
The Global Village: Linkages between International Coffee Markets and Grazing by Livestock in a South Indian Wildlife Reserve

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Abstract: *India's heritage of natural habitats and wild species is under growing threat from its biomass-dependent rural peoples and its consumeristic urban economy. As the mainstay of its wildlife conservation effort, then, India's wildlife reserves continue to face a range of extractive uses. The Indian conservation/development discourse has, however, drawn a distinction between traditional subsistence use and modern commercial use of natural resources in wildlife reserves. It has also been suggested that subsistence use must be accommodated within Indian wildlife reserves because it caters exclusively to local consumption for livelihood, whereas commercial use warrants greater restriction because it furthers profit-based goals of distant interests. How valid is such a clear distinction between subsistence use and commercial use? I address this question using the village of Hangala on the boundary of Bandipur National Park in south India as a case study. Hangala's livestock were reared primarily for their inputs of dung and draft power into local agriculture, and customarily grazed in the forests of Bandipur. This practice qualified as subsistence use because all goods and services obtained from livestock grazing in Bandipur catered exclusively to village-level consumption. In the last two decades, major upheavals in the global coffee markets dramatically boosted profit margins of coffee growers in the hill districts abutting Bandipur. The profits enabled coffee growers to afford expansions of their resource catchment for dung, an important farm manure in short supply in the coffee districts. When this demand reached Hangala, it resulted in large-scale export of dung, which transformed it from locally produced and locally consumed manure for village agriculture to a high-value organic fertilizer for commercial export to coffee plantations. Following the dung export, livestock numbers in the region increased, aggravating grazing pressures on the forests. This case study thus challenges politically correct notions that subsistence use is distinguishable from and preferable to commercial use in the context of protected-area management in India.*

Key Words: forest produce, global market, subsistence use

La Aldea Global: Conexiones entre Mercados Internacionales de Café y Pastoreo Ilegal por Ganado en una Reserva de Vida Silvestre del Sur de India

Resumen: *El patrimonio hindú de hábitats naturales y especies silvestres está bajo la amenaza creciente de sus habitantes rurales dependientes de biomasa y de su economía urbana consumista. Por lo tanto, las reservas de vida silvestre en la India, sostén principal de sus esfuerzos de conservación de vida silvestre, continúan enfrentando una variedad de usos extractivos. Sin embargo, el discurso hindú de conservación/desarrollo ha diferenciado entre el uso tradicional de subsistencia y el uso comercial moderno de recursos naturales en las reservas de vida silvestre. También se ha sugerido que el uso de subsistencia se debe acomodar dentro de las reservas de vida silvestre porque provee sustento al consumo local exclusivamente, mientras que el uso comercial garantiza mayor restricción porque favorece metas basadas en ganancias de intereses distantes. ¿Qué tan válida es esa clara distinción entre el uso de subsistencia y el comercial? Atiendo esa pregunta utilizando como estudio de caso a la aldea de Hangala en el límite del Parque Nacional Bandipur en el sur de India. El*

ganado en Hangala era criado principalmente por su producción de estiércol y fuerza de tiro en la agricultura local, y habitualmente pastaban en los bosques de Bandipur. Esta práctica calificaba como uso de subsistencia porque todos los bienes y servicios obtenidos del pastoreo del ganado en Bandipur proveían consumo a nivel de la aldea exclusivamente. En las dos últimas décadas, convulsiones mayores en los mercados globales de café aumentaron dramáticamente los márgenes de ganancia de cafeticultores en distritos en las colinas contiguas a Bandipur. Las ganancias permitieron que los cafeticultores expandieran su captación de estiércol, un abono importante de baja disponibilidad en distritos cafetaleros. Cuando esta demanda llegó a Hangala, resultó en una exportación de estiércol a gran escala, por lo tanto lo transformó de estiércol producido y consumido localmente como abono en la agricultura a un fertilizante orgánico de alto valor para exportación comercial a plantaciones de café. Después de la exportación de estiércol, el número de cabezas de ganado incrementó, agravando las presiones de pastoreo en los bosques. Por lo tanto, este estudio de caso desafía a las nociones políticamente correctas de que el uso de subsistencia es distinguible de y preferible a el uso comercial en el contexto de la gestión de áreas protegidas en la India.

Palabras Clave: mercado global, productos forestales, uso para subsistencia

Introduction

The conservation challenge in India, as in other countries of the world's tropics, is characterized by a familiar juxtaposition of ecological and societal goals. It is a day-to-day battle, where the survival requirements of a vast diversity of species and ecosystems confront the livelihood needs of a high-density human population and the growing aspirations of an economy in rapid transition. Within this context, the main thrust of India's wildlife conservation effort has been the creation and upkeep of a network of wildlife reserves (Rodgers & Panwar 1988), which today number around 593 and cover some 156,000 km², or 4.7% of the country's land area (Forest Survey of India 2000). Even within these wildlife reserves—which, in theory, range from inviolate national parks to the use-tolerant wildlife sanctuaries—human presence and resource use is ubiquitous (Kothari et al. 1989). Unconfirmed estimates put the population of resident human communities in India's wildlife reserves alone at some 3 million people (Kothari et al. 1995a). Recent surveys report a dependence on forests by more than 170,000 villages, inhabited by a staggering 147 million people (Forest Survey of India 2000). Thus, traditional hunting, livestock grazing, shifting cultivation, extraction of nontimber forest produce, and even permanent agricultural settlements are all established features of Indian wildlife reserves (Kothari et al. 1989). Significantly, besides such local-level dependence from resident and neighboring human communities, the wildlife reserves are also under heavy and relentless pressure from both corporate and state establishments to divert reserve land to commercial and developmental uses such as industry creation, dam building, and mining (Gadgil & Guha 1995; Kothari et al. 1995a, 1995b; Madhusudan 1998).

Against this backdrop, the conservation and development discourse in India has drawn a strong distinction between the pressures emanating from subsistence use and commercial use of natural resources in wildlife reserves (Daniels et al. 1995; Gadgil & Guha 1995; Kothari et al. 1995a, 1995b; Madhusudan 1998; Saberwal et al. 2001).

Although this divide between subsistence use and commercial use is somewhat clouded by the absence of formal definitions, operational categorizations have formed the bases for divergent prescriptions for wildlife conservation in India.

The term *subsistence use* has been used broadly to denote regimes of traditional natural resource harvest aimed at local consumption and in which harvest levels are determined directly by the resource needs of the local community (e.g., hunting and gathering, pastoralism, and shifting cultivation). Further, such harvest is a loosely organized activity, does not rely on modern technology, and occurs over relatively small resource catchments (but is pervasive in space and time and often involves large numbers of consumers, each responsible for a relatively low per capita resource offtake). On the other hand, *commercial use* generally denotes well-organized regimes of technologically intensive natural resource harvest founded on motives of making cash profits (e.g., logging, commercial plantations, trawling, or ranching). Its technology-reliant nature facilitates intensive resource extraction with an economy of scale, allowing high per capita offtakes, and hence, opportunities for profit making. Commercial use also involves a harvest of natural resources from global resource catchments, caters to global demands, and is regulated, if at all, by equations of supply and demand in global markets. On a country-wide scale, then, the broad issue that continues to be debated in the context of wildlife conservation is which of the two—the “overpopulation” of the subsistence user or the “overconsumption” of the commercial user—is more culpable in the decline and loss of wildlife.

Although there is near unanimity that commercial use of natural resources within wildlife reserves is undesirable, the Indian conservation community is deeply polarized in the way it views subsistence use within wildlife reserves. Some authors suggest that subsistence use in wildlife reserves is sustainable, remissible, or even desirable (Gopal 1991; Gadgil & Guha 1995; Saberwal 1996; Saberwal et al. 2001). Others have strongly questioned the

wisdom of such a view on ecological grounds (Mishra & Rawat 1998; Madhusudan & Karanth 2000; Raman 2000; Mishra et al. 2001; Madhusudan & Karanth 2002). Implicit in the assertions that subsistence use is remissible is the humanistic concern that it provides directly for basic resource needs of the local consumer and that the scope and practice of subsistence use within wildlife reserves has largely remained unchanged over time. What is also posited, therefore, is that if greater authority is devolved to subsistence users, they would ensure resource sustainability (and hence, resource conservation) via the use of traditional knowledge systems (e.g., Gadgil 1992; Wood 1995).

But, given today's rapidly changing socioeconomic contexts, does traditional subsistence use within wildlife parks continue to cater only to local consumption, or has it enlarged in its scope? I address this question by presenting a case study from Hangala, a village flanking the Bandipur National Park in southern India. Livestock have always been an important feature of Hangala's traditional agropastoral economy, serving as sources of manure and muscle power for local agriculture. Most of the grazing needs of these village livestock have been routinely met in the adjacent forests of Bandipur. This practice qualified as subsistence use because all goods and services obtained from the livestock grazing in Bandipur catered exclusively to village-level consumption. In the last two decades, major upheavals in global coffee markets dramatically boosted profit margins of coffee growers in the hill districts abutting Bandipur. With widening profit margins, coffee growers expanded their resource catchment for dung, which is an important fertilizer in short supply in the coffee districts. When this demand for dung reached nearby Hangala, the prevailing socioeconomic factors permitted villagers to export more than 60% of the dung produced for cash. From locally produced and locally consumed manure for village agriculture, dung rapidly became a high-value organic fertilizer that is commercially exported to coffee plantations in the adjoining districts. Without altering its original form, grazing by Hangala's livestock in Bandipur began to serve a completely new function. These emerging linkages have helped augment livestock holdings around Bandipur and added to the existing pressures of livestock grazing on the park.

Study Area

The 874-km² Bandipur National Park and Tiger Reserve lies at the foothills of the Western Ghats hill range in Mysore and Chamaraajanagar districts of the state of Karnataka in southern India (Fig. 1). The park is dominated by open deciduous forests, which, in the better-protected ranges, support large herbivore biomass densities that are among the highest in the world (>18,000 kg/km², Madhusudan 2004). Bandipur is among the global strongholds for endangered large mammalian predators, such as the

tiger (*Panthera tigris*) (Karanth & Nichols 1998), and megaherbivores, such as the Asian elephant (*Elephas maximus*). In marked contrast to other wildlife reserves in India, there are no villages within the boundaries of Bandipur, and all anthropogenic pressures—primarily livestock grazing and fuel wood removal—on the park originate from the 159 villages that lie within 5 km of the reserve's northern flank.

Agriculture in the landscape adjoining Bandipur has been dominated by low-yielding, rain-dependent crops of staple millets (*Sorghum vulgare* Pers. and *Eleusine coracana* [L.] Gaertn.) and pulses (*Dolichos lablab* L., *Phaseolus vulgaris* L., *Cajanus cajan* [L.] Millsp., *Vigna unguiculata* [L.] Walp., *Cicer arietinum* L., *Arachis hypogaea* L.), along with commercial crops of cotton (*Gossypium herbaceum* L.) and castor (*Ricinus communis* L.). Cattle dominate the livestock of the region and are a vital part of the agropastoral system. The hardy native cattle breeds are used extensively as draft animals in the fields, but more importantly, their dung represents the primary source of organic fertilizer in this otherwise nutrient-impooverished agricultural system. Milk yields from these cattle are poor (averaging 750 mL/day/animal), and as sacred animals, their meat is taboo in the region. Importantly, most of the grazing needs of village livestock are met in the forests of Bandipur, although this is prohibited under law. The mid-1990s saw the emergence of an intriguing practice in the region involving a large-scale, cash-driven export of cow dung from the agropastoral systems adjoining Bandipur to coffee estates in the neighboring districts of Kodagu in Karnataka, Wayanad in Kerala, and Nilgiris in Tamil Nadu. This system of dung export is noteworthy because it signals the advent of cash into a traditional system of livestock rearing that was hitherto governed largely by local agricultural needs of dung and draft power.

Methods

To understand factors that facilitated the emergent practice of exporting cow dung, I carried out interview-based surveys in January 2000 among 79 villagers in Hangala (population approximately 5400; 2000 data), the largest among 159 villages within 5 km of Bandipur's northern boundary. I carried out additional surveys with 15 and 34 villagers, respectively, in two smaller villages, Maguvinahalli (population: 569) and Melkaamanahalli (population: 487), also located in this belt. The interviews specifically probed into the history of the export of cow dung in the villages; the source and destination of the exported dung; the income derived from dung exports; and general accounts of agricultural practice, livestock rearing, and dung export in the villages.

To assess the scale of dung export from Hangala, I estimated the daily production of dung. First I surveyed Hangala's livestock population by species, age, and gender. Then I estimated daily dung production in adult

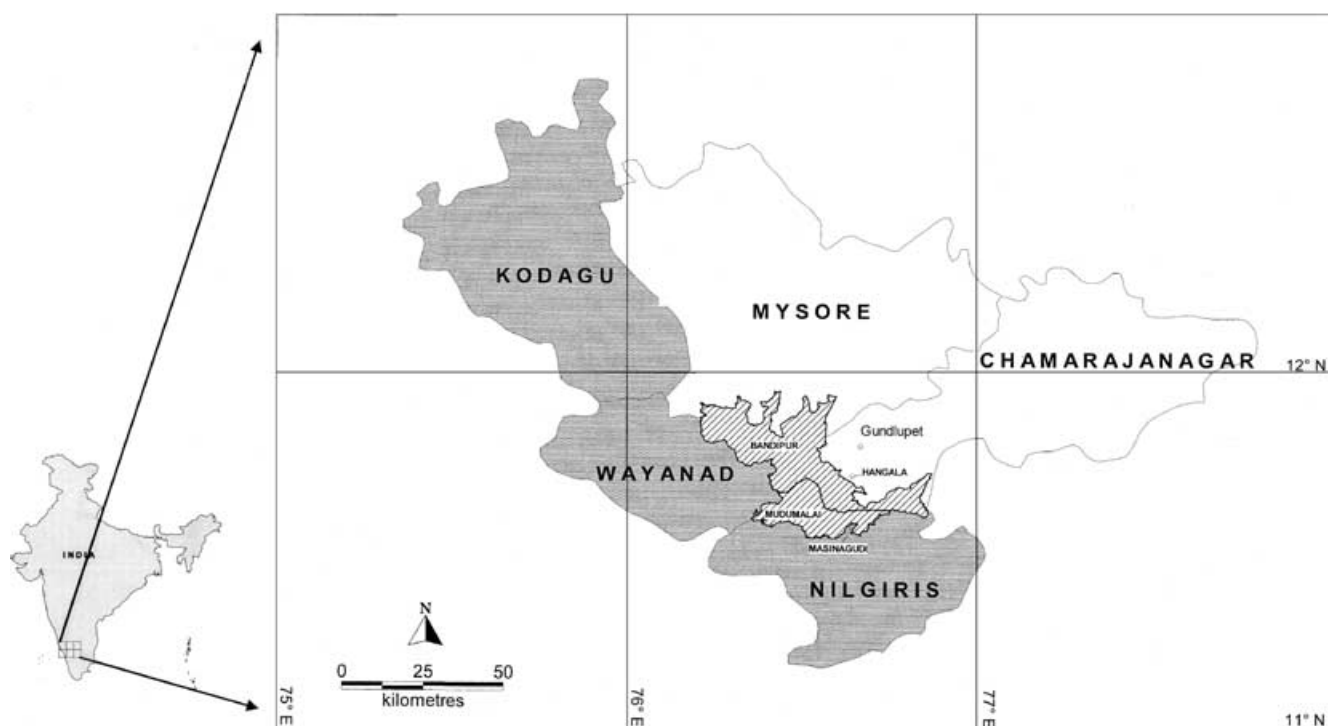


Figure 1. Location of Bandipur National Park, Hangala Village, and the coffee-growing districts of Kodagu, Wayanad, and Nilgiris. Melkaamanaballi and Maguvinaballi lie to the south of Hangala. The locations of Masinagudi and Mudumalai Wildlife Sanctuary are also shown.

males, females, and young (<2 years) cattle by collecting and weighing dung produced by 7, 9, and 3 animals, respectively, in two 24-hour periods. I also monitored seven adult goats over the same period to estimate their daily pellet production. Based on known differences in body size (Mishra 1978), I assumed that buffalo produced 1.5 times the dung of adult cattle and that sheep produced the same amount of dung as goats. I then assessed the scale of dung export from Hangala by counting trucks laden with dung at the village toll gate over a 2-week period, and by examining secondary data from the Hangala village council on toll fees collected from such trucks at the exit toll gate in different years.

I collected data from the Coffee Board of India (2001) on the geographic extent and the temporal variability in productivity and value of coffee grown in these districts. In addition, I interviewed six experienced coffee growers/plantation consultants from the coffee-growing districts to obtain estimates of farm input into coffee cultivation. Because most of the coffee grown in the region is for export, I obtained estimates of this region's contribution to India's coffee exports (Coffee Board of India 2001) and data on the volume and value of coffee traded by India and market leaders on the global coffee markets (Food and Agriculture Organization 2003).

I used village-level data from the 1997 census of the Karnataka State Department of Animal Husbandry and Veterinary Services to depict spatial distribution of livestock on the villages fringing Bandipur and to portray

the scale of threat from livestock to Bandipur's forests. Because data on livestock population changes over time were unavailable for Hangala, I used serial data from the neighboring villages of Melkaamanahalli and Maguvinahalli for which cattle population estimates were available for 1991, 1997, and 2000 from the local veterinary center. I also used published information on livestock population changes from the nearby village of Masinagudi (Fig. 2), which was involved in the dung trade as well (Silori 1996; Silori & Mishra 2001). To establish the impact of livestock on wild herbivores, I discuss published results from a separate study in Bandipur (Madhusudan 2004), which demonstrated livestock-mediated resource limitation for wild herbivores in areas grazed by livestock. I used available estimates of the nutrient value of dung (John et al. 1989) in conjunction with my own estimates of dung retrieval from Bandipur's forests to assess the resulting level of nutrient losses.

Results

Agriculture around Bandipur

The farming cycle in the villages near Bandipur typically commences at the end of summer (March and April), when land is plowed and fertilized in anticipation of premonsoon showers, and the crop is sown soon after the first rains. Given an average annual family income

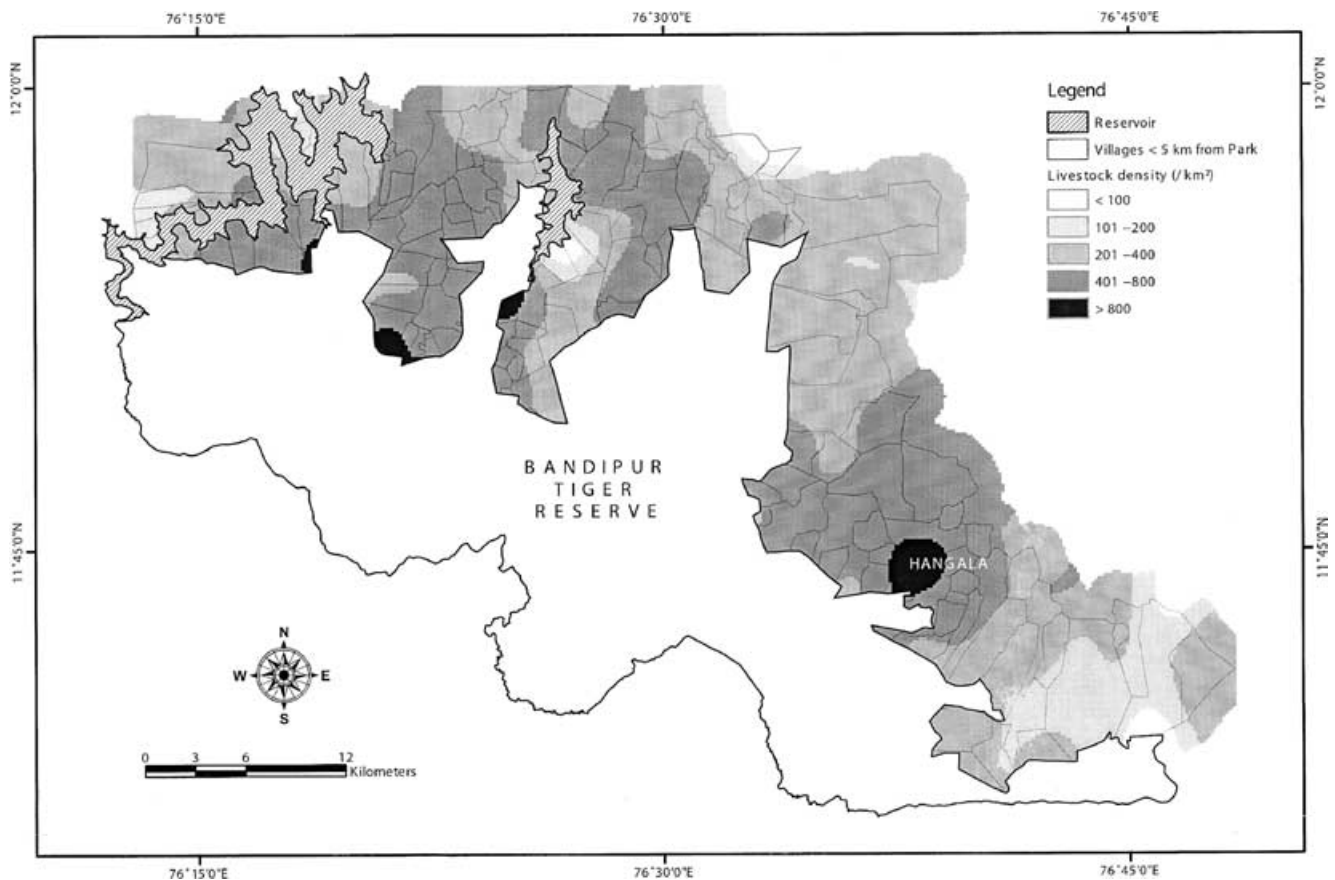


Figure 2. Density and distribution of livestock in villages located within 5 km of Bandipur National Park. Original data were presented at the village level and are derived from 1997 census of the Karnataka State Animal Husbandry and Veterinary Services department.

of Rs.16,922 (US\$376) for small landholders in the region (National Council for Applied Economic Research 2001), relatively large investments (Rs. 2,500–12,000 or US\$56–\$267/ha) are made in agriculture in terms of labor, manure, and seeds even before the monsoons arrive. These investments are almost invariably made from loans secured from local moneylenders at high interest rates (60–340%/year).

Crop performance in this dryland region depends primarily on the amount and temporal distribution of rainfall (Gadgil & Rao 2000). Besides unpredictable rainfall, the extent of crop losses to wildlife, particularly elephants and wild pigs, is also a critical determinant of agricultural yields in the villages. So serious has the uncertainty in crop yields been in these parts that villagers often incur heavy losses and go deeper into debt at the end of a growing season. Villagers retain a small portion of their cereal crop for family consumption but sell most of it (often to the same moneylender) to service their agricultural debts. Rarely do villagers achieve agricultural profits on which they are able to subsist until the next season. During the fallow season (November to April), wage labor at an average wage of <\$1/day is the villagers' main source of income.

Thus, two important aspects of the agricultural landscape around Bandipur, namely exorbitant interest rates on agricultural credit and high levels of uncertainty in agricultural yields, have favored the adoption of a risk-averse farming strategy by the villagers. Villagers therefore minimize cash investment in agriculture or switch to crops that are relatively more robust to variations in rainfall and less prone to wild animal depredation (e.g., castor and cotton). With improving transport and communication links to this region, however, villagers have been presented with opportunities to supplement their cash income and have increasingly shown willingness to offset agricultural risk by exploring these options. One such opportunity to supplement cash incomes arose when, in the late 1980s and early 1990s, coffee growers from the hill districts of Kodagu, Wayanad, and Nilgiris (Fig. 1) began looking to the villages around neighboring Bandipur for a supply of organic manure in the form of cow dung.

Coffee Production and Trade: the World and India

After crude oil, coffee is the most heavily traded commodity in global markets, and the value of annual global exports exceeds US\$12 billion (FAO [Food and Agriculture

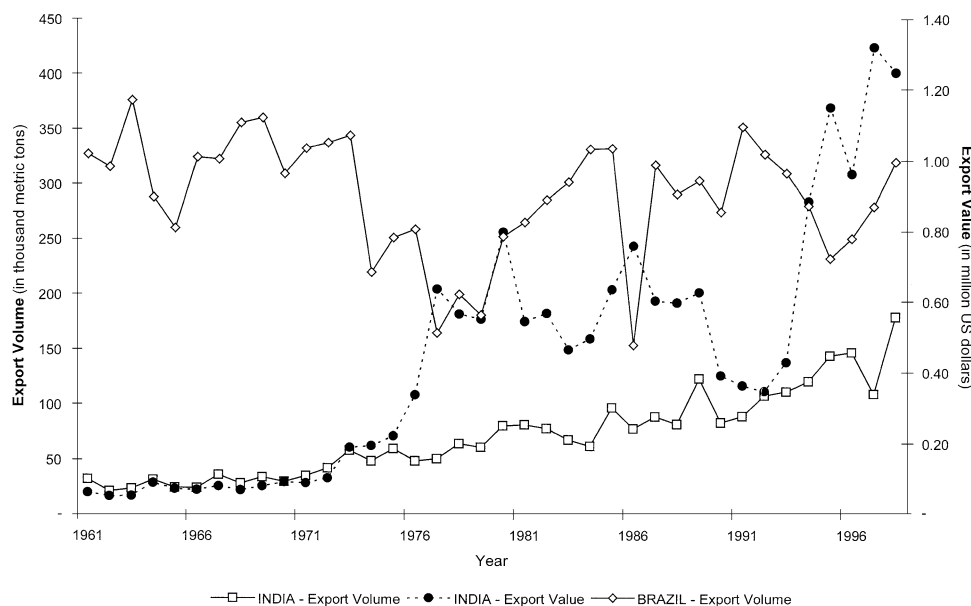


Figure 3. Value of coffee exports from India and its relationship with volume of coffee exports from India and Brazil.

Organization] 2003). Since coffee was introduced into South America from Africa more than 170 years ago, Brazil and Colombia have traditionally dominated the international coffee market. Of 60 countries, they contribute approximately 30% and 20%, respectively, to the world's annual production of coffee (FAO 2003). India, on the other hand, has a small but significant share in the world's coffee markets, contributing 25% to Asian production and about 3–4% to world production (FAO 2003). India exports nearly 70% of its annual production of coffee, with the remainder consumed domestically (Coffee Board of India 2001; India Infoline 2002).

Although Brazil dominates the world's coffee markets, its production is seriously affected by recurrent frosts and droughts (Coffee Research Institute 2001). Frosts have damaged Brazil's coffee crop 31 times in the last 172 years, with destructive frosts increasing during the latter part of the twentieth century (Karatzas 1999). In the last four decades, the most serious frosts in Brazil occurred during the mid-1970s and the mid-1990s (Coffee Research Institute 2001), depressing its coffee exports by nearly 50% (FAO 2003). Such large fluctuations in the export volume of the market leader have had dramatic repercussions on the fortunes of smaller competitors such as India. In the years when Brazil's coffee outputs declined, India recorded increases in the value of its coffee exports that were disproportionate to the increase in export volumes (Fig. 3). The fluctuating coffee export volume by Brazil, however, did not register uniformly in the Indian export value. Its impact on the Indian export value was negligible in the 1960s, when all coffee export from India was processed through a monopolistic state concern, the Coffee Board of India. As state control of the coffee trade was diluted through the 1980s and completely withdrawn in the early 1990s, the Indian coffee grower came into direct contact with fluctuations in the international coffee market.

The geographical distribution of India's coffee export profits is rather localized. Nearly half (45.4%) of India's 3,467-km² expanse of coffee-growing areas falls within the three contiguous districts of Kodagu, Wayanad, and Nilgiris (Coffee Board of India 2001). Together, these districts produce about 57.2% of India's coffee. Between 1993 and 1998, when Brazil's coffee exports decreased because of the frosts, India's export value climbed significantly (Fig. 3). Indeed, the value of India's average annual coffee export increased by 158% between the periods from 1989 and 1993 and 1994 and 1998, although the corresponding increase in export volume was only 36%. These increases in India's coffee export value between 1994 and 1998 approximately translated into an 834% increase in profits for the coffee growers of this region (Table 1). Soaring profit margins for coffee thus facilitated an expansion in the resource catchments from which coffee growers in the region could access goods and services. In the fertile, high-rainfall districts of Kodagu, Wayanad, and Nilgiris, which are dominated by cash crops such as coffee, tea, ginger, cardamom, and pepper, there was little land on which livestock could graze. As a result, the plantation industry operated under a constrained availability of farmyard manure. Once profit margins widened, it was economically viable for coffee growers to overcome this limiting factor. They made forays into the well-connected neighboring region around Bandipur where livestock were abundant, and chances of purchasing manure were high.

Conditions Favoring the Trade in Dung

More than 116,000 head of livestock reside in the 159 villages on Bandipur's northern boundary, with their density averaging 236 animals/km² over this 500-km² landscape (Fig. 2). It is possible to rear such large numbers of

Table 1. Monetary investments made by growers into coffee, and returns obtained in the Kodagu-Wayanad-Nilgiris region before (1988–1992) and during (1993–1998) the coffee price escalation in the global markets.^a

	1988–1992	1993–1998
Annual investment		
labor (maintenance & processing)	9,498	14,869
inorganic fertilizer and pesticides	3,799	5,018
organic manure (dung)	949	1,487
establishment costs	1,900	3,718
miscellaneous	949	1,859
total working capital	17,095	26,951
interest on working capital @ 14% p.a.	2,393	3,773
total investment ^b	19,488	30,724
Annual return		
coffee yield ^b	783 kg/ha	864 kg/ha
producer price ^b	33 Rs./kg	100 Rs./kg
total return	25,448	86,400
net profit	5,960	55,676

^aAll figures in the table, unless otherwise specified, are in Indian rupees/ha.

^bWeighted averages from the two varieties of coffee, *Coffea arabica* and *C. robusta*, grown in Kodagu, Wayanad, and Nilgiris. Weights were assigned in proportion to the area under each variety as 30:70 (*C. arabica*:*C. robusta*) during 1988–1992 and 25:75 during 1993–1998 (data from Coffee Board of India 2001).

livestock in these villages because they have virtually unrestricted access to grazing inside the northern boundary of Bandipur. Although these livestock have served local agriculture through their inputs of manure and muscle power, their contributions in supplementing cash incomes of villagers or in alleviating agricultural risk were negligible. The promise of cash returns from the sale of dung to coffee growers was therefore an appealing proposition to the region's villagers. Nevertheless, the opportunity to export dung to coffee growers came along with the constraint of decreased availability of manure for agriculture within Hangala itself. My surveys revealed, however, that heavy government subsidies on chemical fertilizers ensured that they cost considerably (about 69%) less than the dung needed to fertilize an equivalent area. Therefore, for the price at which farmers in Hangala sold the dung needed to fertilize their fields, they were able to purchase equivalents of chemical fertilizer and still be left with surplus cash. In this way it was possible for the villagers from Hangala and elsewhere to sell dung to coffee growers without seriously affecting their own agriculture. Interestingly, the coffee growers themselves did not favor the more economical option of chemical fertilizers because they perceived qualitative and quantitative improvements in the coffee crop when dung was used as fertilizer. Moreover, prevailing market trends ensured better prices for coffee that was cultivated with greater amounts of organic (as opposed to chemical) inputs.

The Dung Trade

The earliest reported instance of systematic dung export around Bandipur was in the late 1970s in the village of Berambaadi, 25 km west of Hangala. Up to the early 1990s, the dung trade was an endemic practice in a few villages around Berambaadi. Thereafter, the trade spread to most of the Bandipur's adjoining villages and intensified through the later 1990s, covering most of the 74 villages (in a total of 159 located within 5 km of Bandipur National Park) that had paved road access to state highways connecting the coffee districts. Today, trade in livestock dung proceeds on large scales in Hangala and the surrounding villages.

My surveys of livestock numbers and field estimation of per capita dung production in Hangala (Table 2) indicated that approximately 39 t of dung (wet weight) is produced by the village livestock daily. Of this, I estimated that the quantity of dung exported daily ranges between 16 and 24 t (an average of 4 truckloads/day at 4–6 t/truckload, depending on the proportions of dry and wet dung), particularly in the dry months between November and March when dung harvest levels increase. At a conservative estimate, this implies that approximately 41–62% of the dung produced is being harvested for export, and a part of the remainder is used locally as manure. This is remarkable considering that nearly half the dung produced by livestock is deposited outside their stalls when they are grazing.

The harvest system for dung in Hangala is geared toward maximizing efficiency of collection. Dung deposited overnight in cowsheds, which is 34–51% of the daily dung production, is retained by the cattle owner. Dung deposited as the animals graze in the adjoining forests is sought out and gathered by dung collectors, who number 25–30 in Hangala. Further, the Village Council of Hangala auctions exclusive rights of dung collection at nine public locations, including the cattle pound and eight village streets along which cattle pass as they are led out to graze.

In the villages, dung is usually purchased in units of "sack loads" (20–25 kg), "truck loads" (4–6 t), and "heaps" (quantity variable). A truckload of dung fetches between Rs. 2500–4500, whereas prices for a sack load range between Rs. 30–35. At rates prevailing in 2000, the monetary value of dung exported from Hangala daily varied between Rs. 16,500 and Rs. 26,500, translating to an average annual family income of between Rs. 5,874 and Rs. 9,673 (or 36–59% of the average annual smallholder family income from the region; National Council for Applied Economic Research 2001).

Besides the dung seller, the proceeds of the dung trade also accrue to other groups of people within the village. Today, there are vocations within the village that are exclusively linked with the dung trade. Dung agents broker deals between prospective buyers and sellers of dung

Table 2. Census of livestock and estimates of daily dung production in Hangala in the year 2000.

Livestock species	Population	Daily per capita dung production ^a		Daily total dung production	
		wet wt. (kg)	dry wt. (kg) ^b	wet wt. (kg)	dry wt. (kg)
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) ^c	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

^aFigures in parentheses indicate standard error of estimates, where available.

^bConversions between wet and dry weights of dung are based on empirically established relationship during this study, where 1 kg wet weight = 0.3 kg dry weight for cattle and buffalo and 1 kg wet weight = 0.45 kg dry weight for goat and sheep.

^cAverage per capita dung production for goat and sheep was estimated across age classes.

and deploy dung loaders to fill trucks with dung for a daily wage. Vocational dung collectors follow the village livestock each day into the forests and gather dung deposited by the animals in the forests. Hangala has about 15 dung agents, 200 dung loaders (including those who accompany trucks to neighboring villages), and 25–30 dung collectors. Dung agents earn Rs. 100 a day, dung loaders Rs. 75–80, and dung collectors gathering 2–3 sack loads of dung a day earn between Rs. 70 and Rs. 105. At a minimum, these earnings are 20% higher than prevailing agricultural wages in the region. Indeed, the dung trade today supports the livelihood of at least 250 daily wage earners and contributes Rs. 18,250–20,650 in terms of daily wages.

Other than the individuals profiting from the trade, the Village Council of Hangala earns substantial amounts (Rs. 67,095 in 1999–2000; Rs. 148,000 in 2000–2001) by auctioning rights to collect dung on streets within the village and to levy a toll on trucks carrying dung out of the village. Thus, the augmentation of cash income for Hangala's villagers has come as a result of their ability to exploit an opportunity to link their subsistence resource-use regime—the grazing of livestock in Bandipur to produce dung for village agriculture—with markets such that their resource harvests are now directed less at local consumption and more at faraway consumers who offer cash returns.

Changes in Livestock Populations

Although no time-series data were available for Hangala itself, data from the neighboring villages of Maguvina-halli and Melkaamanahalli showed that between 1991 and 1997 the average annual growth rate for cattle was 6.3%

and 8.4%, respectively, which was 13–17 times greater than the national average for the same time period (FAO 2003). Between 1997 and 2000, however, the growth rates for the two villages had dropped to 3.3% and –5.5%, respectively. Similarly, in the dung-exporting village of Masinagudi on the boundary of the neighboring Mudumalai Wildlife Sanctuary (Fig. 1), livestock populations increased by 31% in the 5 years between 1987 and 1992 (Silori & Mishra 2001), when the value of dung exports increased by more than 50%. These data strongly suggest that the lucrative dung trade stimulated increases in livestock population in the region.

Discussion

How then has the integration of Hangala and other villages with the market-driven coffee plantation industry affected the conservation prospects for Bandipur National Park? Today, the density of livestock (approximately 236 animals/km²) along Bandipur's northern boundary is far greater than the densities attained by wild herbivores (81 animals/km²) even in the best ranges of the park (Madhusudan 2004). Because most of these village livestock graze within the northern boundary of Bandipur, they have the potential to adversely affect the park's vegetation and native wild herbivores. Indeed, recent work in Bandipur (Madhusudan 2004) has shown that mean densities of gaur (*Bos gaurus*) and chital (*Axis axis*), both wild grazers, and the Asian elephant, a bulk feeder, were 132, 11, and 6 times higher, respectively, in livestock-free areas than in adjacent livestock grazed areas. The mean palatable plant biomass in livestock-free areas was twice

as high as in livestock-grazed areas. Results of this study also showed that livestock grazing limits forage for species like gaur, chital, and elephant in shared grazing areas, with the result that their densities declined exponentially with increasing livestock density. In Masinagudi village, where 98% of the 15,000–17,000 cattle graze within Mudumalai Wildlife Sanctuary (Silori & Mishra 2001), a survey from the late 1980s (John et al. 1989) estimated that livestock consumed more than half of the total grass productivity. By 1993, with resident livestock numbers having increased by 31% (Silori 1996), their fodder demands had already overshot the area's grass productivity by 32% (Silori & Mishra 2001).

Further, a significant outcome of the dung trade is the emergence of an unprecedented practice of dung harvest from the forests where livestock graze. Based on available data on the chemical composition of cow dung (John et al. 1989), approximately 43.8 kg/ha of nitrogen, 18.3 kg/ha of phosphates, 7.3 kg/ha of potassium, 32.9 kg/ha of calcium, and 7.3 kg/ha of magnesium are being lost annually because of dung collection from the forests. In the case of nitrogen, these losses are about 1% of the soil nutrient pool in the region (M.S. Nagaraja, H.S. Dattaraja, C.A. Srinivasamurthy, and R. Sukumar, unpublished data) but may be as high as 30–50% of the annual nitrogen input from litter fall (based on data from other tropical deciduous forests; Vitousek 1984). The large-scale biomass removal by livestock, the already prevalent practice of fuelwood removal, and the intensive nutrient mining through dung removal could combine to seriously disrupt nutrient cycling regimes and hasten the degradation of Bandipur's forests.

Thus, these data strongly suggest that the increase in livestock numbers that has resulted from the lucrative dung trade plays a significant role in the degradation of the region's forests and is driving the decline of wildlife in those forests. From my interviews with villagers, it seemed clear that although they do recognize the degradation themselves, they feel constrained by their socioeconomic circumstances to value the substantial cash rewards brought in by the dung trade more than the threat of a fading forest. Thus, the blossoming of individual prosperity in the region has proceeded against a grim backdrop of receding forests and declining wildlife.

Taken in a country-wide context, the commercial export of dung around Bandipur is not an isolated example of how regimes of traditional subsistence use within protected areas can integrate with regional/global commercial enterprises. Even the oldest forms of human land use or the remotest of regions do not seem immune to the opportunities and pressures of the global markets. In a particularly well-documented example, Mishra (2001) gives a comprehensive account of how the market-driven transformation of an ancient agropastoral production system in the remote region of Spiti in the Indian Trans-Himalayas—from a subsistence agriculture for local ce-

reals and pulses to an export-based cultivation of green peas (*Pisum sativum* L.)—has enabled a diversion of cash profits to livestock supplementation. This, in turn, has resulted in widespread overstocking (Mishra et al. 2001) and possible local extinctions of wild herbivores in competitive interactions with livestock (Mishra et al. 2002) and continues to pose a serious threat to this fragile mountain ecosystem and its large wildlife (Mishra 2000, 2001).

Rigorous and comprehensive studies are urgently needed to document changes in resource-use regimes within India's protected areas and the implications of these changes for wildlife and their habitat.

The results of this case study challenge politically correct notions that subsistence resource use is distinguishable from and preferable to commercial resource use in the context of protected-area management in India and perhaps elsewhere in the developing tropics. As for formulation of conservation policy, this analysis emphasizes the need to recognize subsistence use and commercial use, not as distinct regimes of resource use within protected areas, but as extremes of a resource use continuum along which dramatic shifts can occur swiftly, depending on local and global contingencies. Further, if wildlife conservation indeed takes precedence over direct human interests within protected areas, there is a need to employ ecological—rather than economic—criteria to identify compatible extractive resource uses by humans. Deciding that subsistence resource use is remissible and commercial resource use is not is simply not a good approach to conserving wildlife. Rigorous ecological studies in India's protected areas across varied ecosystems and human contexts have convincingly demonstrated the serious impact of extractive anthropogenic use on several large vertebrate taxa (Raman 1996; Pandav et al. 1997; Datta 1998; Mishra et al. 1998; Mishra 2001; Raman 2001; Bagchi et al. 2002; Madhusudan & Karanth 2002; Raman & Mudappa 2003) and emphasized the need for maintaining *de facto* inviolate areas (Madhusudan & Karanth 2002). Given the reality of human presence in India's protected areas today, this will not be easy to achieve. In the long term, steps are needed to shift economic opportunities outside parks, or to retain them within parks, if at all, based on sound ecological criteria (Mishra et al. 2003). In the short term, however, there is no alternative but to protect what exists, and this calls for a sincere implementation of India's preservationist program.

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