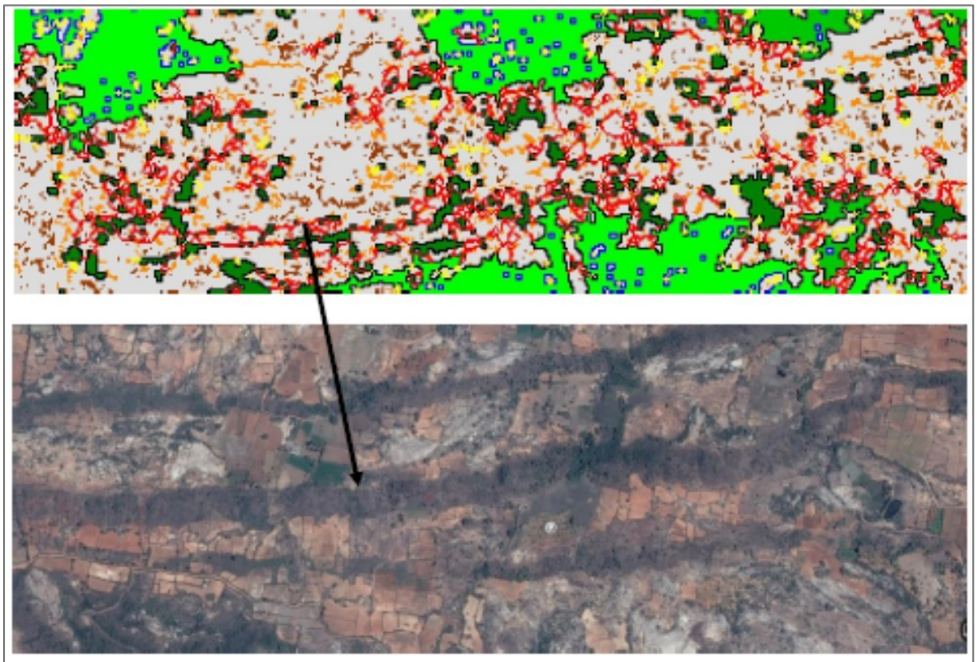

Figure 2.9 Example of co-production between the biophysical and social
The figure above is a sub-section of the Spatial Pattern Analysis output
The figure below shows dikes in the non-forested area between two Reserve Forests (Google Maps)

[53] Dikes or dykes are magmatic intrusions in sedimentary rocks. In the study area, dikes are a common feature. Since dikes are intrusions in the ground, cultivating that portion of the land is impossible hence farmers have no other option but to let them be.

The linear connections in red connecting small cores, are dikes that run through agricultural land.[54] The soil around dikes is fertile and one often finds trees like Neem (*Azadirachta indica*) and Custard Apple (*Annona squamosa*) growing there along with a mix of scrub species. According to the farmers trees grow here naturally and they also plant useful species. Neem finds its use in a variety of local natural treatments and custard apple fruit is both consumed and sold locally. Scrub is used as fuelwood and also to build temporary fences around agricultural fields when they are cultivated. Hence, dikes potentially create linear connections in the matrix that may be useful for wildlife movement. The way in which farmers encourage plant growth on these strips supports my claim towards ways in which landscapes are a result of coproduction between physical geography and land-use practices. Even if not for large mammals, they certainly facilitate movement for smaller mammals, birds, reptiles and insects which is critical from an ecosystem perspective.

Finally, when the structural configuration of the landscape is also influenced by temporality. The satellite image used to develop the base land-use/cover map is from May 2015, peak summer in the study area. In addition to the timing of the image, rainfall in preceding years was deficient and this impacts vegetation, which in turn would influence reflectivity of the remotely sensed image. And consequently, the classification of land-use/cover. In terms of social practices that shape the matrix leaving lands fallow is common. 74% of the respondents of the household surveys said that they had left at least one or more plots fallow over the past year. This practice is useful because after harvesting certain crops leaving land fallow allows for regeneration of soil and vacant

[54] A snapshot of the same area from google maps is also below to assist with the comparison

plots mean less human activity in the matrix which can also be advantageous to wildlife.

2.5 Discussion

Conservation is not a singular concept and wildlife conservation differs based on scale, geography, species, history, culture, socioeconomic and political contexts. Acknowledgment of differences in each aspect is critical to the conceptualization of wildlife conservation. Universalizing discourses deemed logical for wildlife conservation at the cost of lives and livelihoods of local communities are clearly influenced by a long lineage of separation between "nature" and "society". This ahistorical approach to conservation loses sight of specificities of place, culture and context. Further, certain concepts become defining factors resulting in the neglect of some spaces and species from conservation priorities. Human population density is one among many significant ideas that gained scientific credibility and strengthened the idea that wildlife and human spaces must be disconnected. This is despite evidence that landscapes are formed and continue to be shaped by rainfall, historic land-use, geology, vegetation, changing social practices, wildlife and cultural values. Only a deeper and more contextual understanding will allow conservation frameworks to strive towards a balance between human and non-human needs. In this chapter, I try to identify the ways in which biophysical characteristics and social factors merge to support wildlife presence presently, as they have historically. Lived landscapes make separating the physical from the social (and vice versa) a challenge. In other words, forest composition (the type of vegetation based on climatic, soil and moisture conditions) and everyday practices (what people do and their use patterns of both agricultural land and forests) produce the landscape. Relatedly, landscape configuration or structural patterns also depend on the practices of people and

the biophysical characteristics. Hence the interdependence and coproduction of the physical and social is undeniable, and as Holmes states, there is “A need to move away from the idea that conservation is about saving nature from humans” (2015, 94). A landscape approach thus moves away from this dichotomy and recognizes nature and humans as interdependent entities. In my study area, there is no other alternative but to consider the interdependence because the entire system has evolved through centuries.

Integration of the physical and social landscape thus provides a few practical directions towards a conceptualization of conservation in lived landscapes. By taking these interdependent entities seriously one is able to gain a perspective on coproduction of a landscape. For instance, in the study area forest cover outside Reserve Forests produces connections through forest patches and “wastelands”. These connections become critical to mammals, birds, reptiles and insects at different spatiotemporal scales. Additionally, connectivity in the landscape is also critical to ecosystem functions and processes. The connections become particularly important in human-dominated landscapes. Though not rigorously documented in the study area, discussions with the local communities suggest that wildlife moves out of the RF for forage and water. The changing agricultural practices and increase of irrigated agriculture provide a ready source of water close to forest boundaries. As the results show, vegetation composition and the spatial heterogeneity of different land covers correspond with habitat requirements of the Four-Horned Antelope, Sloth Bear, Leopard and Wild Boar. Further, the faunal surveys correspond with higher elevations in the study area. This is explained by the local communities as a result of higher human presence at the foothills on a regular

basis. Hence, a consideration of anthropogenic factors also contributes towards a richer understanding of species habitats and behaviors.

Landscape composition or more specifically the dry deciduous, open and dense scrub forest cover support multiple species in this area. The presence of forest cover (landscape composition) outside Reserve Forests in the form of smaller patches, the lack of hard boundaries and linkages (landscape configuration) explain why a landscape approach is logically the only possible one in this area. The spatial pattern analysis also shows that the RFs are not islands in the matrix even though they are wildlife habitat. This further establishes reasons to assess the matrix and its heterogeneous land-use/cover instead of isolated habitats. Small patches play a critical role in providing refuge in lived landscapes. The density of links, bridges and loops within the matrix point to a high level of heterogeneity and potential connections across the four RFs. Although the connections are not always linear, they do offer access routes to wildlife.

As mentioned earlier agricultural practices are unintentionally providing forage and water for wildlife. Even though these practices are contradictory to the semi-arid setting and possibly detrimental to the ecosystem in the long run. Yet, the increase in irrigated agriculture caused by market forces, government intervention and a push towards maximizing profits is beneficial to wildlife from one perspective. But irrigated agricultural practices involve a high use of pesticides and chemical fertilizers. The detrimental effects of this to the food chain are already evident in the presumed local extinction of foxes. Persistent drought years, outmigration and changing livelihood choices are also leading to an increase in fallow lands which results in less human presence in the matrix. More fallows allow growth of grass and scrub species increasing

vegetative cover over time. Other contradictory changes involve increasing area under plantations, which works well for mobile species like macaques and birds but fence out other wildlife. Overall, decreasing crop diversity and fluid livelihood choices work as contradictory forces in the process of pin pointing factors that facilitate and those that hamper wildlife presence.

The different actors, interests and interactions within a matrix make for a complex configuration of land-use and everyday practices. The results show that landscape composition and structure are critical to estimating matrix quality and permeability for wildlife. More so wildlife in lived landscapes share a fundamental relation with agroecosystems (Vandermeer and Perfecto 2013). Hence, my focus on the agricultural practices and the changing social dynamics in the villages are a way to grasp the present-day realities of the matrix and how these systems are evolving. Matrix quality and permeability for wildlife movement and dispersal will ultimately be determined by all these factors. Piecing together the finer aspects that contribute to the processes involved is important to undertake biodiversity conservation in human-dominated landscapes, with a moral responsibility towards both humans and non-humans. As Sundar, states, "The ethos of open use of habitat to benefit wildlife is both ironic and an antithesis to dominant paradigms of conservation thought in this part of the world, but is clearly an effective direction to undertake wildlife conservation with minimal compromise of human use of the landscape" (Sundar 2015, 92). The objective of this research was limited by the data collected hence functional connectivity of the matrix for the species was not estimated. Yet an investigation into the structural parameters of composition and configuration has opened up avenues on how conservation efforts can be optimized in human dominated

spaces. Livelihood diversity and changing practices can potentially facilitate a more sustainable landscape for wildlife and humans if undesirable aspects are curbed (like increasing pesticide use) and by taking a more inclusive approach. In the next chapter, I assess how mutual adaptations between people and wildlife coproduce shared spaces.

Chapter 3. People and Wildlife: Shared Spaces & Mutual Adaptations

3.1 Introduction

Wildlife conservation is often synonymous with Protected Areas, biodiversity hotspots and charismatic endangered species. These concepts and frameworks rely on an ontological and spatial separation of nature from society. Despite the logistical difficulties involved in enclosing spaces and wildlife, involving/excluding local communities and governments, the conservation agenda based on this exclusion and separation is pursued globally. Protected Areas (PAs) often erase historical and cultural uses of the land in question and consequently are blind to any other form of conservation practice (Brockington, Duffy and Igoe 2008). In addition, PAs do not account for landscape heterogeneity and people's environmental practices that may support wildlife and livelihoods in a sustainable way. This is evident from research by scholars across different countries and conservation settings where wildlife conservation set in motion unpredictable and unintended outcomes (Dressler and Roth 2011; Holland and Brandon 2005; Lele et al. 2010; Li 2007; Naughton-Treves, Neumann 2004; Peluso 1993; Schroeder 2008; West 2006). These include the militarization of conservation across Africa, coercive conservation in south east Asia and displacement of local communities in India. Although it has taken time, there is now an acknowledgment among conservationists that humans are part of the landscape and are not necessarily a hindrance to wildlife conservation (Carter and Linell 2016; Chapron et al. 2014; Dorresteijn et al. 2015; Ghosal et al. 2015). Human dominated, and multiple use landscapes are gradually becoming part of conservation studies. These include agricultural, mining, urban and post-industrial landscapes (Holmes 2015; Kareiva and Marvier 2012).

In India wildlife presence outside PAs is more the norm than an exception given that only five percent of the country's forested areas are protected as national parks, wildlife sanctuaries, or biosphere reserves. Critiques on Protected Areas (PAs) and scientific forestry in India are extensive and relate to the lack of ecological insight used to demarcate these areas, the isolation of PAs and conflicting outcomes for both humans and animals (Borges 2003; DeFries et al. 2005; Gadgil and Guha 1993; Murali 1995; Saberwal and Rangarajan 2003). The ineffectiveness of PAs in preventing poachers has also come under scrutiny, particularly in the case of the Sariska Tiger Reserve (Rastogi et al. 2012; Shahabuddin 2014). Protected Areas have indeed reduced habitat loss and played a role in preventing extinction of species. However, research also shows that species populations outside PAs remain unexamined (Brooks et al. 2009), and clearly PAs are not applicable or appropriate conservation models for every physical and social context. Additionally, large mammals require large spaces and often there is no other alternative but for these animals to use and adapt to human-dominated areas

Species distributions in tropical, non-protected areas or in areas of high human pressure are often under reported due to a bias in the global distribution of ecological observations (Martin et al. 2012). [55] Unexamined species populations are symptomatic of a larger politics of who decides to conserve what species, why, where and how (Brockington, Duffy and Igoe 2008). As a result, The Eastern Ghats are one such underrepresented biogeographic region, in both global conservation literature and within conservation studies in India. Wildlife observations in the study area are not isolated

[55] Based on 2573 terrestrial study sites studied between 2004 and 2009, the authors find an over representation of PAs, temperate deciduous woodlands and wealthy countries in conservation studies (Martin et al. 2012).

incidents and nor are these species stray.[56] According to the local communities and the Andhra Pradesh Forest Department, wildlife in the Eastern Ghats includes the Leopard, Antelope, Deer, Sloth Bears and Wild Dogs among other mammals, birds and reptiles (APSFR 2014).[57] One can ascertain whether these populations are isolated or genetically viable only through detailed biological surveys. Yet, equally important is establishing the presence of wildlife in the Reserve Forests (RFs), the likelihood of their distribution and an acknowledgment that wildlife persists in the absence of state or non-state intervention.[58]

Multiple-use landscapes are not a recent phenomenon, and nor are they particularly unusual. Humans and wildlife have shared or co-inhabited the landscape since centuries across the world. Yet, owing to myopic conservation discourses and practice emphasizing exclusion and protection of "biodiversity", researchers and policy makers have neglected conservation potential in human-modified landscapes. As a result, a large proportion of scholarly work on wildlife in human dominated landscapes reiterates this dichotomy. Work discussing wildlife and human interactions in India (Defries et al. 2010; Karanth et al. 2012) is often located in and around PAs (Ghosal et al. 2013). Researchers, moreover, largely focus on human-wildlife conflict, leading to contradictory claims particularly as the term "conflict" is ambiguous due to complex

[56] Oral histories suggest that wildlife has always been in the forests in the study area. Further, a broad survey of flora and fauna of the Eastern Ghats also provides evidence on wildlife presence in the area (Rawat 1997).

[57] The Forest Department's observations are at a larger scale and do not provide specifics for the four Reserve Forests (RFs) in my study area which are *Noorkuppalakonda*, *Tavalam*, *Kanduru* and *Madirimalai* West, located in Chittoor West Forest Range (See Figure 3.1). There are no wildlife population estimates for these RFs.

[58] By intervention I refer to the lack of any active conservation activity or program by either the Forest Department or NGOs in the study area. Although there is one local NGO working on wildlife conservation-their focus remains more on research rather than active conservation initiatives. Further since Reserve Forests are not recognized as conservation spaces it is a challenge to work on wildlife conservation here.

context specificities. The question as Redpath et al. (2015) discuss is whether conflict is between humans and wildlife or humans who have divergent objectives. Rifts between conservation imperatives, driven by territorial expansion for biodiversity protection, and local community needs, or visions are common (Neumann 2004; Redpath et al. 2015; Schroeder 1999). This is not to say that human-wildlife conflict does not exist, in fact it does cost lives - of humans, livestock and domestic animals (Barua, Bhagwat and Jadhav 2013). The critical part is in its framing and the same applies to human-wildlife coexistence (Dorresteijn et al. 2015; Ghosal et al. 2015). As researchers have largely focused on conflict, less work has been done on coexistence between humans and different species outside Protected Areas.[59] This research thus fills a critical gap by assessing the coproduction of shared spaces and mutual adaptations by humans and wildlife in and around Reserve Forests, located in the southern Eastern Ghats. These forests are not Protected Areas and the landscape matrix includes multiple land uses and cover types.

In India coexistence of humans and wildlife is explained through two familiar tropes, one defined by culture and religion as in the case of the *Bishnois*, a religious sect of people who believe in preserving biodiversity and second, through the hunting ban under the Wildlife Protection Act (1972). The first becomes problematic when it is interpreted as an idealized state without a historical context of the landscape or interactions between people and wildlife.[60] The second gives credence to power of the

[59] Recent research on carnivore presence within human settlements has acknowledged the coexistence of carnivore and humans for centuries, and the spatial overlap of "co-occurrence", which is opening up a new approach to how we think about conservation (Athreya et al. 2013; Carter and Linnell 2016).

[60] A recent example of representation of an ideal/romantic situation is in the case of the leopards in *Jawai*, a small settlement in Rajasthan, India. According to media reports *Jawai* represents a peaceful

law and is easily refutable based on the number of poaching and illegal hunting cases reported. Alternatively, Carter and Linell (2016) provide a more comprehensive understanding of coexistence that looks at "mutual adaptations" as the key facilitating mechanism.[61] The authors also mention the role of effective formal and informal institutions that govern the interactions between humans and wildlife. Chapron et al (2014) make a similar assertion regarding institutional support, public opinion and other practices that make human-carnivore coexistence possible in Europe. Although the power of institutions and context in India is discernibly different from the European context, it is still worthwhile to explore the formal and informal linkages and institutions that intentionally and unintentionally work towards human-wildlife coexistence.

In this chapter, I build on previous research in the field that deals with wildlife in human dominated landscapes but look at wildlife presence in unprotected forests or outside PAs. Within the framework of my larger project that examines the coproduction between rural people's land use practices, wildlife and the landscape matrix, two questions drive my argument. First, how is wildlife perceived by the local communities and how do people adapt to wildlife presence? Second, what is the likelihood of species distributions in the study area and what are the potential adaptations made by wildlife to human presence? Hence, I claim that shared spaces between humans and wildlife are a result of a complex intersection of the biophysical and social conditions that include government policies and everyday practices of local communities. The results provide an

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coexistence between leopards and humans (https://www.nytimes.com/2015/05/08/t-magazine/life-among-the-leopards-jawai-india.html)

[61] They define coexistence as "a dynamic but sustainable state in which humans and large carnivores co-adapt to living in shared landscapes where human interactions with carnivores are governed by effective institutions that ensure long-term carnivore population persistence, social legitimacy and tolerable levels of risk" (Carter and Linell, 2016, 575)

insight into the socio-ecological conditions under which shared spaces are created, untangling the relationships mediating the presence of biodiversity in places that we do not expect.

To situate my problem within conservation in India I provide a brief overview to policies instrumental to wildlife and forest conservation and management. This helps explain how the state apparatus renders wildlife outside PAs invisible. This is like the case of "invisible forests" in El Salvador that are unrecognized due to the overpowering conservation discourse and fetish for pristine landscapes and primary forests.[62] Wildlife in unprotected areas appear to be in a similar liminal space where neither policy, nor conservation practice acknowledge wildlife presence outside PAs. As Hecht (2004) states,

> As long as anthropogenic and regenerating forests are "invisible" as conservation entities, they are potential sacrifice zones without environmental support. Certainly, these ecologically and socially important landscapes deserve more policy attention that supports their positive impact on biodiversity and environmental services and recognizes the populations that increasingly manage and create these ecosystems (96).

Thus, acknowledging wildlife presence in this semi-arid landscape shaped by human practices is a first step towards creating a space for wildlife outside PAs. Other scholars correspondingly show how land-use classifications and the conservation status of certain species have practical implications (Brockington et al. 2008; Holmes 2015; Robbins 2001). I also use this section to provide a background to specific concerns within the study area in context of land management and policy.

[62] Hecht (2004) shows how Malthus and the markets have been used to study forest loss and degradation and these scientific epistemologies have led to the devaluation of secondary and anthropogenic forests. On the contrary, she finds forest resurgence, a structural and diverse landscape mosaic supporting biodiversity and livelihood patterns that help in maintaining these spaces.

3.2. Background & Context

Wildlife Protection & Forest Management Policies

Wildlife protection in India has a long history usually interwoven with an acknowledgement to princely states and colonial rule. Other than formal mechanisms that have been documented, rural communities across the country had varying levels of dependence and a reverence for wildlife. Environmental historians and social scientists have discussed these relationships through studies located across different parts of the country. The common thread across these studies is the intimate relationship between people and nature, refuting the divisions set commonly by conservation agendas (Rangarajan and Sivaramkrishnan 2014). Historically, rulers and elites hunted for sport. Certain species and consequently certain forests were prized more than others and protected accordingly to ensure the success of hunting expeditions (Divyabhanusinh 2014). In Colonial India, conservation for wildlife's intrinsic value was not priority. Local villagers were forbidden from hunting species like the lion, tiger or wild boar under feudal and colonial management systems. Instead the villagers relied on small game and birds to supplement their diets (Rangarajan et al. 2013). Hunting grounds owned and managed by princely states were also constantly "made and remade" through processes like reserving areas for grazing and cordoning off other areas for hunting, selective felling, digging water holes and clearing access routes for hunters (Rangarajan et al. 2013). As a result, forests were, and continue to be coproduced by legal diktats, practices of the local communities and the bioclimatic variables that determine its composition.

Conservation as we define it today emerges in India in the 1970s influenced by a developing global awareness on environmental degradation and the need to conserve the

world's remaining biodiversity.[63] The Wildlife (Protection) Act of 1972 was the first legal mechanism for wildlife protection in India, and instituted a complete ban on hunting. Project Tiger, 1973 was launched by the government soon after, and brought the need for in situ conservation and a species-centered approach to the forefront. Since then, the Wildlife (Protection) Act of 1972 has undergone six amendments leading to widening of its ambit to include stringent implications for poaching, illegal trade in wildlife, and to ensure protection of ecosystems, endangered flora and fauna. The Act also included a category of vermin, allowing certain species to be hunted under specified circumstances. The species listed as vermin initially were mice, rats, the common crow and fruit bats. Over the years the list undergone revision and most recently state specific allowances have been made to deal with "vermin". These include the Neelgai, Wild Boar and Rhesus Macaque. ("Environment ministry to allow hunting of nuisance wild animals" 2015; "Move to allow wild boar hunting" 2016; Purohit 2015). The focus of the Wildlife (Protection) Act is explicitly on the punitive implications of hunting, usually defined within protected areas which include national parks, wildlife sanctuaries, conservation reserves, community reserves and tiger reserves (Kalpavriksh 2006). There is no mention of Reserve or Protected forests nor is there any reference to wildlife outside PAs. Yet the ban on hunting applies to the entire country except one state Jammu & Kashmir.[64]

[63] Even though there are examples from across the country where rural communities protect biodiversity through traditional and informal systems- For instance mechanisms to protect the Painted Stork in Kokrebellur (Karnataka) Leopards in Akole (Maharashtra), Sarus Cranes in Uttar Pradesh, Snow Leopards in the Indian Himalayas etc. (Athreya et al. 2013; Rangarajan et al. 2013).

[64] This exception is due to other political complexities, unrelated to wildlife conservation.

Peculiarly wildlife is not a focus in forest management, and nor in scholarly work on the subject despite the presence of different species across the country.[65] Forest management and policy seem to completely bypass the presence of wildlife except when alluding to PAs. The question that arises is whether this absence (or bare mention of wildlife) allows for fluidity in definitions and management and to what advantage or disadvantage. Unlike wildlife, forests were a high priority for the colonial government. This was predominantly due to timber requirements and the contribution of forests to other revenue producing streams (Lele and Menon 2014). Forest policies in independent India continue to be influenced by both theory, and management systems established by the British. [66] The Indian Forest Act, 1927 was the first colonial legislation on forests, revenue oriented and largely influenced by the concepts of "exclusion, extraction and centralization of power in the state FDs (Forest Departments) …" (Lele and Menon 2014, 226). Remnants of these concepts are still evident in forest management practices at the ground level. During the post-independence period, a rush towards industrialization and a development paradigm led to large-scale forest degradation. Due to high levels of deforestation and the conversion of forest land for non-forest uses, the Forest Conservation Act, 1980 was passed to control forest depletion. Within a few years the National Forest Policy, 1988 was instituted, shifting focus from revenue generation to meeting the needs of local people and environmental stability. These policies have been

[65] There is a substantial body of work that discusses the success/failure of different forest management systems in India over the past three decades (Fleischman 2014; Lele and Menon 2014; Singh 2013; Sivaramkrishnan 1999).

[66] The critical role of forests in state-making, civilizing nature and people during the colonial period and even earlier is documented extensively by several scholars like Skaria (2001), Sivaramkrishnan (1999), and Rangarajan (1996). I do not directly deal with this literature here, as my focus is on forest management policies.

amended at regular intervals and efforts gradually moved towards including people in forest management.[67] This was taken up under different programs across the country, including Participatory Forest Management (PFM), Joint Forest Management (JFM), Community Forest Management (CFM) etc.

The Reserve Forests (RFs) in my study area managed by the Forest Department had active JFM/CFM systems in place for two decades. Both programs were state run and funded through World Bank projects among other funding sources. Presently, there is no formal arrangement (village level forest management institutions) between the local communities and the Forest Department.[68] Wildlife presence is mentioned in annual reports published by the Forest Department but there is no reference to conservation or human-wildlife interactions in these RFs.[69] Obscuring wildlife in forests that are not recognized as PAs has material implications. For instance, forest officials are not concerned with wildlife in RFs because they operate with the assumption that wildlife requires conservation within a PA. In other words, they fail to attach importance to actually existing biodiversity due to dominant assumptions about conservation. These conventions erroneously presuppose the (lack of) potential of wildlife presence in fragmented forests within human-dominated landscapes. Nevertheless, the RFs in my study area are wildlife habitats and it is not simply the RF but the surrounding matrix that is also critical for movement and dispersal as I show in the previous chapter.

[67] More recently, the Forest Rights Act, 2006 was passed that recognizes the rights of scheduled tribes and other traditional forest dwellers in India.
[68] According to forest department officials there are plans to revive JFM/CFM initiatives in the near future.
[69] There have been no formal wildlife surveys conducted by the Forest Department in the area. Wildlife presence is apparently reported based on discussions with local communities.

Another imminent threat to RFs and the landscape matrix is the introduction of CAMPA bill (Compensatory Afforestation Planning and Management Authority) that was recently passed by the central government.[70] Although the objective seems worthwhile because it aims to increase forest and tree cover, the bill focuses on the diversion of forest lands for non-forest purposes. Through this Act the state has the power to divert forest lands provided the "user agency" takes up compensatory afforestation. Without going into details or the metrics of this bill and the associated issues, what is of concern is what happens to wildlife that is not named in the RFs.[71] Under this legislation, a RF can be diverted for industrial or mining purposes as long as the concerned agency agrees to afforest and pay the cost for the loss of ecosystem services.[72] Similar clauses have led to widespread obliteration of rainforests and other irreplaceable ecosystems and species across the world. Compensatory afforestation may work to restock forest cover over time, but the loss of flora and fauna is not easily replaceable.[73]

Wastelands

In the study area common land is managed under broad categories of Reserve Forests, "Wastelands" and agricultural fields. "Wastelands" are a colonial category of presumably "unproductive land" managed by the Revenue Department.[74] These lands

[70] The initial phase of this Act started in 2000 which involved constituting a committee, and multiple other steps and formulations before it was actually passed by both houses of the Parliament in July 2016 (Kalpavriksh, n.d)

[71] I use the term "named" here to represent acknowledgement of presence rather than actual naming of species.

[72] As I discuss in more detail in Chapter 4, the state Forest Department is focused on maintaining tree cover which explains the clause on afforestation in case forest land is diverted for other uses.

[73] I discuss afforestation techniques in my study area in more detail in Chapter 4.

[74] The concept of wastelands has to be viewed in context of its historical construction. Judy Whitehead (2010) traces this land category to Lockean conceptualizations of private land and value. She highlights the importance of understanding wastelands as a social rather than natural category of infertile or unused land. She states, "Hence, it (the concept of wastelands) conflated specific types of land-use with a singular form of ownership, naturalizing this combination in the process"

were termed unproductive by the British because no agriculture was done on these patches, and therefore they could not levy taxes. The use of these lands historically as grazing lands or their importance to pastoralist communities was disregarded, making them a waste from a tax perspective rather than the land's productivity. This categorization continues despite a critical role played by "wastelands" to biodiversity and rural people, as I discuss in more detail in the next section. The vegetation cover on "wastelands" in the study area is similar to the Reserve Forests and includes scrub and thorn, mixed with dry deciduous species and grassy patches. Several vegetated patches and hillocks located adjacent to the four RFs are categorized as "wastelands". Reserve forests and "wasteland" land cover are extremely heterogeneous and grassy patches are located in between dry deciduous and scrub vegetation. These patches are critical for wild herbivore and livestock survival. This complex tapestry of vegetation combines with human settlements and agriculture to create a diverse landscape matrix. Wildlife exist in, and navigate the matrix, in co-production with biophysical conditions (like drought and vegetation) and human practices (irrigated agriculture, soil and water conservation mechanisms etc.).

Further, the category of wastelands in the study area includes several land uses reserved for common purposes. These include threshing areas, settlements, temple land, grazing lands, catchment area of the irrigation tanks/water bodies (stream inflow/outflow) etc. Simplistic and isolated categorizations of land-use as "wasteland" or "reserve forests" (which are ineffective for conservation by official accounts) miss these complex relationships between land-use categories, people and animals. Wildlife is largely rendered invisible to conservationists, policy-makers, ecologists and others. Wastelands

are framed as useless and needing development through mining and other revenue generation activities, while forests are valued largely for vegetative cover.

Goldstein (2014) among other scholars argues that "By officially classifying these commons as wasteland, the state hides the ways in which these areas are *already* included in circuits of value and provide crucial resources for the poor" (130). Local communities in my study area use the "wastelands", which are otherwise highly productive grassland ecosystems, to graze livestock, collect fuelwood and other non-timber forest produce. Based on evidence gathered in the field, I argue classifying these areas as "wastelands" hides their use to both people and wildlife.

Research shows that the naming of wastelands has led to multiple forms of injustice across the country. These involve the dissolution of village commons through leases to industries for plantations or biofuels, turning wastelands over to the Forest Department for social forestry, and more broadly reducing the capacity of the poor to depend on these village commons to sustain themselves (Kashwan and Lobo 2014; Menon et al 2014). The importance of wastelands to biodiversity has also been noted in studies on the Jerdon's Courser and the Indian Wolf in Andhra Pradesh, among other species (Agarwala et al. 2010; Ghatge and Ramdas 2014). Despite all this evidence and scholarly work by conservation and development experts, the value of wastelands is yet to gain prominence. The predicament of wastelands is usually analogous to that of grasslands, which are not considered significant biomes in policy circles in India (Ghatge and Ramdas 2014). The administrative bodies responsible for land management in the state do not share a common vision or work on collaborative plans.

A disconnect between land management agencies as well as disparate forest and wildlife policies results in a marginalization of what people do in these unprotected forests and the surrounding landscape. Interestingly, local communities in the study area do not frame their interactions with wildlife as conflict. Rather, people discuss strategies they use to cohabit with wildlife. The results provide details on the practices and tactics used by the local communities, that in in turn unintentionally maintain these spaces as wildlife habitat. This by no means suggests a utopian coexistence of humans and wildlife in the study area. Instead, the data points to an insignificant response from local communities as well as government representatives to wildlife presence. In the next section, I elaborate on the methods used in this chapter to understand species distributions and everyday practices of local communities that lead to mutual adaptations. I first explain the data used, followed by the analytic tools and modeling procedure.

3. 3. Methods

3. 3. 1. Data Used

Household Surveys

191 household surveys using stratified random sampling was undertaken in eight villages located on the periphery of the four Reserve Forests between June-November 2015 (Figure 3.1). The surveys were stratified based on villagers' dependence on Reserve Forests because the surveys targeted responses on forest use, perceptions and rules of access among other questions.[75] Hence, 40% of the sample represent those dependent on Noorkuppalakonda, 30% are dependent on Tavalam, 12% on Kanduru and 18% on Madirimalai West Reserve Forests.[76]

[75] In each village the surveys covered 25-30% of the total number of households
[76] I describe the composition of each RF in Chapter 4

The household surveys generated data on the diverse livelihood patterns, land holding size, livestock rearing practices, use of forests, presence of and interactions with wildlife in agricultural fields and within forests. The surveys also included questions on perceptions towards wildlife to understand human-wildlife relations in the area. A combination of open and closed ended questions was used. These villages were selected based on prior visits made to the study area in June 2013 and 2014. All surveys were conducted in Telegu and translated to English while in the field. The survey protocol was approved by Rutgers University's IRB in 2015.

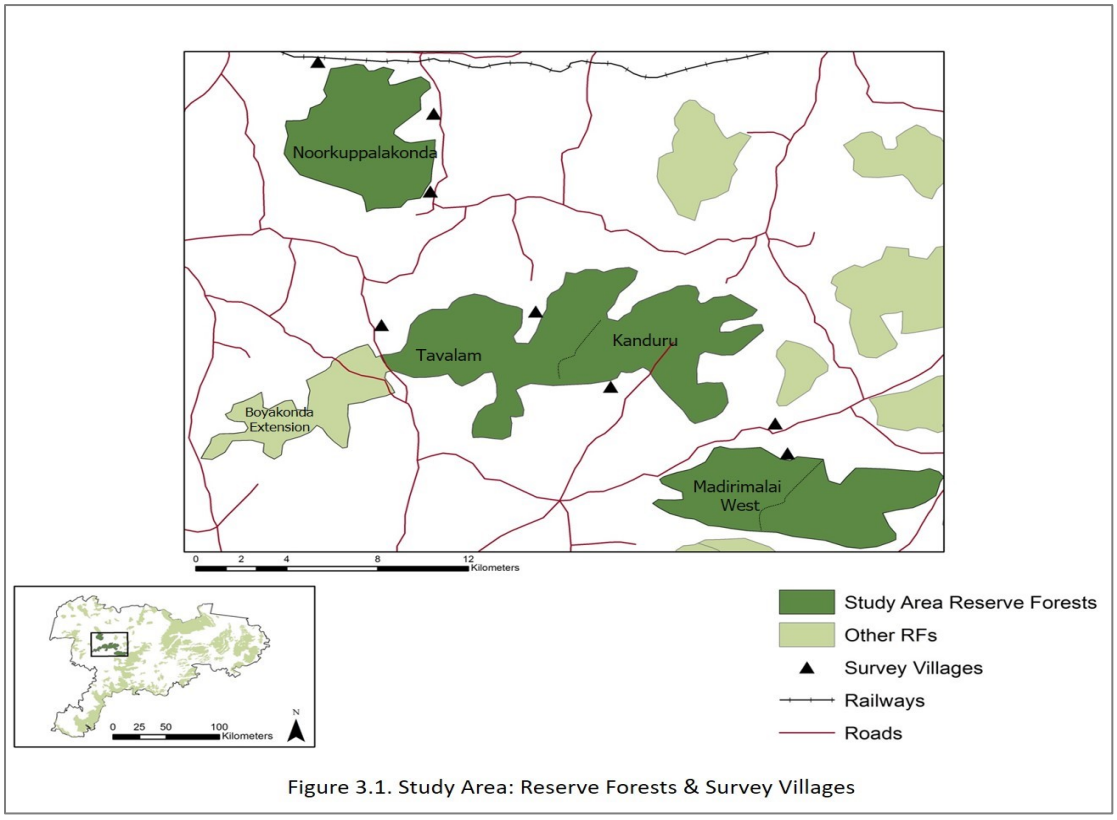

Figure 3.1. Study Area: Reserve Forests & Survey Villages

Faunal Data

Field surveys were carried out from June-November 2015 to record the presence of four wild mammalian species in the study area. The species selected are the Four-

Horned Antelope (*Tetracerus quadricornis*), Sloth Bear (*Melursus ursinus*), Leopard (*Panthera pardus*) and Wild Boar (*Sus scrofa*). I focus on these four mammals as the first three are listed as "vulnerable" in IUCN's Red List, and the Wild Boar is considered a problem animal by farmers. I discuss the habitat requirements of these species in the results section. Faunal evidence included animal scat/droppings (for the Four-horned Antelope, Leopard and Sloth Bear), dug up mounds in the forest and tank beds (for Sloth Bear and Wild Boar), and tracks (for all four species). Geographic coordinates and elevation were recorded at the site of evidence along with a basic description of the land cover and a qualitative estimation of anthropogenic pressure in the area (Figure 3.2). This was estimated using categories of low, moderate and high based on the visible cut branches, goat and sheep pellets and evidence of fuel wood collection.

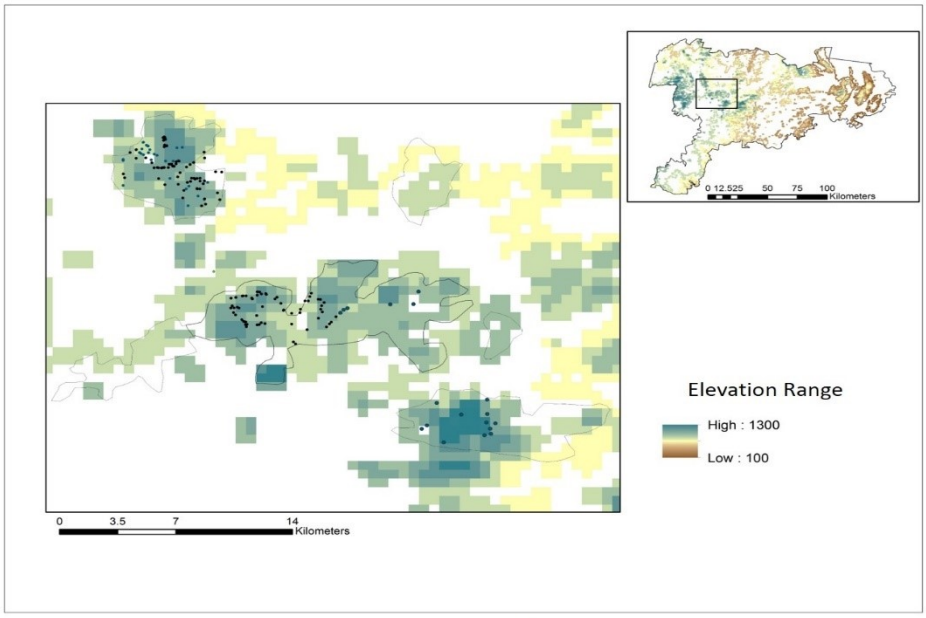

Figure 3.2. Faunal Data Points in the Four Reserve Forests

The terrain, access routes into the forest and the inability to access certain areas made opportunistic sampling the only way to record species data, although equal stratified sampling based on environmental variables defining the species niche was

planned.[77] Guided walks over six months were carried out to the four reserve forests in the study area.[78] These walks covered at least 50% of the area of each RF and ensured the sampling of diverse micro and macro habitats.[79] Repeat visits were also made to at least half the sites to record additional presence data to ensure suitability of the data collected (Franklin 2009). This included using different approach routes to record wildlife evidence and avoid environmentally biased samples. Imperfect detection can distort the relationships/outcomes of the modeling process. According to Guillera-Arroita et al. (2015) if the same observer carries out all the surveys i.e. there is constant detectability and a lesser chance of sampling bias. Since I was the only one recording data this aspect was taken into consideration.

Explanatory Variables for Detection Probability

The explanatory variables used to model the likely spatial distribution of the four species included climate variables, land-use/cover and distance from roads as the anthropogenic variables. Climate variables from the WorldClim database are widely used as predictor variables in Species Distribution Models. Of the 19 variables, available on the Worldclim database, I used eight in the final model owing to issues of collinearity and based on the relative importance (lack of) of each variable to the model (Table 3.1). These include five variables measuring temperature and three variables for precipitation. The layers were tested for collinearity (Pearson's correlation coefficient) and layers that

[77] Equal stratified sampling would have been based on stratifying the study area according to environmental variations or even terrain specifically. Based on the lack of environmental variation in terms of precipitation and temperature within the study area this was not a feasible option.

[78] The guided walks were undertaken with a field guide and a naturalist local to the area. Both individuals are familiar with the forests and the species of interest.

[79] Micro habitats refer to a description of the location where the sign was recorded i.e. foothills, stream bank, plateau, ridge or ravine. Macro habitat includes the vegetation type i.e. dry deciduous forest, open scrub, dense scrub or mixed.

had an $r \leq +0.85$ were selected. Multiple runs of the model using all 19 climatic variables were carried out to assess the importance of each variable and double-check the elimination of some over others. The variables derived from precipitation and temperature provide insight into the resource and limiting factors influencing the species niche, as they determine food availability, host plants and define the realized niche of the species. Bucklin et al. (2015) also suggest that SDMs using climate predictors are effective in "initial assessments of environmental suitability" (23). Further, I reviewed the variables in lieu of the habitat requirements of the species based on published literature to make a priori assumptions regarding each species. The anthropogenic variables used included a land-use/cover map with 17 categories for the entire district (WWF-India 2002). All the variables were resampled to the area covered by the district at 27.5m resolution and re-projected to UTM.

Table 3.1: Explanatory Variables used in the Species Distribution Models

Biophysical *WorldClim database*	Temperature	Annual Mean Temperature
		Maximum Temperature of Warmest Month
		Mean Temperature of Wettest Quarter
	Precipitation	Mean Temperature of Driest Quarter
		Mean Temperature of Coldest Quarter
		Precipitation of Driest Month
		Precipitation of Driest Quarter
		Precipitation of Wettest Quarter
Anthropogenic	Land-use/cover *Source: WWF, India*	Dry Evergreen Forest, Dry Deciduous Forest, Mixed Dry Deciduous, Thorn Forest, Scrub, Water, Open Barren Rock, Plantations, Wasteland, Agriculture & Fallow Land

The land-use/cover dataset incorporates both use and cover allowing one to assess the influence of anthropogenic use (dry land, irrigated land and settlements) along with

different forest types and cover in the district. Though literature reviewed on the Four-Horned Antelope and Sloth Bear suggests that elevation plays a role in defining the niche of the species I chose not to include this in the model. This was because elevation is known to be correlated with certain climatic variables, and further anthropogenic pressure in the study area also limits wildlife habitat to higher elevations within the RFs.

3.3.2. Data Analysis Methods

Qualitative Data Analysis

Descriptive and inferential statistics are used to summarize data generated from the household surveys conducted in the study area. These contribute to understanding how communities perceive wildlife and the strategies they use to deal with wildlife in the fields and forests.

Modeling Procedure

Species distribution models or SDMs are models built with the purpose of predicting species distributions across a particular geographical area based on correlations between species occurrence data and environmental variables. I use MAXENT a machine learning software generative in nature to model the species distributions because it provides a way to use presence-only data.[80] Based on the assumptions of a niche based model MAXENT typically describes the suitability of a species in ecological space and then projects the results onto geographic space. Ecological space refers to the concept of an ecological niche by Hutchinson and is usually interpreted as a fundamental niche that can potentially be occupied by a species

[80] Generative models are described as machine learning and probabilistic models. Data provided is used to predict likelihood of a phenomenon or in this case distribution.

based on the conditions that allow for its long-term survival (Phillips et al. 2006). On the other hand, the realized niche is a subset of the fundamental niche that is actually occupied by the species (Phillips et al. 2006).

A species distribution model using presence-only data is limited because it cannot be used to estimate the occupancy probability of a species. Instead it provides the relative likelihood of species occurrence in an area (Elith et al. 2011). However, using SDMs allows one to map understudied areas and species (Pokharel et al. 2016). Estimating the likelihood of species occurrence in lived landscapes and unprotected reserve forests is the first step in acknowledging wildlife presence in these areas. Species distribution models reflect a snapshot in time for both species and environmental data, and keeping cognizance of this assumption is important while interpreting results of the model (Guisan et al. 2005). Not only does this matter in terms of anticipated climate change but also when dealing with presence-only data collected in the field based on tracks and other indirect evidence. As mentioned earlier SDMs inherently work on quantifying a realized niche for the species, but along with this SDMs also provide users with knowledge on the potential distributions and critical biophysical factors responsible for this niche. Using SDMs for conservation planning and selection of reserves benefit from this process. I use the species distribution maps to assess the likelihood of distribution for the Four-Horned Antelope, Sloth Bear, Leopard and Wild Boar. Even though SDMs are lacking, since they do not take into account interactions with other species such as competition and predation the ability to view an area in geographic space based on ecological factors is useful with the objective to conserve the area in the future. More so, for areas in which wildlife population surveys have not been carried out so far.

Presence-only modeling uses occurrence data and background points and is also known as presence-background data (Guillera-Arroita et al. 2015). One of the core assumptions made while using presence-background, is that the species data sampling is either random or representative throughout the landscape (Yackulic et al. 2013). Though unbiased samples are ideal, this is rarely the case because sampling efforts depend on the probability of an area being included in the survey, probability that the location was occupied by the species and probability that the species was detected (Yackulic et al. 2013). Further, imperfect detection is also an issue in SDMs. All these can lead to the over/under estimation of the model and even predicting sampling effort instead of species distributions. Methods to correct for sampling bias include the use of a "target-group background" among others (Phillips et al. 2009; Young et al. 2011). A target-group background has the same bias as the occurrence data, or in other words a group of points collected using the same methods and equipment (Phillips et al. 2009). I include a sampling bias file in the model which uses land-use/cover coordinates collected during the same time period (Schadt et al. 2013).

The software or Maxent also has an in-built feature called 'regularization' that reduces over-fitting caused by correlated variables (Merow et al. 2013). I used a regularization value of 15, and carried out five replicates using Subsample with a random seed of 25 (i.e. an option that allows the user to define the percentage of test and training points using the same dataset). The relative likelihood of occurrence map was created using Maxent output and Arc GIS. Lastly, to evaluate the discriminatory ability of the model and to ascertain that the output is better than random, I use AUC values or the area

under the Receiver Operating Characteristic curve.[81] AUC values close to 1 are considered to be good, while values close to 0.5 are interpreted as no better than random. The response curves of the significant environmental variables are in Appendix I.

3.4. Results

In this section I illustrate how shared spaces between humans and wildlife are a product of socioecological conditions that mediate mutual adaptations. My results indicate that wildlife presence in forests in the study area is unexceptional according to farmers, shepherds and others in my sample. First, I draw on the perceptions of farmers to wildlife presence in agricultural fields, the tactics used to deter crop damage, ways in which people adapt to wildlife presence and the influence of the Wildlife Protection Act, 1972. In the second section, I document forest dependence, strategies adopted to avoid negative encounters with wildlife and ways in which other broader development practices influence forest use. Finally, I present results for the relative likelihood of distribution of the Four-Horned Antelope, Sloth Bear, Leopard and Wild Boar. In this process I attempt to show how different systems and conditions interact in unintentional ways to produce wildlife spaces.

3.4.1 Perceptions & Adaptations to Wildlife

Farmers in the study area observe different mammals in their fields namely the Spotted Deer, Four-Horned Antelope, Indian Hare, Sloth Bear, Pangolin, Porcupine, Macaques and the Wild Boar. In terms of crop damage, the Wild Boar is named as a

[81] The use of AUC as an evaluative measure has been critiqued (Jiminez-Valverde 2011; Lobo et al. 2007) based on its inability to distinguish between errors of commission and omission and since it is a relative value that calculates the ratio of prevalence to background points (Yackulic 2012). Since the use of SDMs in this study is investigative in nature, at this point I report the AUC values with an understanding of its limitations.

problem by a large percentage of respondents (Table 3.2) among other species. According to the farmers wildlife primarily come for water available in irrigated lands, especially when water holes in the forest are dry. The Spotted Deer may browse on certain crops and there is evidence of Sloth Bears raiding groundnut fields that are ripe for harvest.

Table 3.2. Mammals that cause crop damage according to the local communities	
Crop Raiders	**Percentage of respondents** (n=191)
Wild Boar	70
Macaques/ Monkeys	9
Spotted Deer	15
Sloth Bear	2

Discussions reveal that crop raids by Wild Boar are not recent, although the amount of damage differs from year to year. 50% respondents believe that the Wild Boar population has increased and hence frequency of raids has also increased. The Wild Boar accompanied by its litter of six to a dozen young ones further multiplies the potential for damage. Since the species is a generalist species it has adapted to the changing cropping patterns in the study area. According to the farmers earlier the wild boar restricted itself to groundnut fields but now it raids irrigated rice fields, tomatoes and vegetable patches. At present there is no system for farmers to receive compensation for crop losses in the area.[82] The Wild Boar is not categorized as "vermin" in Andhra Pradesh, so it cannot be

[82] During the informal conversations I had with the Forest Department staff they mentioned the complexities of providing compensation owing to a lack of proof and the bureaucratic hurdles that may arise.

legally hunted. During the household surveys several respondents correlate the increase in Wild Boar populations to the hunting ban under the Wildlife Protection Act, 1972. The law itself did not result in immediate changes among the communities and their hunting practices. Instead, when the government clamped down on gun ownership in the 1990s due to the presence of Naxalites (communist guerilla groups) a higher level of awareness was generated on the punitive implications of hunting. Since gun ownership became a felony twenty years ago, most respondents are not forthcoming with information although there is a tacit understanding among people that wild boar hunting continues. This does not imply that there is an absence of guns in the villages, yet making it illegal led to a further reinstatement of the illegality of hunting. [21]

The strategies used to deter wild boar include experimenting with scarecrows, fencing the property using thorn fences, staying on the field at night, keeping dogs and even the use of fire crackers to scare away the animals (particularly to protect the crop ready for harvest). In general, farmers suggest that wild boars destroy some amount of the crop but not too much. Yet, given the labor and chance that goes into cultivating the fields, even small amounts are a problem particularly for small farmers. On the other hand, several older respondents take a more unperturbed stance and say, "... poor things (referring to the animals), they also have to eat. There is nothing in the forest in summer, let them come, they eat, and they go." (Multiple respondents, 2015). I heard this kind of a dispassionate response from small and large farmers alike, contrary to the assumption that farmers with small landholdings have more to lose. This attitude towards the wild

[21] Most villagers claim that their guns were taken away by the state. But a few men did suggest that they still hunt although not as frequently and keep the guns hidden.

boar specifically cannot be placed into a box described commonly as coexistence, although it does point towards an attitude of sharing space and resources between humans and animals. Further 10% of the households surveyed do not take any measures to deal with the wild boar menace. This is because either their fields are close to the village or because the male member of the family works outside the village or is unable (sick or old) to stay on the field through the night.[83] Contrarily, according to one farmer staying the night on the field did not make a difference (although he did) because wildlife had God on their side. He had tried various methods to keep himself alert through the night, but for some reason he always fell asleep just when the animals came to the field. Thus, the cultural and spiritual ambiguity of human wildlife relationships also come into play when discussing such issues and is more evident when discussing macaques.

The bonnet macaque is common in this area and is often seen in the villages. Macaques raid crops during the day unlike the wild boar, and the scale of destruction depends on troop size and crop type. Like many people in India the villagers in the study area also share a sense of reverence towards the macaque species. Yet, when it comes to crop raids the species is a menace particularly for farmers who have fruit trees. Recently, several people in the study area suggest there is a change in the macaques eating habits as they attack any crop. Since they are a mobile species restraining efforts do not work and interestingly several respondents feel that macaque attacks are gender biased. Apparently, the macaques are fearless when they see women and will venture into agricultural fields more easily if women are the only ones around, according to the female respondents in the survey. Women in informal focused group discussions also pointed at this aspect of

[83] Crop raids on fields located away from the forest edges are rare. Women usually do not stay out at night as they have primary responsibility of the home, children and elderly.

macaque behavior when discussing the activities women undertake in the fields. But there is a sense of humor attached to these descriptions rather than antagonism towards the species.

A tangentially similar jocularity was observed during conversations with men on the Wild Boar. A handful of respondents made indirect references to hunting as a strategy to curb the population. Asking questions on hunting practices is a challenge because hunting is always something that "others" do or an activity of the past. Aware of these realities I asked if hunting was common in the past, 71% of the respondents responded in the negative although this became more ambiguous as the survey progressed. The 29%, who said yes, added that they did not hunt, other people did, or their fathers used to. These innuendos were invariably in a hushed tone and there was an unsaid refusal to take the conversation forward. Approximately 10% of the respondents mentioned that the police had arrested individuals who had guns after the state wide ban was implemented. Off the record I gathered that hunting is still a practice in the area although it has decreased. Wild boar hunting requires the involvement of several people, as the animal must be flushed out from the undergrowth. Wild boar meat is a delicacy in the villages and restrained access makes it even more enticing in a way. Yet, none of the respondents claim to kill the animal when it comes to raid crops.

Discussions about hunting led me to a small village within the study area consisting of the *Boya* community, a community historically associated with hunting in the area. As anticipated, people were not particularly forthcoming with information. Yet my field guide did get into conversation with a few old-time hunters he knew. They validated the general idea that there was an overall decrease in hunting owing to changing

livelihood practices and stricter vigilance by the Forest Department. Contrarily, they pointed to a temple close by where animal sacrifices were routine and suggested off the record that the norm was to sacrifice livestock but sacrifices of wild animals like the Spotted Deer and Four-horned Antelope were not unheard of.

With reference to perspectives on wildlife populations, the larger claim was that population has reduced. Only 38% thought that population has increased. People said Spotted Deer, Bear and Wild Boar populations have increased, but these are speculative observations. At least half the respondents correlate wildlife populations with rain, and state "if there are good rains, the population will be more. Animals move around as per their requirements" (Multiple respondents 2015). This observation obliquely correlates with the output of the species distribution models that I discuss later in the chapter, where precipitation of driest and wettest month are critical variables in determining the likelihood of presence for all four species.

To assess the independence of primary occupation/livelihood, land holding size and associated RF with responses to problems with wildlife a chi-square test was carried out based on the 191 household surveys. There was a significant association ($p \leq 0.05$) between those who went to the RF and considered wildlife to be a problem. However, there was no significant association between primary occupation, age, gender, land holding size and responses to the questions on wildlife. More than land holding size, crop type or ownership status it was location of the field that mattered most. Hence, the small proportion of respondents who did not have a problem with wildlife had fields located at a distance away from the forest boundary, close to the village. To assess if there is a spatial difference across the four reserve forests in my study area, I analyzed the

responses to problems with wildlife based on each forest. There was no significant difference in the responses and this lack of a spatial association helps in generalizing the findings.

3.4.2. Everyday Practices in the Commons

Forests and wastelands are common pool resources used to graze livestock and collect both fuel wood and non-timber forest produce in the study area. These common lands are managed by the Forest Department (RFs) and the Revenue Department (Wastelands). There is a wide-ranging perception that anthropogenic pressure in the forests has reduced. The reasons assigned are an increase in access to cooking gas, a reduced number of native cattle and smaller livestock, an overall trend towards changing livelihood patterns and in some cases migration.[84] Contrary to this 45% of the respondents go to the forest or wasteland every day. The boundaries between forests and wastelands are not physically marked, although all the respondents know where one begins and the other ends. Only 23% had stopped going to the forest completely.

Among those who go every day to the forest, half go to graze livestock and only 20% claim to have problems with wildlife. The species considered problematic by shepherds and goat herders are Wild Dogs and Leopards. While Wild Dogs are known to migrate, the leopard is usually territorial in nature. Yet, since the communities do not lose livestock on a regular basis they believe that Leopards are also migratory in the area. News of a leopard kill in any one of the RFs seems to travel fast and villagers start taking precautions to safeguard their livestock. The Sloth Bear does not come into frequent contact with people since it is primarily nocturnal in the area. Yet, two percent of the

[84] Perceptions of forest use, increase/decrease are discussed in detail in Chapter 4.

entire sample has had close encounters while collecting fuel wood. In general, the community is aware of Sloth Bear breeding season and takes precautions to avoid certain areas of the forest. The *Irula* community visits the forest regularly to collect NTFPs, go in groups of 2-4 and make noise by singing or chatting to keep wildlife at bay. On the other hand, shepherds and goat herders who take their animals to areas high in elevation to access better forage avoid these spaces during Sloth Bear breeding season. The shepherds know where Sloth Bear dens are located and stay away from these areas, particularly when bear cubs are young. During this time livestock graze on the foothills and wastelands, as well as in fallow lands and on crop residue. These mundane strategies in reality are adaptations that facilitate cohabitation between wildlife and humans. These strategies are a likely outcome of a long association that people have with forests and wildlife in the area.

The presence of people in Reserve Forests naturally influences wildlife in the Reserve Forests. For instance, based on sightings by the locals' wildlife has adapted to a nocturnal or crepuscular pattern in the area due to human activity during the day. The everyday practices of the communities are also changing, and the villages are part of a larger political economy and development practices in the region. This makes tracking the role of other drivers of change necessary. For instance, over the past five years the government has facilitated the provision of cooking gas to several households in villages in the district. In the study area this activity is primarily undertaken through DWCRA, a women's collective in each village.[85] The objective of the program is to reduce the

[85] DWCRA (Development of Women and Children in Rural Areas) is a program started in the state of Andhra Pradesh to build savings and credit groups in each village. Some villages have 3-4 groups depending on the size of the population.

burden on women of collecting fuelwood and also aims at improving their health as wood stoves used indoors are known to cause bronchial and other health issues. Further, the changing livelihoods of people in this area, involve an increase in migration (both temporary and permanent), an increase in irrigated agriculture, an underlying disinterest of the educated and youth to pursue agriculture and livestock rearing as a livelihood (discussed in detail in Ch.2). Of the sample, close to half of the respondents send their children for higher education to nearby towns. When asked if their children would come back to work to stay in the village, the answer was in the negative. As parents witnessing the hardships of living off the land, they hope the next generation will get jobs and make their lives in the city.

Landscapes are dynamic and undergo constant changes, affected by both social and biophysical factors. For instance, land-use decisions at the individual and collective level combine with biophysical factors like drought. As much as drought determines livelihoods of people, it also effects the natural landscape and hence wildlife habitat. This makes the Forest Department's soil and water conservation efforts in the Reserve Forests another instrumental factor in shaping wildlife habitat. The Forest Department usually takes up soil and water conservation activities in summer to provide wage labor to the communities and create water sources in the forest for livestock. Desilting old water holes is one of the activities undertaken. These water holes are also useful to wildlife. On the other hand, these water holes unfortunately provide hunters with a space to easily target certain species. Hence, there are multiple push and pull factors that facilitate and simultaneously discourage wildlife persistence in this landscape.

3.4.3 Species Distributions

Species Distribution Models or SDMs are useful tools to answer questions in conservation ecology, that include prioritization of core areas/site selection, forecasting responses of species to climate change, assessing invasive species distributions and a variety of other questions that deal with the suitability of areas for species based on underlying environmental factors (Elith and Leathwick 2009). I use SDMs to discuss species presence in the study area through habitat maps that the model allows one to generate.[86] Second, I identify the environmental explanatory variables that play a significant role in determining the distribution of species, and connect this to the literature reviewed on the species. Finally, I use the estimated habitat maps or the relative likelihood of occurrence maps to analyze the responses I received from people on wildlife presence. In general, use of SDMs requires the user to evaluate the results of the model through detailed statistical analyses of the outputs. I provide a brief evaluation of the models and the response curves of the environmental variables for each species in Appendix I. In this section, I discuss the results of relative habitat suitability maps for each species and the significant environmental explanatory variables. The model output provides a detailed view of the significant categories when categorical variables like land-use/cover are used. Hence, I point at these variables when discussing the results. The likelihood of presence in geographic space corresponds with the RFs and some of the wastelands in the study area. Since presence-only data has its pros and cons, using it for

[86] Presence-only data does not lend itself to creation of accurate habitat maps hence "relative likelihood of occurrence" is used.

exploratory analyses of wildlife habitat in the study area is a justified first step. I present results of each species next.

Four-horned Antelope

The Four-Horned Antelope has received little scientific attention making it a data deficient species according to the IUCN (Baskaran et al. 2011). More so, the few studies carried out on the behavioral ecology, habitat preferences and breeding habits of the four-horned antelope are restricted to protected areas. Based on a review of the literature published so far, the Four-horned Antelope shows a preference for dry deciduous forests and dry thorn forests. The species is partial to open canopy, short grass and stunted trees-often called tree savannahs (Baskaran et al, 2011). Based on the habitat requirements of the species, I posit that the significant covariates will be those that are variants of precipitation and land cover, specifically areas covered with forests.

Model Performance

The 133 presence-only points of the Four-horned Antelope resulted in a model with a mean AUC of 0.831 which shows that the model has a high discriminatory ability. The AUC as mentioned earlier is a threshold independent measure to evaluate model performance, values close to 1 are considered to be good. It shows the probability of a randomly chosen presence point being ranked higher than a randomly chosen background point (Merow et al. 2013).

Distribution Range

The relative likelihood of occurrence map (Figure 3.3) based on the logistic output shows a higher relative likelihood of occurrence within two of the four Reserve Forests in the study area, ranging from 0.48-0.87. The other two RFs also have a likelihood of presence,

but this appears patchier and lies within a likelihood of 0.23 to 0.47. This in fact corresponds with the household surveys where communities around the two RFs with a higher likelihood of presence of the Four-Horned Antelope reported seeing the species or at least seeing signs (middens). In the study area, majority of the middens were located in grassy areas with stunted trees on higher elevations ranging from 650-850m although some were also recorded at 900-950meters.

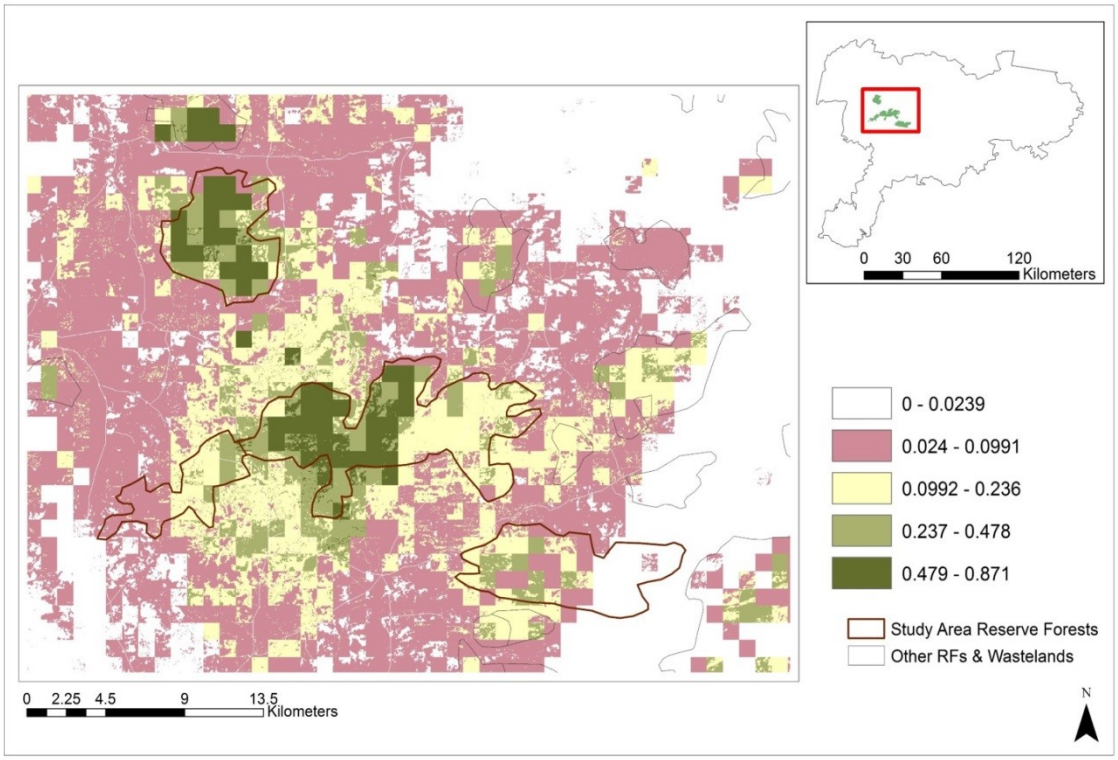

Figure 3.3. Four Horned Antelope: Relative Likelihood of Occurrence

Predictors of the Distribution

The five variables that contribute most to the model based on the percentage contribution are mean temperature of the coldest quarter, land-use/cover, precipitation of the driest quarter, precipitation of the wettest quarter and precipitation of the driest month (The covariate graphs for these are in Appendix 1). The percentage contributions of each

variable are in Table 3.3. The jackknife tests also show similar results but the most significant variable in terms of its contribution to the model is precipitation of the driest quarter (bio 17). With regard to the only categorical variable in the model, land cover under dry deciduous, mixed dry deciduous and scrub forests are most relevant.

Sloth Bear

The Sloth Bear (*Melursus ursinus*) is also endemic to the Indian subcontinent, found across parts of India, Nepal, Bhutan and Sri Lanka. Although population estimates are not complete, researchers believe that the population is in decline (Puri et al. 2015). [87] These bears are known to be nocturnal and crepuscular (Yoganand et. al.2012) which works to their advantage in human dominated landscapes. The sloth bear is myrmecophagus (feeds on ants and termites) as well as fruits. Essentially a tropical deciduous forest species, Sloth Bears are reported in lesser abundance from evergreen and scrub forests (Yoganand et al. 2006). The home range size of the species depends on food availability (Akhtar et al. 2004). Based on the habitat requirements of the species, I posit that the significant covariates will be those that are variants of precipitation and land cover, specifically areas that have rocky outcrops that Sloth Bears use for denning.

Model Performance

The 46 presence points for the Sloth Bear resulted in a model with a mean AUC of 0.892, which points at a model with a high discriminatory ability.

Distribution Range

[87] The population of sloth bears has historically been under pressure due to poaching for its parts and to train bear cubs as "dancing bears". But to a large extent both these have been under control over the past three decades through collaborations between the state, local communities and NGOs involved with bear rescue and rehabilitation projects.

The relative likelihood of occurrence map (Figure 3.4) based on the logistic output shows a higher relative likelihood of occurrence within two of the four Reserve Forests in the study area, ranging from 0.54-0.93. The other two RFs in the study area have a much lower likelihood of presence. Conversely, one RF that was not included in the study north of the study area (the dark blue patch on the uppermost section of the map) also falls within the range of a high likelihood of presence. This is possibly due to its proximity to other RFs and similar environmental covariates in the area.

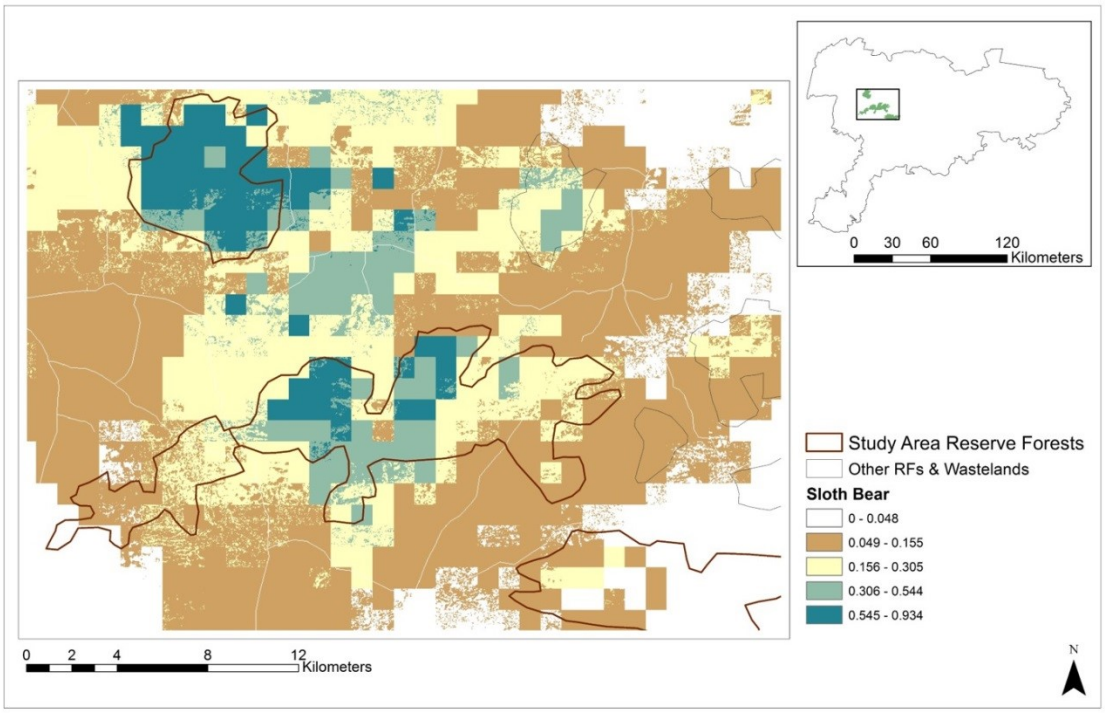

Figure 3.4. Sloth Bear: Relative Likelihood of Occurrence

Although according to the local communities there is reportedly a complete absence of the Sloth Bear in this northern RF for the past decade. They attribute the absence of the Sloth Bear to the presence of a highway, a higher level of forest degradation and hunting.

Predictors of the Distribution

The five variables that contributed most to the model are precipitation of the wettest quarter, precipitation of the driest month, mean temperature of wettest quarter, land-use/cover and precipitation of the driest quarter. The percentage contributions of each of these are in Table 3.3. The jackknife tests also show similar results but the most significant variable in terms of its contribution to the model is precipitation of the wettest quarter (bio 16). With regard to the only categorical variable in the model, land cover under open barren rocks and mixed dry deciduous are most relevant as was expected.

Leopard

The leopard (*Panthera pardus fusca*) in India according to the IUCN is categorized as vulnerable. Studies show that the leopard is able to survive in multiple forest types and even in areas with high anthropogenic pressure like tea plantations and sugarcane fields (Athreya et al. 2013). This makes the frequency of encounters with humans relatively high and puts the leopard at greater threat. Known to be elusive and nocturnal leopard presence in the study area is known only after a kill or with the loss of livestock. According to the villagers, both leopards and wild dogs are migratory. This in a way makes people more accommodating to the species despite the losses which are sporadic.

Model Performance

The 11 presence locations for the Leopard resulted in a model with an AUC of 0.993 which points at a model with a moderate discriminatory ability. The output of this model has to be cognizant of the small number of presence points and the seasonal presence/migratory nature of the species to the area.

Distribution Range

The relative likelihood of occurrence map (Figure 3.5) based on the logistic output shows a higher relative likelihood of occurrence within all the four Reserve Forests in the study area, ranging from 0.6-0.9, although the distribution is patchy. Interestingly, the area between the two RFs in the southern part of the map shows a moderate likelihood of occurrence. This corroborates with the results of the previous chapter where I show the importance of the agricultural landscape matrix in combination with forests and wastelands. This particularly would influence the Leopard since it has a larger home range than the other species.

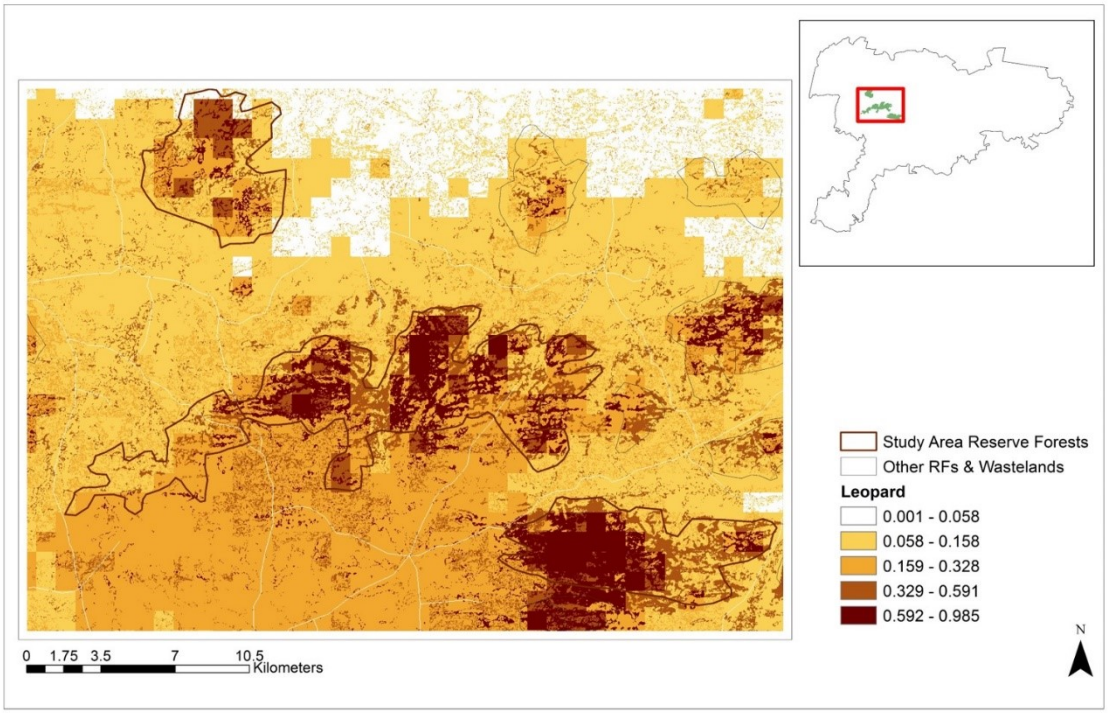

Figure 3.5. Leopard: Relative Likelihood of Occurrence

Predictors of the Distribution

The four variables that contributed to the model are precipitation of driest quarter, mean temperature of coldest quarter, land-use/cover and maximum temperature of warmest month. The percentage contributions of each of these are in Table 3.3. The jackknife tests

also show similar results but the most significant variable in terms of its contribution to the model is mean temperature of coldest quarter (bio 11). With regard to the only categorical variable in the model, land cover under mixed dry deciduous and thorn forests are most relevant.

Wild Boar

The Wild Boar (*Sus scrofa*) is a wide ranging species of least concern according to the IUCN. In India they have been recorded as crop raiders historically causing varying amounts of damage. Studies on the home range and habitat requirements of the species suggest that these differ based on several factors like seasonality, anthropogenic pressure etc. and classify the species as habitat generalists (Allwin et al. 2016). In the study area as in other parts of India, wild boar crop raids are common.

Model Performance

The 33 presence points for the Wild Boar resulted in a model with a mean AUC of 0.992 which points at a model with a high discriminatory ability.

Distribution Range

The relative likelihood of occurrence map (Figure 3.6) based on the logistic output shows a higher relative likelihood of occurrence across the landscape and particularly in the four Reserve Forests and surrounding wastelands in the study area, ranging from 0.54-0.97. The ubiquitous nature of Wild Boar and its use of different landscapes is evident in this distribution map.

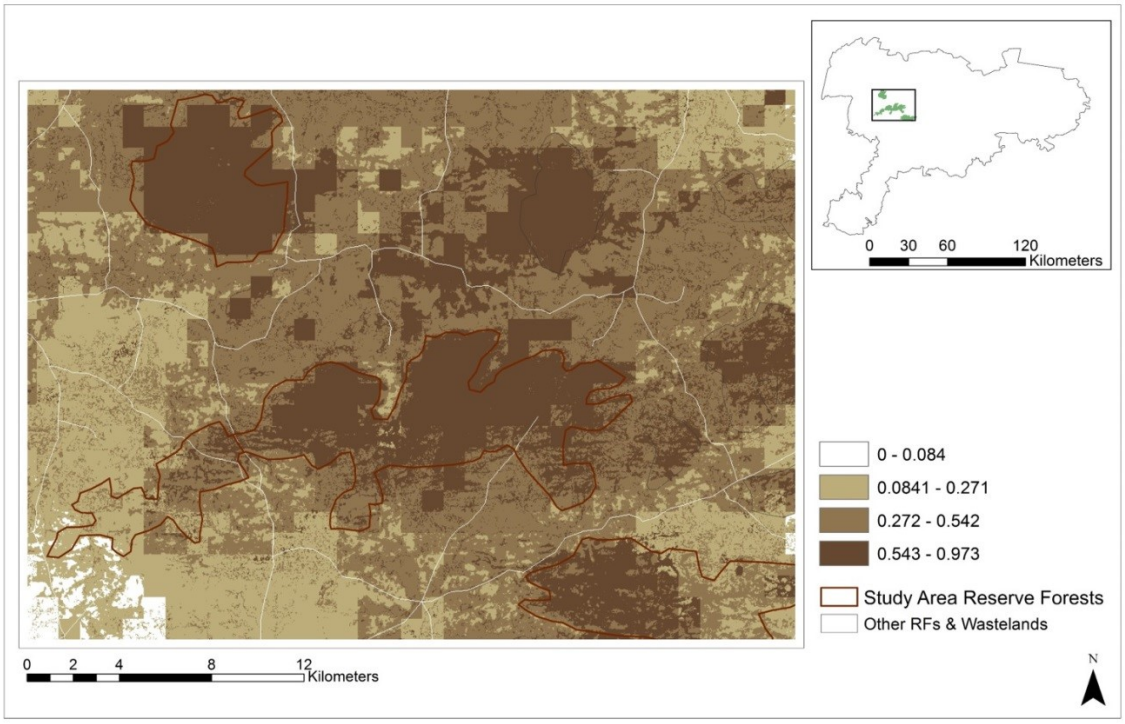

Figure 3.6. Wild Boar: Relative Likelihood of Occurrence

Predictors of the Distribution

The five variables that contributed most to the model are maximum temperature of warmest month, land-use/cover and precipitation of the driest quarter. The percentage contributions of each of these are in Table 3.3. The jackknife tests also show similar results but the most significant variables in terms of contribution to the model is precipitation of the driest quarter (bio 17) and mean temperature of coldest quarter (bio 11). With regard to the only categorical variable in the model, land cover under dry deciduous and mixed dry deciduous are most relevant.

To sum up the species distribution models based on recorded occurrences of the four species in the four Reserve Forests are a preliminary step to knowing the actual distribution of species in the area. The covariates used to model the likelihood of

presence point at plausible environmental requirements for the species to persist. Based on Table 3.3 one can surmise that the covariate defined as mean temperature of driest quarter contributes the least to the predicted distribution of all four species. On the other hand, mean temperature of coldest quarter appears to contribute to the likelihood of all species except the Sloth Bear. Although this is an exploratory analysis, it is worth noting that the covariates representing precipitation influence the likelihood of presence.

Table 3.3. Contribution of Environmental Variables to Species Distributions

Percent Contribution		**Four-Horned Antelope**	**Sloth Bear**	**Leopard**	**Wild Boar**
Variables					
Annual Mean Temperature	bio1	4.1	0.1	0	3
Max Temperature of Warmest Month	bio5	3	0.5	16.1	0
Mean Temperature of Wettest Quarter	bio8	2.8	1.8	0	0
Mean Temperature of Driest Quarter	bio9	1.6	0.1	0	0
Mean Temperature of Coldest Quarter	bio11	35	0	51.4	36.2
Precipitation of Driest Month	bio14	12.9	35.1	0	10.1
Precipitation of Wettest Quarter	bio16	12	40.9	0	23.3
Precipitation of Driest Quarter	bio17	16.8	17	5.3	14.8
Land-Use/Cover	lulc	11.8	4.4	27.2	12.6

The response of land-use/cover to all species was also significant in terms of meeting the known habitat requirements. This corresponds to the apriori assumptions made prior to the modeling exercise. Given the ubiquitous nature of the Wild Boar and the migratory nature of the Leopard, these results are clearly not conclusive for these two species

specifically. The predictions of the Four-Horned Antelope and Sloth Bear correspond with other published studies on the species. Finally, the scale in the species distribution models was restricted to the study area to avoid extrapolating to forests outside and account for sampling biases.

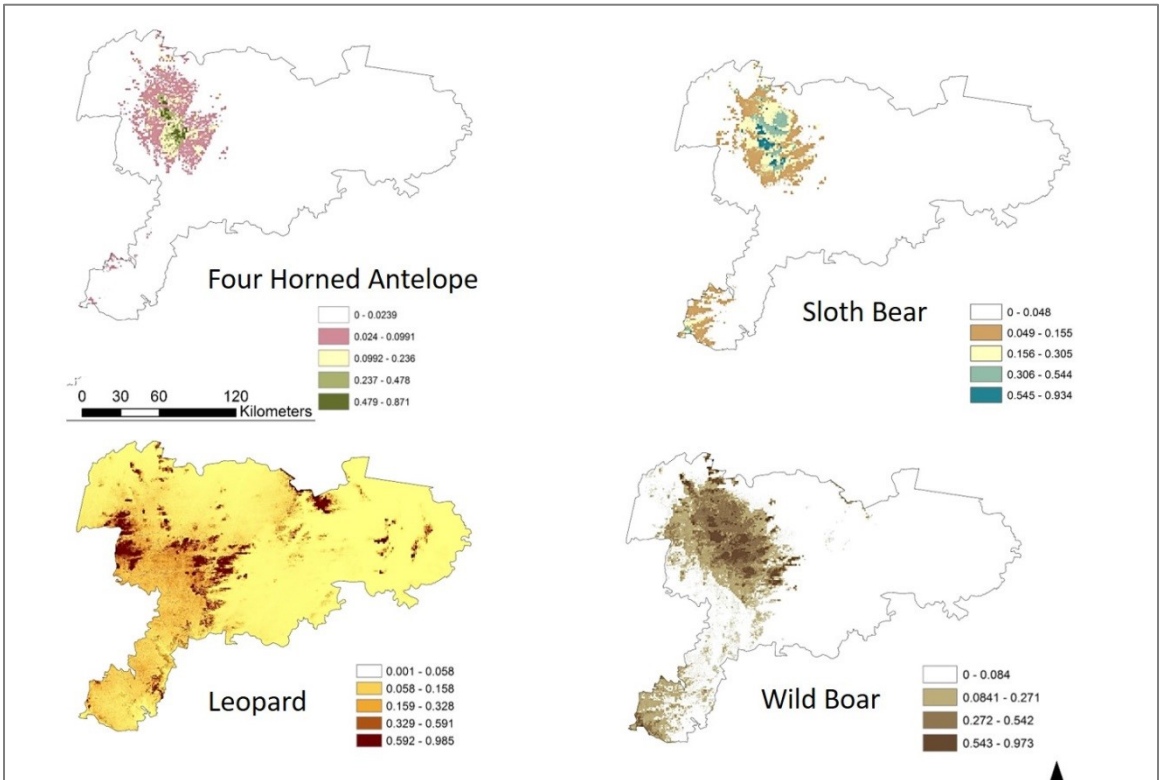

Figure 3.7. Relative Likelihood of Occurrence of Four Species in Chittoor District

In the figure above (Fig. 3.7) I provide outputs of the modeling exercise within the entire district. There is a bias towards the western side because of the location of the study area in addition to, elevations on the western part of Chittoor district being much higher than the east. In conclusion, the results show a likelihood of species presence within Reserve Forests in this human-dominated landscape.

3.5. Discussion

Conservation in India and in several parts of the global South is often presented as a challenge, where land is a scarce resource and population density high. One of the reasons is the assumption that conservation requires exclusive spaces. Instead, my results show that wildlife outside Protected Areas adapt to anthropogenic pressure and may not require exclusive spaces. Likewise, rural communities are habituated to sharing space with wildlife and develop strategies to avoid conflict. As other scholars have shown, spatial overlaps between human and wildlife spaces do not necessarily lead to negative encounters (Carter and Linnell 2016; Dickson et al. 2005; Odden et al. 2014). Further, this research responds to a need for wildlife studies in human-dominated landscapes to identify factors that constrain and promote "sustainable interactions" between humans and other species including herbivores (Carter and Linnell 2016). Although I do not claim that human-wildlife interactions in my study area are sustainable, I do identify specific practices and adaptations that facilitate co-habitation in this landscape. These appear to be broadly: Mutual adaptations that minimize negative impacts on humans and wildlife; Changing livelihoods and decreasing dependence on Reserve Forests; Sociocultural acceptance of wildlife presence and traditional strategies to mitigate crop damage and Biophysical factors like drought and land-use/cover in the matrix.

Shared wildlife spaces are not conservation in absentia or conservation at a distance (through legal mechanisms like the Indian Wildlife (Protection) Act, 1972) and neither are cultural beliefs of the local communities a simple explanation to why such spaces exist. Hence, a pluralistic approach to this problem extends our engagement with different perceptions, practices and the likelihood of species distributions in lived

landscapes. Much scholarly work has focused on the social construction of nature (Cederlöf and Sivaramakrishnan 2006; Ghosal et al. 2013; Hecht 2004; Robbins 2003; Whatmore 2002) and its ramifications. But there is also a need to be cognizant of the feedback loops between the biophysical and the social, and comprehend the coproduction of space. To illustrate, drought as a factor leads communities to make particular livelihood choices and it also determines where and how wildlife can survive. Similarly, the everyday practices and presence of people in wildlife habitats have resulted in mutual adaptations by humans and non-humans. The local communities have developed strategies through experience to avoid negative encounters with wildlife. Similarly, based on the lack of conflict one can conjecture that wildlife also avoid encounters with people by adapting to more crepuscular routine.

From depictions of "invisible forests" in El Salvador (Hecht 2004) to Fairhead and Leach's (1995) seminal work on deforestation in West Africa and Sundberg's (2011) demonstration of the role of non-human actors in boundary enforcement, scholars elucidate the impact of the social construction of nature. I have attempted to include wildlife in this complex conversation that untangles the linkages between humans and the environment. Shared spaces between humans and wildlife result from history, geography and social practices.[88] The naturally fragmented forests and broken hill ranges (of the Eastern Ghats) in Chittoor district resist the conservation discourse of PAs, by virtue of the landscape pattern they create i.e. small forest patches interspersed with subsistence farms, grazing lands and rural settlements. PAs rely on a separation of nature and society, and in India are no more than half a century old. However, heterogeneous and human-

[88] Archaeobotanical research in south India including from Andhra Pradesh reports evidence of plant domestication dating back to the third millennium B.C. (Fuller et al. 2004).

dominated landscapes (with high species diversity but at low densities) where humans and wildlife share spaces do not lend themselves to a need for protection in the traditional sense. In addition, the migratory nature of wildlife (fugitive species) that uses the landscape matrix to survive (as habitat and for movement), these forests, the landscape and wildlife band with human actors and policies to create spaces of species diversity outside the conservation discourse. A continuous and structured marginalization of wildlife in forests outside PAs and the humans who share the landscape not only risks the future of these wild populations but also accelerates potential for human-wildlife conflict.

Defining human-animal interactions as conflict or coexistence makes a difference to the issue on the ground as well as in policy interpretation. A lot of work has been done on understanding human-wildlife conflict within socioeconomic and ecological factors that contribute to its management (Naughton-Treves and Treves 2005; Redpath et al. 2015). [89] Other studies have also assessed the implications of conflict to gender and household vulnerability (Ogra 2008). My results show that certain socioeconomic and ecological factors contribute to perspectives towards wildlife in the area. Naughton-Treves and Treves (2005) provide an exhaustive list to discern factors that influence human-wildlife conflict, my results add one more factor that is significant which is, the location of the individual's field. Farmers with fields closer to forest boundaries are more susceptible to crop damage and hence their coping strategies and perspective to species like Wild Boar differ from others whose lands are located close to the village. More

[89]The socioeconomic factors include, land availability, ownership of wildlife, coping strategies, the social unit absorbing the loss, value of wildlife, type of damage and alternate income. The ecological factors are wildlife body size, wildlife group size, crop preferences, crop part damaged, timing of raid, crop damage and the frequency of raids (Naughton-Treves and Treves 2005).

significant is the finding that the rural communities do not frame these interactions as "conflict". Hence, it is possible that "conflict" emerges when there is a sense of imposed conservation. Redpath et al (2013) also discuss how conflict is often human-human, and wildlife or particular species become symbols of conflict because of conflicting priorities.

Presently crop raids by Wild Boar do not ruin the entire crop, hence farmers are tolerant of the losses. Further, rodents like rats and field mice are bigger problems for farmers cultivating rice as compared to the Wild Boar. This is contrary to Naughton-Treves and Treves (2005) point on body size of wildlife as one of the ecological factors determining conflict. In context of socioeconomic factors, the results show that alternate incomes or diverse livelihood options indeed reduces financial stress caused by crop raids. Crop loss does not drive livelihood diversification, instead diverse livelihoods allow a household to distribute their losses. As mentioned earlier the semi-arid, drought prone conditions have shaped the livelihood choices and consequently livelihood diversity in this area. In addition, gendered responses should be considered based on both the gendered attacks of macaques and the increasing number of women headed households. Overall, although there is a jocularity among people when discussing wildlife, one cannot assume that tolerance levels will remain static. The tipping point will probably depend on several other factors like previous harvest success/failure, household financial situations and also whether the government steps in to provide compensation for the losses. Finally, a host of ecological factors are also critical for wildlife survival.

My results show that people in the study are wary of the Sloth Bear but rarely come into conflict with it. Based on traditional knowledge and through shepherds most villagers know when is breeding season and approximate den locations of the species.

Hence, this knowledge combined with the crepuscular nature of the Sloth Bear results in a level of cohabitation. These findings are contrary to other studies on the Sloth Bear in the subcontinent, where Sloth Bear conflict is a serious problem for local villagers (Debata et al. 2016; Dhamorikar et al. 2017; Ratnayeke et al. 2014). However, another study located in the Western Ghats, India suggests that Sloth Bear human interactions are "relatively benign" (Puri et al. 2015). It will probably be useful to determine what ecological/social factors are responsible for this discrepancy in the species behavior.

The use of species distribution models to answer my question allowed me to first show the relative likelihood of species distributions in the study area. This helps fill a gap on the paucity of species data from the area bringing to attention the unprotected landscape of the Eastern Ghats. Second, through the model I identify critical environmental covariates that contribute to the species habitats. These align with published literature on the four species further validating their presence and occupancy in these RFs. The maps showing relative likelihood of presence will have to be validated by both expert opinion and further field surveys. Though many issues arise when dealing with presence-only data, it is still valid (Peterson et al. 2011). Finally, the model outputs also provide insight into species distributions within lived landscapes, as opposed to PAs where most other studies are carried out. Species behavioral patterns and even realized niches are likely constrained by human presence during the day.

In semi-arid landscapes, rainfall plays a significant role in the fruiting and flowering time of shrubs and the regrowth of grass species, which are critical habitat for the Four-horned Antelope. The Four-Horned Antelope likely distribution also corresponds with other studies on the species that show their preference for steep slopes

and higher grass stands (Pokharel, Ludwig and Storch 2015). Similarly, precipitation is critical to Sloth Bear habitat as their diets include fruits and termites, which are correlated with alluvial soil as shown by Joshi et al. (1995). Finally, a prey base exists for both Leopards and Wild Dogs in the area that include livestock among other wild mammals. The presence of leopards among other carnivores in areas outside PAs with high human population densities is well documented by Athreya et al. (2013). This case offers another example of the same phenomena although detailed population surveys will have to be done to determine occupancy.

The objective of this chapter was to explore how humans and wildlife share spaces in intentional and unintentional ways. The need for identifying and studying areas outside protected areas has been discussed extensively in conservation literature. My research shows that wildlife exists in Reserve Forests in the southern Eastern Ghats, without conservation initiatives or specific interventions. These spaces persist and are maintained so far, through different permutations of the landscape, policy and the everyday practices of local communities. Humans and wildlife cohabit and coproduce the landscape adapting to the variant pressures of human and nonhuman presence. Invisible wildlife spaces are potentially vulnerable to changing priorities policies and practices at the local and national level and need to be acknowledged. Likewise, recognizing the role played by local communities and differentiating between coexistence and tolerance is important, because there is a fine line that determines when an individual perceives wildlife as a threat to her/his life and livelihood. Consequently, tolerance thresholds are hard to define because they depend on multiple factors and are often context specific.

Hence, the results from the four models presented above are not necessarily conclusive. But they do provide an estimate to species distribution of the Four-Horned Antelope, Sloth Bear, Leopard and Wild Boar in an area that does not have prior data on wildlife distributions. This can facilitate the process of spatial prioritization in the landscape matrix for conservation in the future. Further these findings can also contribute to an understanding of species adaptations in lived landscapes. I also show how naming "wastelands" as such, hides their utility to both people and wildlife. Disregarding wastelands a common pool resource for the poor and a potential wildlife habitat allows the state to use these areas for other purposes like mining. This is indeed not limited to India and the lack of a land management vision, but also in other postcolonial nations. The Vietnamese state similarly categorized valueless wastelands (or bare hills) to justify a regreening project (McElwee 2016). This massive project comes at the cost of native biodiversity and local uses of the bare hills.[90]

To conclude, the conservation discourse needs to open up to different ways of approaching conservation in practice. Ironically, multiple spaces and ecologies remain excluded since they do not fit the fortress conservation paradigm of exclusivity (Naniwadekar et al. 2014; Quinn et al. 2014; Suryavanshi et al. 2014). In the previous chapter, I made the case for a landscape approach to conservation, and this chapter calls for a more nuanced understanding of ground realities that show human-dominated landscapes support wildlife. I use the next chapter to focus on forests and understand the competing narratives on the value of RFs, through the situated knowledges of an indigenous forest dependent community and State Forest Department.

[90] The regreening project replaces native vegetation of trees and grasses with fast growing exotics like *Acacia* and *Eucalyptus* species (McElwee 2016).

Chapter 4. Fringe Forests: Perceptions, Representations and Access

4.1 Introduction

This chapter examines how specific practices and narratives shape Reserve Forests in the study area. These forests are part of the lived landscape I discuss in previous chapters and critical to both wildlife and human lives. In India, conservation discourse and practice largely center on protected areas and biodiversity hotspots. Further, the dominant approach has been to exclude, forcibly resettle and relocate people to save wildlife from humans (Gopi 2014; Rangarajan 2014). Through this project, I aim to advance scholarship on conservation in lived landscapes. It is already widely acknowledged that wildlife, including large predators use human landscapes for movement and dispersal (Athreya et al. 2013). Yet, there is a gap in the literature on how people use and shape such spaces. In the previous chapters, I analyze the everyday practices of rural communities that influence and coproduce the landscape matrix around the four Reserve Forests in the study area. In this chapter, I investigate the plurality of knowledge claims with regard to the state of forests through an analysis of official representations, vegetation composition, community perceptions, practices and forest management. This analyses in a lived landscape is critical to broaden our understanding of how Reserve Forests are shaped (through everyday practices, diverse people and formal state intervention) in order to undertake wildlife management in a more just manner.

In India unprotected forests like Reserve Forests have limited protection mechanisms. There is no provision for wildlife conservation in these spaces. Management of RFs rests with the government or state forest departments with the

primary objective of maintaining forest cover. In Andhra Pradesh and other parts of the country, official representations of forests often depend upon the economic potential of forest resources. This association between forests and state revenue is a direct consequence of the colonial history (Rangarajan 1999; Sivaramkrishnan 1999; Skaria 1999).[91] Consequently, state management practices rely on official representations that classify and categorize the Reserve Forests primarily based on tree cover. These representations are one-sided and lend themselves to a narrative that marginalizes rural communities who are dependent on forests. Hence, I claim that Reserve Forests are constantly shaped through messy entanglements between state, forests and diverse actors.

These messy interactions shape subjectivities and identities which intersect with state management coproducing the forests. Subjectivity is defined by various scholars to include the processes involved in bringing people into relations of power therein forming identities (Nightingale 2011), ways of becoming in this world through different relations, practices and ways of seeing and consequently shaping the world (Hausermann and Ferring 2018; Kelly 2015; Singh 2013). A common critique of studies exploring subjectivity and subject making is the complete reliance on state power and its structures (Himley 2008). In other words, this singular focus obliterates agency and action on part of the subjects (Read 2011; Singh 2017). With an attempt to bring in agency and action into understanding subjectivity by proposing the need to examine its production more broadly Read (2011) suggests a consideration of "the myriad ways in which actions, habits and language produce effects, including effects on subjectivity, ways of perceiving, understanding and relating to the world" (114). Hence, I argue that state

[91] The Government of India owns and manages close to 95% of forest land in the country. Forests defined and delineated under colonialism continue to remain state property post-independence.

representations of Reserve Forests determine management, but these representations differ from local community perceptions and benefits gained. Further, community perceptions are not homogenous; rather there is a plurality in perceptions, access and use of Reserve Forests.[92] This plurality which is a consequence of the intersection of caste, class, livelihood and social relationships determines how forests are valued beyond state categorizations.[93] Finally, the biophysical environment or vegetation composition effects both state representations and community perceptions and use of forests.

Studies on common property resources, natural resource management and even conservation, have considered the role of power structures, legal diktats and affective relations in the making of environmental subjects (Agrawal 2005; Li 2007; Robbins et al. 2009; Singh 2013; West 2006). State versus local knowledge is the fulcrum on which some studies examine an amalgamation or disconnect between the two. Subject formation is non-linear and occurs most often through state and community interactions. Likewise, in this chapter, I examine official representations, community practices and the lifeworld of a forest dependent community to acknowledge the processes and conditions of subject formation in the study area. Both state representations and the everyday practices of rural communities need to be contextualized within the characteristics of this semi-arid landscape. To incorporate lived landscapes in wildlife conservation it is critical to consider the different factors that shape state owned and managed Reserve Forests. This

[92] Access is defined as "the ability to derive benefit from things" (Ribot and Peluso 2003, 153). Theorizing access, the authors draw out the difference between property and therefore the "right" to derive benefits as opposed to access. In the case of the reserve forests, communities have rights of access but not ownership.

[93] Value is a subjective term and has been considered under several dichotomies, some of which include "subjective vs objective, moral vs monetary, intrinsic vs instrumental, use value vs exchange value" (Gallagher and DiNovelli Lang 2014, 4). I situate value in the liminal space between the state's way of knowing and the relation rural communities have with the Reserve Forests.

broadly considers the physical and social landscape, but as evidence shows it is far more complex than a simple binary. Climatic and ecological characteristics intersect with different practices across social groups as well as discourses.[94] First, I discuss how the state characterizes the four Reserve Forests followed by an insight into the vegetation and how it influences representation and management. Second, I explore the perceptions, differential access and consequent benefits derived by *Irulas*, shepherds and farmers from the RFs. Historically disenfranchised, the *Irulas* who inhabit part of Andhra Pradesh and the Eastern Ghats are one of many forest dependent communities (Krishnamurthy et al. 2014). The *Irulas* were nomadic forest dwellers, until they were forced to settle by the government post-independence (Krishnamurthy et al. 2014).[95] I focus on communities living around four unprotected forests in western Chittoor district (*Noorkuppalakonda, Tavalam, Kanduru and Madirimalai West*). The four forests in the study area are used through the year by individuals gathering fuelwood, shepherds and goat herders with their animals, and *Irulas* harvesting forest produce. This leads me to ask two questions pertinent to Reserve Forests: First, how do official representations of Reserved Forests (RFs) differ from perceptions of rural communities and actual vegetation composition in semi-arid landscapes? Second, how is forest use and management affected by differential access regimes? The next section places this research within recent scholarship on human-environment relations with an emphasis of forest use and conservation.

[94] Forest use by rural communities has been explored through caste differences present at the village level (Guha 1989). These categories of caste are oftentimes livelihood based and are a consequence of historical processes of structural discrimination and social exclusions.

[95] The *Irula's* level of dependence on forests for their livelihood and intimate knowledge about forests drew me to investigate their role. Based on interviews I undertook with the *Irula* community, 90% of the sample said that forest produce (seeds, honey, resin and other non-timber forest produce) forms their primary source of income.

4.2. Plurality in Perceptions, Representation and Access

Scholarly work on environmental governance shows how policies, people's perceptions and everyday practices coproduce results on the ground (Hausermann 2012; Robbins 2000; Singh 2013). Ultimately, it is an unexpected coupling of official rules and everyday realities that regulate access, use and therefore management of forests and village commons. This is further complicated by social heterogeneity which is evident in the everyday practices and in people's perceptions towards the forest (Nightingale 2011). In turn these social differences influence access. Hence to contextualize perceptions one also has to interpret the plurality within rural communities. As Ribot and Peluso (2003) state, "people and institutions are positioned differently in relation to resources at various historical moments and geographical scales" (154). In addition to varying individual stakes, the social landscape is characterized by embodied experiences and changing perceptions towards the forest at the collective level. The plurality of knowledge claims is discussed extensively by scholars who examine human-environment relations and complexities of resource access (Agrawal 2005; Birkenholtz 2009; Bose et al. 2011; Robbins 2000; Robbins et al. 2009). For instance, Robbins (2000) decenters the state in Rajasthan, India and shows how diverse knowledge groups form communities, and alliances. In the Indian context, intersections between class, caste, gender, social relationships and livelihoods determine the formation of knowledge and power that eventually defines environmental change and management (Birkenholtz 2009; Robbins 2000). Subject formation is political and has multiple facets that include legal and illegal practices as well as other tactics of governance. Governance practices and techniques of governance have been extensively deliberated upon in various forms and spaces, from the

urban to the rural (Agrawal 2005; Ghertner 2015; Li 2007; Mitchell 2002; Scott1998). With regard to forests and conservation, Li (2007) and West (2006) among others provide a comprehensive analysis on the implications of governance and its tactics on the resource, lives and subjectivities of the rural poor. Li (2007) focuses on the "will to improve" through technical expertise, the calculability of the development apparatus and its implications. While West (2006) focuses on how conservation produces space, through "conservation as intervention" and "conservation as development". Though set in different locations and contexts, both these authors highlight the significance and implications of governance strategies and tactics on subject making and the body politic. Conversely, my project examines how subjectivities are formed in the absence of "conservation as intervention" and through oblique interventions by the state apparatus in unprotected forests.

Scholarly work that discusses the role of the state or the Forest Department in India often portrays the state as distant, instrumental, revenue oriented and exclusionary (Lele and Menon 2014). Local communities and their connection with forests vary geographically and historically. Policy imperatives and ever changing socioeconomic dynamics at multiple scales tie into these variations. Nevertheless, a preoccupation with trees dominates official and popular narratives. This arboreal obsession is not limited to Indian forestry but is widespread, and also influences conservation agendas (Walker 2005). Since the Reserve Forests in my study area are not priority for the state in terms of conservation or revenue generation, the state relies on satellite imagery and estimates value from a distance.[96] The complexity of this way of knowing is critiqued by several

[96] Contrarily the state categorizes large percentages of these RFs as "degraded". The vegetation and semi-arid landscape do not generate high revenue for the Forest Department.

scholars (Nightingale 2003; Robbins 2000) but in a way logistical necessity justifies the method. As such the partial and situated official narrative must be put into context as much as the situated knowledges of local communities. In this chapter, I establish that reserve forests need to be (re)valued based on ecological specificities and the value of RFs for rural communities. As a result, the focus of forest management on trees which I discuss later in this chapter ties into a much larger politics of forest representation. The problem is further accentuated in semi-arid areas where tree cover does not meet standard definitions of canopy cover, which is used to define land cover in forests. Semi-arid regions across the world support approximately 15% of the global human population (Mbow et al. 2013). In addition, semi-arid regions also harbor critical ecosystems and wildlife. Forest management strategies used in other climatic zones have proved to be fallible and research shows that, "the climatic and ecological functioning of drylands is fundamentally different from that of their more mesic counterparts…" (Herrmann and Hutchinson 2006, 21).[97] This can make standard forest management procedures problematic and further explains why certain forests need to be seen for more than the trees. In the next section I discuss the methods that inform this chapter.

4.3. Methods

Data & Data Analysis

Andhra Pradesh State of the Forests Report (APSFR)

I use annual reports published by the Forest Department (2013 and 2014) to draw out official representations of Reserve Forests in the study area through the categories and assessment techniques deployed. These reports provide estimates of forest cover in each RF across the state. This allows me to juxtapose the state's representation with the

[97] Drylands refer to arid, semi-arid and desert areas (Herrmann and Hutchinson 2006)

greenness index of the four RFs that I calculate. I also draw on people's perceptions and informal discussions I had with Forest Department staff in 2014 and 2015 to contextualize the official narratives.

Normalized Difference Vegetation Index (NDVI)

I use Landsat 8 data from USGS with a resolution of 30m for the entire year of 2015. [98] Due to excessive cloud cover and a lack of alternate images I use nine scenes, and omit June, July and November. I used ERDAS Imagine, to calculate NDVI for nine months. NDVI is a vegetation index frequently used to estimate vegetation canopy. To calculate the index, the Near Infra-Red (NIR) and Red (RED) bands of the electromagnetic spectrum are used to estimate reflectance, which ranges from -1 to 1. This is estimated based on the difference in reflectance between the wavelengths (NIR-RED/NIR+RED). Vegetation or the leaves in plants absorb wavelengths between 0.4-0.7ụm (RED) and the cell structure on leaves reflects wavelengths from 0.7 to 0.11 ụm (NIR). Values closer to 1 signify healthy, green vegetation. I calculate the NDVI values for the four forests (*Tavalam* and *Kanduru* are clubbed together as they are contiguous) to estimate a greenness index. This allows me to compare the state's classification of the land cover in the RFs with an index that estimates vegetation vigor.

Unfortunately, scrub and thorn vegetation are not easily captured through satellite imagery of low resolutions. Hence, albeit partial and contingent NDVI allows me to show the variation in greenness across the RFs.[99] NDVI is a snapshot in time and space but is useful to get an overview of seasonal variations (Weiss et al. 2004). In semi-arid areas, seasonal variations are high since vegetation responds to minimum amounts of rainfall

[98] United Stated Geological Survey (http://earthexplorer.usgs.gov) Path 143, Row 51

[99] NDVI is not designed to consider the history of the area with regard to fire, past drought years or pest attacks.

(Bradley and Mustard 2005). Since the study area is semi-arid and drought prone, assessments of the vegetation index has to be at different comparative levels. NDVI values for dry deciduous forests and semi-arid vegetation usually range from 0.2 to 0.5.

Semi-Structured Interviews & Household Surveys

I undertook 51 semi-structured interviews, 38 with *Irula* women and men, and 13 with shepherds and goat herders.[100] The questions queried their everyday practices, access and use of the forests, and perceptions towards forests and wildlife. I used snowball sampling based on the small number of *Irula* households living around *Noorukuppalakonda, Tavalam, Kanduru and Madirimalai West* Reserve Forests.[101] Opportunistic sampling was used for the shepherds and goat herders, and this was supplemented with responses from household surveys since several respondents among the sample also rear livestock.

I use NVivo 11 software designed to analyze qualitative data to organize and analyze my interview transcripts. The transcripts were imported into NVivo along with a classification sheet that had information on each respondent. This was used to first interpret differences between age, gender and location of the respondents. Thereafter, codes were developed based on my broader research questions to interpret the data.

191 household surveys using stratified random sampling were undertaken in eight villages located on the periphery of the four Reserve Forests. The surveys were stratified

[100] The number of semi-structured interviews were based on a saturation point and the logistics involved in terms of the number of *Irulas* available, dependent on the RFs in the study area and being able to locate their settlements.

[101] During the study design I did not realize that small scattered populations meant that there could be as few as two *Irula* households in a village. Getting to each village meant a 10-30km drive with every possibility of not meeting anyone as they may have already left for the day or week, and in some cases temporarily migrated out. Further, based on their disassociation with the rest of the village it was impossible to know this without physically going to the village.

based on the dependence the local villages have on the Reserve Forests.[102] Hence, 40% of the sample represent those dependent on *Noorkuppalakonda*, 30% are dependent on *Tavalam*, 12% on *Kanduru* and 18% on *Madirimalai* West Reserve Forests. The household surveys generated data on the diverse livelihood patterns, land holding size, livestock rearing practices, use of the forests as a resource and human-wildlife relations. The surveys also included questions on perceptions towards wildlife and the forests to understand how local communities perceived the presence of wildlife in the area. All surveys and interviews were conducted in Telegu and translated to English. The survey protocol was approved by Rutgers University's IRB.

4.4. Results

I first discuss official representations of Reserve Forests (RFs) through data specifically for the four RFs in my study area and juxtapose this with an analysis of vegetation vigor. This allows me to identify how the state estimates/categorizes the RFs in comparison to other parallel narratives. Calculating the greenness index that shows vegetation vigor provides insight into the biophysical characteristics of semi-arid vegetation. I follow this up with the ways in which forest management is realized in the study area because management is indicative of how state knowledge is implemented. In the third section, I discuss how community perceptions and everyday practices need to be situated and contextualized. Finally I consider the lifeworld of the *Irulas*, a marginalized forest dependent community who share a unique relation with the RFs in comparison with the state and the larger village community.

[102] In each village the surveys covered 25-30% of the total number of households

4.4.1. Official Representations

The *State of Forests Report* (2014) of Andhra Pradesh demarcates forest cover under the following categories: Open Forests, Moderately Dense Forests, Very Dense Forests, and Scrub (APSFR 2014). Each of these is defined based on canopy density, and while the first three are largely viewed as "good forests", scrub is described as "degraded" (APSFR 2013). These definitions are not arbitrary and nor are they determined solely by the state or the central authority i.e. Forest Survey of India. Instead, these definitions are influenced by the Food and Agriculture Organization due to a need for common denominators that are globally recognizable.[103] The nomenclature of the *State of Forests Report* determines forest working plans, policies and implementation of activities taken up by the Forest Department.[104]

Forests cover 23.64% of geographic area in Andhra Pradesh (APSFR 2014). In my study area in Chittoor West Division among the four Reserve Forests, three have more than 50% of cover categorized as Moderately Dense while the fourth (*Noorkuppalakonda*) has 54% under Open Forests (Table 1). The clear demarcations signified by these classifications is misleading, based on my field transacts to each RF in the study area. Secondary forests particularly when regrowth is a consequence of natural regeneration rarely has defined patterns.[105] For instance, in the four RFs that I examine there are patches of Open forests within Scrub vegetation. Similarly, forest cover along

[103] The FAO is an agency of the United Nations that leads efforts to deal with global hunger and is instrumental in the improvement of forestry, fisheries and agricultural practices internationally.
[104] The top-down approach in which maps are created using satellite imagery, processed and analyzed by "experts" is not novel to forestry, India or the Andhra Pradesh Forest Department. Universal categories and logics evolve in particular spatial and temporal contexts as shown by several scholars (Li 2007; Mitchell 2002; Robbins 2012).
[105] Further degraded forests resist definition owing to the shifting nature of their existence, lack of a comparative baseline and oftentimes a contextual understanding of what they really are (Goldstein 2014).

gullies and streams is Moderately Dense but also has an undergrowth of Scrub and Thorn vegetation. Clearly the simplistic and abstracted categories used to represent forest cover by the Forest Department do not reflect on the ground ecological complexities. The report makes a reference to forest classifications but ignores the type of vegetation in the RFs relying on abstracted categorized instead. [106]

If we limit ourselves to the *State of Forests* report, we know the 'state' of the forests. The glossary defines these categories as:

1. Very Dense Forest(VDF): All lands with forest cover having a canopy density more than 70%;
2. Moderately Dense Forest(MDF): All lands with forest cover having a canopy density between 70-40%;
3. Open Forest(OF): lands with forest cover having a canopy density between 40 to 10%;
4. Scrub: Degraded forest lands having canopy density less than 10% and areas with dwarf and stunted growth (APSFR 2013).

[106] The report states that the forests of the division fall under Dry Tropical South Indian Mixed Deciduous Forests, Southern Thorn Forest Groups & Tropical Dry Evergreen Forests as per Champion and Seth's classification (a classification system used to characterize forests in India).

Table 4.1. Forest cover of the four Reserve Forests

Reserve Forest (RF) Area in ha. [Values in parenthesis represent percentage cover]	**Very Dense Forest**	**Moderately Dense Forest**	**Open Forest**	**Scrub Forest**	**Total (includes water bodies & non-forest)**
Noorkuppalakonda (NKK)	0.00	1114.90 (**32.76%**)	1853.27 (**54.45%**)	266.38 (**7.83%**)	3403.64
Tavalam	3.19 (0.10%)	2494.13 (**75.04%**)	670.91 (**20.19%**)	115.41 (**3.47%**)	3323.55
Kanduru	2.57 (0.08%)	2133.96 (**66.02%**)	946.72 (**29.29%**)	73.88 (**2.29%**)	3232.14
Madirimalai West	34.03 (1.68%)	1494.98 (**73.77%**)	430.97 (**21.27%**)	44.78 (**2.21%**)	2026.42

Source: APSFR 2014

This classification system (using Very Dense, Moderately Dense, Open and Scrub) ignores the vegetation type as well as the ecosystem services provided by forests. Further, qualifying categories like “good” and “degraded” are unhelpful as tree cover is the only indicator for official representation and measurements. Using canopy cover as an indicator to represent vegetation that has a miniscule percentage of trees that grow to heights of 5 meters or canopy covers of more than 10 percent is problematic. This has material consequences with respect to forest management. For example, official representations consider scrub as degraded and in need of intervention. This approach negates the importance of scrub vegetation to pastoralists and other species like birds, reptiles etc. In other words, the state’s approximation and representation of these Reserve Forests are solely based on the need to tree (“green”) the area regardless of the characteristics of native vegetation, needs of people or wildlife. I next calculate the greenness or vegetation vigor of the four RFs in the study area using satellite imagery for

2015. NDVI is an index often used to measure vegetation across seasons.[107] By juxtaposing NDVI of the four RFs with official classifications I show how the categories discussed above are partial and characterize one aspect of forest cover, which is tree cover.

Based on the forest cover classification by the Forest Department, one can hypothesize that greenness index for *Madirimalai* West will be the highest among the four RFs. Since *Noorkuppalakonda* RF has the least percentage of area covered by Moderately Dense Forests the index should be significantly lower. This would also corroborate with my field observations where the most anthropogenic pressure was recorded in *Noorkuppalakonda* RF. NDVI mean values across all four RFs range from 0.16 to 0.36, within the recognizable range for semi-arid vegetation. Both seasonality and effects of the south-west and north-east rainy season are evident from the mean NDVI values across each RF in Figure 4.1. Additionally, in November 2015 the entire region received unseasonal torrential rainfall, which explains the spike in the index. As expected *Madirimalai* RF shows the highest values which is comparable to the official data, and lesser amount of anthropogenic pressure. On the other hand, the greenness index for *Noorkuppalakonda* does not meet the hypothesis of being significantly lower. Overall, the NDVI values across the four RFs follow a very similar pattern within the same range.

[107] Since the data published by the Forest Department does not differentiate between forests and plantations, and neither does NDVI (in this case) it is a valid index to draw a comparison.

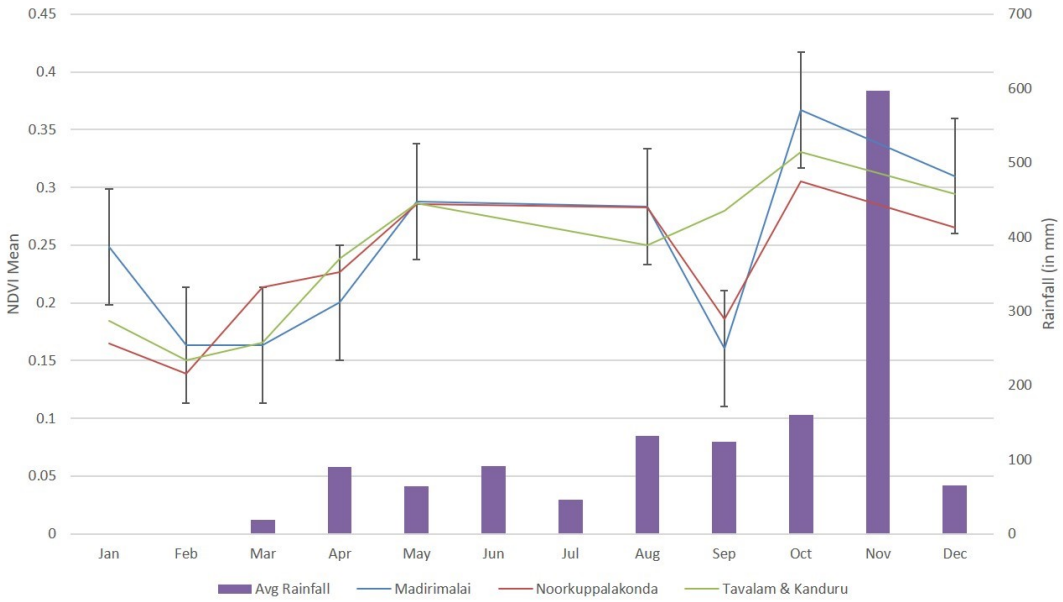

Figure 4.1. Mean NDVI for the study area & Average Rainfall Received in the District 2015

Official representations based on tree cover and NDVI based on greenness or vegetation vigor are clearly different techniques used to analyze satellite imagery. Each one has its advantages and drawbacks. For example, forest cover (used by the state) does not capture the variegated forest cover and vegetation composition while NDVI is limited by spectral variation captured through satellites, which as I discuss earlier is influenced by leaf size and moisture. In a semi-arid landscape several species are thorny, and many species have tiny leaves that are difficult to detect using satellite imagery. One would need a detailed understanding of the biology of the annuals, perennials and grass species in the area to arrive at a conclusive understanding. Further a detailed understanding of the effects of precipitation and temperature patterns, and geology is also necessary (Schmidt and Karnieli 2000). Nevertheless, Higginbottom and Symeonakis (2014) advocate using NDVI as one component to understand vegetation dynamics for degraded landscapes, along with stakeholder usage and ecosystem functions. This justifies my use of different

methods to elaborate on the particularity of knowledge claims. As Nightingale (2003) states, "all knowledge is partial and linked to the contexts in which it is created" (77). Hence, the state's way of knowing must also be put in context of a history which involves a specific discourse (forests=revenue), a global focus on increasing tree cover (which percolates scales) and the marginal status of secondary forests in areas that are not identified as ecologically important (like biodiversity hotspots). In the next section, I discuss forest management practices observed in the four RFs in the study area.

4.4.2. Forest Management in Reserve Forests

The Andhra Pradesh State Forest Department relies on mapping tools and techniques to develop action plans for forest management. Forest management in the Reserve Forests is carried out completely by state machinery since participatory forest management programs (Joint Forest Management-JFM and later Community Forest Management-CFM) [108] are no longer functional.[109] Presently the Forest Department continues to fund interventions in Reserve Forests as part of their management and

[108] The differences at the implementation level between JFM and CFM are reportedly minor, although CFM was envisaged to be led by the communities. For specific differences and details see Reddy et al. (2004 & 2013).

[109] JFM and CFM involved constitution of a village level governing body consisting of eight women and seven men from either one village or neighboring villages. Based on the spatial location and number of villages in proximity to the RF, there were one or two such committees formed for each RF. Although the state managed these programs in Andhra Pradesh, they were funded through both the World Bank and centrally sponsored schemes targeted at employment generation (Reddy et al. 2004). Since 2013, funding has ceased and my informal discussions with the District Forest Officer and Forest Section Officer, suggest that there are plans to resume these programs soon. Under these programs, forest protection mechanisms involved community level decisions on rotational grazing, protection of the forests from illegal felling, restrictions on sand mining etc. Plantation activities, soil and water conservation measures and construction of fire lines/breaks were also taken up at regular intervals. These investments primarily targeted improving vegetation, reducing the spread of fire, and providing communities with wage labor.

greening initiatives. This also provides the rural communities with wage labor for short time periods, creating a relation between the state and people. Across the four forests I observed that plantation work was carried out along with soil and water conservation activities. This included digging pits for the saplings, making tree rings, contour trenches, desilting water holes and earthen bunds. The Forest Department was clearly investing money in the four RFs on a recurring basis. In the past, the Village Forest Committee or the *Van Samrakshana Samiti* played a role in developing plans for these activities. Since the committees were not functional any longer, the Forest Guard usually called upon ex-members to organize labor for these activities. Discussions during the household surveys alluded to this being standard practice, although a few individuals commented on its futility since the survival rate for saplings was very low. On the other hand, all the respondents expressed the necessity of de-silting old water holes for humans, wildlife and livestock use. Yet, the community refrained from questioning the Forest Department and their choice of work (or tree saplings), as it offered several households additional income for a few days of the year. Based on my field observations the survival rate of plantations is dismal, most plants were dead or dying due to recurring drought. Soil and water conservation measures are indeed useful for this kind of semi-arid environments, yet when it comes to plantations there is a need to question both the reasons for it and the choice of species.

Plantations encouraged by the Forest Department in India have been criticized due to the factors mentioned above by several scholars (Nagendra 2009; Shiva 1993). Although forest policy has shifted its focus from revenue generation (as established by the British) to include watershed protection, biodiversity conservation and poverty alleviation, the technical training and rhetoric of forest=trees continue are still dominant.[110] There appears to be a need for tangible evidence by both those who are 'professionals' and the lay public, which leads to recirculation of the notion that a forest=trees are still dominant. Several respondents in the household surveys suggested that trees are growing, so the forest is doing better. The emphasis was always on the fact that people do not cut trees, so it must be better. The contradiction lies in attempts to tree (used as a verb), an area that is ecologically fragile, semi-arid, and more conducive for short trees, scrub and thorn bushes.

Informal discussions with Forest Department staff suggest that the fixation with plantations continues. Plantations appear to be a recurring activity undertaken despite the rate of success or failure. It is almost like an activity in automate mode. On one hand the department undertakes removal of *Eucalyptus* trees, and at the same time Forest Department nurseries continue to propagate the species. This contradiction can be grasped only through the characteristics of *Eucalyptus* trees. *Eucalyptus* is fast growing and contributes to revenue for the state. But it is detrimental to the water table and effects

[110] In an ethnographic study carried out across two state forest departments in India, Fleischman (2014) finds that contrary to several studies and policy recommendations, bureaucrats are prompted by a combination of scientific bureaucracy, professionalism/ forester values, rent seeking and discursive power to influence the public and institutionalized incentives particularly the ability to monitor trees and their planting.

agriculture, but it does help "green" the degraded forests and increase forest cover.[111] The state clearly sees Reserve Forests for the trees as evident from its management practices and categories used to estimate forest cover (as discussed earlier). There is little consideration of the importance of native vegetation or the different faunal species the Reserve Forests provide habitat to. By no chance does this suggest that the state is ignorant of species presence or critical ecosystem services that RFs provide. Rather, the omission is a consequence of the semi-arid vegetation and relatively low revenue value accrued from such spaces, in addition to a lack of conservation focus on biodiversity coldspots such as these.[112] In the next section, I focus on community perceptions to the state of forests based on their use and everyday practices.

4.4.3. Community Perceptions and Practices

The need for contextual interpretation and highlighting situated knowledges is paramount in the process of data generation at the field level from rural communities. I provide a summary of responses to the question framed around the state of the forest over the past decade (improved/increased or degraded/decreased) in Table 4.2.[113] In the table below the responses are summarized according to three broad groups of forest users- the *Irulas*, shepherds and farmers.

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[111] A forest official I spoke with reiterated this through his recent experiment with a new species he was trying to encourage in plantations. This was an exotic tree species and the success of this trial was based on the lack of use of this tree or its parts to people. Additionally, he said that the species was useful because it was exotic hence it will be of little use to the native biodiversity. Most importantly plantations of this kind will enhance forest cover.

[112] Biodiversity coldspots contain species diversity, are habitats to rare and endangered species and perform critical ecological functions (Bøhn and Amundsen 2004; Carolan 2009; Kareiva and Marvier 2003; Marchese 2015).

[113] The questions on increase/improvement or decrease/degraded was framed simply and respondents were asked for an answer based on their experience over the past ten years. Most often this turned into a longer answer as people would explain why they thought there was an improvement or decrease in forest cover.

Table 4.2. Perspectives of the Local Communities to the State of Forests			
	Forest Improvement	Forest Degradation	Don't know/ No change
Irulas (n=38)	54%	27%	19%
Shepherds (n=40)	50%	35%	15%
Farmers & others (n=165)	46%	41%	13%

Although community perceptions are not tangibly different towards the state of forests, there is a noticeable difference in how each group contextualizes their response. The shepherds illustrate their response based on availability of grass for livestock. Similarly, the *Irulas* discuss their opinions in context of the availability of forest produce. On the other hand, responses from the farmers (small, marginal and large) differ very slightly across gender[114]and livelihood patterns. Instead perceptions are more contingent upon the level of forest dependence: for grazing, fuelwood or other forest produce. Hence perceptions are clearly contingent on an individual's needs, exposure, experience, knowledge and practices. Interestingly, irrespective of social categories, rain and drought were highlighted as primary drivers for forest improvement and degradation, across the entire sample. Although the forest department represents *Noorkuppalakonda* (NKK), *Tavalam, Kanduru* and *Madirimalai West* Reserve Forests to be at different levels of degradation (APSFR 2014), the local communities who go every day do not think the forests are degraded. There is consensus that forest use was higher in the past and forest fires more frequent, and much of this lived experience leads people to believe that forests

[114] For instance, 39% of women and 45% men said there was an increase. I refrain from analyzing this further because a large majority of women claim that they do not know much about the forests. Although it was not difficult to access women, getting them to give definitive replies to some of the questions required probing and convincing them we (my field assistant and I) wanted to know their perspective, and there was no right answer that we were looking for.

have regenerated over the past decade. To interrogate the rationale underlying different ways of seeing and different practices, I use the household surveys to analyze use and access to the RFs in more detail.

The non-tribal community as I term it is a mix of different castes and communities who have diverse livelihoods.[115] The data presented below combines responses from farmers, daily wage laborers, livestock owners and a minority of those who have other income sources such as driving taxis, running small businesses etc. 42 percent of the sampled population said they go to the forest every day, while 21 percent go to the forest every week. The respondents who go every day, primarily go to graze livestock (cows, sheep or/and goats) and may collect fuel wood while they are there. Those who go once a week, usually go to collect fuel wood to meet their energy requirements.[116] Based on the data generated through household surveys one can infer that more than half the population continues to depend on the forest regularly. The primary reasons the community gives to explain their perception of improvement in forests over the past decade include: changing patterns of energy use and therefore a reduction of fuelwood extraction, lesser livestock in the village due to recurring drought, the increased presence of forest guards who makes frequent visits, reduced instances of forest fires and a drastic reduction in the illegal cutting of trees. Though all these reasons are based on observations made by the rural community and the everyday practices, there are a few divergent strands in the narrative that complicates the present situation. I

[115] It is difficult to put 95% of the respondents into a single category of livelihood choices- a farmer also has livestock, a shepherd may cultivate crops, a landless person who works on the farm may also have a herd of goats etc.

[116] Fuel wood is used by more than 60% of the villagers in my study area for cooking and heating water.

discuss each of these points in more detail below.

a. ***Changing Patterns of Energy Use***: Vegetation in forests and wastelands have traditionally met the energy requirements for rural and semi-urban populations in this area. 45% of the sample suggests that fuel wood demand from semi-urban areas has reduced over the past decade. In addition, over the past five years access to cooking gas in the villages has increased through government subsidies and incentives. In the process the pressure on forests for fuel wood extraction has decreased, but simultaneously households who depended on selling fuelwood have lost a source of income. Nevertheless, as a community all the respondents perceive the changing energy use patterns beneficial to forests.

Based on the surveys and discussions in the villages, less than 40% of the population has shifted away from fuel wood to cooking gas. Apart from the cost of getting a gas connection the mediating channel is membership in the women's self- help groups (SHGs) that are operational in every village.[117] The SHGs provide loans and facilitate the process of applying for a gas connection. A small percentage of households who are relatively well-off have acquired this themselves. In short, those who are not a part of the SHG or have a dysfunctional group do not get access to change their energy source. Among my sample 25% of the women were not part of a functional SHG and there are no SHGs among the *Irula* women. Thus, although changing patterns of energy are underway it is a slow process and inconsistent across the social landscape.

[117] The women SHGs are groups of 10-12 women organized under a government program for women's development. The primary objective of the group is to provide a space for savings and credit mechanisms. The number of SHGs in a village depend on the population.

b. ***Changing Patterns of Livestock Rearing***: Livestock numbers have decreased in every village; however, this does not provide the complete picture.[118] The reduced numbers itself do not explain forest recovery. Instead the primary driver of less pressure in forests is a change in the preferred breed of cows as well as household management. More than 50% of livestock owners in the study area own the HF (*Holstein Friesians)* hybrid breed of cows that are large and ill-suited to the semi-arid, rocky landscape of the study area. These animals must be stall-fed and require much more care and water in contrast to the native breed called the *Halika*. The native breeds can graze the forests and wastelands and require little maintenance but are not preferred due to low milk yields. Additionally, persistent dry weather has led to a reduced number of people who choose to rear goats and sheep. Although sheep and goats are well adapted to semi-arid climates, recurring drought leads to distress sales in many households. Further, drought often leads to other compulsions where at least one member of the family is forced to migrate as seasonal labor or to work in construction projects. This leaves women, the elderly and children at home. In such cases women work for those who have irrigated fields while the older folk take livestock to graze. In nuclear families, the woman is compelled to take livestock to graze in the absence of the male. Most women prefer to stay close to the village so that they can return home easily and handle

[118] Based on a comparison of the data in the 18th and 19th Livestock Census of India one sees a decline in the number of exotic/crossbred cattle, indigenous cattle, and the number of goats in Chittoor district from 2007 to 2012. The largest decrease is in the number of indigenous cattle that have reduced by 160136 within five years. (18th & 19th Livestock Census of India)

other responsibilities. This inherently leads to grazing of livestock on the foothills, the wastelands or fallow lands as trekking up and down the forest can be difficult and time consuming. This point is further corroborated with the data from the household surveys, where 73% of the women go to the forest as opposed to 52% of the men on a daily or weekly basis.

c. ***Increased Surveillance***: Rural communities can use and access reserve forests under certain restrictions: a complete ban on felling trees and hunting, permission to collect dry wood and graze livestock. Within livestock, goats are discouraged implicitly through an annual fee charged by the Forest Department. As mentioned earlier, each RF is under a division and forest beat and consequently has an entire bureaucracy devoted to its management. In my study area, the four reserve forests *Noorkuppalakonda*, *Tavalam*, *Kanduru* and *Madirimalai* are managed at the ground level by two different forest guards. The guards are responsible to survey the forests on a daily basis, oversee plantation and other improvement activities taken up by the department. The department does not expect the guard to survey 3000 hectares or more of forested area, across undulating terrain and dense scrub every day on foot.[119] Hence, the guards make rotational visits to different villages and access points to monitor the forest. The unscheduled visits and an increased frequency of these visits were reported by 85% of the population sampled in the household surveys. This presence of the guard that some maintain is weekly and others say is random, makes the critical point that the community does not know when the forest guard will come. So, there is an almost underlying sense of

[119] All four reserve forests have a semi-motorable road up to the forest boundary. Beyond this one has to walk.

governmentality at work here, which appears to control and reduce illegal felling of trees from the RFs according to the community.

In case the forest guard sees someone with fuel wood that is not dry, or timber he can impound it, fine the individual and even file a legal complaint that requires appearing in court. The non-tribal communities are well aware of these rules and seem to appreciate the forest guard's frequent visits at one level. But at another level, they also suggest there are illegal practices and relate past instances when people have used bribes to get out of such situations. The fine line between legal and illegal resource use in and around a wildlife sanctuary in Western Rajasthan showed that noncompliance is the norm and people work within institutional frameworks to access resources in highly specialized ways (Robbins et al. 2009). Although the rules in the reserve forests I assess are different from those in protected areas, evidence of informal negotiations between locals and the state exist. The non-tribal communities negotiate rules-in-use with the forest guard. Likewise, goat herders and the shepherd community use fallow lands and wastelands to avoid paying the annual fee charged for goats. In short, people negotiate, strategize and avoid conflict with the forest department in different ways. An increase in surveillance adds to the need for such measures, by the forest guard and more recently the *Irulas* as I discuss later in the chapter.

d. ***Reduced Forest Fires***: Close to 60% of the respondents in the household surveys assert that forest fire frequency has reduced since less people go to the forest. Forest fires in this area are caused by human negligence or mischief makers.[120]

[120] There are superstitions associated with the positive consequences of setting fire to the forest – these include a range of beliefs from appeasing the rain gods to curing stomach pains.

> The question on forest fire demonstrated community dynamics in an intriguing manner. The first response by most of the respondents was denial of responsibility, followed by a blame towards another community (usually the shepherds or the *Irulas*) and on understanding the question that did not ask for names but frequency they all claimed that it has reduced.[121]
>
> One of the reasons for this response is that anthropogenic pressure has perceptibly reduced due to changing livelihoods. The general opinion is that less people implies a reduced chance of accidental forest fires. Contrarily the shepherds feel otherwise. They assert that less people in the forest give troublemakers more leeway. In other words, when the forest is used and accessed regularly there are more eyes and ears to be wary of. I heard a similar remark from one of the farmers, who hinted at an increase in "people" brewing liquor in the forest because there are less chances of getting caught.

These divergent perspectives and everyday practices across social categories shape the RFs and determine use and access by rural communities. It is these specificities and pluralities which are critical to conservation processes in lived landscapes. Official conservation practice and discourse often tends to amalgamate community as a cohesive unit. This has been critiqued by several scholars over the past two decades. More recently there is an acknowledgment of the differences within rural communities living in and around protected areas. Yet conservation in lived landscapes demand a closer inspection

[121] Since shepherds and *Irulas* go most often to the forest, it is easy to blame them. Shepherds are held responsible as post-fire vegetation growth is supposed to be good for sheep. And *Irulas* are known to light fires for cooking or smoking out bees hence are also easy to blame.

of the historical and sociocultural practices that shape forests and wildlife habitats in unintended ways. Hence, in addition to changing livelihood practices and an understanding of the political economy of resource use, a consideration of the lifeworld of forest dependent communities offers insight into a more than utilitarian conception of the value of the RFs. This is based on my discussions with the *Irulas* and the assertion made by several interviewees that the "forest is home" (Multiple respondents, 2015). In the next section, I discuss my results from the semi-structured interviews with the *Irula* community who see these RFs for more than the trees.

4.4.4. People on the Margins: The *Irula* Lifeworld

The *Irulas* are one of 33 different tribes in Andhra Pradesh (and in the study area are also referred to as *Yanadis*), although there is a lack of consensus on the exact number of tribes who occupy the Eastern Ghats (Krishnamurthy et al. 2014).[122] Studies on *Irulas* often characterize the community as poor, uneducated, primitive, forest dependent, indigenous and as snake-catchers (Alex et al. 2016; Krishnamurthy et al. 2014; Sinu and Mahadevan 2013).[123] I use my interactions with the community to situate them within the village and elaborate on their everyday practices that make them insiders and outsiders.

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[122] In India the term "tribe" has a complicated history and contemporary usage is political and contentious in several parts of the country. Based on a historical analysis of tribal habitat, language and religion within the Indian subcontinent Betéille (1998) shows that assuming tribes as "indigenous people" can be misleading. Although India is a signatory to the UN Declaration on the Rights of Indigenous Peoples, Bose et al. (2012) explain the government resists from using the term indigenous. While I do not go into this literature in-depth, explaining my rationale for including the *Irula* voice is important for two reasons. First, understanding the *Irula* lifeworld is an ethical imperative because they are a part of the social landscape. Moreover, it is not possible to grasp the value of RFs in the study area without a consideration of the relationship between *Irulas* and forests. Second, the disenfranchised status of *Irulas* within the larger village community necessitates that their voices be included rather than ignored.

[123] Populations of *Irulas* are present in three southern states, Andhra Pradesh, Kerala and Tamil Nadu. Most research and documentation has focused on Tamil Nadu and Kerala (Alex et al. 2016; Sinu and Mahadevan 2013). There is a dearth of studies on the *Irulas* in Andhra Pradesh, and the available literature tends to club them with other tribes in the state (Krishnamurthy et al. 2014).

As a forest dependent community, the *Irulas* play a critical role in shaping this landscape through their everyday practices and cultural beliefs. In the study area the *Irulas* are forest dependent and are known to have immense knowledge of the forest and its produce.[124] This is not a culturally deterministic view but based on the primary livelihood of this community (Alex et al. 2016; Krishnamurthy et al. 2014; Sinu and Mahadevan 2013). Unlike other tribal communities (*Chenchus*, *Madigar, Valmiki* etc.) in Andhra Pradesh, and *Irulas* in other parts of south India this community has always relied on the forest (Krishnamurthy et al. 2014). They did not cultivate land or partake in shifting cultivation as commonly reported among other scheduled tribes in India.

Certainly, one cannot assume that *Irula* perceptions are homogeneous across the entire sample. In fact, their responses are spatially and temporally contingent, entwined with history and individual experiences with the larger village community and government representatives. Moreover, one has to acknowledge that people's perceptions can also be affected by what they think the interviewer expects to hear.[125] Nevertheless, wanting to talk to *Irula* households elicited surprise by not only other villagers, but even *Irulas* themselves. Owing to their invisibility (linked to the small, scattered populations

[124] The *Irulas* positioning is explicated in this chapter through the narrative on their lifeworld as well as differential access to the RFs. Through this process I try and parse out how *Irula* positionality emerges and is articulated by outsiders. Although I do not apply it to the body politic of the *Irulas* because that would require a larger sample and a more in-depth examination of the community through a historical lens. I do instead make observations on how governance tactics use the community to gain knowledge on forest use and misuse. I align with using the term "tribe" since that is what government documents and other scholarly works use. Finally, as the data generated through six months of field work illustrates the *Irulas* are now instrumental to forest management in the study area.

[125] With basic conversation skills in the local language, I was accompanied by my field assistant during the surveys and interviews. Introducing my field assistant who had just finished her studies in nursing, and myself as a student researcher possibly confounded the respondents as it was not easy to fit both of us into a single category. In a way this worked to our advantage as there were no expectations in terms of "what we wanted to hear", unlike when the community interacts with government and NGO representatives.

and spatial distribution), their reticence to talk to outsiders and their fringe status within the larger sociocultural milieu of the village rarely does anyone ask for their opinion.[126] Although as my results show this outsider status is becoming more fluid with the Forest Department's recent management strategies, which I discuss later in this chapter.

The *Irula*s as a people live on the margins.[127] Their houses/settlements are usually located outside a main/larger village, and the distance between can range from 0.2 to 1km. This is a consequence of decades of social discrimination, and not only the location of their houses that are outside the village. Eight out of ten *Irula* households I visited were located outside the village and in some cases on the edge of the village. As mentioned earlier, the number of *Irula* households in a village varies between two and four.[128] The location of their houses is one mechanism that shows how "producing of difference" (Radcliffe 2015) or *Irula* positionality emerges through such historically situated tactics.

The *Irulas* live physically, socially and metaphorically on the fringes, creating their life world through practices that involve gathering forest produce, working for the landed and making it through each day with very little. When there is no opportunity for wage labor particularly in summer, *Irula* men usually go to the forest to gather forest produce. The women accompany them if the children are old enough or if there are elder

[126] Most *Irulas* whom we (my field assistant and I) sat down to talk to were taken aback that we wanted to talk to them and know about what they do.

[127] As Sarah Radcliffe (2015) explains, "Indigeneity is hence a positioning, a relational reading and a producing of difference and subjectivity on/in the body politic that is always embedded in power differentials at multiple scales…the concept signals the need to carefully parse the conditions under which this positioning emerges and how it becomes articulated … (2).

[128] Within the study area there are two cases, where the village was established by the government and is referred to as an *Irula* colony/settlement. Only these locations have 10-12 *Irula* households within the same radius. The *Irulas* in these settlements are less forest dependent and depend more on farming, goat rearing or daily wage labor.

family members who can take care of them. Even during the agricultural season, they may go to the forest based on the availability/seasonality of the produce they are gathering. On days that they go to collect honey, they must go in groups because it is not possible for an individual to harvest honey alone. In this rocky landscape, granite boulders and escarpments are prime locations to look for hives. Even now they prefer to use a vine to reach the hive, although some individuals say they carry a rope. It is not easy work and nor is it safe (according to women), but it is what they do. One individual said, "The bees make honey for us and the bears, so we do a small puja[129] before we harvest the honey" (R8, 2015).

Going to the forest is the most natural thing for *Irulas*. There are days when they may not gather any produce but it's a day well spent. When they go to distant forests, they stay in the forest for a week or two based on what they are harvesting. Culturally and historically tied to the forest, nine out of ten individuals in my sample refer to the forest as "home" or allude to other maternal references. With a preference to stay amongst their own people, the community restricts their interactions with others in the village. Irrespective of where they were born or how many years they had spent in their present home, several *Irulas* said, "the forest is our home, we just live here" (with reference to the house in the village) (Multiple respondents, 2015).[130] While I am not attempting to make a distinction between the value of home versus house, I think it is important to understand how the *Irula* views her own standing within the larger physical and social landscape. Being an outsider is not limited to physically living on the edge or outside the

[129] Religious ritual that involves thanking the forest for the harvest and leaving a small amount of it at the location

[130] Prior to being forced to settle outside the forest, the *Irulas* only went out of the forest to sell forest produce and buy essential items.

village, rather it is being an outsider to the socio-cultural milieu of the larger village. The difference in their livelihood practices and their intimate knowledge and relation with the forest, positions them as dissimilar to the rest of the village community.

Things have changed over the past few decades, and *Irula* children now go to regular schools and overt discrimination has ceased. Yet the positionality of the *Irula* continues to remain outside. They refrain from getting into altercations or even talking to others in the village. As more than one *Irula* respondent said, "We used to fear other people. If they came to call us for work, we all would run into the forest and hide. It would be hours before we came out ..." (R10, 2015). The *Irulas* are inherently wary of the outside world, suspicious of intentions and scared of authority. These characteristics are a result of generations of structural and social discrimination, that involved being treated differently since they were forest dwellers and nomadic.

Different practices create different lifeworlds and even today the lifeworld of an *Irula* revolves around survival and avoiding conflict. On the other hand, the *Irula*s share a strong sense of kinship within their own community. In all my interactions with individuals across different villages, not even one used the word “I”. The interview questions were designed and directed at individual responses, but the community responded in terms that define the collective, or the community. It was always “we”, “us” and “our people”, contrary to individualistic responses that I received from the farmers and shepherds in the villages. While honey is always harvested as a group, other forest produce is collected individually or by one or two individuals in a family.

This sense of kinship extends to the way *Irulas* view the forest and the tubers, seeds and leaves harvested. Though they all consider the forest as a primary source of

income, none of the *Irulas* I interviewed believe that there is scope for conflicts or contention between their own community (with regard to gathering forest produce). Discussions on the reduction of certain species are attributed to the lack of rainfall or over-extraction due to market forces. It almost felt as though they did not have a word for competition or conflict in their vocabulary. In trying to probe this further, at least half the respondents said, "If other people find it first, it is theirs, what is the problem…the forest provides for all of us" (Multiple interview respondents, 2015). Most of the interviewees readily listed out the different species they harvest through the year on realizing that we (my field assistant and I) wanted to know what they extract, how they process and prepare it for sale. Unfortunately, not many respondents willingly spoke of the plants and herbs they collect to add to their diet or use as traditional medicine.[131]

Shifting Practices: Outsiders or Insiders

The need to disassociate from the past and embrace modernization comes out in subtle ways when conversing with the community. The first response to a question on hunting was "our people don't hunt", or "we know hunting is illegal" (Multiple interview respondents, 2015). Over further discussion some of the interviewees mentioned that their forefathers used to hunt. They are all aware that hunting and owning firearms is illegal. Traditionally the community did not use guns but snares to catch small game to supplement their diet. The elders in the community suggest that the younger generation probably do not know how to trap animals in the forest. *Irula* reality is harsh, they are indisputably the poorest households in a village. Of the sample, approximately 90% lived with their families in one thatched hut with barely any material items except the absolute

[131] There is a strong underlying need to disassociate from the past and embrace modern medicine, technology and practices similar to those among others in the village.

bare necessities that included cooking utensils and a pair of clothes.[132] Poverty is not new when rural or even urban India is discussed, but the starkness of it becomes more real when within the same settlement there are large farmers who have houses made of brick, mortar and concrete. Hence, the process of becoming insiders within the village requires social and material changes that are difficult to negotiate given the difference in perspective and opportunity.

Since 2015 was the third consecutive year that rains had failed the agricultural season, most of the villages I visited (to meet with *Irula* families) had one or two households that had migrated. Further, 65% of the interviewees stated that roots and tubers are becoming harder to find and the quantities harvested are not remunerative. The younger generation also appears to be disenchanted with forest dependence and inclined to migrate into towns for labor.[133] At the same time, several are hesitant to migrate unless desperate. The lack of rains reduces forest produce, as well as scope to work as wage labor on farms. Yet there is a tremendous belief that the forests will help them survive. This stands contrary to how the state values the same RFs. While the state is situated differently, as owner and manager of the forests, a dry deciduous, scrub forest has little value as opposed to forests that have timber potential and megafauna as is the case in most PAs.

Inclusion or exclusion to land with regard to conservation is often violent as

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[132] According to Krishnamurthy et al. "… accumulation of resources is non-existent in tribal communities" (2014, 311).

[133] Two 19-year-old *Irula* boys I met, had recently returned from Bangalore, the nearest big city where they spent two weeks working on a road construction project. "I went to the city to work as a laborer for 2 weeks and earned enough money. I bought myself a smart phone, and clothes for my mother and sister before coming home. When I run out of money I will go again." (R2, 2015). Towns and cities give them exposure to the cosmos/metropolis and access to disposable income, much more and faster than harvesting forest produce.

evident from case studies across the globe (Neumann, Schroeder, Li). Some people are rendered as insiders or outsiders by protection mechanisms, while others negotiate their status through licit and illicit means (Robbins 2009). More recently, Kelly (2015) shows how insider/outsider subjectivities change over time in the case of "protected area dilapidation". Focused on "insider/outsider subjectivities" Kelly (2015) shows how access is determined by identity, giving some people advantages through different means. To return to the Reserve Forests in my study area, access is also determined by identity and strengthened through negotiations and relationships with forest management. At the field level, the forest guard oversees forest management and has developed a relationship with the *Irula* community across all four RFs. Although this is an informal practice it does seem to be a governance tactic in practice presently based on 85% of the interviews conducted. Statements like, "Yes, the guard was here yesterday morning. He came and spoke with us for a while" (Multiple interview respondents 2015) or "We have the guard's phone number. We are supposed to call him if we see anyone doing anything illegal in the forest and especially if we see a vehicle close to the forest" (Multiple interview respondents 2015), were casually made by *Irulas*. [134] Conversely, I did not hear this from farmers or shepherds although 65% of this population was aware that the forest guard made weekly trips to the area.[135] The state was clearly using existing differences in social identity to subsume the *Irulas* into forest management. Plurality in knowledge claims thus emerge through different practices and differential access regimes that in turn

[134] The exception to this was one *Irula* colony who lived close to a highway. This group was comparatively less forest dependent and extracted only one species from the forest, *Phoenix sylvestris* or *Eetakku*

[135] Conversely, when I asked the shepherds if the forest guard came to the forest or village. The response was "Yes, he comes sometimes. I don't know when he comes or goes. He does not talk to any of us." (R42, 2015). This stood in contrast with the *Irula* responses: "Yes, he comes at least once a week. He comes and talks to us about what we have seen etc." (Multiple respondents, 2015).

reinforce the insider/outsider positionality of the *Irulas*.

Based on a historic dependence on forests, *Irulas* have a right to access the forests and extract non-timber forest produce (NTFP). The intimate relation of the *Irulas* with the forest makes the Forest Department a key actor, in their lives and livelihoods. Discussions with the community point at a unique relation with the state. Reference to the state was made by 90% of the interviewees: presence of forest guards, rules of extraction and hunting. For instance, every respondent I spoke with referred to a "forest card", which is an identification card that indicates permission to harvest forest produce. [136] This was something that every interviewee emphasized on, to ascertain that I was aware that had legal rights to extract forest produce. The *Irulas* are supposed to carry this card with them whenever they go to the forest to collect NTFPs. The non-tribal community members have access to the RFs but do not have access to forest produce. They can collect dry wood and take their livestock to graze. Hence, the forest card is what allows *Irulas* to collect produce without getting into trouble with the state. In terms of the *Irula* lifeworld discussed earlier this is significant because in the past they have been labelled (by others in the village) as thieves and untrustworthy. Hence, access to collecting forest produce and an acknowledgment by the state of their traditional livelihood makes a difference.

Irulas go to the forest regularly and are well aware of the different species and access routes. This coupled with their outsider/fringe status to the larger village community make them perfect undercover representatives of the state. The regular visits

[136] The card gives them a sense of entitlement and several respondents explicitly stated "We can go anywhere in the state, to any forest and collect anything we want. We have a card." (Multiple respondents, 2015).

and interaction by the guard helps her/him maintain an affable relationship with the *Irulas* who are otherwise barely involved with outsiders. These interactions also work to shift the *Irulas* positionality within the village. It is no secret that the forest guard maintains a close relation with the *Irulas* yet keeps the larger village community at bay. Several interviewees speculated on the implications of telling on their own community (with reference to the larger village) and dismissed the idea that they would call the guard. At the same time, a few individuals had called the guard to inform him about a forest fire or in one case when they saw outsiders in the forest. The consequence of this form of surveillance must be investigated more carefully but analyses based on the household surveys and interviews show that the villagers are wary. As one woman in the household survey said, "We don't dare to collect anything other than dry wood- the *Irulas* are there, they will report us" (R 161, 2015). Similarly, a shepherd stated, "The *Irulas* they go to the forest every day, they know what is going on there…and the guard talks to them, not us" (R43, 2015). In addition the frequent, yet unannounced presence of the forest guard adds to a reduced potential of illegal activities in the forest.

To investigate if the use of the *Irula* as a governance tactic was one forest guard's ingenuity, or an institutionalized method, I analyzed the data across the four reserve forests in my study area. Surprisingly, the same kind of interaction was narrated across *Noorkuppalakonda*, *Tavalam*, *Kanduru* and *Madirimalai* Reserve Forests. The four reserve forests are part of two different forest ranges (Madanapalle and Punganur). Each range has multiple forest guards based on the size of the range and size of the forest beat.[137] This led me to conclude that this was not one forest guard's ingenuity. Rather it

[137] Forest area is governed based on a hierarchical process and divisions- My study area is in Chittoor West Division, that has 84 beats. Each forest beat comes under a Range, managed by a Forest Range

was a practice that has been informally institutionalized. I say informally because there is no evidence of this practice in any report or document published by the Forest Department. Additionally, I interacted with Forest officers at three different instances during field work and neither one mentioned this practice. This leads me to believe that knowledge claims within the state bureaucracy and its consequent deployment through management techniques also take multiple forms.

4.5. Discussion

The findings suggest that understanding Reserve Forests requires an acknowledgement of the partiality of knowledge and the importance of situating each piece within appropriate context. This fits into my larger research objective that looks at the coproduction between rural people's practices and the landscape matrix, which in turn produces and maintains spaces that people and wildlife share. In this chapter, I claim that a plurality of knowledge and access regimes intersect with social difference, official narratives and management. Understanding the variation of access in terms of who benefits and how, and further who gives access is important if one is to understand the underlying powers at work. "Access analysis" helps identify or map the ways in which multiple processes and systems (formal and informal) allow actors to benefit from resources (Ribot 2003). This involves identifying the benefits, establishing who controls access, how is access maintained and how is access to the resource gained. The state reproduces differential access regimes, which intersect with diverse livelihoods of both the tribal and non-tribal communities. Although social differences in village communities

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Officer. The Range Office has forest guards monitoring the range and section officers at a higher position. Recently, the designation of each of these positions has been changed but the villagers continue to use the old designations. Hence, I stick with the old ones in this chapter.

are constantly being (re)produced through everyday practices; changing livelihoods and social dynamics are also in a constant state of flux. Both the tribal and non-tribal communities living around these four reserve forests perceive a recovery.[138]A recovery in forests can mean different things to different people. While the farmers or non-tribal community shares a more utilitarian relation with forests, the *Irulas* feel that they belong in the forest and have a much more intimate relation.

This analysis also responds to Singh (2013) who explores forest management and subject making in Orissa (India) and shows how rural communities develop an understanding of environmental crisis through a combination of environmental discourse, techniques of governance and their lived experiences. I focus on the lived experiences of the rural communities to understand the processes and conditions of subject formation in context of Reserve Forests. It is eventually these relations and ways of seeing that determine the value, which lies between what the state knows and the affective relations between the resource and those dependent on it. Sundberg (2004) shows how "identities-in-the making" guide performance and environmental practices establishing different kinds of resource governance. Based on her research in northern Guatemala, she examines how conservation practices (which involve actors at the local, state and international scale) and social science research shape gendered and racialized identities (Sundberg 2004). The results of my enquiry into forest access and management illustrate that social differences are part of the rural tapestry and influence use and community

[138] Based on the difference in the way forests are owned and managed by the state as opposed to the scenario in other countries, this improvement in forests cannot be labeled as a transition. Because forest transitions refer to a change from one land-use/cover to another particularly with reference to a change in area. In this case, although forests are recovering the area under forest versus non-forest is not changing.

perceptions towards forests. The state works to create certain identities through the *Irulas*: a people who were excluded from the forest decades ago and now governance strategies recruit the same people to be critical eyes and ears for forest management.

The state continues to manage these forests from a distance and appropriate value through measurements that are not tailored to either the semi-arid landscape and its vegetation nor the use of the RF to local communities. Hence there is a need for a broader comprehension of how forests are valued particularly through processes that lead to their coproduction. Only through an integration of multiple voices and practices is it possible to begin to see forest complexity and the benefits accrued. Likewise, establishing context for both human and biophysical claims is critical. As the results of NDVI/greenness index discussed earlier show how measurement indices must be considered based on climatic conditions or the particular context. Contrarily, the state's measurement indices apply standard definitions and further use qualitative terms such as "good" and "bad" to describe the state of the forests. The limits of forest management in semi-arid, drought prone landscapes is captured by Gautier et al. (2015) state, "Because forest management in the drylands depends on agricultural, livestock and gathering systems, it needs to be considered in the wider framework of a landscape approach…" (121). And a landscape approach has to consider differential access regimes by local communities.

Environmental governance takes different shapes based on the category of forest protection, governing mechanisms, historical relations between people and the environment and the context (Arts 2014; Bose et al. 2012; Robbins 2009; Rutherford 2007). Forests in lived landscapes need to be recognized for their value to the state and local communities along with changing ecological and socioeconomic aspects. In my

study area the RFs evidently are of limited value to the state except to maintain forest area as “forested”. This is apparent in both the state’s representations and management practices observed. I use the term fringe forests to locate these RFs within commonplace understandings of forests in lived landscapes as well as a tendency to sideline “degraded”, secondary and scrub forests despite contrary evidence. To conclude, semi-arid landscapes and forests need to be appreciated for the ecosystem services and habitat that scrub, dry deciduous and thorn vegetation support. Colonial logics and stereotypical forest management techniques focused on plantations need to be reconsidered. Further thought needs to go into native versus exotic species, if greening the landscape is the objective. Finally, all of these changes have to take into account and work for local communities who depend on the Reserve Forests.

Chapter 5. Conclusions

The Eastern Ghats as a biogeographic region, wildlife in Reserve Forests and local communities who share and shape these landscapes are marginalized in conservation discourse. Sparse representations and a lack of focus on this area is an outcome of assumptions that dominate conservation discourse and praxis in India. Conservation is complicated and deals with a relationality of scale, that connects a local pastoralist, a global organization like the IUCN, ecosystems and species. This makes it a particularly different (and political) resource management issue. Scientific rationale and decisions combine with limited resources to prioritize which species, ecosystems and landscapes require conservation support. This incorporates funding, knowledge systems and policies at the international, national and local levels. An intersection of biogeography, socially constructed relations, institutions and policies determine "conservation value". Despite high floral endemism documented in the Eastern Ghats including in areas outside PAs they continue to remain under represented within conservation discourse and practice (Ramachandran et al. 2018).[139] Similarly, in the study area, the state overlooks the ecosystem services, wildlife habitat and relation local communities share with unprotected forests. Hence this dissertation contributes to an existing gap on wildlife presence in Reserve Forests and human-wildlife cohabitation within a lived landscape in a part of the southern Eastern Ghats.

Based on my research, the assumption that wildlife and people need to be separate for successful conservation appears to be unjustified because: forest boundaries are permeable, wildlife has and continues to persist in human-dominated landscapes and,

[139] In this study the authors assess land use and land cover changes in the Eastern Ghats from 1920-2015 with a focus on rare, endangered and threatened (RET) and endemic plants.

even Protected Areas are not isolated but lie within a landscape matrix. I thus developed my project to examine the coproduction of this landscape through its biophysical and social characteristics. The biophysical was important to emphasize wildlife presence, biogeography and climatic constraints of the study area. The social was critical because it is a lived landscape where rural communities have diverse livelihoods, social practices and differential access to the forests. Hence, combining the two let me explore the coproduction of rural people's land use practices, wildlife habitat and the landscape matrix.

A focus on this area in the Eastern Ghats provides insight to specifics significant to the future of the Reserve Forests, wildlife and people living here. However, given that in India, approximately 21% of the geographical area is estimated to be forested in addition to the six percent that is under protected status, Reserve Forests are significant spaces for the future of conservation. These forests are spread across the country, biodiversity rich and provide critical grazing and energy resources to rural communities among other benefits. Thus, my research on wildlife presence in Reserve Forests and intersections with the agricultural matrix, everyday practices of rural communities and policies lets me respond to calls for an alternative conservation framework.

My research builds on first, conservation in a lived landscape and second the need for a landscape approach to conservation. It is well established that humans are a dominant presence and globally more than 75% of land and ecosystems are under the influence of humans than ever before in history (Martin et al. 2014). Although human-dominated landscapes are ubiquitous in India, the conservation discourse built around the separation of nature and society continues to influence conservation practice. Thus, an

incorporation of lived landscapes into wildlife conservation studies is producing new insights into both the ecology of species and coexistence, even between carnivores and humans (Athreya et al. 2013; Carter and Linnell 2016). Yet, due to a fixation with the "wild" for over a century there remains a gap in understanding the conservation potential of such spaces and how they can be incorporated into biodiversity conservation. Mixed results on community-based conservation strategies initiated in the 1980s, led to a renewed call for a separation of wildlife and people as discussed earlier.

One of the prerequisites to conservation in a lived landscape is opening up the narrative to a landscape approach. This stands in opposition to the fortress approach that has become synonymous with protected areas globally. Proposing a new conservation paradigm, Perfecto and Vandermeer (2008) show how the "matrix matters" in tropical agricultural systems. The authors illustrate how the agricultural matrix is significant for conservation especially based on the reality of small farms interspersed with plantations and forest fragments. Adopting a landscape approach to conservation does not imply doing away with established ecological theories, rather building on them for more realistic assessments. In India, agriculture is the dominant land use in rural areas. Environmental historians discuss the interrelated nature of the system at the local level with animal husbandry and forestry forming the other parts. This interdependent system continues to form much of the rural landscape even today (Sundar 2015), and is also evident in the southern Eastern Ghats.

Finally, my results on wildlife in a lived landscape through a landscape approach to conservation also responds to appeals for a greater focus on the conservation social sciences and a more "critical physical geography" (Bennet and Roth 2015; Lave et al.

2014). I show how "socio-biophysical landscapes are as much the product of unequal power relations, histories of colonialism…as they are of hydrology, ecology and climate change." (Lave et al 2014, 2). Examining wildlife in fragmented forests of the Eastern Ghats thus has to be contextualized through understandings of knowledge of land-use/cover, practices of rural communities and their diverse livelihoods within the semi-arid, drought prone landscape. Hence, my research context justifies use of an integrated framework of political ecology and land change science, as well as mixed methods, as discussed in Chapter 1. I summarize the findings of this dissertation based on the two larger thematic approaches mentioned above.

Conservation in Lived Landscapes

Despite species of conservation significance, wildlife presence in the Eastern Ghats goes unacknowledged owing to a combination of policies and underlying assumptions regarding the type, and size of forests that should be conserved for wildlife. For instance, forests in human-dominated landscapes are usually "secondary forests", as opposed to "primary forests" that have considerably more conservation value. In my study area, the four Reserve Forests are not only secondary forests but are broadly classified as "good" and "degraded" by the state Forest Department, based on canopy cover, and the lack of it. As I show in Chapter 4, these classifications are misleading based on the semi-arid vegetation composition in the area. Yet the way the state "knows" influences management decisions, and leads to an underappreciation of these forests for both wildlife and rural communities. My results show that all four Reserve Forests are habitat to several species including the Four-Horned Antelope, Sloth Bear, Leopard and Wild Boar. Further, according to the village communities I interacted with, among

carnivores, wolves and foxes are locally extinct, but Wild Dogs seem to use these forests as corridors seasonally. Wildlife presence is indeed a part of this landscape although the lack of attention has resulted in an absence of population estimates and conservation efforts. This is possibly due to an underestimation of conservation potential in human-dominated landscapes in addition to policy frameworks and priorities.

Present governance mechanisms clearly do not acknowledge wildlife presence in RFs and nor do they value the ecosystem services or benefits that forests in semi-arid areas provide to the people. There is a thus a need to revalue how RFs are defined, measured, categorized and evaluated. As I show in Chapter 4, rural communities have differential access to the RFs and a varying relationship with the forests based on sociocultural pasts. Each of which need to be recognized if anthropogenic spaces are incorporated into conservation. Besides access to fuel wood, fodder and other forest produce, the rural communities also relate to RFs on a cultural and spiritual basis. As the section on *Irula* lifeworlds specifically highlight, the significance of these forests are much more than what can be measured or defined in categorical terms. All these claims also justify and help develop an appreciation of plural methodologies.

The land-use/cover in the study area is representative of a lived landscape shaped by agricultural practices, livestock rearing and forest dependence. My results show that people are in constant interaction with the forest. This shapes not only vegetation but also wildlife adaptations to anthropogenic pressure and similarly people adapt to wildlife presence in the forest (Chapter 3). Further, wildlife presence in the matrix has resulted in farmers across the study area using various strategies to safeguard their crops. This

cohabitation is not new or novel, rather something that farmers have always practiced, and hence a level of tolerance is built-in to the system.

Based on traditional paradigms, human presence in wildlife habitats threatens conservation through illicit activities like hunting, extraction of forest resources and conflict. My results suggest that the Wildlife Protection Act, 1972 and strict laws on gun possession have possibly lowered hunting among the rural communities. Yet, as I discussed hunting practices of the past with a group of farmers, one farmer reminded me that it was unwise to assume hunting is in the past. He said, "Will anyone admit to subterfuge, probably not" (R122, 2015). Hence one can conjecture that although hunting continues, with the trend towards changing livelihoods hunting pressure is low. Discussions with several "old-time hunters" suggest that when they went hunting in the past it was for the Wild Boar. The meat was always for subsistence and never for sale. In addition to the legal implications of hunting, the unannounced and regular presence of Forest Guards (vigilance) makes it an illicit activity.

To conclude, human-dominated landscapes can be conservation spaces provided there is a willingness to engage with the rural communities. It is only through an engagement with the different socioeconomic groups and categories that one can grasp how such spaces are coproduced and shared. Finally, Reserve Forests have to be acknowledged for their materiality and not only for the tree cover that is made to matter through various discourses and networks (even in semi-arid landscapes).

Landscape Approach to Conservation

A landscape approach to conservation considers the agricultural matrix and sociocultural practices of rural communities. This notion disregards several tenets that the

Protected Area model is built on, like the habitat-matrix paradigm. Yet, as I discuss in Chapter 2, and the literature shows PAs are not isolated islands but are influenced, and influence the landscape matrix. As I establish, the four reserve forests in the study area are surrounded by an agricultural matrix that includes dryland and irrigated farming with diverse cropping patterns. Small farms are dominant and a move towards increased irrigated agriculture seems to be the direction of land use patterns in the area. Changing cropping patterns in the study area unintentionally contribute to wildlife forage and water requirements. Livestock rearing also contributes to water access to wildlife in an unintended manner. Shepherds and goat herders who take their animals to the RFs require access to water as a result of which the communities have desilted old water holes in collaboration with the Forest Department and NGOs. Similarly, other unconnected initiatives like government programs encouraging the use of cooking gas over fuel wood is decreasing pressure on forests. Although the realized niche of wildlife I examine lies within the forest landscape, there are established associations with the matrix for foraging and access to water more critically. In other words, the forest makes for habitat but the matrix around provides access to complimentary resources. This is evidently a result of the semi-arid climate and drought prone nature of the area as my results show.

I further explore landscape composition and configuration and assess the everyday practices and livelihoods of the local communities. This includes crop choices, soil and water conservation mechanisms, livestock grazing as well as access to forests and common lands, and how these are shaped by and in turn shape landscape patterns in the study area. The results show, how the biophysical combines with everyday practices and leads to a permeable landscape matrix for wildlife. The heterogeneous land-cover,

and soft boundaries between vegetation on forests and wastelands make this a possibility along with a decrease in anthropogenic pressure. This permeability facilitates wildlife movement beyond forest boundaries and access to the matrix.

A landscape approach also necessitates a common land management strategy rather than a dispersed one. In the study area multiple management authorities translate into differing priorities and independent plans for forests, common lands/wastelands and private lands. The different actors and their interests within a matrix make it far more complex than the fortress model of conservation.

Finally, the advantage of incorporating Reserve Forests and the surrounding matrix into conservation is that it gives credence to the biophysical and social from the onset. A consideration of people's practices, strategies and perceptions will help develop a conservation strategy, rather than impose one. Protected Areas and rural communities are portrayed as opposing factions for multiple reasons. A landscape approach on the other hand, does not create separate spaces for humans and wildlife instead recognizes cohabitation based on history and sociocultural practices. Taking up conservation in Reserve Forests within the realm of human-dominated landscapes provides an alternative to traditional conservation paradigms that have had mixed results so far. More specifically, this approach has the potential to meet conservation objectives in a more sustainable manner without relocating communities and espousing a bottom-up approach as opposed to the top-down approach that is dominant.

In conclusion, undertaking a landscape approach and taking up conservation in a lived landscape leads to questions pertaining to how to navigate policy frameworks, conservation priorities and the social context. It is probably naïve to assume that centuries

of discourse built around exclusive spaces for wildlife, and praxis can change. Yet based on my research, ground realities obligate a change in both how conservation is framed, and which species and spaces are considered worthwhile. This is not an isolated case in India, as the literature reviewed suggests. Moreover, studies on the Snow Leopard in the Himalayas (Bhatnagar and Mishra 2014) and Wolves in the grasslands of southern and western India (Ghotge and Ramdas 2014; Ghotge 2016) are depictive of a changing paradigm. Through this research I focus on a small area in the Eastern Ghats, where an alternative conservation paradigm is possibly the only option. Hence, future research in the study area necessitates a comprehensive biodiversity survey which must be undertaken along with a more nuanced exploration into the relationality that coproduces shared spaces and mutual adaptations.

Appendix I

Household Survey Format

Code Identifier:_____Village:_____Gram Panchayat:_____

Mandal:_____ Associated Reserve Forest:____

Respondent Name:_____

1. Male ☐ Female ☐

2. What is your age? _____

3. How much education have you completed? No education☐ Primary ☐ Highschool/SLC ☐ Bachelors ☐ Masters ☐

4. How long have you lived in this community? _____

5. How many people live in this household? _____

6. Of all the people living in this household, how many are children under 15years of age? _____

7. What is your primary occupation? _____

Which of these activities contributes to your household income?

Agriculture	Livestock Rearing	Forest extraction	Mining	Coolie/Daily wage labor	Other

I. Agriculture

1. How much land do you own? _____ acres

Dry Land

2. How much is dry land? _____ acres

2.a Crop		2b. Mixed or single cropping?	2c. What do you do with this? (e.g. eat only, sell, etc.)	2.d. What did you grow in this field 20 years back?
Groundnut		Mixed ☐ Single ☐		
Tomato		Mixed ☐ Single ☐		
Rice		Mixed ☐ Single ☐		
Beans		Mixed ☐ Single ☐		
Fodder		Mixed ☐ Single ☐		
Vegetables		Mixed ☐ Single ☐		
Red Gram		Mixed ☐ Single ☐		
Other		Mixed ☐ Single ☐		

3. How much land is irrigated?_____ acres

3a. Crop		3b. Mixed or single cropping?	3c. What do you do with this? (e.g. eat only, sell, etc.)	3d. What did you grow in this field 20 years back?
Rice		Mixed ☐ Single ☐		
Tomato		Mixed ☐ Single ☐		
Sugar cane		Mixed ☐ Single ☐		
Vegetables		Mixed ☐ Single ☐		
Fodder		Mixed ☐ Single ☐		
Fruits		Mixed ☐ Single ☐		
Other		Mixed ☐ Single ☐		

4. What is the source of irrigation?

	Now	In the Past
Well		
Borewell		
Tank		

5. Did the government/panchayat provide a subsidy for the investment you had to make for irrigation?

Yes	No	Partial

How do you decide which crop you should grow?

Self	Elders	Family	Agricultural officer/ Horticulture department	Market rate

6. a. Of the crops you have, which has the best future?

_____

b. Why?

_____

7. Which crop has the most challenging future? _____

Why? _____

8. Do you have land that does not have any crops? Yes ☐ No ☐

9. Have you changed the amount of land dedicated to particular crops in the last 5 years?

Yes ☐ No ☐

If yes:

Crop	Decreased or increased land?	Why did you make this change?
	Decreased ☐ Increased ☐	
	Decreased ☐ Increased ☐	

	Decreased ☐ Increased ☐	
	Decreased ☐ Increased ☐	

10. What kind of inputs do you use on the land?

		From the house	Buy from the market or village	Buy from government
Natural	Manure			
	Other			
Chemical	Fertilizers			
	Pesticides			

11. Soil erosion and water retention strategies:

Field Bunds	Trees/ Shrubs	Rock fences	None	Other

12. Do you have any problems with wild animals in your agricultural fields? Yes/ No
    a. If Yes, which animals are a problem? For which crop?
    b. Has the number of animals coming increased or decreased?

---

13. Do they destroy the crops? Yes/ No
    a. If yes, what do you do to stop these animals from destroying crops?

_____

II. Livestock

Which animals do you keep?

Goats _____Sheep _____Cows _____Bullocks _____Buffalo _____ _____Other_____

1. What percentage of your household income depends on livestock?

Less than 50%	
More than 50%	

2. Do you take them for grazing? Yes/ No

Where?		Where did you take them 20 years back?	Who takes the animals for grazing?					
			Husband	Wife	Son	Father	Mother	Other
Forest								
Wasteland								
Private Land								
Other								

3. Are there any problems associated with taking the animals here?

_____

_____

4. If there is a leopard or wild dogs in the forest, what do you do to keep your cows/sheep/goats safe?

_____

_____

III. Forests & Wastelands

Now, I have a few questions about the forest and wastelands in this area

1. How often do you or someone from your household go to the forest?

	Forest	Wasteland	For what purpose (Fodder, Grazing, Firewood, Timber, NTFP/Other products from forest)
Everyday			
Weekly			
Monthly			
Rarely			
Never			

2. Are there any rules that you have to follow in the forest?
   Yes☐ No☐

Who made these rules? (Forest Department, Villagers, VSS)	When were these rules made	Do people follow these rules? Yes ☐ No ☐ If yes, who makes sure that the rules are not broken?

3. How do you think the forest has changed over the past 10 years?

   Increased ☐ Decreased ☐ No change☐

4. Do you think there is any change in the number of wild animals in the forest?

   Increased ☐ Decreased ☐ No change☐

5. What are the animal species that you have seen in the forest?

Hare/Rabbit ☐ Deer ☐ Monkeys ☐ Wild Boar ☐ Leopard ☐ Wild Dogs ☐ Bear ☐ Langur ☐ Monitor Lizard ☐ Birds Other ☐

6. a. Does the forest guard or ranger come to the forest?
Yes☐ No☐

b. How often does she/he come?

Weekly☐ Monthly☐ Rarely☐ Never ☐ Don't know☐

7. When are there forest fires?
Every summer ☐ Any time of the year☐ Rarely☐ Never ☐ Don't know ☐

8. a. Do people in this village hunt?
Yes ☐ No ☐
b. What do they hunt?
Hare/Rabbit☐ Deer ☐ Monkeys ☐ Wild Boar ☐ Leopard☐ Wild Dogs ☐ Bear ☐

Langur ☐Monitor Lizard ☐ Birds Other ☐

9. a. Do you collect any medicinal plants from the forest?
Yes ☐ No ☐

b. If yes, do you find these plants easily?
Yes ☐ No ☐

c. Do you find these plants in the revenue wastelands?

Yes ☐ No ☐

14. a. How have the trees/shrubs on the wasteland/ banjar bhumi/ poramboke changed over the last ten years?

Increased ☐ Decreased ☐ No change☐

b. What are the reasons for this change?

Agriculture ☐ Pattas/DKT ☐ Less rain ☐ More rain ☐ People have gas ☐ Don't know ☐

15. Who controls the wastelands?
Government/ Revenue department ☐ Panchayat ☐ Villagers☐ Other☐

16. a. Are there any rules in these lands (about who can use them or who can do agriculture here)?
Yes ☐ No ☐

b. Do you do agriculture here?

Yes ☐ No ☐ In the past ☐

17. Have you seen any wild animals in the revenue wastelands? If, yes which ones?

Hare/Rabbit☐ Deer ☐ Monkeys ☐ Wild Boar ☐ Leopard☐ Wild Dogs ☐ Bear ☐

Langur ☐Monitor Lizard ☐ Birds Other ☐

Quarrying/Mining

1. Is there any quarrying activity around your village? Where?
   Yes ☐ No ☐ In the past ☐

   Forest ☐ Wasteland ☐ Private Land☐

2. Who owns these quarries?

3. Do you or does anyone from your household work here? Who?
   Yes/No

4. Since when have they been mining here?
   Less than 2 years ☐ 5-10 years ☐ 20-30 years ☐

5. Do you think mining has an effect on the environment?
   Yes ☐ No ☐ Don't know ☐

6. a. Does it affect the agricultural fields or any water bodies in and around the village? How?
   Yes ☐ No ☐

   _____

   b. Are there any benefits to mining?

   _____

1. Are any of your children living/working/studying outside the village?
Yes ☐ No ☐

   a. If yes, where?_____

   b. Do they send you any money for your expenses? Yes ☐ No ☐

   c. Do they plan to come back to stay in the village in the future?
      Yes ☐ No ☐

2. Are you a part of any kind of a committee or group or association, in the village or outside?
Yes ☐ No ☐

If yes, what is it called and what do they do?

_____

_____

3. Is anyone in your family part of any group?
Yes ☐ No ☐

If yes, what is it called and what do they do?

_____

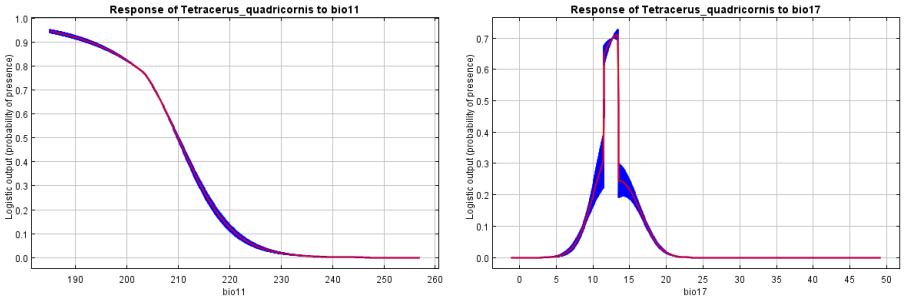
4. Are there any practices associated with your religion that make these forests good?

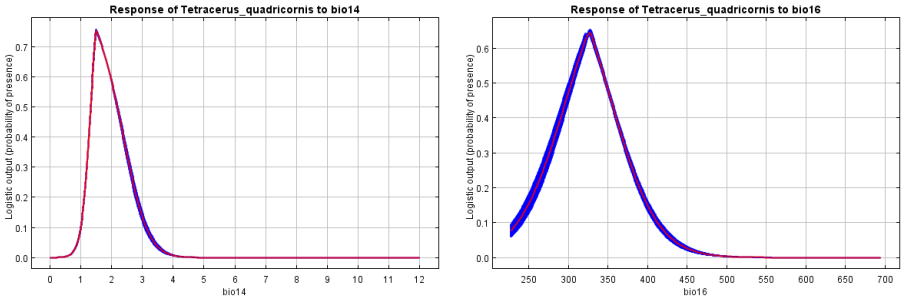
_____
_____

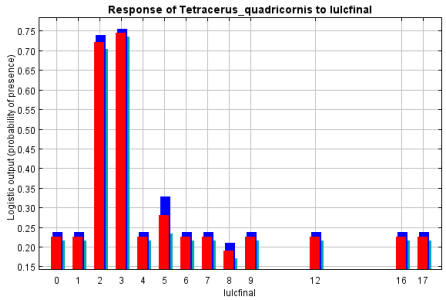
Appendix II

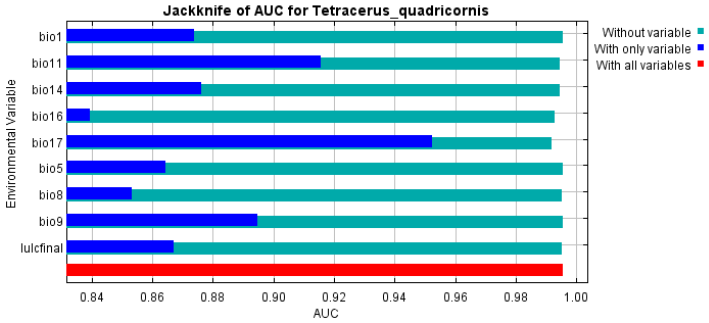
Response Curves & Jackknife Test Results

1. Four-Horned Antelope

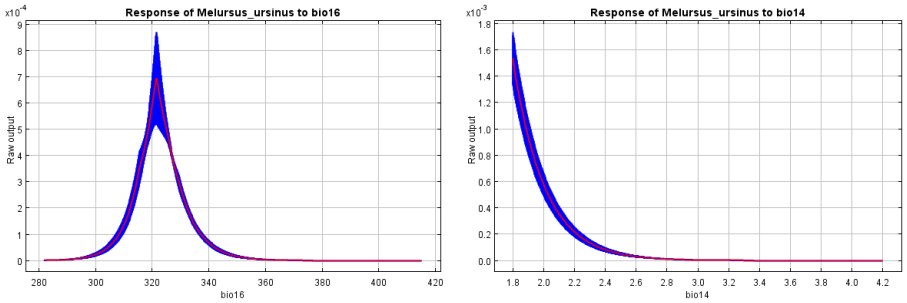


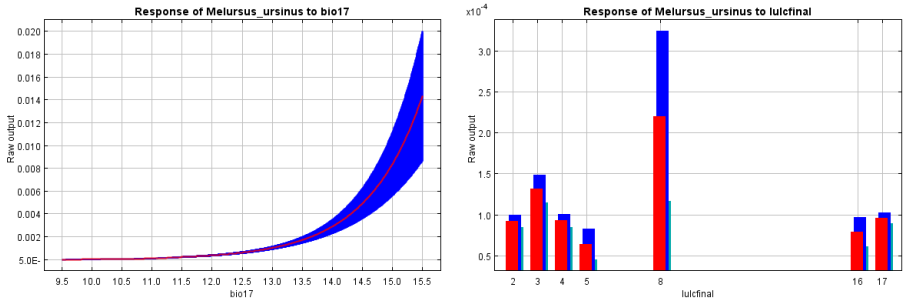


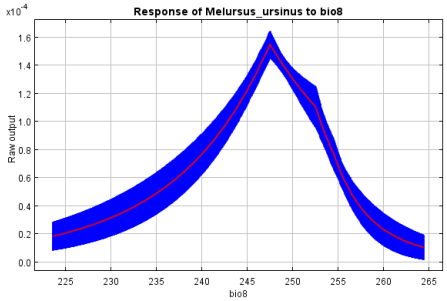


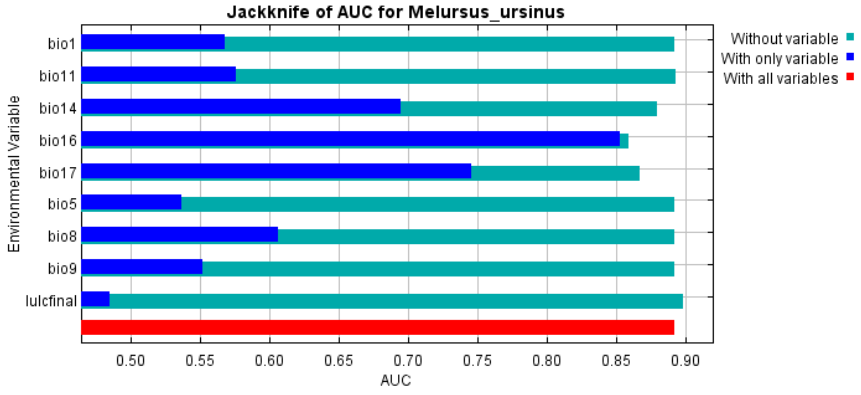


2. *Sloth Bear*

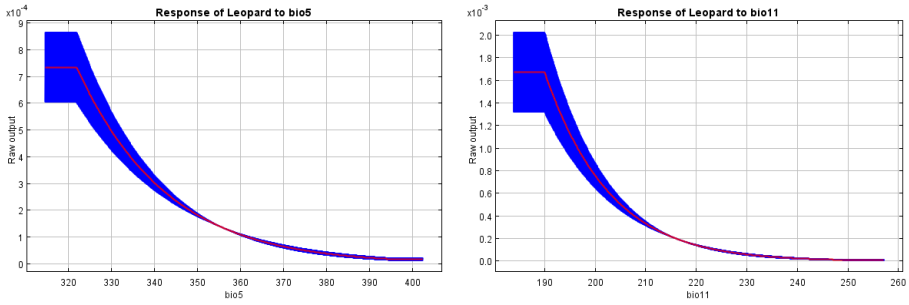

Response of Melursus_ursinus to bio16
Raw output
bio16
Response of Melursus_ursinus to bio14
Raw output
bio14

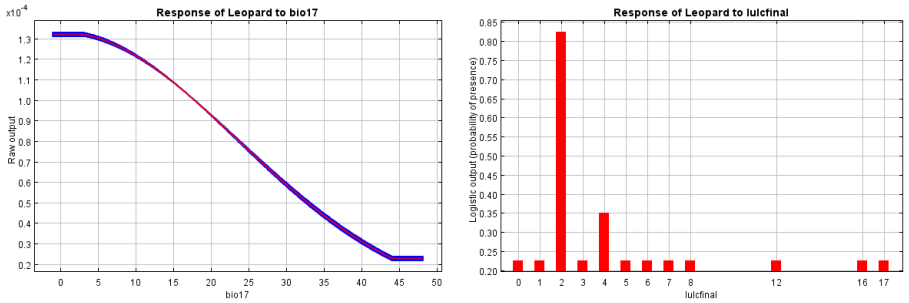

Response of Melursus_ursinus to bio17
Raw output
bio17
Response of Melursus_ursinus to lulcfinal
Raw output
lulcfinal

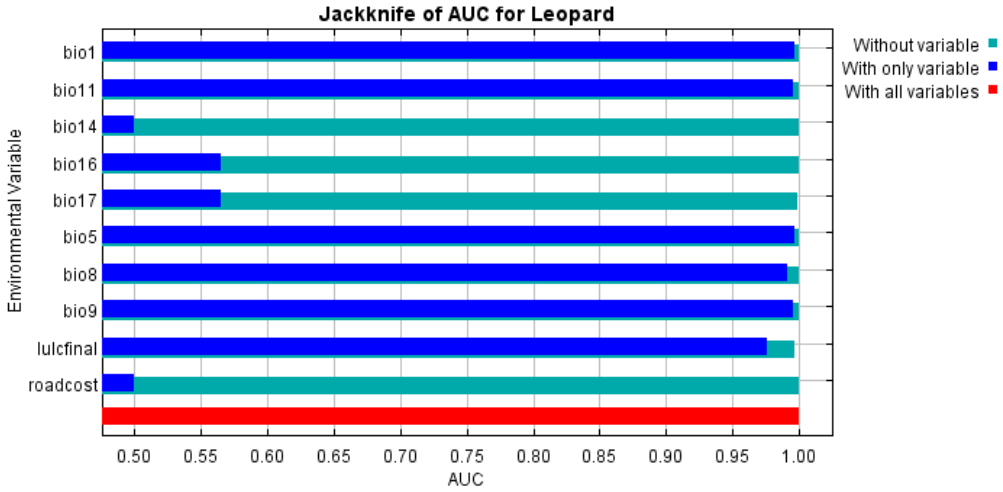

Response of Melursus_ursinus to bio8
Raw output
bio8


Jackknife of AUC for Melursus_ursinus
Environmental Variable
bio1
bio11
bio14
bio16
bio17
bio5
bio8
bio9
lulcfinal
AUC
Without variable
With only variable
With all variables

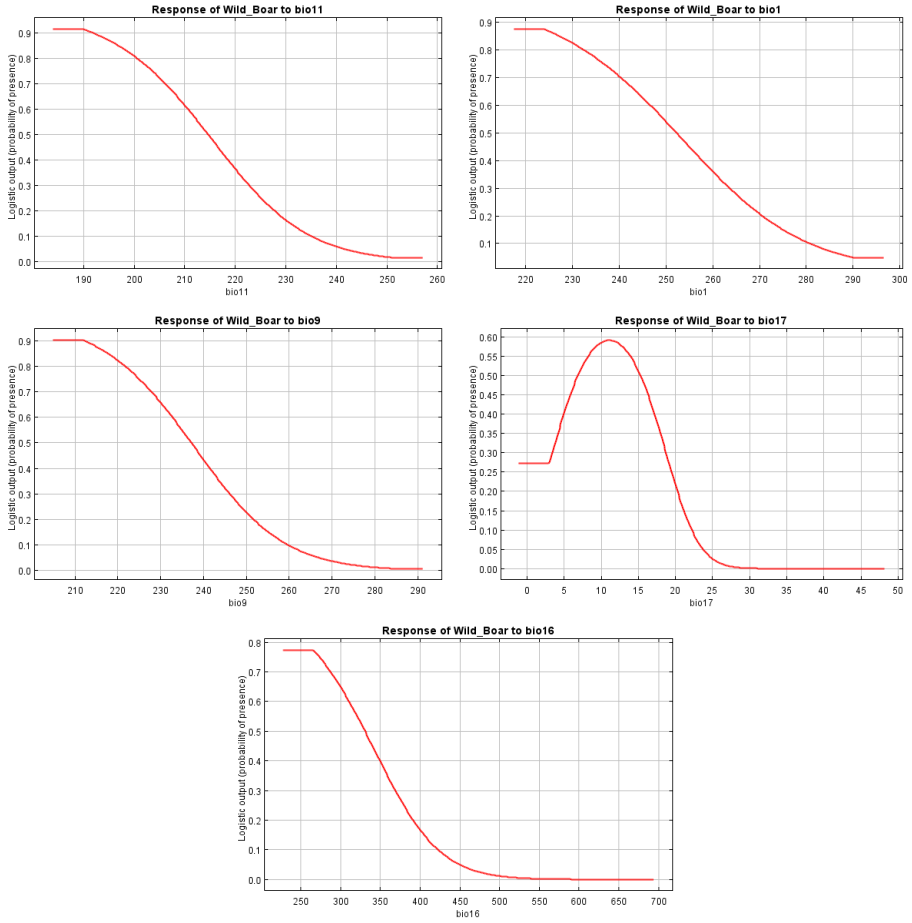
3. Leopard

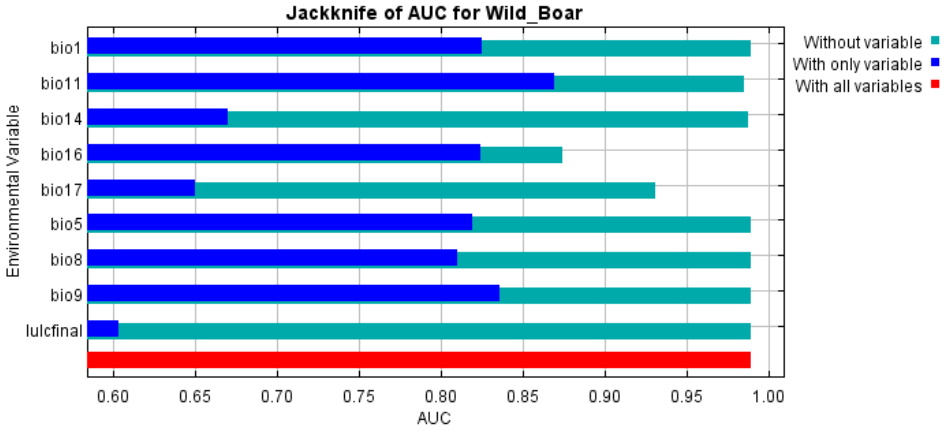

Response of Leopard to bio5
Raw output
bio5
Response of Leopard to bio11
Raw output
bio11


Response of Leopard to bio17
Raw output
bio17
Response of Leopard to lulcfinal
Logistic output (probability of presence)
lulcfinal


Jackknife of AUC for Leopard
bio1
bio11
bio14
bio16
bio17
bio5
bio8
bio9
lulcfinal
roadcost
Environmental Variable
AUC
Without variable
With only variable
With all variables

4. Wild Boar


Response of Wild_Boar to bio11
Logistic output (probability of presence)
bio11
Response of Wild_Boar to bio1
Logistic output (probability of presence)
bio1
Response of Wild_Boar to bio9
Logistic output (probability of presence)
bio9
Response of Wild_Boar to bio17
Logistic output (probability of presence)
bio17
Response of Wild_Boar to bio16
Logistic output (probability of presence)
bio16


Jackknife of AUC for Wild_Boar
Environmental Variable
bio1
bio11
bio14
bio16
bio17
bio5
bio8
bio9
lulcfinal
AUC
Without variable
With only variable
With all variables

Appendix III

Semi-Structured Interview Guide

1. How many people are there in your family? Which forested areas do you use?
2. How many months a year do you think your family depends on forest resources for sustenance?
3. How has your use of forest resources changed in the last 10??years? Historically/In the past: where did you live? Did you depend on the forest more or less for your sustenance? How has farming within the community changed in the last XX years? Did your community ever do shifting cultivation? What were the livelihood options in the past? Why has it changed? What do you think it will look like for the next generation?
4. Can you tell me a little about who in your family is responsible for collecting NTFP? Does your son/daughter come with you to collect NTFP from the forest? How did you learn about collecting these products and ways to use them? Is collection of forest resources shared between husband and wife or is only one member responsible?
5. What do you collect? What do you do with these items? Is this for sustenance or sale? If for sale, where do you sell it? How much time on average do you spend on a day-to-day basis collecting forest produce?
6. Are you free to collect anything or are there restrictions? Who enforces these restrictions? Does the forest guard or anyone from the village ever tell you what to collect or what not to? Are there any limits on the collection of any herb or root? Were there limits in the past/ How do you ensure sustenance of this particular resource?
7. Is there any competition between you and other people collecting the same resource? Or any kind of conflict? How do you deal with this?
8. In the past when there was a VFC did they impose any rules of access to these forest resources? What kind of rules? Who made them? Were you or other people in your community part of the VFC and part of the decision making process?
9. What about conflicts with wildlife? (for example bears and honey) What strategies/techniques do you use to avoid conflict with wildlife in the forest?
10. Wild boars are known to come to the groundnut fields; does any other wild animal exploit man-made resources or anything in the village and surrounding area?
11. What about hunting? How often do you hunt wild animals? Do you hunt for subsistence or for sale?
12. If you catch a wild boar how do you distribute or preserve the meat? Do you usually use guns or other trapping methods? What about leopards and wild dogs? Do people catch them too?

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