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Sacred Cows and the Protected Forest

A Study of Livestock Presence in Indian Wildlife Reserves

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By

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Chapter One

THE PROBLEM IN PERSPECTIVE

The societal context of livestock presence in Indian wildlife reserves

Even as India enters the twenty-first century, it remains an economy that is heavily reliant on the production and value-addition of biomass. Given India's population of one billion plus that continues its remorseless upswing, the ability of the land to provide for the needs and aspirations of its people is being increasingly challenged. Over 57 % of India's land area is pledged to feeding its millions, and there is an unrelenting demand for more land to be brought under the plough, or transferred to developmental uses. Under such pressures, forests and pasturelands in India have taken serious cutbacks in the recent decades. In particular, there has been a serious and epidemic loss of pastureland: indeed, between 1981 and 1993 the niggling 3.8 % extent of land area under pastures in India decreased by a further 4.1 % (WRI 1996). Importantly, such losses of pastureland must inevitably be viewed in the context of the more worrying fact that India supports the world's largest population of hoofed livestock: a whopping 449 million, which has swollen by nearly 6 % in the decade between 1984 and 1994 (WRI 1996).

At this point, it is important to note that India's problem of vast human and livestock populations, and their spiralling demands are juxtaposed against the survival of its rich and varied treasures of wild species and ecosystems. Indeed, authors have recognised India among the biodiversity hotspots (Myers 199x, Mittermeier et al. 1998) and centres of endemism and species richness in the world. Today, however, significant portions of India's biodiversity – particularly, its wild large vertebrates – are confined to a countrywide network of 593 wildlife reserves (Madhusudan and Karanth 2000). At the same time, over five million people are estimated to reside within these very reserves (Kothari 1995). Thus, the land and the biomass resources in these wildlife reserves are virtually under siege: on the one hand, from the subsistence demands of resident, high-density human communities, and on the other, from the billowing pressures of commerce and development. Together, these forces test the capacity of India's reserves to persist into the future as refuges for wildlife.

Among the various anthropogenic activities in India's wildlife reserves, the presence of domestic hoof stock has frequently been recognised as a significant factor affecting vegetation, wild ungulates and large predators. Surveys have shown that over two-thirds of India's wildlife reserves are grazed by local livestock (Kothari 1995), and at places, livestock even outnumber native wild ungulates (Chundawat 1999, C. Mishra *personal communication*). At this point, it is important to recognise that factors well beyond the sway of conventional ecology shape land-use practices such as livestock rearing the world over. The economics of the activity, its socio-cultural significance, and the administrative environment under which it is managed, are all critical determinants of the way livestock rearing can affect wildlife and their habitat. Yet, scant attention has been paid to this issue until now. Even the most basic descriptions of the fallouts of livestock presence in wildlife reserves are not to be found for Indian wildlife reserves.

How do livestock affect the composition and biomass of understorey plants in an area? Does their presence compromise the availability of forage for wild ungulates? How serious is the problem of livestock depredation by large carnivores? How effective are the strategies to alleviate this problem? How do larger scale changes in economy and infrastructure alter livestock rearing practices, and in turn, livestock impacts on wildlife habitat? Answers to these and many other questions are critical to an understanding and the management of livestock presence in Indian wildlife reserves.

This study is an attempt at elucidating the range and complexity of issues involved in understanding the fallouts of livestock presence in Indian wildlife reserves in India. Chapter Two reports observed differences in the composition and biomass of herb and shrub vegetation in two ecologically comparable areas differing in incident pressures of livestock grazing. Chapter Three explores the emerging nexus between subsistence use and commercial markets by presenting a case study of Hangala, a village on the border of Bandipur Tiger Reserve, wherein the system of local subsistence use of livestock dung has forged linkages with faraway commercial dung markets as a cascading effect of India's changing fortunes in the global coffee trade. Chapter Four presents data on the extent of livestock killing by large carnivores and examines the biological and administrative framework for alleviating conflict between people and parks. During the course of the work, additional data were gathered on the extent of conflict with elephants over crops, as also about measures undertaken by the administration to assuage such conflict.

Chapter Two

LIVESTOCK GRAZING AND FOREST VEGETATION

Effects of differential livestock grazing pressures on forest vegetation communities

Chapter Introduction

Viable populations of most Indian large herbivores and their predators occur primarily within India's designated wildlife reserves. Over two-thirds of these wildlife reserves are grazed by populations of local livestock. Their presence and foraging in wildlife reserves holds the potential to alter the structure and composition of forest vegetation. Such vegetation changes could, in turn, have cascading effects on the ability of habitats to support native wild herbivores. However, in India, basic quantitative descriptions of livestock impacts on forest vegetation have been scanty (for exceptions see Singh et al.), and in their absence, speculation has been rife as to the fallouts of livestock grazing.

In this study, I report differences in the biomass, structure and composition of shrub and herb vegetation between two ecologically-similar, adjacent moist deciduous forest sites that differed in incident grazing pressures. I also discuss the significance of these differences for native wild herbivores and for the persistence of bamboo-dominated moist deciduous forests.

Study Area

Bhadra Tiger Reserve (hereafter Bhadra) straddles the districts of Chikmagalur and Shimoga in Karnataka State. Here, the Western Ghats Mountains descend to the elevated tableland of the Deccan Plateau. Bhadra, covering an area of 495 sq. km. (Figure 1), was notified as a wildlife sanctuary in 1974, and subsequently, in 1998, was included as a tiger reserve under the Indian Government's Project Tiger initiative.

Bhadra receives over 2000 mm of rain annually, with most of it falling during the South West Monsoon between June and September. Bhadra is among the finest examples of southern moist deciduous forests. The upper canopy of these forests comprise species like *Terminalia alata*, *T. bellerica*, *T. paniculata*, *Grewia tilaefolia*, *Tectona grandis*, and *Diospyros montana*, while the middle canopy is dominated by species such as *Cassia fistula*, *Wrightia tinctoria*, *Kydia calycina*, and *Zizyphus xylopyrus*. In addition, Bhadra is particularly rich in bamboos: three species of bamboo – *Bambusa arundinacea*, *Dendrocalamus strictus*, and *Oxytenthera stockii* abound in the region. Riverine and moist tracts tend to add evergreen species such as *Syzygium cuminii*, *Vateria indica*, *Garcinia*, *Celtis*, and so on. A great variety of understorey shrub and herb species are also found in Bhadra. Local proliferation of exotic invaders such as *Eupatorium sp.*, *Ageratina sp.*, and *Lantana sp.* pose problems in certain regions of the reserve.

The large mammalian fauna of Bhadra comprises a diverse assemblage of predator and prey that includes large herbivores like the Asian elephant (*Elephas maximus*), gaur (*Bos gaurus*), sambar (*Cervus unicolor*), chital (*Axis axis*), wild pig (*Sus scrofa*), and muntjac (*Muntiacus muntjac*), and large carnivores such as the tiger (*Panthera*

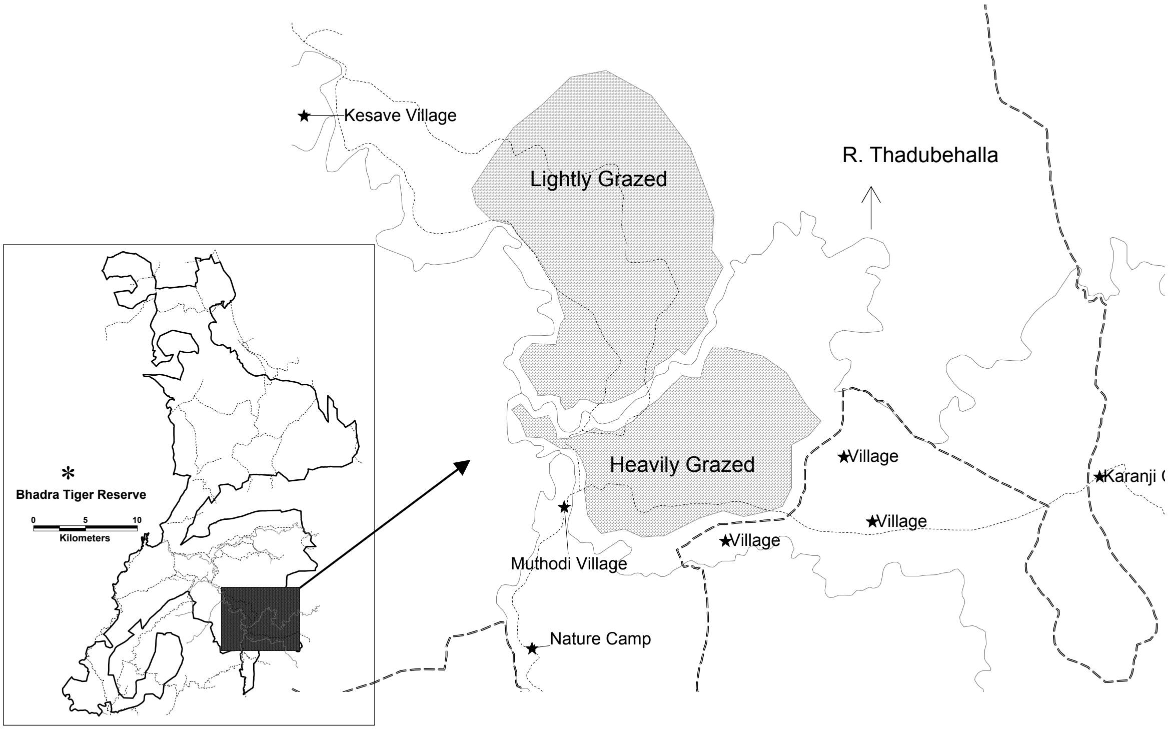


Figure 1. Map of Bhadra Tiger Reserve showing the heavily and lightly grazed sites

tigris), leopard (*Panthera pardus*) and the dhole (*Cuon alpinus*). Over 250 species of birds have also been recorded in these forests.

Sixteen revenue villages occur within the boundaries of Bhadra. In all, 736 families own interests in these villages (GOK 1992), although in reality, the number of families actually residing within the reserve is much lower. Several families have moved to nearby towns and moffusil centres to access better amenities. Most resident villagers carry out wet-paddy cultivation, while others gather assorted forest produce or work as daily wage-labourers in coffee estates outside the reserve. Resident livestock primarily consists of cattle, and infrequently, buffaloes, sheep and goat. Oxen are kept primarily as draught animals, while cows provide milk. More importantly however, irrespective of gender, cattle provide valuable manure for cropfields. With no identifiable pasturing commons available to them, the villagers graze their livestock in the forests of the reserve. Outside the cropping season, some livestock may also graze on crop fallows.

Methods

Choice of Study Sites

Based on my field observations, and in consultation with local villagers and park staff, I identified Thadubehalla (see Figure 1), a small river that cuts across the park, as a line of zonation with regard to the distribution of cattle activity. Areas on the South bank of the river were grazed by c. 200-300 cattle from Muthodi, Malgar, Kumbaragundi and Jaagra villages, while the areas on the North bank, besides being farther from villages, also came under the tourism zone of the Reserve, and were thus seldom grazed by cattle. The two sites, which I refer here as heavily- and lightly-grazed sites, were of similar topography and located not more than 10 kilometres apart, and hence, received similar amounts of rainfall. The two sites also had similar levels of other anthropogenic activity, which primarily included vehicular and human traffic and the collection of minor forest produce (seegé: *Acacia sinuata*). The two sites also had comparable fire-histories.

Vegetation Sampling

The sampling was carried out at the conclusion of the growing season, i.e., between January and May 1999. I sampled herbaceous and graminaceous ground vegetation in both strata on plots of 100 cm x 100 cm. I overlaid each plot with a quadrat divided into 100 grid cells (each cell was 10 cm x 10 cm), and used the grid to estimate the percent cover of different species within the plot. After estimating percent cover species-wise, I clipped a random subset of 19 and 17 plots in the heavily- and lightly-grazed sites, respectively, to examine the relationship between percent herbaceous cover and standing above-ground biomass (dry).

I sampled shrub species on circular plots of two metres radius (area = 12.57 m^2). 36 and 49 plots were placed in the heavily- and lightly-grazed sites, respectively. I counted the number of individual stems and recorded the height of each individual plant. However, for bamboo species, I counted the number of thickets falling within the plot and estimated an average height for the thicket. From six of the commonest shrub species, I collected a total of 107 individuals, representing different height classes. I dried these separately and weighed them to examine the relationship between shrub height and shrub biomass.

I also used a crude measure of palatability to classify all plant species encountered. This classification was based on field observations made on grazing cattle, or by means of a 'cafeteria experiment', wherein I checked whether penned cattle fed on a particular species or not.

Data analysis

Standard techniques of vegetation analysis (Kent and Coker 1992) were used to interpret the data. I used linear regression through the origin to examine relationships between herbaceous cover and above-ground standing biomass, and between shrub height and shrub biomass, respectively. During the analysis of data, I also examined saplings of tree species distinctly from shrub species. I estimated the following parameters, plot-wise: stem density, species richness, Shanon-Wiener index of species diversity, and evenness. Besides these, I also examined the above parameters after classifying plants into functional groups based on their palatability (palatable / unpalatable) and habit (tree sapling / shrub). I used t-tests to examine differences in these parameter estimates between the highly grazed and lightly grazed strata. Since these parameters were often closely correlated to each other, I carried out a Principal Components Analysis in order to accommodate interrelationships in the parameter estimates. Subsequently, overall differences between the strata were investigated using t-tests on the Principal Component Scores. For herb and shrub vegetation, I estimated Jaccard's index of similarity (Magguran 1988) for all pairs of plots, within the heavily and lightly grazed sites, and between them.

Results

Correlates of Plant Biomass

A strong increasing relationship was found between percent cover of herbaceous vegetation and its above-ground standing biomass (Figure 2) in both the heavily- and lightly-grazed sites. Interestingly, lightly-grazed sites showed a significantly higher rate of biomass accumulation with increasing percent cover, clearly indicating that for a given cover value, the overall herbaceous biomass was higher in the lighly-grazed site. I also examined relationships between shrub height and shrub biomass for six common species

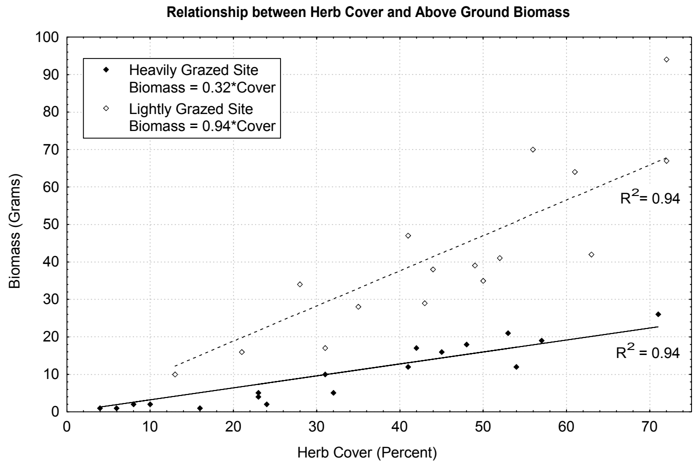


Figure 2. Relationship between herbaceous plant cover and biomass

at the two sites, taken together. Here too, linear regression analyses confirmed a significant increasing relationship between shrub height and shrub biomass in the range of values measured. However, there was considerable variation in the strength of the relationship (Table 1). Thus, herbaceous plant cover and shrub height were considered surrogates for the standing biomass of herbs and shrubs, respectively.

Table 1. Relationship between plant height and biomass for six common shrub species

Species	Regression Equation	R^2	N	P
Cipadessa baccifera	Biomass = 0.27 * Height	0.84	15	< 0.05
Clerodendrum infortunatum	Biomass = 0.26 * Height	0.88	15	< 0.05
Eupatorium odoratum	Biomass = 0.14 * Height	0.78	23	< 0.05
Lantana camara	Biomass = 0.27 * Height	0.52	24	< 0.05
Randia sp.	Biomass = 0.42 * Height	0.77	16	< 0.05
Stachytarpheta indica	Biomass = 0.52 * Height	0.46	14	< 0.05

Plant Cover, Density and Biomass

The lightly-grazed site had significantly higher herbaceous plant cover, and a greater stem density of shrubs (Table 2). However, the index of shrub biomass density (product of stem density and shrub height), although greater in the lightly grazed site, was not statistical significant between the two sites.

Table 2: Plant cover, density, and biomass in heavily- and lightly-grazed sites

Parameter	Heavily Grazed	Lightly Grazed	t-value	df	p
HERB SPECIES	(N = 40)	(N = 49)			
*Percent Vegetation Cover (per plot)	32.70	44.04	-2.87	87	0.005
SHRUB SPECIES	(N = 35)	(N = 49)			
*Stem Density (stems per plot)	37.97	46.31	-2.14	82	0.035
Index of Biomass Density (cubic units per plot)	4419.33	4845.04	-1.19	82	0.236

Species Richness, Diversity, and Similarity

In the herb layer, a greater number of species (30) were found in the heavily grazed site in comparison with the lightly grazed site (25). Estimates of plot-wise species richness and evenness did not vary between the sites. However, lightly grazed sites had a greater per-plot diversity of species (Table 3). In the shrub layer too, the heavily grazed site had a greater overall richness of species (71 species) as compared to the lightly grazed site (65 species). However, there were no discernable differences in the plot-wise estimates of shrub species richness, diversity and evenness between the two strata (Table 3). Measures of between-plot similarity (Jaccard's index) showed a greater homogeneity in species composition of herbs and shrubs in the lightly grazed site, as compared to plots in the heavily grazed site.

Table 3: Species richness, diversity, and similarity in heavily- and lightly-grazed sites

Parameter	Heavily Grazed	Lightly Grazed	t-value	df	p
HERB SPECIES	(N = 40)	(N = 49)			
Total Number of Species	30	25	-	-	-
Species Richness (per plot)	3.00	3.34	-1.37	87	0.174
*Shannon-Weiner Diversity (per plot)	0.65	0.83	-2.11	87	0.037
Evenness (per plot)	0.68	0.74	-1.25	87	0.213
*Jaccard's Similarity Co-efficient	14.6	33.1	-19.6	1769	< 0.01
SHRUB SPECIES	(N = 35)	(N = 49)			
Total Number of Species	71	65	-	-	-
Species Richness (per plot)	10.31	11.45	-1.54	82	0.127
Shannon Wiener Diversity (per plot)	1.90	2.03	-1.44	82	0.154
Evenness (per plot)	0.83	0.84	-0.58	82	0.561
*Jaccard's Similarity Co-efficient	15.2	25.2	-18.3	1769	< 0.01

Palatability

Under this functional category, the lightly-grazed site exhibited a greater per-plot richness of palatable herb species, as well as a lower richness of unpalatable herb species. Lightly-grazed areas also had a greater percent cover of palatable herb species (implying a greater biomass of palatable herbs), while having a lower cover value, and hence, biomass, of unpalatable herbs. With respect to shrub species, the lightly-grazed site had a greater biomass of palatable species, whereas it did not differ significantly from heavily-grazed sites in terms of either its unpalatable shrub biomass or per-plot richness of palatable and unpalatable shrub species.

Table 4. Richness and biomass of palatable and unpalatable species in heavily- and lightly-grazed sites.

Parameter	Heavily Grazed	Lightly Grazed	t-value	df	p
HERB SPECIES	(N = 40)	(N = 49)			
*Palatable Species (per plot)	2.33	3.06	-3.40	87	0.001
*Unpalatable Species (per plot)	0.67	0.28	3.18	87	0.003
*Percent Palatable Cover (per plot)	29.87	43.33	-3.57	87	0.000
*Percent Unpalatable Cover (per plot)	2.82	0.71	2.75	87	0.007

Parameter	Heavily Grazed	Lightly Grazed	t-value	df	p
SHRUB SPECIES	(N = 35)	(N = 49)			
No. of Palatable Species (per plot)	3.80	4.55	-1.59	82	0.117
No. of Unpalatable Species (per plot)	6.51	6.90	-0.79	82	0.430
*Index of Palatable Biomass (cubic units per plot)	1809.51	2409.05	-2.25	82	0.027
Index of Unpalatable Biomass (cubic units per plot)	2609.83	2435.99	0.54	82	0.591

Habit Guilds: Shrubs, Tree Saplings and Bamboo

I also categorised shrub species into habit guilds, namely shrubs, tree saplings and bamboo. The lightly-grazed site had a greater per-plot species richness, density, and biomass of tree saplings than the heavily-grazed site. Lightly-grazed sites also had a significantly greater density of bamboo clumps than the heavily-grazed site. However, no differences were observed between the sites with respect to the richness, density of biomass of shrub species.

Table 5. Richness, density and biomass of shrubs, tree-saplings and bamboo in heavily- and lightly-grazed sites.

Parameter	Heavily Grazed	Lightly Grazed	t-value	df	p
No. of Shrub Species (per plot)	4.43	4.00	1.09	82	0.277
*Tree Species (per plot)	5.89	7.45	-2.11	82	0.038
Density of Shrubs	20.51	22.43	-0.70	82	0.487
*Density of Tree Saplings	17.46	23.88	-1.97	82	0.052
*Density of Bamboo Clumps	1.39	3.00	-2.29	82	0.025
Index of Shrub Biomass	3796.05	3805.24	-0.03	82	0.979
*Index of Tree Sapling Biomass	623.28	1039.80	-3.59	82	0.001

Multivariate Analysis

Since the parameters I chose above to describe vegetation communities were likely to be correlated, I carried out a principal components analysis to control for their correlated effects, facilitate investigation of differences in the vegetation of heavily- and lightly-grazed sites under a multidimensional framework.

The PCA carried out on the herb data extracted three principal components (PC), which explained 83.8 percent of the variation in the dataset. PC1, which I called the palatability axis, correlated positively with proportion of palatable species, proportion of palatable cover and negatively with richness and cover of unpalatable species. PC2 correlated positively with overall species richness, species diversity, and the richness of palatable species. PC3 correlated positively with overall plant cover and palatable cover. Heavily-grazed plots had significantly lower PC scores than lightly-grazed plots along all three axes (Table 6), indicating that they had were characterised by lower palatability (PC1), lower richness and diversity (PC2), and lower cover (PC3).

Principal components analysis carried out with the shrub data extracted two PC axes, which accounted for 77.4 percent of the variation in the data. PC1 showed positive correlations with overall species richness and diversity, as well as with the richness of tree-saplings and palatable species. PC2 was positively correlated with overall biomass, and the biomass of palatable species, tree saplings, and bamboo abundance. Here again, heavily-grazed plots assumed significantly lower values of both PC1 and PC2, indicating that it was characterised by lower values of species richness, diversity and biomass.

Table 6. Principal component scores of plots in heavily- and lightly-grazed sites

Parameter	Heavily Grazed	Lightly Grazed	t-value	df	p
HERB SPECIES	(N = 40)	(N = 49)			
*PC1 Score – Palatability Axis	- 0.435	0.355	-4.02	87	0.000
*PC2 Score – Richness & Diversity Axis	- 0.294	0.240	-2.59	87	0.011
*PC3 Score – Cover Axis	- 0.236	0.193	-2.05	87	0.042
SHRUB SPECIES	(N = 35)	(N = 49)			
*PC1 Score – Richness & Diversity Axis	-0.26	0.18	-2.03	82	0.045
*PC2 Score – Biomass Axis	-0.33	0.24	-2.65	82	0.010

Discussion

This study has shown that heavy grazing pressures by livestock are accompanied by a decline in the abundance of understorey vegetation (Table 2). However, it is important to note that the pressures of biomass depletion are not felt equally among all plant species. First, there is a clear pattern that heavier grazing pressures are accompanied by a lowered variety and abundance of palatable species (Table 4). This could set off significant second-order effects on native wild herbivores that share resources with livestock. Second, heavier grazing pressures are also shown to go with a lowered variety and abundance of tree saplings (Table 5). The sustained loss of tree saplings as an effect of grazing has obvious effects for tree species recruitment, and in the long run, indeed for the structure and composition of the forests themselves. In the light of this fact, the glaring differences in the diversity and abundance of tree saplings in the heavily grazed ares of Bhadra are a cause for concern. Third, the lowered abundance of bamboo clumps in heavily grazed areas (Table 5) suggest that bamboo too is among those species that are differentially impacted by cattle grazing. This is an important concern to be borne in mind, considering the fact that the dominant thorny bamboo (*Bambusa arundinacea*) has commenced gregarious flowering, and its regeneration prospects can change considerably under varying regimes of livestock grazing intensities.

This study also reaffirms an important limitation of community measures such as richness and diversity that are not sensitive to biological attributes of individual species. The overall richness of herb and shrub species was higher in the heavily grazed site. However, once species had been categorised into guilds as palatable and unpalatable species, or as shrubs and tree-saplings, these patterns tended to change drastically. For instance, although the two strata did not differ in terms of species richness per plot (Table 3), further analysis showed that heavily-grazed plots showed a greater richness of unpalatable species, and a lower richness of palatable species.

The impacts of livestock grazing on tropical forest vegetatation has hitherto mostly been a matter of conjecture. Thus, the management of livestock presence in Indian forests has long proceeded in the absence of even simple quantitative descriptions of the pattern of impact. As this study indicates, livestock grazing does seem to play a serious role in the degradation of forest ecosystems. Further, given the variation of natural systems and the anthropogenic impacts on them, there is an acute need for the variability in grazing impacts on tropical forest vegetation. Better understanding is also needed into the processes (e.g., productivity-biomass relationships, survival and recruitment in tree saplings, diet and habitat choice by wild ungulates and livestock, and so on) governing these patterns. Given the enormity of the grazing problem in Indian wildlife reserves, if this understanding is late in coming, it will inevitably go with serious costs to the conservation of wildlife and their habitat.

Chapter Three

OF COW DUNG AND COFFEE

Conservation in the grey zone of subsistence and commerce

Chapter Introduction

In India, and indeed, the world over, two important forces are recognised in the degradation and loss of wildlife habitats: the subsistence pressures of local users and the commercial pressures of regional and global markets. Broadly, subsistence has been characterised as those human activities that owe their origin to a tradition-based fulfilment of basic local needs (e.g., hunting, pastoralism, and non-timber-forest-product removal). On the other hand, technologically-intensive enterprises of extractive natural resource use founded on motives of profit making (e.g., logging, trawling, or ranching) have been recognised as commercial activities. Further, subsistence use is also distinguished by the presence of a local catchment for a resource, by its local consumption, and commonly, by a local regulation of its extraction. Besides these, it also occurs on extensive scales of space and time, typically involving large numbers of consumers, each responsible for a relatively low *per capita* off-take of the resource. In contrast, commercial use involves the extraction of resources from global catchments, caters to global demands, and is regulated, if at all, by equations of supply and demand in global markets. Its technology-reliant nature facilitates intensive resource extraction with an economy of effort, resulting in high *per capita* off-takes, and enabling profit motives to the extraction enterprise.

In general, subsistence and commerce have been regarded as distinct and independent modes of natural resource use, affecting conservation prospects for wildlife differently. Behind such a clear-cut distinction is a prevalent notion of stasis in the defining attributes of subsistence and commercial resource use. For instance, traditional land-uses such as pastoralism and non-timber forest product collection, which undoubtedly have originated as forms of subsistence resource use, are often still assumed to remain so, regardless of their current context. Such assumptions often neglect vital elements of dynamism within these resource use regimes, as well as in the reciprocal relationships between them. This issue assumes conservation significance in the light of the fact that today, global and local conservation agendas are increasingly being driven by the utilitarian ideology of sustainable use, which makes *provision* – rather than *protection* – the path to conservation. Subsistence use, in particular, has pleaded consideration as a sustainable and remissible form of natural resource use that is compatible with conservation goals since it is meant to serve the immediate basic needs of local consumers.

But, in today's rapidly changing socio-economic contexts, is this at all a valid assumption to proceed on? Today, do traditional subsistence activities continue to serve basic local needs, or have they expanded in their scope? On the other hand, do technologically intensive extractive enterprises founded on profit making involve inputs from many hitherto subsistence-based systems? Few studies have actually examined relationships between commercial markets and subsistence activities. In their absence, several critical questions remain unanswered. For instance, what factors contribute to the maintenance of a subsistence activity in its original form? What factors facilitate the penetration of commercial markets into the arena of subsistence use? What are the biological, social, economic, and administrative fallouts of such a juxtaposition of subsistence use with commercial markets? Where conservation of the resource in question is priority, how are such qualitative transformations in resource use to be managed?

In this chapter, I introduce a unique dung-based livestock production system in the agro-pastoral village of Hangala in southern India, where nearly all livestock raised for dung production graze within the adjoining forests of Bandipur Tiger Reserve. I then examine factors that have, over the last decade, helped transform livestock dung from a locally-produced and locally-consumed organic fertilizer to a high-value commodity for commercial export to faraway coffee plantations. Finally, based on biological, economic, and administrative criteria, I analyse the conservation implications of this transformation in the dung economy: from local subsistence use to regional commercial export.

Hangala Village: Living on the Edge

Hangala Village is located at the foothills of the Western Ghats Mountains in Chamarajanagar District of Karnataka State in southern India. It lies on the north-eastern boundary of the 874 square kilometre Bandipur Tiger Reserve, dominated primarily by open deciduous forests. Bandipur is acknowledged among India's finest wildlife reserves, supporting high densities of large herbivores including the gaur (*Bos gaurus*), the Asian elephant (*Elephas maximus*), and large carnivores such as the tiger (*Panthera tigris*), leopard (*Panthera pardus*) and dhole (*Cuon alpinus*). In marked contrast to most other wildlife reserves in the country, there are no human settlements within the boundaries of Bandipur Tiger Reserve, and all anthropogenic biomass pressures – primarily livestock grazing and fuelwood removal – on the park originate from the 180-plus villages that occur along the Reserve's northern flank.

Hangala (area: 768 ha., families: 1017, population: c. 5400) has traditionally been a village of dryland agro-pastoralists. Hardy, low-yielding, rain-dependent crops dominated by millets and pulses have formed the mainstay of the agriculture in these parts. In addition, rearing of livestock—primarily cattle—forms a vital link with the dryland agriculture of the villages. The hardy breed of native cattle reared here are used extensively as draught animals, but more importantly, their dung has always constituted the primary source of rich organic manure in an otherwise nutrient-impoverished agro-ecosystem. Milk yields from the village were generally poor, and thus, catered only to local consumption. The village livestock have always had ready availability and free access to grazing land in the forests and scrubland of the adjoining wildlife reserve.

The agrarian economy of the village has traditionally been based on subsistence. Farmers mostly practised mixed cropping of cereal crops such as jowar (*Sorghum vulgare*) and raagi (*Eleusine coracana*) with pulses such as horse-gram (*Dolichos sp.*), groundnut (*Arachis hypogea*), *avaré*, *thogari*, *alasandé* in addition to the oilseed, castor (*Ricinus communis*). The farming cycle typically commenced by the end of summer (March-April), when farmers ploughed and manured their land in anticipation of the pre-monsoon showers, and sowed their crop soon after the first rains. Thus, a farmer had to sink in a considerable investment into the agricultural enterprise in terms of labour, manure and seeds even before the monsoons had arrived in earnest. Very often, this investment was made possible through loans secured from local moneylenders at prohibitive interest rates. After the sowing, the crop performance depended primarily on the amount and temporal distribution of rainfall. Besides unpredictable rainfall, the extent of crop losses to marauding wildlife, particularly elephants and wild pigs, was also a critical determinant of agricultural yields in the villages. So serious has the uncertainty in crop yields been in these parts that it is not uncommon for a farmer to incur a heavy loss, and go deeper into debt at the end of the growing season, either because of a failed monsoon or serious crop depredation by wild animals. Of the final harvest then, the farmer typically retained a small proportion as seed crop for the next sowing year, sold a larger portion repay his loan, and consumed the rest domestically. Only rarely was the average farmer able to achieve a surplus in cereal crop that he could exchange in the market in nearby towns for extra cash.

Thus, rain-dependent agriculture in these dryland areas has clearly been an activity beset with high risk. Substantial investments by farmers in the form of labour, manure, and seed at the beginning of the agricultural season (see Table 1) have had to be recovered almost exclusively from agricultural output. Understandably then, the high degree of uncertainty involved in the realisation of a proper harvest has favoured the adoption of a risk-minimisation strategy in the villages. Such a strategy has assumed many different forms, whereby a farmer minimises cash investment into agriculture, or switches to crops that are relatively more robust to variations in rainfall (cotton) or suffer lower levels depredation by wild animals (sunflower, castor), or perhaps, even by exploring alternatives to agriculture as a means of sustenance.

Table 1. Approximate Agricultural Investments and Yields (in Rupees per Acre) in Hangala, 2000

Crop	**Investment ***	**Fertilizer Options**		**Yield**
		Dung	**Chemical**	
Jowar Native	3,200	1,500-1,800	600-700	4,800-7,200
Jowar Hybrid	3,770	1,500-1,800	600-700	16,800-19,200
Raagi	3,050	1,200-1,500	600-700	4,500-4,900
Castor	3,000	600	60-70	4,800-6,500
Groundnut	4,500	1,200-1,500	755-855	10,000-14,400
Cotton	3,630	1,200-1,300	600-700	10,400-13,000
Sunflower	4,850	900-1,050	300-350	6,300-9,600
Avaré †	980	0	0	6,400-7,200
Horse Gram †	1,050	0	0	4,800-5,600
Lentil †	1,020	0	0	4,000-6,000
Alasandé †	1,000	0	0	2,000-3,600

* Calculated as total costs of ploughing, seeds, weeding, pesticide, harvest & transport. Labour from farmers' family has not been included in the valuation.

† Pulses grown as mixed crop along with jowar and sunflower

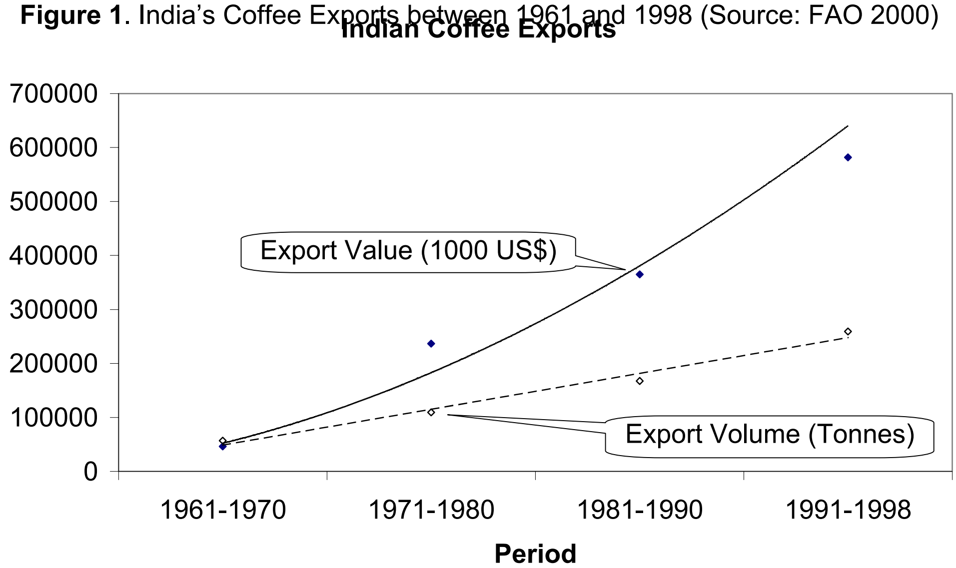
Brazil's Cup of Woe, India's Cup of Joy: Changing World Coffee Fortunes

Ever since coffee was introduced into Latin America from Africa over 170 years ago, Brazil and Columbia have traditionally dominated the 60-strong community of coffee growing countries of the world's tropics. They contribute c. 30% and 20%, respectively, to the world's annual production of coffee. India, on the other hand, has a small but significant share in the world's coffee markets, contributing 25% to the Asian production and c. 3-4% to the world production of coffee. India exports nearly 70% of its annual production of coffee, the remaining amount being consumed domestically.

Although Brazil dominates the world's coffee markets, it is plagued by the vagaries of climate, particularly by frosts and droughts that inflict serious damage on its coffee crop. Frosts have hit Brazil's coffee 31 times in the last 172 years, with the frequency of damaging frosts showing an increase during the latter part of the 20th century. In the last four decades, the most serious frosts in Brazil have occurred during the mid-1970's and mid-1990's, depressing its coffee exports by nearly 50%. Such radical fluctuations in the export volume of the market leader has had dramatic repercussions on the fortunes of smaller competitors such as India.

Following the slumps in Brazil's coffee outputs in the mid-1970's and mid-1990's, India recorded increases in the value of its coffee exports that were disproportionate to the increase in export volumes (Figure 1). Producer prices for coffee in India have been in

Figure 1. India's Coffee Exports between 1961 and 1998 (Source: FAO 2000)



a continuous upswing in India since the 1970's. Interestingly, the geographical distribution of these export profits have not been spread out wide. Over half (52%) of India's coffee-growing areas fall within the three contiguous south Indian districts of Kodagu in Karnataka State, Wynaad in Kerala State and Nilgiris in Tamil Nadu State (CBI 2000). The three districts together have a 54% share in India's total coffee production and export. Of great relevance to this essay is the fact that all these districts are virtually adjacent to Chamarajanagar, wherein the peripheral villages of Bandipur Tiger Reserve (including the villages of Hangala and Melkaamanahalli) are located.

Thus, hefty profits accruing from India's coffee exports were dispersed within the narrow geographic confines of three adjacent coffee-growing districts of Kodagu, Wynaad and Nilgiris. Widening profit margins made it possible for coffee-growers in these parts to afford materials and services that were otherwise out of their reach, both literally and figuratively. For instance, in the 1990's, there was an emergent problem of labour shortage, and hence, high labour wages in the coffee-growing regions of Thithimathi in Kodagu. This problem was rapidly offset as a result of the newly-acquired ability of many coffee-growers to afford the import, on a daily-basis, of the requisite workforce from the nearby dryland region of Periyapatna. Thus, enlarging profit margins for coffee faciliatated an expansion in the resource catchment for coffee growers of Kodagu, Wynaad and Nilgiris.

Higher labour wages in coffee estates had yet another unforeseen consequence on the wet-paddy cultivation that was carried out in the valleys. It gradually resulted in a shortening supply of labour for the labour-intensive and low-paying cultivation of wet paddy. Consequently, paddy came to be replaced by ginger, which required less labour investment, and assured much higher per-acre monetary returns than paddy. However, this advantage went with a rider: like coffee, ginger too required large amounts of organic manure, which was a commodity in short supply in these regions. The fertile, high-rainfall districts of Kodagu, Wynaad and Nilgiris are hilly and well-suited to intensive land-use, primarily the cultivation of cash crops such as coffee, tea, ginger, cardamom, and pepper. It has therefore remained an uneconomical proposition to transfer land in these areas to low-yield uses such as pasturing of livestock for manure production. Thus, the cultivation of cash crops in these regions has always proceeded under an important constraint, namely the free availability of organic manure.

Predictably, this problem too was surmounted by an enlargement of resource catchments. Just as labour catchments had enlarged to offset labour shortages in these districts, a similar expansion of catchment began to unfold even in the instance of vital organic manure required by the growers of coffee and ginger.

The Subsistence-Commerce Handshake

Under changing scenarios of profit from coffee export — and the proliferation of ginger cultivation as its knock-down effect — it became economically viable for these cash-croppers to expand their catchment for organic manure to include nearby rain-starved areas such as the villages adjoining Bandipur Tiger Reserve. This option was also logistically feasible since the villages enjoyed convenient highway access from the coffee-districts. In villages like Hangala, on the border of Bandipur Tiger Reserve, the rearing of livestock was still a relatively profitable proposition, given that there was virtually unrestricted access to grazing within the Reserve's boundaries, and dryland farming on the Reserve's border was beset with serious economic risks for the farmer. The demand for dung from the adjoining coffee-growing districts, thus came as welcome succour to the villagers of Hangala and other villages in this region.

The commercial trade in livestock dung, according to the local villagers interviewed during the course of this study, came into existence approximately two decades ago, beginning with Berambaadi, a small village on the Karnataka-Kerala State border. The timing coincides with the first major spurt in India's profits from coffee exports (Figure 1), which followed the devastating Brazilian coffee frosts of the late-1970's. Villagers also report a subsequent intensification of the trade over the last 7-8 years, which, interestingly, corresponds to the most recent profit-pulse recorded with India's coffee exports, and coinciding with the Brazilian coffee frosts of the early 1990's.

Today, trade in livestock dung proceeds on monumental scales in Hangala and the surrounding villages. From estimates of livestock numbers and per capita dung production made in Hangala (Table 2), approximately 39 tons of dung (wet weight) is produced by the village livestock daily. Of this, the quantity of dung exported daily ranges between 16 and 24 tons (a mixture of dry and wet dung). At a conservative estimate, this implies that approximately 41 to 62 percent of the dung produced is being harvested for export. This, by itself, is significant considering that substantial amounts of the dung produced by livestock are deposited outside their stalls. The harvest system for dung in Hangala, however, is geared towards maximising efficiency of collection. Dung deposited overnight in the stall (roughly half the daily production) is retained by the owner. Dung deposited while grazing in the adjoining forests is sought out and gathered by professional dung collectors, who number 25-30 in Hangala alone. Further, the *Mandal Panchayat* (Village Council) of Hangala issues competitive tenders annually for exclusive rights of dung collection at nine public locations, including the cattle pound and eight village streets along which cattle are marched as they are led out to graze and back. Thus, serious effort is invested in maximising the amount of dung gathered for export.

In the villages, dung is usually purchased in units of *sack-loads* (approx. 20-25 kilos), *truck-loads* (approx. 4-6 tons, depending on volume of dry dung), and *heaps* (quantity variable). Purchase prices for dung have soared over the last twenty years, when the trade first began: one truck-load of dung, which then fetched Rs. 300, today fetches between Rs. 2,500-4,500, while the going rates for a sack-load today range between Rs. 30-35. At prevailing rates, the monetary value of dung exported from Hangala daily ranges between Rs. 16,500 and Rs.26,500.

Table 2. Census of Livestock and Estimates of Daily Dung Production in Hangala, 2000

Livestock Species	Population	Daily Per Capita Dung Production (Kilos)		Daily Total Dung Production (Kilos)	
		Wet Wt.	Dry Wt.	Wet Wt.	Dry Wt.
CATTLE					
Adult Male	515	18.2 (0.75)	5.47	9,298.9	2,817.8
Adult Female	1,531	13.4 (2.65)	4.03	20,340.3	6,163.7
Young	605	8.3 (0.57)	2.50	4,992.2	1,512.8
BUFFALO					
Adult Female	154	20.1 (-)	6.04	3059.8	927.2
Young	62	12.5 (-)	3.75	772.5	234.1
GOAT					
Adult	1,005	-	} 0.16 (0.04)	455.6	205.0
Young	245	-			
SHEEP					
Adult	44	-	} 0.16	217.2	97.7
Young	552	-			
TOTAL	**4,713**	**-**	**-**	**39,136.4**	**11,958.4**

(1) Figures in parantheses indicate standard error of estimates, where available
(2) Buffalos are assumed to produce 1.5 times more dung per day than cattle; sheep are assumed to produce similar amounts of dung per day as goats
(3) Conversion between wet and dry weights of dung are based on empirically established relationship during this study, where 1 kilo wet weight = 0.3 kilo dry weight for cattle and buffalo and 1 kilo wet weight = 0.45 kilo dry weight for goat and sheep.

Besides the dung seller, benefits of the dung trade have also accrued to other sections of people within the village. Today, there are professions within the village that are exclusively linked with the dung trade. Dung agents who broker deals between prospective buyers and sellers of dung are now an integral part of the trade. These agents also organise the labour force required to load dung on to trucks. The labourers, who load dung on to trucks for a daily wage, constitute a second segment of people whose work revolves around the dung trade. Besides the agents and loaders, there are dung collectors who follow the village livestock each day into the forests, and gather dung deposited by the animals in the forests. Hangala alone consists of about 15 dung agents, at least 200 dung loaders (including those who accompany trucks to neighbouring villages), and 25-30 dung collectors. Dung agents are paid Rs. 100 a day, dung loaders are paid Rs. 75-80 a day, while, dung collectors, gathering 2-3 sack-loads of dung a day earn between Rs. 70 and Rs. 105. These daily wage rates are at least 20% higher than prevailing agricultural wages in the region. Thus, the dung trade today supports the livelihood of at least 250 daily wage earners by contributing Rs. 18,250–20,650 in terms of daily wages alone. Besides individuals who profit from the trade, the *Mandal Panchayat* also earns substantial amounts (Rs. 67,095 during 1999-2000) by auctioning rights of dung collection along the village roads, and the licence to levy a toll on trucks carrying dung out of the village.

The widespread changes in the local village economy as a result of the dung trade have had a cascading socio-economic effect within the village. The emergent dung trade has conferred a prominent role for cash in the life of villagers. Cash has opened access to a variety of commodities and services that were previously beyond their reach as subsistence farmers. For instance, villagers report an increasing preference for commercially profitable non-cereal crops such as castor, cotton, and sunflower, which require greater preliminary investment, but are less prone to raids from wildlife, and offer larger margins of profit. A more striking change has arisen with regard to the use of manure in the local agricultural system. Traditionally, dung was the favoured method of fertilising cropfields since it was freely available as a bye-product of livestock rearing, and did not require monetary investments. Chemical fertilisers, in contrast, required an investment of cash, to which the risk-prone subsistence farmers were averse. The advent of the dung trade transformed dung into a source of ready cash, and gradually allowed farmers the facility to purchase chemical fertilizers. Indeed, today, the prevailing market rates for dung are so high that, for most crops, it is now possible to sell the dung requirement for cash, purchase an equivalent of chemical fertilizer (see Table 1), and still be left with surplus cash. Unrelated policies of the Indian Government, favouring subsidies on fertilizers have also unwittingly facilitated the abandonment of dung-as-fertilizer by making chemical fertilizers available cheaply.

An extreme manifestation of the cash-for-dung phenomenon can be seen in the neighbouring village of Melkaamanahalli, which testifies to the greater profitability of land use based on dung export, as opposed to traditional agriculture. Farmers here have constantly suffered heavy agricultural losses under the onslaught of crop-raiding elephants, implying that an investment of dung within their agricultural fields has proved a risky and costly bargain. Those only selling dung, however, fared quite well. Thus, over the last three years, 14 of the 15 land-owning families in the village have completely discontinued cultivation on their land, and now use it to pasture additional livestock brought in from nearby towns. This arrangement has enabled a mutually-beneficial relationship between the villagers and townsfolk, whereby villagers now graze livestock from towns (without a change in ownership) in return for exclusive rights over dung and milk. Villagers, who were once dependent on subsistence agriculture to meet their requirements of foodgrain, are now able to purchase foodgrain from cash incomes generated from the dung trade. Thus, agriculture in Melkaamanahalli has virtually vanished at the instance of a booming, risk-free dung trade.

Cash has also played an important role in altering livestock holding patterns within the villages. Traditionally, large holdings of livestock were concentrated with large land-owners, who commanded the ability to invest in them and provide for their maintenance. This investment, besides the actual cost of livestock, also involved employing a herder who was paid a herding fee consisting of his annual requirement of grain. Thus, livestock holding was highly skewed in favour of a few wealthy people. However, in recent times, herders expect to be paid in cash, and no longer accept the antiquated mode of payment in kind. Herders today charge an advance annual fee of Rs.

150 per head of cattle or buffalo, Rs. 200 per head of sheep, and Rs. 250 per head of goat. Thus, large holdings of livestock have now become uncommon owing to the hefty investment of cash required to have them herded. On the other hand, a greater availability of cash among the landless has favoured a proliferation of small livestock holdings that are tended by owners themselves. Thus, although there is probably little conceivable change in the overall livestock numbers at the village level, their distribution today is perhaps less skewed than in earlier times.

Increasingly, there exists a potential for the dung trade to develop linkages with other systems of commercial livestock production. The milk co-operative movement, which has been eminently successful elsewhere in India, oversees the production and marketing of milk in Hangala as well. The milk cooperatives offer a steady market for milk in these villages. In Hangala, the milk cooperative, with 250 active members, collects 805 litres (±55 litres SE) of milk every day, valued at approximately Rs. 8,050. Although a small number of high-yielding hybrid cattle are reared in the village for milk, a significant share of the milk output does come from the relatively unproductive (in terms of milk) native cattle that are primarily reared for their dung. Thus, today, milk offers a smaller, second-line market for those rearing dung cattle in these villages. In recent years, a third market involving cattle become an important force in the region. The neighbouring state of Kerala, which both consumes beef domestically, as well as exports it to the Middle East, imposes a heavy demand for beef cattle (estimated at 11,000 animals per week) from different parts of the neighbouring state of Karnataka. The villages around Bandipur, which lie on the state border, have become veritable junctions for this trade. Weekly cattle fairs in the region have increased from two to five in the last two decades, offering the local villagers better opportunities to buy and sell cattle.

In conclusion, the emergence of a linkage between subsistence livestock-rearing and commercial markets for dung has transformed the subsistence village economy of Hangala into one driven by cash. For the average villager, this transformation has meant an appreciation in living standards through a lowering of agricultural risk and an enhancement of cash income. For the forests of Bandipur Tiger Reserve, however, the story is altogether different.

Implications for Conservation and Management

Over 100,000 cattle from nearly 180 villages graze diligently in the buffer zone of Bandipur's northern fringes (Lal 1994), primarily to provide dung for faraway consumers. Intense grazing pressures issuing from such a dominant presence of livestock can have serious impacts on the vegetation communities (see Chapter Two) of these forests, as well as on resident communities of large herbivores. The cattle of this region primarily work as devices that convert and transport standing forest biomass into rich barn manure. However, the singular aberration in this system is that even the dung deposited within the forests is retrieved for export: nutrient removal here occurs virtually without nutrient replenishment. Although this study did not attempt to evaluate the biological impacts of such a flawed system of biomass harvest, it is self-evident that this has been accompanied by a clear and visible degradation of forests. Close at the heels of pressures from grazing livestock comes the pressure for fuelwood removal. Fuelwood collectors in these villages, mostly women, do not venture into dense forests that are relatively undisturbed since they are heavily elephant-infested. However, once livestock graze and open up the vegetation in an area, the fuelwood collectors follow and cut down the standing woody vegetation. The collectors gather two headloads a day on average, and earn Rs. 50 per headload by supplying them to easily accessible markets in nearby towns like Gundlupet. Clearly then, under the two-fold pressures of market-driven grazing of livestock and fuelwood collection, the forests on the border of Bandipur are quickly receding. Indeed, over 90% of the 96 villagers questioned echoed this sentiment: they reported that today, their livestock needed to trek twice as far into the forests for grazing than they did a decade ago. Thus the blossoming of individual prosperity in the region has proceeded against the grim backdrop of declining biodiversity and subsistence potential in the adjoining forests.

The qualitative transformation in cattle rearing — from an enterprise founded on local subsistence dung-use to one based on commercial dung export — has serious implications in general for the management of subsistence and commercial activities within areas of designated conservation priority, such as wildlife reserves. First, the increasing emergence of linkages between the two resource use regimes emphasises the fact that although subsistence use might provide for the immediate unchanging needs of the local consumer, it is perhaps the profits of commercial use that are better able to support his aspirations of growth. Where opportunities exist, subsistence users seem quick to recognise this fact, and often show a readiness to discount the future, and act as conduits for commercial markets in order to secure immediate gains. Second, the establishment of a nexus between subsistence use and commercial markets is necessarily accompanied by a dilution of local control and regulation over resource extraction. In particular, where commercial markets exert heavy suction on a resource, it is nearly impossible to achieve local regulation of resource extraction without inflicting serious economic setbacks to the local users. The grim reality, therefore, is that there are perhaps no tractable solutions that are both simple and enduring to the dung-driven devastation of Bandipur's forests. Thus, where conservation is priority, the most prudent course of action seems to lie in preventing linkages from being forged between commercial markets and the resources in these areas, either directly, or through subtler means utilising subterfuges of traditional subsistence activities. Finally, in changing times characterised by the sweeping power of global markets, it would be rather naïve to perpetuate clear and exclusive definitions of subsistence and commerce, and ignore dynamic relationships between these resource use regimes. It is important to recognise them as a continuum along which dramatic shifts can occur swiftly, depending on local and global contingencies.

Chapter Four

LIVING AMIDST LARGE WILDLIFE

Managing conflict with large wildlife over livestock and crop in wildlife reserves

Chapter Introduction

In India today, most ecologically viable populations of large mammals are believed to occur within the boundaries of designated wildlife reserves. Resident human communities estimated to number around 5 million also inhabit the very same wildlife reserves. Besides supporting a whole range of direct extractive uses by humans including agriculture, over two-thirds of these wildlife reserves are used to pasture local livestock. Such a tight juxtaposition of man and animal has precipitated serious conflicts between humans and wildlife over access to space and resources distributed therein (Sukumar 1994, Madhusudan and Mishra *in review*). While the offending species and the exact nature of the problem differ from place to place, mostly large species of mammals are implicated in these conflicts. Thus, within India's densely populated landscapes, the conservation of large and potentially dangerous mammals, poses singular challenges. Losses suffered by humans in such conflicts inexorably erode local goodwill and generate animosity towards the efforts to conserve large mammals.

Here, I present a case study of livestock depredation by large carnivores and crop depredation by elephants in Bhadra Tiger Reserve, and assess the extent of losses inflicted upon resident villagers in such conflict. I also evaluate existing measures instituted to compensate villagers for such losses, and based on my findings, recommend means of streamlining the management of conflicts between humans and large mammals.

Methods

Study Area

Bhadra Wildlife Sanctuary (hereafter Bhadra)(lat long) straddles the districts of Chikmagalur and Shimoga in Karnataka State. Here, the Western Ghats Mountains descend to meet the elevated tableland of the Deccan Plateau. Bhadra, covering an area of 495? sq. km., was notified in 1974, and subsequently, in 1998, was included as a Tiger Reserve under the Indian Government's Project Tiger initiative.

Sixteen revenue villages occur within the boundaries of Bhadra. In all, 736 families reside within these villages, totalling to a population of c. xxxx. Of these villages, I chose five representative villages – Muthodi, Késavé, Madla, Hipla and Karvani – that accounted for xx % of the total resident population. Nearly 65% of the resident families are landless, and either till the land of the gentry as sharecroppers, or work as wage labourers in coffee estates surrounding Bhadra. Monsoonal wet-paddy (*Oryza sativa*) cultivation is the dominant agricultural activity in the villages. Some families also grow pulses, or maintain small plantations of coffee (*Coffea robusta*) and areca (*Areca catechu*), in addition to paddy cultivation. Cattle dominate the livestock held in the villages, which also include buffalo, sheep and goat. Oxen make up a majority of the cattle population, and are employed principally in ploughing agricultural fields. In addition, livestock constitute an important source of organic manure that is used in the fields. During the growing season (May- December), livestock graze exclusively in the surrounding forests, while, at other times, they also graze in the fallow cropland. Greater detail about the study site is available in Chapter Two.

Data collection

During April-May, 1999, after spending four months in Bhadra, I conducted door-to-door surveys of 81 households that either owned livestock or raised crops in the five sample villages of Bhadra: Muthodi, Késavé, Madla, Hipla and Karvani. My interviews gathered the following details regarding the village livestock: stock size and composition, annual stock sale and purchase between April 1996 and March 1999, and annual stock mortalities between April 1996 and March 1999 attributed to large carnivore predation. Further, I collected information regarding the amount of agricultural land owned or tilled by an interviewed family, their estimated annual crop production, and estimated annual crop losses to elephant depredation between April 1996 and March 1999. From each interviewee, I also gathered details of compensation sought and received from the State Forest Department for livestock depredation or crop losses.

Reported loss of livestock or crops was randomly cross-verified with other villagers and one local field assistant in order to corroborate the correctness of the information gathered. In general, it was difficult to obtain information on retaliatory tactics adopted by villagers against marauding large carnivores or elephants. However, some interviewees were willing to divulge information on counter-strategies they adopted. With elephants, I recorded visible injuries evidently sustained in skirmishes with farmers.

From the records of the State Forest Department in Chikmagalur, I obtained detailed extracts of compensation sought and paid to the villagers for livestock and crop losses to wildlife between April 1996 and March 1999. Figures were obtained from villagers were used to estimate the current market value of livestock and crop. The market value of a bullock was estimated at Rs 4000, while that of a cow and calf were estimated at Rs. 2500 and 1000, respectively. (what about buffalo and goat). The market value of paddy was estimated at Rs. 625 per quintal.

Results

The 81 households interviewed accounted for over 50% of the total livestock held, and 52% of the total cropland tilled in the five villages.

Livestock size and composition

Eighty-one households in the five villages owned a total of 611 livestock heads. The per household ownership of livestock was about 7.6 (sd=7.3) animals. Of the total livestock holding, 92% were cattle, while buffaloes (4%), goats (2%) and sheep (2%) made up the remainder. A striking feature of the adult cattle population was that it was male-biased, at 130 males per 100 females. Stock fecundity was estimated at 74 young per 100 females. This, however, is likely to be an overestimate of fecundity since the 'young' class I used also contained calves older than one year.

Livestock depredation and compensation

In the three years between April 1996 and March 1999, the sampled households attributed a total loss of 219 livestock to large carnivore predation. In nearly all these cases, the identity of the predator was not readily available, however, villagers attributed nearly all kills to tigers and leopards, and none to wild dogs. Of the 219 kills, 216 were of cattle alone, while two goats and one buffalo were the only other livestock species killed.

The kills were equivalent to a loss of 0.9 animals/household/year, or an annual loss of 12% of the livestock holding. In monetary terms, the loss amounted to Rs. 2808 /household/year.

Interestingly, most (64%) livestock kills occurred between January and April, when the livestock were primarily grazed on fallow cropland, while, only 36% of the kills occurred between May and December, when the croplands were cultivated and the livestock driven into the surrounding forests for grazing.

In the 131 cases of livestock depredation where the interviewees were involved, compensations were sought in 71 cases (54%), while in the remaining 60 cases, no compensation had been sought by the villagers. Of the 71 applications for compensation, villages reported that 15 cases were compensated to a tune of Rs. 11,100. Thirty-five applications were rejected by the FD, 10 of them since kills were made on forest land; 3 of them since the applicants did not possess proper documents of "land rights"; and 22 for reasons not available. Twenty-one applications were still pending before the FD when these data were collected. Among the 60 cases where villagers did not seek compensation, 19 cases (32%) involved livestock kills made in forests, 16 (27%) cases involved the absence of a statement of land rights, while there were 25 (42%) cases where respondents did not specify reasons for not applying.

Over the three years between April 1996 and March 1999, the Forest Department records indicated that in the five villages, a total of 18 cases of livestock depredation had been compensated to a tune of Rs. 12,950. This figure of compensation paid out to the people was only 20% of the compensation actually sought (total = Rs. 64,700) by the applicants, and 1.9% of the actual loss sustained by the villagers. In addition, FD records also indicated that applications took, on average, 180 days (sd=55 days; N=18) to be processed from the stage of application to compensation.

Livestock Dynamic in Bhadra

Data over the three years showed that purchase was the principal method of stock supplementation in Bhadra, and together with births, contributed by adding 0.4 animals/year/household. On the other hand, mortality attributed to large carnivore predation was 0.9 animals/year/household. Thus, even under a conservative assumption of zero livestock mortality from natural causes, the livestock population of the sample villages was declining at a rate of 6.2% per year (see Table x).

Land Holding Patterns and Crop Production

Sixty eight of the 81 villagers (84%) interviewed tilled land totalling to 362.25 acres. Of these 68, 49 interviewees owned a total of 241.35 acres, at an average of 4.9 acres (sd=6.1 acres) per household. Another 15 interviewees had encroached a total of 52.9 acres, at 3.5 acres (sd=1.6) per household. In addition, 22 interviewees (including landed ones) tilled others' land as sharecroppers. Sharecropped land totalled to 68 acres, at 3.1 acres (sd=2 acres) per household. Crop productivity per acre averaged 12.6 quintals (sd=3.6 quintals; N=66). Sharecroppers paid the landowner an average share of 4.2 quintals per acre (sd=1.6 quintals; n=19), which amounted to approximately 33% of their produce. Nineteen percent of the interviewees raised a second paddy crop in summer, which contributed 23% of their annual crop production, and 6% of the total output.

Crop Loss and Compensation

Most elephant damage to crops occurred in the month before harvest. In the three years between April 1996 and March 1999, interviewees attributed a total crop loss between 114.7 and 118.7 tonnes to damage by elephants. This amounted to a loss of 14.8 and 15.3

percent of the total crop production. In monetary terms, the total loss was estimated between Rs. 717,000 and 742,000, while the loss per household per year was estimated between Rs. 2315 and Rs. 2388.

In 63 out of 137 cases of crop losses to elephants, victims applied for compensation. Of those who applied, 37 (59%) cases were awarded compensation totalling to Rs. 29,800; 15 (24%) applications were rejected mostly for reasons unknown to applicants; and 11 (17%) were still pending before the FD. Among 74 cases where victims did not apply, 38 (51%) did so because the losses occurred on encroached land for which they did not have relevant legal documents, 14 (19%) did not apply owing to the lengthy bureaucratic process involved in obtaining compensation, while 8 (11%) did not apply since they were sharecroppers without access to the relevant land documents, and 14 (19%) did not specify reasons for not applying.

According to the Forest Department records, between April 1996 and March 1999, 67 cases of crop loss totalling to 52.8 tonnes were compensated to a tune of Rs. 53,090. This amounted to approximately 51% of the actual compensation sought by the applicants, and less than 1% of the total loss attributed by the interviewees to elephant damage of crops. The Forest Department, on average, took 77 days (sd=21; N=67) in order to fully process an application for compensation of crop loss.

Discussion

From the foregoing analysis, it is clear that resident villagers in wildlife reserves face serious economic losses as a result of wild animal depredation of livestock and crops. From a biological standpoint, however, a simple but vital point emerges from this analysis with respect to human-wildlife conflic, i.e., a certain level of conflict inevitably accompanies any interface between humans and large mammals. Even under circumstances where there is abundant natural food, large, contiguous stretches of habitat, and relatively little human impact on wildlife habitat, the inherent appeal and vulnerability of livestock and crops will always ensure that some level of conflict persists. Thus, it does seem unrealistic to manage conflict as an aberration, and becomes important to recongise at the very outset that conflict can, at best, be minimised, but never eliminated.

Measures to minimise conflict can be broadly classified as: proactive, where measures pre-empt conflict, and reactive, where they follow incidents of conflict. Typically, proactive measures include physical and psychological barriers to deter animals, alternative access to resources sought in human habitation (e.g., waterholes), precautionary measures such as increased vigilance, or schemes of life, crop, and livestock insurance. However, since none of these measures are known to effectively eliminate conflict, it becomes important to focus attention on how existing conflict can be proximately handled, while ultimately attempting to make proactive measures more effective.

It is here that compensations do serve a vital function. Serious and recurrent economic losses to wildlife erode local goodwill for conservation, and encourage acts of retaliation in the form of poisoning livestock kills, maiming elephants, poaching in reprisal, or even the setting of forest fires. Thus, it becomes crucial to institute efficient mechanisms of compensating losses incurred by villagers to wild animal depredation.

As the above survey shows, existing systems of compensation grossly undervalue losses incurred by the victims. Besides this, the procedures involved in applying for compensations are extremely long-winded and dissuade many victims from even seeking compensation. Thus, as a first step to resolving these administrative problems, there is urgent need to review rates of compensation that have not been revised in over ten years now. Second, administrative procedures need to be streamlined such that they are only as elaborate as is required to verify the authenticity of claims and estimate extent of loss. Timing is of serious concern in compensation schemes as losses absorbed over time tend to get compounded. Finally, it is extremely important to explore avenues of insuring crop and livestock against wildlife damage. Ideally, these schemes should involve a premium that is subsidised by the government as a token of its concern in alleviating the economic losses to villagers. A contribution from villagers to the premium is essential to prevent such schemes from being misused as incentives to increas livestock holdings in the vicinity of forests. Villagers need to be simultaneously educated about the advantages of insuring crop and livestock, whereby there is an assured recovery of the full value of the loss. Thus, these vital measures would go a long way in preserving India's extraordinary traditions of tolerance for wildlife, to which it owes a large part of its conservation successes.

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