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Conservation of Forests of India: An Ecologist's Tour

Bruce G. Marcot

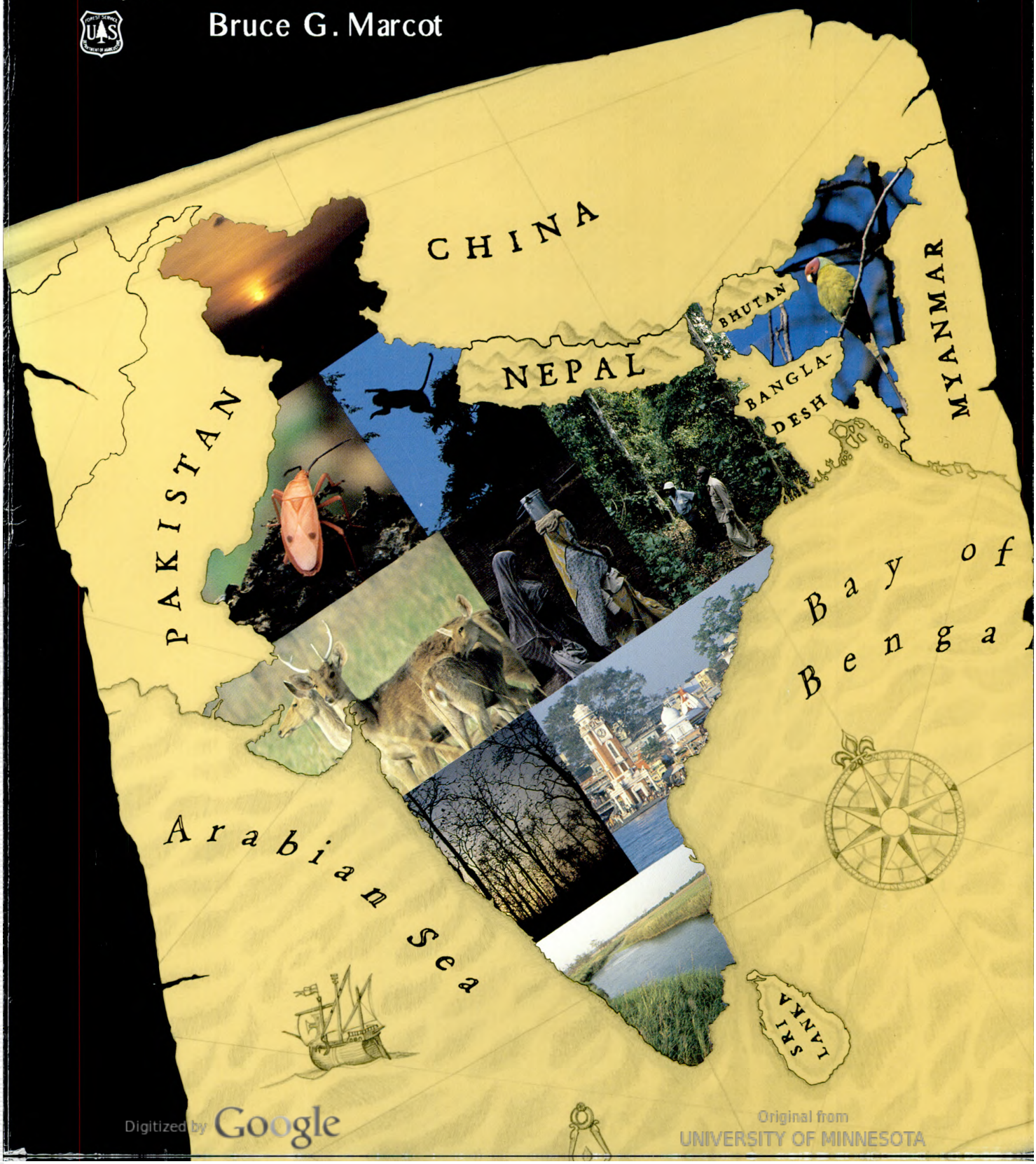

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Photo Caption

Cover photos (left to right). **First (top) row:** sunset over Western Ghats mountains of south India. **Second row:** stink bug (Pentatomidae) found in the increasingly exploited semievergreen forests of south India; an acrobatic Nilgiri langur of wet evergreen forests of south India. **Third row:** the extremely rare and endangered swamp deer, found in north India; Indian women carrying food containers; Indian scientists and local villagers discussing resource use in a managed stand of semievergreen forest, south India; male blossom-headed parakeet in a tea plantation of north India. **Fourth row:** dusk in the dry deciduous teak forest tiger habitats of central India; the holy city of Hardwar on the banks of the River Ganges. **Fifth (bottom) row:** broad expanses of tal (oxbow lake) and elephant grass of the scarce terai (marshland) habitats along the border of the Himalayas of north India.

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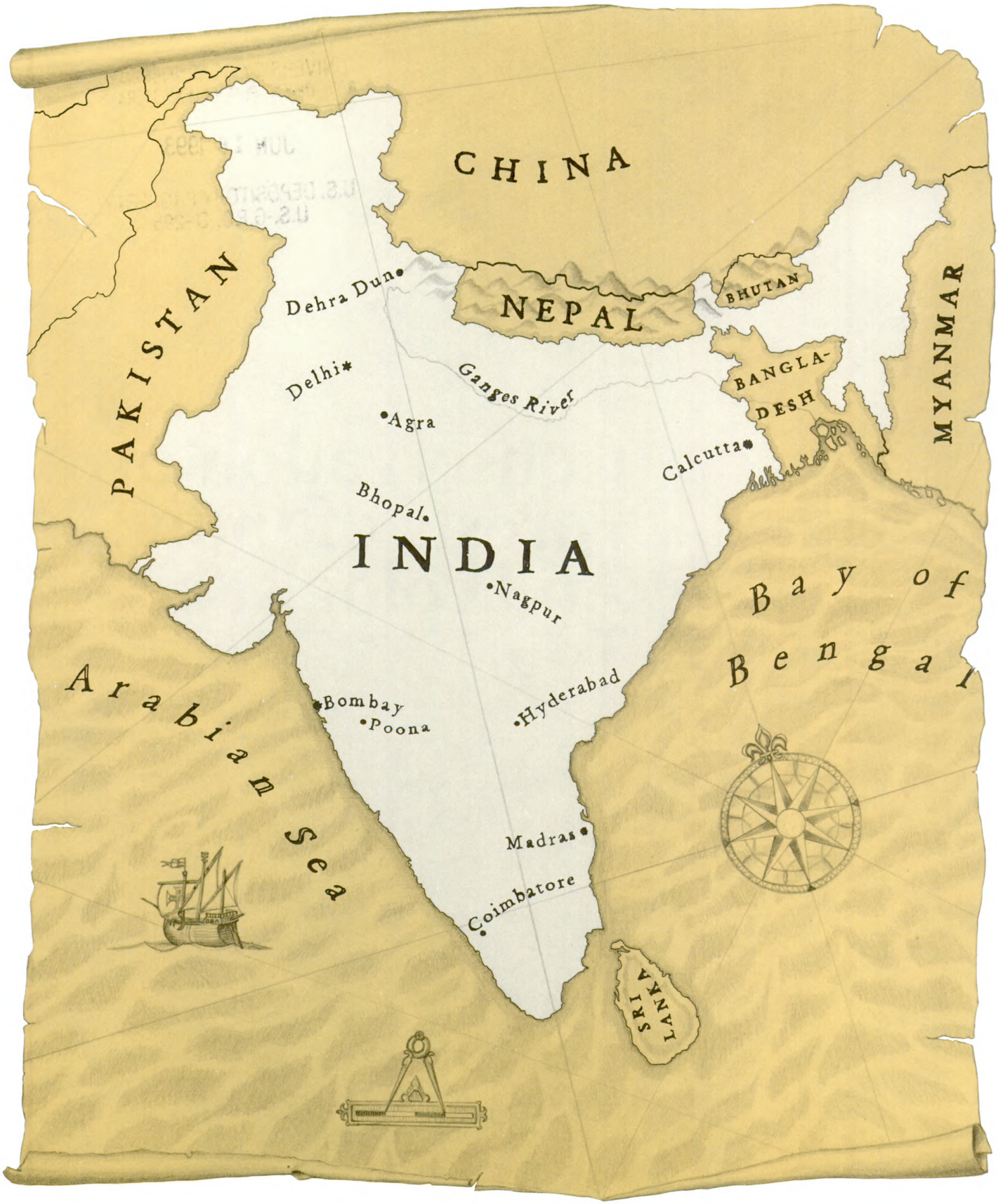


Preface

I moved quietly from the rest of the group half a kilometer up the dusty road, alone, in the tall dry grass of central India. Tiger country. Fresh tracks in the earth led to this spot. The grass crackled under foot even as lightly as I could tread, with heel down first, gently, then full weight, then the balls of my foot, then toes. I marveled at how the big cats could ease through the dry grass without a sound.

Crouching low, I slowly swung the big lens to eye level and crept around a large boulder, my quarry in sight: a black-winged kite perched 80 meters away on a young teak tree now leafless in the spring heat. The grass sprung upright behind me with a quiet snap, and I assured myself it was not the exacting stalk of padded feet. Cicadas chirred loudly in the sun as the kite watched for movement of insects or voles. I held my breath as the image came into focus, and, as if sighting prey along a barrel in some earlier era, I squeezed the button with steady pressure to make the capture.

In another few weeks I would see the results of the stalk. For now, I was midway in a 6-week journey through a country becoming as familiar as it was intimidating. I had come here to uncover its wildlife and forests, to begin to decipher its cultures and populations, to deal with its bureaucracy, and to encourage its future visions.

As part of a team of wildlife ecologists from the USDA Forest Service, I was engaged in an international exchange of science and technologies. The purpose of our mission was to help develop long-term conservation strategies for the remaining forests, parks, and wildlife sanctuaries throughout the subcontinent of India. Our project was dubbed "Wildlife in Managed Forests of India" and was administered as part of a series of technology exchange projects through the U.S. Department of the Interior, Fish and Wildlife Service. The full set of exchange projects is intended to share with India various techniques in wildlife science, including laboratory methods, veterinary medicine, wildlife nutrition, and other related disciplines. These projects add to an ongoing interchange with Indian scientists and managers who also regularly visit the United States to participate in professional conferences, technical workshops, and university curricula.

Our specific component was intended to aid the Government of India in developing a management framework to conserve wildlife in managed forest lands. The project was begun specifically to assist India in developing a program in wildlife-habitat relationships, but it soon expanded to include many other facets of managing the land for biological diversity, human

presence, and sustainable resource use. One lesson learned early by Americans and Indians alike was that providing habitat for wildlife cannot be dissociated from providing resources for humans. Although some land allocations are intended to mostly exclude permanent human presence, they cannot succeed in providing for long-term viability of associated plant and animal species unless augmented by other nearby lands intended for human use. In similar fashion in the United States, national parks and wildernesses cannot by themselves provide for all scientific and wildlife conservation needs. They must be reinforced by management of other lands, such as the National Forests and state forest lands, to meet dual objectives of wildlife conservation and human use of natural resources.

The challenge in India, then, is not so much to legislate new wilderness. This would be extremely difficult in a land with virtually no roadless areas remaining outside designated national parks and refuges (even many of those are well roaded and inhabited). Rather, the challenges are to (1) describe and inventory habitats and wildlife communities in a way amenable to predicting presence and responses to management activities, and (2) devise and institute an array of management guidelines for a wide spectrum of lands including wilderness. This second challenge ultimately would help conserve key elements of habitats and environments needed by the increasingly scarce plant and animal species and by communities across a broad land area. Our project helped the Wildlife Institute of India (WII) meet the first challenge. As of this writing, the second challenge is being addressed by WII through use of the classification and inventory data, by the WII assisting the Indian Forest Service to train foresters throughout the nation in wildlife conservation, and by the WII helping the Indian Forest Service to implement the National Wildlife Policy and the new Forest Policy of India.

Our joint USDA Forest Service-WII project on Wildlife in Managed Forests of India would result in developing a teaching syllabus, training courses, and a textbook for WII to use as they educate the nation's cadre of foresters in wildlife conservation. At present, much of the syllabus has been written in collaboration between American and Indian managers and researchers. Writing and collaborative visits by each side are ongoing.

Another goal of the project has been to develop a large demonstration area in central India—the Satpura Hills Biodiversity Demonstration Project. The demonstration area shows, on the ground, how biological diversity and wildlife species and communities are being conserved and human use needs met, by coordinating objectives and management of many land allocations across a large landscape area. Included in this demonstration of integrated resource management are allocations of wilderness ("core areas" or national parks in India), wildlife habitat corridors to link core areas, more intensely grazed and used forest buffer areas, and heavily used and permanently inhabited revenue lands. Forest restoration, control of grazing and burning, planting trees for fuelwood, and limited resource extraction from forest buffer areas are methods in the overall plan to provide concomitantly for wildlife and human needs.

The Satpura Hills Biodiversity Demonstration Project has begun. In 1990 and 1991, our Forest Service contingent participated in two national workshops in India to help with this. Forest managers and researchers from the local Indian states, from WII, and from the Indian

Federal Government have shown great support and enthusiasm for the project. Indeed, many local forest managers already have embarked on innovative activities along these themes, including inventory of resources and forest conditions, integration of timber and vegetation classifications, restoration of native forests, and planting of fuelwood and fruit-bearing trees and shrubs in forest plantations.

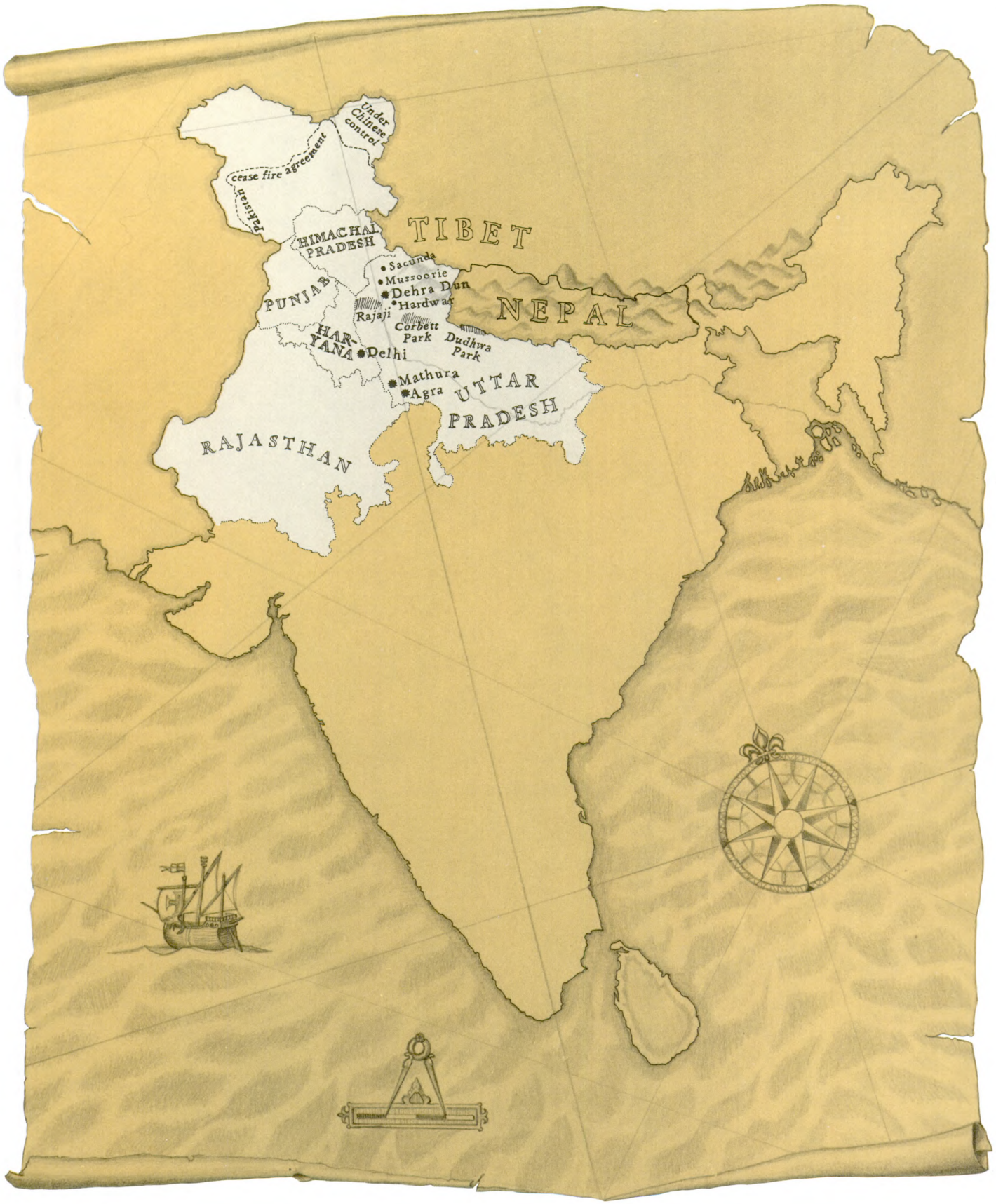
What I brought to the project was a core of scientific ideas for conservation strategies, not to mention field guides, camera gear, and some 60 pounds of miscellaneous camping equipment. What I brought back was an education on a land 4,000 years old and many cultures deep in its use of the land and its vast resources.

As a wildlife ecologist, I have had substantial experience in field ecology research and statistical analysis and modeling of ecological systems. My own work has encompassed wildlife conservation and forestry in research and management. Straddling several areas of resource science and management has helped me to interpret and develop technologies and apply results of scientific theory and research for guiding resource planning.

India plays a special role in global conservation of wildlife and their habitats. Few land areas, except perhaps Australasia, contain as many unique and endemic species of plants and animals; that is, species found nowhere else in the world. The Indian subcontinent hosts a surprising variety of forest habitats ranging from temperate cedar forests of the Himalayas, banyan and riparian gallery *sholas* of the midcontinent, to the moist and wet evergreen rain forests in the soaring mountains of the far south. Increasingly, however, these forests are being compromised. Much of the wet evergreen rain forests have been fragmented into small parcels, thereby isolating the enormous diversity of forest fauna into small populations now progressively threatened with greater threats of extirpation. The Government of India recognizes not only that their biota are globally worthy of conservation but also that protection of their forests means the very livelihood of much of their rural populace. Bold new policies and programs are helping plan for persistence of existing forests, restoration of forests now degraded, and sustainable provision of forest resources for dependent human communities. In this looking glass, we see ourselves in the West, perhaps in not so very many years to come. Now is the time to learn all we can from a land whose ancient cultures today resound with the need to sustain the very forest lands that they have imperiled.

This account draws from my journal, field notes, and photographs taken during my travels. It is a compendium of happenstances, risks, wildlife encounters, and new friends made during a journey from the Himalayan mountains in the north, through dense tiger-pervaded forests of the hot dry central highlands, to sultry tropical evergreen forests of the far south, then back to the tall wet grasslands bordering Nepal again in the north. I offer this as an individual and an ecological perspective of the state of the land in a part of the world where human presence has been dominant and overriding for over 4 millennia. Above all, it is a sobering view into one possible future for the rest of us.

Contents



North India:

Uttar Pradesh and the Himalayas

March 17

Up at 4:20 a.m. after 3 hours of sleep to begin the long journey to my new temporary home at the Wildlife Institute of India (WII) in the Himalayan foothills, Uttar Pradesh State, India. Plans are to fly from my home in Portland, Oregon, to Seattle, Washington, then to JFK International Airport in New York City, where I am to meet up with my colleague Tom Darden, partner on this adventure. We will leave JFK for Frankfurt, Germany, then on to New Delhi, India.

Or so was the plan. Perhaps it is good to taste early in the trip the seemingly arbitrary changes in travel schedules that I would later encounter virtually daily. At New York, Tom never shows up for the plane. He is to fly up from Dulles Airport in Washington, D.C. His incoming flight is delayed first by 30 minutes, then an hour, then two.

Meanwhile, my L-1011 fills to the hatches, and Tom's seat next to mine becomes occupied by a sleepy German heading home. Because the next connecting flight for Delhi does not leave for another 2 days, I know that Tom must make this flight. I corner the flight purser and, waving my official Government passport, which wields no diplomatic power whatsoever but looks impressive, I have him hold the plane. He finally argues that there is no Darden to be found and begins preparations to close the doors. Desperate to stall the flight, I then approach each flight attendant in an authoritative manner, informing them I am on official duty on a special international mission with the Governments of the United States and India, and present my official travel orders (thumb over "Forest Service" so only the U.S. Government Seal shows) and my passport with visa (which, of course, everyone must have for traveling to India). One by one, I send the flight attendants out into the terminal halls to search for a curly-haired man with a mustache, because I know they cannot close the doors without all crew aboard.

Tom is not to be found.

Meantime, while I'm sending my emissaries out on a Tom-hunt, the flight attendants on board cannot get everyone to take their assigned seats to do a head count, which causes additional delay. In fact, they lose track of one passenger, a Turkish fellow, as it turns out, who does not answer the page in English, German, or Hindi. Suddenly, three plain-clothes agents (FBI? CIA?) appear on board and physically search the entire plane for him. Chaos. He is finally located. Lord knows where he was hiding, or why. Or what they do with him afterwards.

Finally, they seal the doors—some 1-1/2 hours later—and I leave New York without my traveling partner (Tom, not the Turk). Quickly bored without access to a window, I have time to review some thoughts on travel to India penned by my friend and biologist colleague Richard Holthausen, who recently returned from his 6-week tour on the same conservation project. A few of the gems that will prove true and useful are:

- Shower clogs are an absolute must. They are hard to find in India, so pack some along.
- If you're like we were, you'll take more pictures of people than you do of animals. The villagers are absolutely great about posing, and we were welcome to take pictures everywhere. However, the villagers complain that everyone takes their pictures and they never get to see them. He suggested that a Polaroid camera would be a smash hit in rural India. This might be a little cumbersome, but it sure would be fun.
- Practice your squatting positions. Personal facilities in India are different than ours, and in some places you won't have any option. Once you've tried it, you may never switch back.
- Learn at least a few words in Hindi. There is nothing worse than being surrounded by a sea of kids and not being able to communicate the simplest thoughts. We once found ourselves at the center of a gang of kids where I repeatedly asked, "What's your name?" They didn't have the slightest idea what I was saying, but they soon started chanting back, "What's your name?" in unison! If I had known three simple words in Hindi, I would have had much better luck. One important word in Hindi is *bas* which means "enough." It's what you say to finally stop them from refilling your plate.
- When you stay in a forest rest house with no shower, the accepted practice is to ask for a bucket of hot water and dump it over yourself (preferably in the bathroom).
- It's okay to ask the driver to slow down. The driver you have is specifically hired by the project, so you are his boss.
- Carry a church key everywhere. Twist-offs are unknown.
- Good medical help often is not available on the road. You should come armed with information about the most likely ailments, like malaria. I got very concerned one night when I came down with a fever and flulike symptoms. The brief medical information I had said that malaria has flulike symptoms. I suddenly realized that I didn't have the slightest idea what to do next. Should I take the Fansidol? Should I wait until the symptoms got more severe? After I took the Fansidol, then what? Should I make a fuss to go to Delhi to see a doctor? Fortunately, my symptoms disappeared after one troubled night. But the lesson is to make someone explain this stuff to you in detail and write it down.

Ten hours and a day's time warp later, I arrive at Frankfurt, and Yo! there is Tom, waiting with German chocolate in hand, 4 hours ahead of me on a different flight!

March 19

On to Delhi. Interminable flight. Snatches of sleep. I keep resetting my watch to "local time," which whizzes by as if at relativistic speed. Flying to Frankfurt from New York, night lasted 4 hours. Let's see, Earth is some 25,000 miles in circumference and turns every 24 hours, so at the equator you're arcing along at over 1,000 miles per hour. At the poles you're relatively motionless. So, at these mid-to-upper north latitudes, Earth is turning at roughly 500 to 600 miles per hour to the west under us, as we dash at some 400 to 500 miles per hour ground speed in the opposite direction into the rising Sun. No wonder night seems compressed. Brief exhausted nap, then another airline meal. My stomach feels as dizzy as my sense of duration.

Tom and I pass some of the time comparing stories on our preparation for the venture. Medical preparedness was not the least of my concerns. Over the previous 4 weeks, I had suffered through several inoculations for typhoid, tetanus, and diphtheria and one of gamma globulin. Current health information suggested I need not worry about con-

tracting meningitis, yellow fever, or cholera, but I had already begun antimalarial medication. I was carrying a portable water purifying pump, and Tom had iodine crystals; during hot, long hikes through tropical forests to come, we would be happy we carried both of the alembics.

Into Delhi, 2 calendar days but 31 travel hours after I'd left, with 4 hours of airplane sleep. Customs at 1:35 a.m., then out into the warm night to be met by a U.S. Embassy driver with an Ambassador brand, right-hand drive taxi straight from a Bogart movie.

In the cab, I am handed an envelope with a telegram from the Department of State. The telegram reads:

> UNCLASSIFIED
>
> FM: EMBASSY NEW DELHI
>
> TO: SECSTATE WASHDC
>
> 1. Embassy welcomes the visit of Mr. Tom L. Darden and Dr. Bruce G. Marcot of the U.S. Forest Service who are scheduled to participate in the FWS/WII [U.S. Fish and Wildlife Service/Wildlife Institute of India] collaborative project's Wildlife in Managed Forests (WMF) component from March 19 to April 23, 1990. Embassy car will meet travelers on arrival and take them to Claridge's Hotel where single room reservations have been reserved for them. Payments for travelers have been issued and arrangements for disbursement of per diem have been made. Visitors should report to the [U.S.] Embassy Science Office on March 19 at 1130 hours for briefing and other administrative matters.
>
> 2. We have arranged for Mr. Darden and Dr. Marcot to arrive Dehra Dun on March 20 via PF 103 at 0750 hours where they will be met on arrival, and taken to their accommodations.

Then, 4 hours of sleep at the hotel after a round of celebratory brandy from Tom's emergency canteen.

Tom is a generous, robust, exuberant man of southern heritage, whose expertise in management and sense of irony and absurdity helped us both enjoy the many adventures and trials of our travels. Tom works in the Washington Office of the USDA Forest Service and knows the needs for field-level support; he carries that message throughout our meetings with the Indian state forest personnel we are to encounter. Tom's particular Strengths that he brings to the project include developing and administering programs to integrate timber resource management with wildlife habitat conservation. In particular, in Southeastern U.S. pine forests, he has helped integrate timber management objectives with wildlife habitat objectives for game, including wild turkey, and threatened or endangered species, such as red-cockaded woodpeckers. Tom also has a good working knowledge of developing wildlife monitoring programs and grazing-wildlife relationships. He also is knowledgeable in use of prescribed burning to aid recovery of forest conditions for wildlife, such as to provide ungulate forage and reduce competition from unwanted hardwood shrubs. Many field managers in our India tour would come to appreciate Tom's varied practical and managerial skills and knowledge; these are some of their needs for field-level support.

Up at 9:00 a.m., breakfast, then a taxi ride through Traffic From Hell for an orientation briefing at the U.S. Embassy. Entry to the Embassy is as secure as could be, with multiple entry points, body and baggage searches, hand-held and door-frame metal detectors, and passport checks. No photographs are allowed within the compound for security reasons; indeed, they impound our cameras until we leave. Our initial per diem payment is to cover several days in Delhi at a rate of 1500 rupees (Rs) per day and comprises a several-inch-high stack of rupee notes of small denomination. The exchange rate is great for us Americans, terrible for Indians. With embarrassingly bulging pockets, we return to the hotel, lose the ties, don our jeans, and tour the ancient city.

By dusk, we return to Lodi Gardens, a tranquil oasis of green in the sea of urban India. The Gardens contain small streams, arched bridges, ancient tombs, and our first peek at the exotic fauna we are to live with for the next month and a half: house crows, hoopoes, pied mynas, pariah kites, red-wattled lapwings, Indian ring doves, rose-ringed parakeets, common mynas, house swifts, and lesser golden-backed woodpeckers. Five-striped palm squirrels dart among the strolling visitors. India has an amazing diversity of mammal life, especially primates and ungulates, but an equally surprising dearth of squirrels: only three species, the others of which (the three-striped palm squirrel and the Indian giant flying squirrel) we will encounter in the mountain wildernesses of central and south India. In contrast, several dozen species of squirrels and chipmunks roam within U.S.

Hoopoe (Upupa epops). *This bird belongs to the monotypic family Upupidae. They unfurl their head crest into a wide, black-tipped fan when displaying or defending territories. Their call is an onomatopoeic* hoo-po *or* hoo-po-po

borders. The difference is in the evolutionary history and biogeography of the two parts of the world. Just a few weeks back, I had cataloged some 17 species of hummingbirds while in Costa Rica in Central America, whereas India has none. Rather, India contains species of insect- or nectar-feeding taxonomic groups absent or weakly represented in the New World, such as the sunbirds and barbets. In the weeks to come, we would encounter many such representatives of the diversity of India's fauna.

Along the streets are commonly seen the Yoda-like images of rhesus macaques, sitting on their characteristically red rumps and waiting for edible food scraps to be flung their way.

Curry chicken, a taste of the local brew—Kalyani Black Label—and to bed, although by my watch's alternate time and my internal clock, it is just turning 7:00 in the morning.

March 20

Up at 4:30 a.m., another 4 hours of sleep. Rich Indian coffee, then an Embassy limo to the airport. Flight up the Indo-Gangetic Plain past the Siwalik Mountains, and into the foothills of the Himalayas to the town of Dehra Dun, home of the Wildlife Institute of India and our new residence. The airline—Vayadoot, also spelled Vayudoot on some of their signs—charges me Rs 95 for excess baggage. In theory, we are traveling under official Government sponsorship and should not have to pay extra. But since US$1 gets you something like Rs 17, the bill comes to just US$5.59, and I don't argue the point.

On board, we are offered tea, always with milk, which we were warned to avoid for health reasons, although the standard practice in India is to boil the tea with milk already combined. The hostess also offers us a small white plastic pack with a couple of candies and a clear package with what looks for all the world like marijuana seeds. The seeds turns out to be anise, which is chewed for its licorice taste that leaves the mouth feeling both clean and malodorous at the same time. In India, anise and betel nut are served after almost every meal, and we quickly learn to enjoy their taste. All announcements for the flight and the onboard notices are in both Hindi and English.

Across the Indo-Gangetic Plain, we can see the pattern of land use below: villages, of perhaps a few hundred people, more or less evenly spaced at intervals of 5 to 10 kilometers (remember, 1 kilometer is about 0.6 mile), all interwoven by unpaved oxcart roads and trails. Each village has one or two water tanks or artificial ponds, some glowing light green from encroaching algae and other exotic water weeds. From this altitude, the network of villages and trails looks like a loosely meshed fishing net that stretches all the way from Delhi to the Himalayan foothills. This seems an appropriate metaphor, as each link in a net contributes to its overall strength, and stretching the net with too heavy a burden—as with taxing the land base to produce resources—ultimately causes it to shred. Most of the land below is intensively used and is devoid of forest cover, riparian (streamside) vegetation, or natural grassland, although I would later see from the ground that the brown arid earth is a bit more fertile than it appears through the haze from 4 miles up.

Forget the subjective concept of an "undeveloped" or "developing country." This country has been developing for 4,000 years. With a land base of 1,269,340 square miles and some 849,994,000 people (est. 1990), India's arable crop fields and grazable pastures are about as developed as possible without major losses of productivity.[1] India's population density is nine times that of the United States. Some 70 to 80 percent of all Indians depend directly on the productivity of the land, whereas nearly 80 percent of U.S. citizens live in urban areas.[2]

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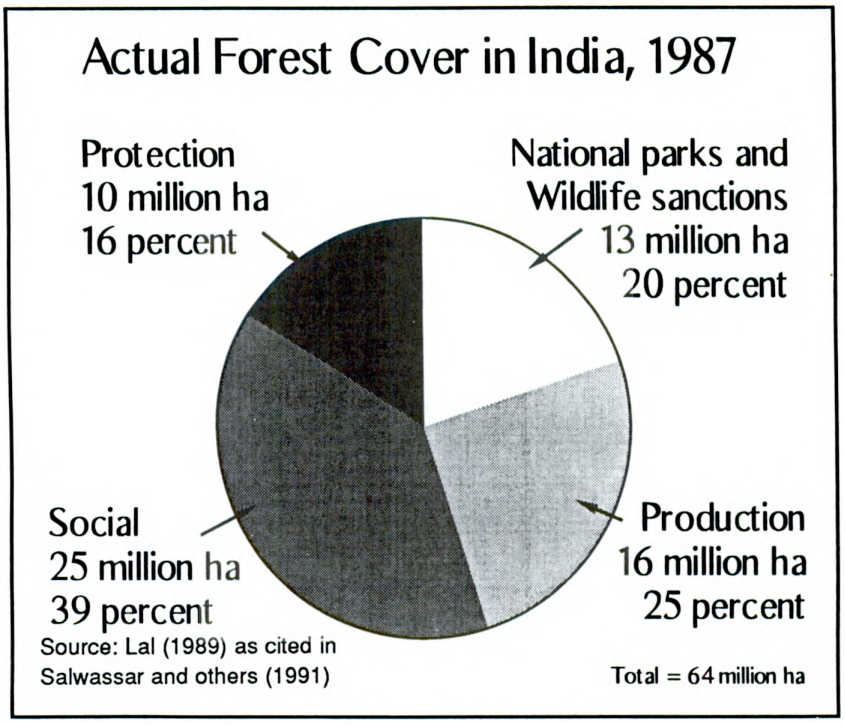
[1] Geographic and demographic data from: United Nations. 1986. Demographic yearbook. New York: United Nations; and U.S. Government. 1989. World population data sheet. Washington, DC: Population Refererence Bureau

References not footnoted may be found in the section, "For Further Reading."

[2] Salwasser, H. 1991. Opening remarks: National workshop on Integrated forest planning and management for conserving biological diversity. 21 January 1991. Pachmarhi, Madhya Pardesh, India.

About 32 percent of the United States is forested as compared with 19 percent of India. Whereas some 7.5 percent of the land base of the United States is allocated to highly protected status, only about 3.9 percent of India's lands are in protected status of national parks, wildlife sanctuaries, and preservation plots. And with such intensive levels of land use, the native forests, grasslands, wildlife, and fish have suffered great declines in abundance, distribution, and long-term security. The accounts of the hunters and explorers from the early 19th century spoke of wide expanses of jungles with high diversity and great densities of wildlife. What will conditions be like in just a decade, when the human population in India is expected to top 1 billion?

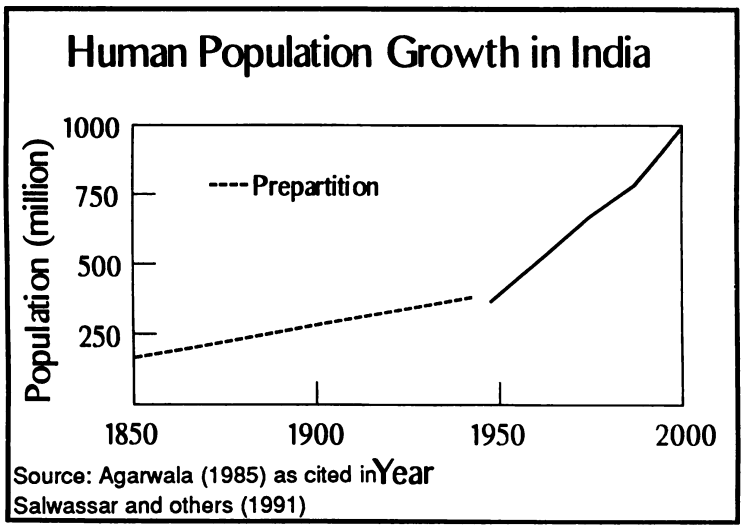
High technology has nothing to do with the solution. Controlling human population growth and guiding land use patterns has everything to do with it. Solutions invoking higher technology, such as increasing crop yield or automating farming or making the vestigial timber industry of the country more efficient, probably would only create greater problems of unemployment because fewer people would be employed for each increment of commodity produced. Further, high technology would urge the masses to seek even greater levels of resource exploitation to meet their general subsistence needs. No, the solution has to involve using the vast reservoir of human labor, weaving



conservation into daily and traditional land use patterns, and creating new ways to live with the land that are commensurate with indigenous patterns of use. Such are the challenges facing India—and our consultation team from the United States—in crafting a new century of conservation for the subcontinent.

And, most obviously, something must be done to dissuade the rising flood of humans. India's population growth is currently estimated at 2.01 percent per year, thereby yielding a population doubling time of only 35 years. In a single generation, the now arable and productive lands will be taxed as never before in 4 millennia of use and development. Many lands once forested are now turned to agriculture or, worse, into "wastelands" from overuse by livestock grazing or crop production. These lands are now on the verge of losing their productive potential and may never be reforested. Increasing pressures on resource use in the remaining isolated forests will stress habitats and their associated wildlife communities like never before.

We fly over the Siwaliks, a mountain range running parallel with the Himalayan foothills. In one account, I heard that the Siwaliks are comprised of the ancient glacial outwash, the terminal moraines, of the icefields that once incised the Himalayas, a recent occurrence in geologic time. Thus, the Siwaliks are highly erodable, a fact that has created problems with siltation and sedimentation of its rivers as the land has been increasingly deforested by tribespeople and villages dependent on its bounties for survival. In another account, I heard that the Siwaliks are metamorphic in origin, more ancient than the still-rising Himalayas.



The geologic origin is actually both of these. The base of the Himalayas traces the edge of the Indian tectonic plate that rafted northward from the ancient supercontinent of Gondwana 50 million years ago and that slammed into the Asian plate of Tibet, bringing a host of new life forms into the north temperate continent. The Indo-Gangetic Plain to the south and west is part of the Indian plate and still is being thrust under the Asian plate; that is, being subducted at a rate of 5 centimeters per year. This subduction has folded Earth's crust, creating the still-growing Himalayas, and has sheared off upper layers of the sedimentary crust along the boundary fault. The layers have been added to by sediments brought down the southern face of the Himalayas by rivers and periodic glaciers, and overlain by further folding and fault thrusts of the older rocks of the lower Himalayan range. This has created a complex landscape and geologic labyrinth that tests even the most clever geomorphologists.

I check the map, then the travel book I am carrying. Siwaliks, Sivaliks. The spelling of place names in India is changeable, as evidenced in these references. Spelling often depends on whether the original language or the later King's English interpretation is used. For example, the city of Poona (English spelling) also is shown as Pune (older spelling), and the central Indian mountain range of Satpura (English) also is spelled Satpuda (older). Likewise, the Siwaliks (English) appear as Sivaliks or even Shivaliks (older). I bring this up because the spelling Shivaliks best fits the root of the name, being derived from that of Lord Shiva.

From our approaching flight, the sudden sight of the green foothills of the Siwaliks/Sivaliks/Shivaliks is a startling contrast to the vast, unforested, arid-appearing Indo-Gangetic Plain country. At the edge of the plain runs the boundary of the reserved forest area, and as prominent and artificial and linear a demarcation between brown crop fields and dense green forests could not be found.

The sal (*Shoria robusta*) forests of north India, along with the teak (*Tectona grandis*) forests of the central and south regions of the country, constitute the major wood source for the country. Some of the forests of the Siwaliks have been spared harvest in recent decades, however, with the establishment of Rajaji National Park, Timley Reserved Forest, and other set-asides. The reason? Seminatural forests have become a threatened habitat in India. And, as of 1988, the country has taken the remarkably bold move of imparting a moratorium on all clearfelling (we call it clearcutting) of forest lands throughout the country. The moratorium will remain in effect until, and perhaps beyond the time when, comprehensive and long-term conservation measures can be instituted to ensure protection of the country's forests and wildlife—thus, the urgency of our project.

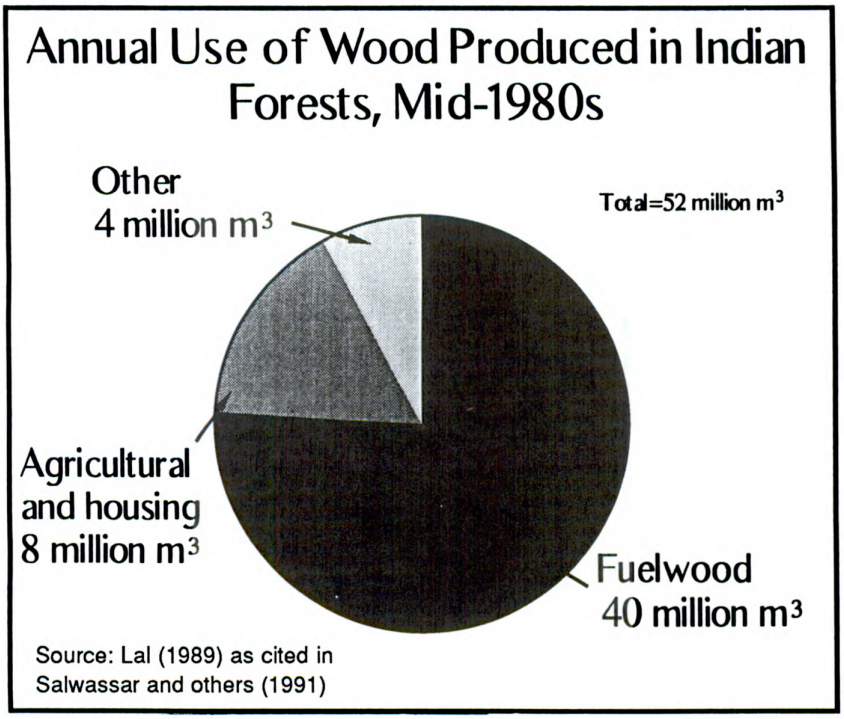
Pouring out of the Himalayas and through the Siwaliks are massive meandering river flood plains running parallel to one another in seemingly endless succession, cutting the steep green and orange sal forests into wide wedges of jungle. I can

see no free water in the river basins, as this is the middle of the dry season. It has been several months since the last major rains and not until late June will the monsoons return in sufficient force to fill the channels. I picture massive walls of flash floods carrying thousands of tons of rock and forest debris along the channels, flooding pastures and cropfields downstream. Indeed, deforestation has accelerated in the Siwaliks and Himalayas in recent decades and added to the silt loads the rivers must carry. Flooding has been increasingly more common and devastating in recent decades from this overuse of the land.

Thus, the combination of topography and geomorphology of the Siwaliks with increases in intensive land use and growth of human populations have combined to result in erosion of soils and loss of long-term site productivity. It is a striking lesson in how a new conservation must account for geomorphology and geologic history as well as human use patterns in identifying levels of resource use and development that will not degrade the land. I doubt if many current villagers of the Siwaliks see how their livelihood today and that of their children tomorrow are directly linked to geomorphology, geologic history, patterns of land use by villagers a hundred miles upriver, and even the distribution of forest habitats for wildlife across the subcontinent. Their lands, the productivity of their soils, and their individual health are all directly touched by prehistory of continental drift and history of their cultures and by activities of their fellow citizens in far away locations. These are the factors that will be considered in developing a comprehensive land-use plan for the country at the first, broadest scale. Specifically, the first level of land use will be planned at the broadest provincial scale and account for capability of the land to produce crops and forests as a function of soils, geology, past land use patterns and cultures, and distribution of reserved forests and habitats within the province and throughout the country.

The plane skims the still-green mixed sal woodlands on its landing at the Dehra Dun strip, a visual flight rule airport (no guiding radio beacons or control tower). Feather-soft landing. In poor weather, as begins with Himalayan storm clouds in early summer, flights are canceled and one has to travel the 60-minute air route from Delhi by a 6-hour bus or taxi drive—that is, if the highways remain passable from high water, accidents, local strikes or demonstrations, and a host of other travel risks.

Our destination in Dehra Dun is the Wildlife Institute of India, the training center for students and for foresters of the state and national forest service of India. The institute is directed by H. Panwar, a man with remarkable vision for integrating wildlife conservation into ongoing programs of social forestry, forest commodity production, and human social programs throughout the country. His associate directors include K. Rao, S.K. Mukherjee, and V.B. ("Vish") Sawarkar, each a bright and energetic expert in many facets of forest conservation. The institute faculty consists of a number of Ph.D.'s who develop and teach courses on wildlife science, ecology, management, and conservation. Panwar and Sawarkar are our key contacts for overseeing the Wildlife in Managed Forests of India project with the USDA Forest Service. The institute faculty are to be increasingly involved in writing teaching-syllabus chapters and developing inventory and research projects for our site-specific demonstration project, the Satpura Hills Biodiversity



Demonstration Project in central India. Overall, the institute helps train the nation's foresters in wildlife conservation in conjunction with the Indira Gandhi National Forest Academy, also housed in Dehra Dun. In time, our project will expand to include explicit collaboration between the WII, the Forest Academy, and Indian Forest Service managers and researchers from the Federal Government and from the States of Maharashtra and Madya Pradesh, which are straddled by the Satpura Hills demonstration area. Such collaboration is essential to successfully meet the visions of the latest Federal forest and wildlife policies and of conservation leaders including Panwar, Sawarkar, and Salwasser.

We are met at the Dehra Dun airport by Rajiv, one of the drivers from WII. Waiting for us in the Jeep-like vehicle (the Indian equivalent is a Maruthi) is a letter from our main contact, Vish Sawarkar. I open it and read:

> 20th March 1990
>
> Dear Dr. Marcot and Dr. Darden,
>
> Welcome to Dehra Dun! I hope you have had a pleasant journey, though you may not be over the jet lag as yet. I will meet you around 0845 hrs at the U.S. Faculty Guest House where the driver will drop you. Your cook is Baban, who will fix you a good breakfast. I am looking forward to meeting with you. I have already arranged our field trips between 28th March to 13th
>
> April '90. There was no time to delay, as field officers need to be informed well in advance, especially in the month of March. More when we meet.
>
> With kind regards,
>
> Yours sincerely,
>
> Vish

We drive up the foothills to the guest house provided by GOI (Government of India). At the guest house we meet our cook, Baban, his wife, our houseboy, and our official driver, Anwar. A holdover from a century of British rule and millennia of caste-based cultures, the use of servants is commonplace throughout the country. I never feel comfortable with the arrangement and always want to include them in our evening discussions and outings and lunch stops while on the road, although they feel their place is in the kitchens and back rooms. It is as difficult for me to let go of my cultural bias of not using servants for the skills for which they have been well trained, as it is for them to ignore their culture and behave against their training. In the end, we each lean a little toward the other's cultural predilections. Indeed, understanding and accounting for the wide variations in social structures and standings must be part of any program to conserve India's forest lands. Each individual must believe that a conservatory life style is to their own personal and cultural benefit.

Our cook, as I have said, is named Baban. We ask if that is his given name or his surname, and what his full name is, but all he reveals is "Baban." He has served with the WII for many years, and before was a cook under the British Rule. He regales us with tales of his travels throughout India and surrounding countries. If we are initially disinclined to believe his many travel stories, we become believers when we taste his wide variety of cooking styles—Indian, English, Australian, to name a few—whereas, by comparison, other Indian cooks we are to encounter hardly seem to have mastered more than one Indian dish. Also, to ensure our good health, he boils and filters all our drinking water and washes all vegetables and fruits before cooking.

Baban stands little more than 5-1/2 feet, with ragged thinning hair and a winning smile of, at most, four visible teeth. More than a cook, Baban is a house mother and good friend, who ensures that the doors and windows are double-bolted at night (local thieves have caused recent trouble) and lectures us on the sanctity of living an honest life and the evils of temptation in a foreign land. Of course, then he shyly accepts a late-night glass of whiskey and keeps his finger on the neck of the bottle until the glass is mostly full.

The guest house in Dehra Dun is a recently built two-story structure with four bedrooms, each with adjoining baths with sit-downs and showers, although some rooms have running water but no heat and others have flushing toilets but no functional showers. By straddling a couple rooms, all our western wants are met, however. The obligatory plastic buckets are present in each bathroom; one for bathing, we guess, and the smaller one for, well, washing after one performs necessary bodily functions.

From the upstairs balcony, we can watch local women dig for tubers and roots in the shrub field across the street. Beyond is the tea plantation with its screeching parakeets, stealthy rhesus macaques, and scattered overstory of magnificently canopied *Bulguria latifolia* trees. At the edge of the tea plantation, we

can see a small Hindu temple and numerous canvas tents of the local law enforcement, who camp by the temple to deter conflicts and violence there. At night we sit on the balcony under the stars and listen to the complex drum rhythms and chants emanating from the temple. During the day, *phalvalas, sabzivalas,* and *kaprevalas* appear—men pushing or riding carts laden with fruits, vegetables, and linens—each vendor with a song announcing their supplies for sale.

It is spring and the breeding birds have moved up from the distant plains and river valleys and fill the morning air with profusions of song. With morning coffee in hand, a stroll onto the balcony reveals no less than 20 species, including Indian robin, green bee-eaters, pied chats, jungle babblers, yellow-bellied wren-warblers, and blossom-headed parakeets. For this wildlife ecologist, it is like learning bird identification all over again. On the course of our journey, I would see over 200 species of birds, only 5 of which I had ever seen before: osprey, pintail, spotted dove, and the ubiquitous house sparrow and cattle egret. All others forms, including their calls, songs, and plumage variations by sex and age, are new.

By 2:00 p.m. our driver takes us to the WII grounds. The institute is the main academy for training the foresters throughout the Indian Forest Service and was built during British occupancy. The primary building is a massive structure of red brick and white columns, erected many decades ago on half an acre of foundation that is accurate from end to end by an error of less than 1 inch. The grounds are wide manicured lawns with planted bamboos and other native shrubs. The WII shares these stately quarters with the Forest Research Institute of India, although WII is currently constructing a new complex several kilometers from here.

Only well after I enjoy several strolls around the grounds am I casually informed about the banded krait that was recently discovered on the front lawn by a groundskeeper. Banded kraits are about the deadliest venomous snakes in all Asia. The story goes that the groundskeeper took the snake home, thinking it harmless, and after much drink showed it off to family and friends. He picked it up, waved it about, and proceeded to kiss it, when it finally struck his cheek, lips, and tongue. In only moments the man fell dead. Although the king cobra, the well-known serpent of wicker basket and flute fame, packs a greater volume of venom, ounce-for-ounce the krait's is substantially more potent. Regardless, it is wise to know where one is stepping, and I am thankful I have not inadvertently crossed paths with either species. Yet.

We spend the afternoon meeting many of the faculty, staff, and students. A rather strict hierarchy of senior faculty, junior faculty, staff, and graduate students is evident. Learning how to address one another is an additional minitraining course for me. A man is referred to as *Shri* [last name] or Dr. [last name], whereas a woman is titled *Shri Mati* [last name] if she is married, the last name traditionally being the husband's. An unmarried woman is

A tea plantation overtopped by old, cavity-bearing trees in Dehra Dun, Siwaliks Mountains, Uttar Pradesh, northern India. The trees provide fruit and nest and roost sites for parakeets, bulbuls, hawk-cuckoos, vultures, and many other wildlife species.

called *Kumari* [last name], equivalent to our "Miss." If she is married with a doctoral degree, she is Dr. *Shri Mati* [last name]. Don't ask me if she is married but has retained her own last name, as my wife has.

Faculty colleagues seem to refer to one another, first or second person, by their last names and without titles, which from my cultural viewpoint seems rather brash. They refer to seniors by their titles (Dr. or Mr.; there are no female senior faculty members or directors). Luckily, they tolerate our different ways, as when we refer to our main host, Mr. Vishwas Sawarkar, simply as Vish.

Our discussions center on the long-term conservation strategy needed for India. The director of the institute, H. Panwar, is an articulate and energetic man with an amazing vision of how the solution to the joint survival of villages and wildlife species and forest habitats must be an integrated one. Panwar also had been director of Project Tiger for the country and now, with his absolutely topnotch institute team, is forging new conservation training throughout India.

The GOI has already instituted an Ecodevelopment Program that focuses on developing standards and policies for managing human habitation in the so-called buffer forest areas. The goal of the Ecodevelopment Program is to find ways to improve the standard of living of rural peoples in a self-sustaining economy. Forest conservation in India consists of designating national parks, reserved forests, wildlife sanctuaries, and other categories of forest land use, all overseen and administered by one single agency, the Indian Forest Service. In contrast, in the United States, public lands with natural forests and wildlands are administered by as many as half a dozen Federal agencies, not to mention the plethora of state and local government categories of land use. But both the Indian and U.S. forests are managed for a wide spectrum of values and interests, including resource preservation, conservation, and exploitation. For National Forests, the U.S. mandates come from the 1976 National Forest Management Act; India's comes from its 1988 National Forest Policy.

India's National Forest Policy calls for management of forests throughout the country for conservation of biological diversity, the variety of species and communities. The preamble to the policy[3] reads:

> Over the years, forests in the country have suffered serious depletion. This is attributable to relentless pressures arising from ever-increasing demand for fuelwood, fodder and timber; inadequacy of protection measures; diversion of forest lands to non-forest uses without ensuring compensatory afforestation and essential environmental safeguards; and the tendency to look upon forests and revenue earning resource. The need to review the situation and to evolve, for the future, a new strategy of forest conservation has become imperative. Conservation includes preservation, maintenance, sustainable utilisation, restoration, and enhancement of the natural environment. It has thus become necessary to review and revise the National Forest Policy.

[3] National Forest Policy. 1988. New Delhi: Government of India, Ministry of Environment and Forests. 13 p.

The objectives of the policy include:

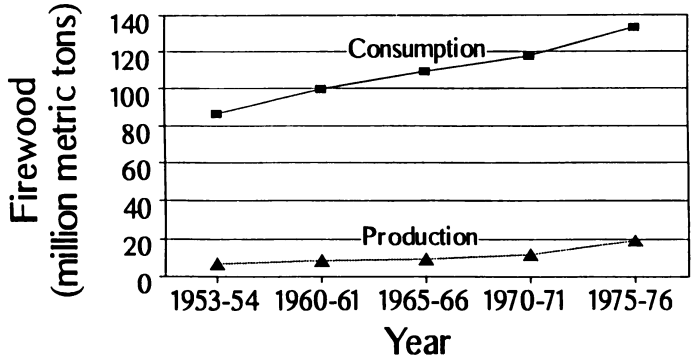
- Maintaining environmental stability by preservation and restoring the ecological balance of depleted forests.
- Conserving the country's natural heritage by preserving remaining natural forests.
- Checking soil erosion and denuding of vegetation.
- Checking the extension of sand dunes in the deserts of Rajasthan and along the coast.
- Increasing substantially the forest and tree cover in the country through massive afforestation and social forestry programs, especially on all denuded, degraded, and unproductive lands.
- Meeting the needs for fuelwood, fodder, small timber, and forest products of the rural and tribal populations.
- Increasing productivity of the forests to meet essential national needs.
- Encouraging efficient use of forest products and maximizing substitutions of wood.
- Creating a massive people's movement, including involvement by women, for reaching these objectives and minimizing pressures on existing forests.

Further objectives relate to ensuring environmental stability and maintenance of ecological balance including atmospheric equilibrium.

This list of objectives is a remarkable overhaul of past forest management objectives in the country. Despite criticisms that the National Forest Policy is too encompassing and unachievable, it is a visionary statement for creating a new and promising future for forest conservation and preservation.

A list of "essentials of forest management" in the policy further calls for afforestation of denuded hill slopes,

Firewood Use Outstrips Production in India



Source: Lal (1989:90)

catchment areas of rivers, lakes, and reservoirs, ocean shores, and semi-arid, arid, and desert tracts. Productive agricultural lands are not to be reforested, however, because of the need to increase food production.

From a landscape planning scale, the policy calls for conservation of total biological diversity by strengthening and extending the network of national parks, sanctuaries, biosphere reserves, and other protected areas. Adequate amounts of fodder, fuel, and pastures will be provided in areas adjoining forests (buffer areas, as discussed below), with special emphasis on afforestation of rural areas to provide fuelwood. The policy also calls for protecting and improving production of "minor forest produce" for tribal populations, with due regard for generating employment and income.

The policy explicitly sets a national goal of re-creating and maintaining a minimum of one-third of the total land area of India under forest or tree cover. Hills and mountains should have at least two-thirds forest cover to stave off erosion. To accomplish this goal, a massive tree-planting program is to commence with emphasis on growing fuelwood and fodder on all degraded and denuded lands in the country, as a "national imperative." Village areas can be procured and villages moved, with protection of the villagers' livelihoods, if the site is needed to reproduce forests. Rain forests in the tropical Indian States of Arunachal Pradesh, Kerala, and Andaman and Nicobar Islands should be "totally safeguarded." Further, no clear-felling of timber shall be allowed; reforestation shall proceed scientifically; and no exotic species are to be introduced without full study of potential effects. Other portions of the policy address rights and concessions of tribes, scheduled castes, and other poor living within and near forests. In fact, much of the policy addresses providing for human needs for forest resources.

The policy explicitly refers to conserving wildlife by providing for corridors linking protected areas of the country to maintain genetic continuity. This is a bold mandate that exceeds even the policy mandates of the USDA Forest Service. It forces development of a process for planning land use allocations and forest management activities over the entirety of the country across all land use classes and ownerships.

The final sections of the policy address the need to extend and develop forestry education, research, management, inventories, and budgets. Much of this section also pertains directly to our U.S. team's role in assisting the WII in developing a new syllabus for training the foresters of the country in implementing the scope and vision of the national policy.

To begin developing a new syllabus, approach, and set of technical tools for achieving the policy's goals, we first must begin by understanding the current situation of land management in the country.

Indian forest lands are divided into several management units, principally core areas and buffer areas. Core areas are referred to as *sanctum sanctora*, the management of which explicitly excludes any human habitation, development, or direct resource exploitation. Accessing the core areas is an experience, as they typically are fenced with multiple locked gates and many are guarded day and night by Forest Service personnel.

Bordering core areas are buffer areas in which human use of resources is allowed through concessions and rights. Concessions are legal permits for use of the forest lands for a variety of stated purposes such as fruit harvest or livestock grazing. Rights are guaranteed allotments given to some tribes to ensure their access to traditionally used forest resources, especially those necessary for continued subsistence, much the same way that Native Americans in the United States are given rights for traditional subsistence fishing of salmon in rivers of the Pacific Northwest or hunting of caribou in interior Alaska.

One of the administrative holdovers from British days seems to be an excruciatingly complex bureaucratic system. Although all forest lands throughout the country are managed by a single ministry of the Federal Government, the Indian Forest Service is itself structured like a tier of miniagencies, seemingly just to keep the paperwork voluminous and the chains of command attenuated. The Federal Indian Forest Service functions as a top administrative veneer for on-the-ground management, which occurs at the state level. Each of India's 16 states has its own Forest Service offices, officers, and staffs, as roughly indicated by the following simplified chart of their organizational structure (organizational levels are shown in bold face and administrative heads are italicized):

FEDERAL GOVERNMENT
Ministry of Environment and Forests
Department of Forests and Wildlife
Indian Forest Service

STATE GOVERNMENT
Principle Chief Conservator of Forests

Chief Conservator of Forests

Chief Conservator for Wildlife (= Chief Wildlife Warden)

–plus numerous other chiefs in charge of various disciplines, including Forest Products and Marketing, Social Forestry, Forest Development Corporation, and others

Forest Circle
Conservator of Forest
–oversees staff and line, constituting the Forest Circle, which is the first functional unit level for forest management:

Line
several jurisdictions
Civil Districts (somewhat equivalent to counties in the United States)

Staffs
–State Forest Research
–Education and Training
–Planning

Forest Division
Divisional Forest Officer
–produces a working plan for each division

Assistant Conservator of Forests
–supervisory duties
–lowest junior officer

Forest Range
Range Forest Officer ("Ranger")

Section
Beat Officer ("Forester")

Forest Beat
Forest Guard

Tribespeople and Forests in India, 1981

52,000,000 people
250 communities or groups
12 percent shifting cultivation
2 percent village residents
15-84 percent dependent on forest (differs by state)
33 percent of tribal livelihood from forest products

Source: Lal (1989) as cited in Salwassar and others (1991)

Not only is this organizational structure longer than the Great Wall of China, but various administrative heads listed above are trained in separate forestry schools. The Federal Indian Forest Service personnel are trained for two years at the famous Indira Gandhi School of Forestry (adjacent to the WII in Dehra Dun), and each state has its own Forest Service college to train their personnel. Additionally, the range officers, section officers, and forest guards are trained in separate schools. Luckily, the single WII, our principle contact, oversees the wildlife ecology and management component of all this training. That is the component I had come to India to assist.

A full one-quarter of the population of India consists of so-called scheduled tribes, casts, backward tribes, and untouchables, as they are categorized by GOI. Tribespeople have special traditional rights in some forests and are a cause of impeding successful resource conservation in others. A solution to the conservation problems of India must account for even this diversity in tribal categories and rights.

Layered over the land categories of forests are national parks, wildlife sanctuaries, and general reserved forests, all administered by the Indian Forest Service and its state subsidiaries. Layered over these categories are tiger reserves and biosphere reserves, which are concepts for managing existing lands rather than designations of new land allocations.

If this sounds confusing, I couldn't agree more. It took me the first 4 weeks in India to understand the system, and I still regularly encounter exceptions. Let me provide an example. Our international team is preparing a demonstration of how to integrate wildlife habitat management with forestry in a large area in central India. This area includes some six administrative units spanning the two Indian States of Madhya Pradesh to the north of the Tapi River and Maharashtra to the south. Our demonstration area resides in the Deccan Plateau of the Central Highlands Province, Satpura-Maikal Subdivision (these are the geographic and ecological categories), and includes the following land management areas:

- Satpura National Park
- Gugamal National Park
- Betul Reserved Forest
- Bori Wildlife Sanctuary
- Pachmarhi Wildlife Sanctuary
- Melghat Wildlife Sanctuary

The area known as Melghat Tiger Reserve is comprised of a combination of Gugamal National Park and Melghat Wildlife Sanctuary. In addition, each national park has a management-designated core area (*sanctum sanctorum*) and one or more buffer areas managed for more intensive resource use. The core areas typically sport their own names, as well; for example, Gugamal National Park is actually the name of the core area located within Melghat Wildlife Sanctuary.

There are overlapping—sometimes competing—jurisdictions for the tiger reserves, national parks, reserved forests, wildlife sanctuaries, core areas, and buffer areas. On the other hand, when human encroachment into national park buffer areas is so intense as to degrade the ecological values and the values of adjacent core areas, responsibility for buffer area management can be self-absolved by all associated officials. Perhaps it seems like management by convenience, but to be fair, nearly all forest officers and administrators we will encounter are true to the resource and want nothing less than the best conservation management for their areas. But, give one ship to two captains and, despite best intentions, orders are bound to conflict eventually, I guess.

There are 18 tiger reserves in the country, and all but one occur as wildlife sanctuary or national park status. (The exception is Bachsu Tiger Reserve in West Bengal; this reserve is in reserved forest status only because the State wants to retain access to the dolomite mines. Sanctuary or park status would preclude that access.) Some tiger reserves also might include additional reserved forest areas. Again, the confusion of land allocations and of land status as dictated by Federal or state policy and as guided by "soft" management concepts, such as the tiger reserves and the core and buffer system, keeps my head spinning.

To make matters a bit more complicated, there are also three main classes of forests in India. Reserved forests have the highest legal status of forest land in India. All acts within reserved forests are prohibited unless specially permitted. No rights per se to use forest resources are allowed in reserved forests, but numerous concessions are allowed—except for major timber harvests. And there are other exceptions. Limited timber removal is allowed, but the Indian Forest Service does all timber marking and oversees all harvest and hauling operations. In many cases, however, concessions in reserved forests effectively become rights through tradition, local politics, legislation, and unfortunate to admit, the occasional bribe. The low pay given to the forest guards is perhaps one of the factors that needs to be directly addressed in strengthening the conservation of forests in India.

The second kind of forest category is protected forest in which several kinds of rights as well as concessions are allowed. Villages within a protected forest may be listed as concessioners to that forest. This sets the stage for very intensive human occupancy of protected forests for uses such as grazing, timber collection, fuelwood gathering, collection of resins and gums, lopping of trees for fodder, and harvest of a vast host of other forest products for food, medicine, religious rites, and various other functions.

The third category is unclassed forests, which include small areas with status currently in limbo. Unclassed forests eventually will become classified as either reserved forest or protected forest, but for now they do not garner the same degree of protection as either category.

Any combination or portions of reserved, protected, and unclassed forests may constitute national parks, wildlife sanctuaries, game reserves, or other closed areas. And any combination of these designations can constitute a biosphere reserve. All these designations in combination constitute so-called "protected areas." Protected areas may have forestry operations present but traditionally there has been no active wildlife management, although legal

Conservation Utility of Various Land-use Classes

Preserve ← Multivalue, Multiuse → Produce

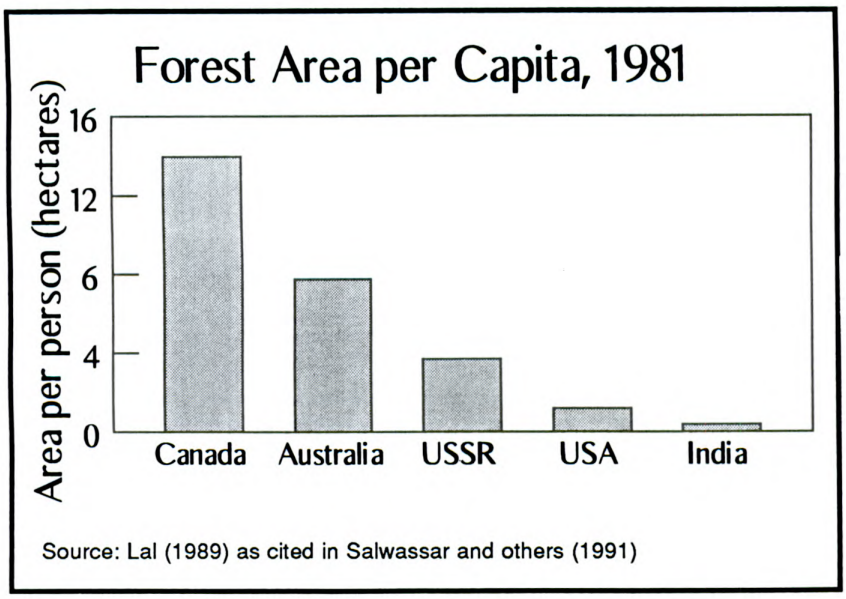
Nature preserves	Reserved forests	Agriculture
Sanctum sanctorums	Wildlife refuges	Tree farms
Research natural areas	Sanctuaries	Game farms
Preservation plots	National parks	Recreation areas
Wilderness	Wild and scenic rivers	

Source: Salwassar and others (1991)

protection of wildlife and their habitats in protected areas is provided by their designations. Of the "forest lands" in India, some 22 percent are actually forested and the rest is agricultural land. Of the 22 percent in forest cover, 85 percent is in reserved forests, 10 percent is in protected forests, and the remaining 5 percent is in unclassed forests. These percentages differ by state.

The Indian Forest Service controls all these categories of forest land, even though the states retain title to the lands. In fact, there are no Federal lands at all. In addition, some lands classified under Indian Forest Service control as forest lands may not have forest cover per se. Such areas might require massive programs of reforestation. These categories include village wastelands, village pasturelands, and village forests. The first two categories can include lands outside the legal forest lands over seen by the Indian Forest Service and typically are all bereft of natural forest cover and have little or no native wildlife present. Many village wastelands and pasturelands are identified generically as "wastelands." And although there is a national recovery program, "Greening the Wastelands," there is neither an agency nor a budget officially allocated for carrying out this laudable-sounding policy.

In marked contrast with the United States and other western countries, there are virtually no privately held timber lands in India. Instead, tribal councils oversee the use of village forests by local villages. This is similar to some of the Native American tribal councils, such as the Hoopa Tribal Council in northwestern California, which coordinates interests of several tribes in the forest and fisheries resources of their jointly administered lands. In India, the local state forestry departments prepare the forest use plans for the village forests. But, with no power of enforcement, the villages use the forest resources at their own whim and rate.



Source: Lal (1989) as cited in Salwassar and others (1991)

A new conservation approach must account for all these land use allocations. In North America, multiple-use lands contribute to an overall conservation strategy, and the same should hold true in India. Reserved lands must complement national parks and wildlife sanctuaries to provide critical wildlife habitats and linkages between habitats in parks and sanctuaries. Even lands managed for high human use of forest resources can play a vital role in extending and linking forest habitats (see footnote 2).

Several key pieces of Federal policy guide conservation of forests and wildlife in India. The Indian Forest Act of 1927, recently revised, and the Wildlife Protection Act of 1972 are two. The Wildlife Protection Act, in one bold move, outlawed all hunting of any game throughout the country, except for wild boar and jungle fowl and as allowed through some tribal rights. I can imagine the utter revolt that would ensue back home were the United States to institute such a law or a law similar to India's 1988 moratorium on all clear-felling throughout the country. But with natural forests being endangered throughout the Indian subcontinent, these bold moves are essential

for ensuring survival of habitats and species until restoration and integrated conservation measures can be devised, demonstrated, implemented, and enforced.

In 1985 there was a major national review of protected areas and how well they served their intended purposes. The review resulted in a set of recommendations to establish a nationwide network of reserves for protection of biological diversity from a broad, landscape perspective. This planted the seed for our project, which will consider how forest reserves and protected areas function ecologically throughout the country in maintaining viable populations of native wildlife, as well as of the attendant and dependent human communities.

It is only a matter of degree in comparing the state of the environments between North America and India. India's current conservation plight—and its bold new plans—is one alternative tomorrow for North America. Thankfully, in North America we still have options. Hopefully, we can look into this remarkable crystal ball and move into a future we consciously choose and create a livable, viable environment for ourselves, our forests, and our wildlife.

By late afternoon I return to the guest house, utterly exhausted from a total of about 8 hours sleep over a period of nearly 3 days. But sleep was to elude me, as we were soon sent off to a lawn party and buffet of Indian food hosted by Dr. Peter Heydeman, science director at the U.S. Embassy. Back home close to midnight. Unconsciousness never felt as welcome. Fell asleep with background sounds of drums and singing radiating from the temple across the dark tea plantation where the blossom-headed parakeets and Indian plaintive cuckoos have now gone to roost.

March 21

Fresh coffee and cookies in bed—Baban's call to service and another cultural difference I guess I will have to learn to accept. Breakfast of *roti,* chili omelets, fruit salad, and vegetable and chili *masala.*

Across the street live Anatoli and Sonia, two Soviet geologists from Moscow. They have been residing here for 2 years on a consulting visit to help India develop their petrochemical technology. They warmly invite us into their house, and we talk in their broken English and my two words of Russian about Gorbachev, peristroika, glastnost, Lenin, and Moscow. I never understood her name. She said Sonia, he called her Sophie, I ended up calling her Sonia-Sophie, and she just laughed at the confusion. They argue with each other on the value of Gorbachev's policies, Anatoli throwing up his arms saying, "To the common man, it's no help, no good," and Sonia-Sophie counseling, "We must wait, be patient, for change. Change come. No?"

First order of technical business: learn a few Hindi phrases critical to getting by. Baban teaches us, quite humbly I'm sure, to praise his cooking with *bahut ache khana!* ("very good meal!"), but I also have him teach me *bas, paet pargia! pura hogia!* ("stop, my stomach is full, I've had enough!"). The primary and most essential Hindi for the road is *dhira dhira!* ("slow down!") and *ruku!, uchla!, sarot bahut karab hai, pul lugia!* ("stop!, the road is bad, I'm getting bounced, and I have an upset stomach!"), which seems appropriate during many overland journeys in the country. As I eventually discover, some of the Hindi I am learning from Baban and our driver Anwar is of a different class or at least spoken with a more slurred accent than the more proper Hindi or Hindustani spoken by our Mr. Vish Sawarkar. In time I would learn a number of other phrases, including the oddball *jacum-jum!,* issued by our cook under virtually every conceivable circumstance and context, from power failures plunging his kitchen into darkness to our praising his cooking. No one else seems to know the phrase, but one Indian suspected it to be Bengali. Given some of Baban's humorous beneath-the-breath exclamations, I thought it best not to ask for a literal translation. For my next visit, if any Hindi, Urdu, Bengali, Marathi, Hindustani, or Punjabi speaking reader can advise me of the social acceptability of *jacum-jum,* I will be in your debt.

Plans are to travel to central India for a week to visit our project in the Satpura Hills. There, we will demonstrate how landscape ecology and integrated resource management can be used to guide land use allocations over a broad provincial area and to craft silvicultural prescriptions for

particular forest stands, all to provide concomitantly for humans and wildlife.

Our demonstration areas include Bori National Park, a spectacular landscape of sal and teak forests set among redrock cliffs and sparse waterholes with a dozen species of ungulates including antelope, bison, elk, and deer. Problems with land use patterns in Bori exemplify what we face in this challenge. In only one forest division in Bori, 10 000 metric tons of firewood are removed each year. This has a devastating effect on key habitats for wildlife. The decaying down logs, standing dying and dead trees (snags), and future recruits to these components all constitute critical habitat for a wide variety of amphibians, reptiles, birds, and mammals and an even wider and poorly known spectrum of invertebrates. These forest components play a vital role in staving off erosion, replenishing organic matter and nutrients in the soil, and maintaining the health of the rest of the forest. The existing working plan, which is essentially the forestry management plan for the area, identifies various concessions for use of firewood, old-world bamboo (*Bambusa arundinacea*), and pole-size timber in terms of allowable numbers of cartloads per family per year. This is not enforced, however. Nearby townships illegally encroach into the park, cut additional wood, and ship it to cities such as Nagpur and Delhi, which desperately need the fuel and obviously cannot forage locally for their own.

One solution to this problem is to train the nearby villagers and tribespeople to recognize and capitalize on alternate sources of income. This could include using forest products for manufacturing paper, weaving cloth and other fabrics, and promoting other ethnobotanical uses of forest resources such as for medicinal industries. The Government has long classed resources taken from forest lands as either timber or "minor forest products." The list of so-called minor forest products, however, is absolutely staggering. Earlier, I had stumbled upon a six-volume catalog of minor forest products in the WII library. Many examples also are displayed in a vast exhibition hall at the institute and show the bewildering range of such "minor" resources as gums; resins; wood for ceremonial bowls, arrows, bows, chairs, walking canes, and musical instruments; medicines for all types of ailments; dyes for cloth and paper; dyes for the skin for traditional and religious ceremonies; bamboo and pole timber for houses; and hundreds of other products. These forest products are hardly minor. They could very well be the key to sustainable forestry and alternative economies and conservatory land use. Perhaps they should be classed simply as "forest products" alongside commercial timber.

I already have mentioned the working plan document written for each forest. This is essentially the timber management plan. Also written for each area is a management plan for the wildlife and habitat resources. These two documents traditionally have been developed in isolation and often clash in intent, content, and objectives. Our strategy for our central India demonstration area is to meld these two plans into one, cohesive unit.

Evening drive home from the office (*krupaya, ghar jelo,* "let's go home please"), dodging Indian hares (the local race is the rufous-tailed hare [*Lepus nigricollis ruficaudatus*]). The silent northern house geckos adhering to the walls of the house were an interesting welcome home after a long, educational day.

March 22

Thunder, heavy rain, and lightning most of the night and early morning. Last night I woke several times to hear the ethereal rumbles echo across the south face of the Himalayas in the wet dark. Earlier in the evening, before the rains began and out from the stand of planted eucalyptus outside the house, I heard a mournful, down-slurred whistle of an owl. Vish said the eagle-owl has a mostly rising whistle and is usually diurnal or crepuscular, active during the day or twilight. So, no identification for now.

More discussions with faculty and researchers at the institute today. I meet one of the institute directors, Shri Sujit Mukherjee, who is to become a fast friend and traveling companion with us to south India. Mukherjee has a quiet and excellent sense of humor. Regional director of planning and budget, Mukherjee also has worked for the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) program on monitoring international trafficking of threatened and endangered wildlife species, as a planning officer developing a working plan, and for the Indian Forest Service in northeast India for 12 years. His disarming smile and easy manner win over Tom and me on our initial encounter. He, like Vish, mentions at one point how emotional Indians can be and how that predilection guides many discussions, arguments, and meetings.

I also spend time with Dr. Ajith Kumar, who tells me of his research in the southern India tropical evergreen forests we will visit. Kumar has been studying the endangered lion-tailed macaque, a unique primate endemic to the vanishing tropical forests of the tall mountains of that region. We examine his data on demography of the species—birth, survival, and death rates—and run a computer population model I had brought along and helped develop to assess the status of the species in his study areas. The results were scarcely encouraging, showing at best a barely stable population or one in decline.

I am reminded that dates in India are written as day-month-year, not month-day-year as in the United States. The Indian system also is used throughout most of the world as well as in scientific and computer literature, and it makes sense. Thus, for the rest of this journal, I will refer to dates in this system.

23 March

More civilized bird-watching from the veranda of our guest house as we sip coffee in our lounge chairs. Brahminy mynas, black drongos, jungle crows, purple sunbirds, magpie-robins, and red-whiskered bulbuls appear on the wires, poles, and trees, and a stringer of graylag geese arc overhead. An English breakfast of potato pancakes, chips, coffee, toast with pineapple jam, and omelette. *Jacum-jum.*

Other faculty at the institute includes Mr. Kishore Rao and Dr. B.K. Mishra. Rao, a most friendly and articulate man, is the director of wildlife extension and is intensely involved in the human ecodevelopment program I mentioned earlier. He had spent a previous Forest Service assignment on the Andaman and Nicobar Islands, remote archipelagos in the Sea of Bengal that host still-dangerous native tribes and a unique and endemic biota. At the institute, Rao is now involved in three ecodevelopment studies of management conflicts between humans and wildlife and their potential resolution. As a part of the ecodevelopment formula for the national Forest Policy, Rao advocates building up "wildlife tourism" as one compatible land use. He defines this not simply as "recreation" in the traditional sense of mere play, but instead as having a central and strong component of environmental education.

Black drongo or king-crow (Dicrurus adsimilis). *Drongos are pugnacious birds of forest and village. Their long, deeply forked tails are distinctive, having evolved in some species to enormous, tufted rackets for use in courtship display.*

One of Rao's research projects is a study of the need for a wildlife travel corridor to span some 40 to 50 kilometers between nearby Rajaji National Park and Corbett National Park. The corridor would accommodate natural migrations of wild elephant herds. The potential corridor area currently has no conservation status and is zoned for commercial development and village construction. Only a thin strip of forest, at

most 5 to 13 kilometers wide, remains.[4] Our visit to the site reveals many barriers to elephant migration and that increased conflicts between elephants and humans surely will arise from further development. Two nomadic tribes, the Gujars and the Bhotias, live inside the corridor. The Gujars lop trees for their buffaloes and the Bhotias run large herds of sheep inside the forest. These activities occur mostly during winter; the tribes migrate to the upper Himalayas from April to October. These activities are acting to degrade the forest structure (although some argue that they are simply part of the ecological system and that their influence on forest structure should be accepted as natural). As well, at least 104 local villages, including 11 villages inside the forest corridor (with a total human population of 85,000 plus their cattle), depend on the forest resources for a wide diversity of forest products. The recent establishment of a major pharmaceutical factory and two urban areas in the corridor zone also is serving to severely compromise the value of the forest as a wildlife corridor. Rao's project is helping to define the existing situation and will recommend alternative courses of action for managing the situation for tribes and animals alike.

Another research project of Rao's is in a wildlife sanctuary in south India where the local Manasugidi Village is encroaching onto forest habitat with heavy grazing by their scrub cattle. Cattle are owned for dung production, which is a major source of fuel. Indeed, the village currently produces four cartloads of dung per day. As in too many sanctuaries throughout the country, the intensive grazing reduces native grass cover and encourages the growth and spread of weedy species. This in turn reduces food and cover for several wildlife species. Such severe grazing pressures exemplify problems in many other forests. And the use of dung for fuel precludes its use as badly needed fertilizer for replenishing the productivity of the fields, which then are even less capable of supporting crops of fuelwood shrubs and trees. It is a vicious cycle.

The need for studying and developing an integrated approach to wildlife habitat management and forest resource use is made all the more exigent when one considers that many large animals cannot meet all their resource needs within the parks and sanctuaries. As with the Rajaji-Corbett corridor, elephants typically follow traditional migration routes that often do not include lands designated primarily for wildlife habitat preservation. Another example of this that I would see firsthand is the wild elephant herds using traditional migration routes from Nepal into Dudhwa National Park in India. This migration route now cuts through a buffer area of the park that holds many villages and cropfields, which are raided by the elephants.

Many parks and sanctuaries are too small to hold viable populations of the larger species, including leopard, tiger, elephant, and bison. Most protected areas in India average 200 to 250 square kilometers and are surrounded by high human density. This is insufficient area to hold wildlife populations large enough to be self-sustaining and to avoid dangerous conflicts between large predators and humans.

Evening at Dehra Dun. Far up on the ridgeline of the Himalayas the lights of the small hill town of Mussoorie sparkle like a village in the clouds, like a new constellation in the sky. I wonder how our town looks from that celestial vantage point. Cold again, and still—the chants and drums from the local temple silent tonight. Just an occasional buzz of an Indian nightjar and a view of the distant shimmer of the lights on the ridge, a temple floating in the merging darkness of mountain and sky.

24 March

Vish is providing us with a visit to Timley Reserved Forest and Rajaji National Park, both within a days tour from Dehra Dun. Steep windy roads through "natural" sal and mixed species forests. I say "natural" with quotes because the very concept requires a new and unique definition in India. There are no forests or wildlife habitats in India whose composition and structure have not been greatly influenced by centuries of human intervention. In contrast to how we often use the term in the United States, "natural" in India means not directly altered in the latest several decades of growth. But even that is not entirely true as some forests are still regularly entered for harvest of bamboo and extraction of many other forest products.

Many forests in India are the result of teak and sal plantations created 50 to 180 years ago. Such forests may bear little resemblance to the truly aboriginal forests of millennia past. In fact, except for a few still-extensive tracts of tropical rain forests of northeast India, we have no idea what the original, untouched, virgin forests of the country were like, so pervasive

[4] Badola, R. 1989. Corridor in peril. Wildlife Institute of India Newsletter. 4(4/5): 33-34.

and intensive is human influence on the land. Our New World concepts of ancient forests and of potential, natural, and climax vegetation must be revised here in light of the pervasive human element.

In the National Forests of the U.S. Pacific Northwest, the conserving of ancient, old-growth conifer forests is a major social and conservation issue. Such forests often consist of trees 2 meters across, 45-60 meters tall, and 400 or even 600+ years old. These are conditions mostly unheard of in India, or much of the rest of the world for that matter. Last year Vish Sawarkar visited the United States, and I gave him a tour of some of the ancient Douglas-fir/western hemlock forests in the Cascades Range. He saw truly natural, cathedral forests unlike any that most of India has seen for centuries. It again impressed me that these ancient conifer forests in my own back yard are a world-wide resource, a rare global jewel.

Still, the Indians have protected some outstanding examples of older forest stands. These are called preservation plots and provide a benchmark for measuring changes in tree size, forest stand composition and structure, and tree species replacements (ecological succession) for younger growth forests. The preservation plot forests, however, are not in any sense truly natural and virgin forests devoid of influence from humans. They serve a similar purpose as our research natural areas in the United States. Research natural areas are designated as the best examples of the oldest "climax" or near-climax forests and are often, but not necessarily, ancient old-growth forests. They are chosen to represent

Indian Attitudes Regarding Forests

2000 B.C. Agni Purana
"A man should protect trees"

500 B.C. Gautama Buddha
"A man should plant a tree every 5 years"

300 B.C. Chanakya
Appointed superintendent of forest
Classified forests based on uses:
most important forest product = elephants

300 B.C. - 670 A.D. Gupta Dynasty
Functional classification of forest
Forests reserved for:
- Study of religion
- Supply of forest produce
- Grazing of royal elephants
- Hunting by royalty
- Hunting by public

670 - 1600 A.D. Political instability
Many forests destroyed by wars

1600 - 1800 A.D. Moghul period
No forest policy no regulations
Forests places for royal hunting

1800 - 1950 A.D. British and Maharajas
Forest protected for hunting
Forest exploited for naval timbers
Forests converted for agriculture

Source: As cited in Salwassar and others (1991)

indigenous forest types and are selected mostly for scientific study. In contrast, though, in India an indigenous or old-growth forest is one that has escaped intensive exploitation for perhaps 50 years to a century or more, not necessarily one at a final, climax state of successional change.

The ancient history of forests in India—as reviewed by the senior forester and ecologist J.B. Lal in his *India's Forests, Myth and Reality* (see "For Further Reading"), a compendium of information on Indian forest ecology, forestry, and land use—necessarily is a lesson in human anthropology. The 4,000-year-old chantings of the Agni Purana (sacred hymns; Agni was god of the sacred fire in the Vedic hymns) directed that trees should be protected to ensure material prosperity for one's family. Even today, signs on the campus of the WII urge, in both English and Hindi:

SAVE THE FORESTS

SAVE THE COUNTRY

– Forest Department –

and also,

A GROWING TREE IS A

LIVING SYMBOL OF A

PROGRESSIVE NATION

– P. Jawar Lal Nehru –

Another teaches that:

FORESTS MEAN TREES

TREES MEAN BREAD

AND BREAD MEANS LIFE

Some 2,500 years ago, Gautama Buddha preached that a man should plant a tree every 5 years. Yet, despite the religious and cultural veneration, the forests have traditionally been thought of as limitless and endlessly renewable.

According to Lal, civilizations in India predate the migration of the Aryans between 2500 and 2000 B.C. and the empires of Mohenjodaro, Harappa, and Channudaro in Sindh, Punjab, and Rajputana from 5000 to 4000 B.C. The great civilizations of the Indus Valley in the north might have perished because of war or because they depleted their natural resources. Evidence suggests that they relied heavily on wood for a fuel source and for building. But, paradoxically, they also venerated their forests. The God of the Indus Valley was said to live in pipal (*Ficus*) trees, and pipal and babul (*Acacia*) trees were thought to have originated in heaven.

Lal notes that relics of the Dravidian civilization still persist as the tribal communities of central and south India, which I would later visit on my journeys. Environmentalists and sociologists have claimed that these tribes have lived in harmony with their forests for hundreds of millennia and that this harmony has been disrupted by the imposition of scientific forestry. Lal disputes this claim, however. He argues that small human population size and low density are the major reasons why the forests had not been depleted historically. Defending the scientific approach to forest management, Lal argues that the current break in harmony is because of major, recent growth in the human population, and not because of the advent of new forestry techniques. Use of the forests beyond their capability for self-renewal, as with overuse of firewood and grazing lands, is the cause for recent declines in productivity of the land.

My own observations of the forests of northern, central, and southern India would lead me, however, to a different conclusion. Yes, human population growth is certainly at the heart of most of the problems of forest resource depletion. With a current human population density averaging 644 people per square mile—that's one person and two grazing animals for every 3 acres of forest—there are many competing uses and interests for the forests. Maintaining enough forest land in a "natural" state for the large wildlife predators and their food webs is virtually impossible in many areas. Conversion of many forests to croplands is a major source of loss of forest and other natural lands. In contrast to Lal's notions, though, I believe that modern forestry in India, as in North America and elsewhere, which has followed the intensive European and German techniques, has drastically simplified the structures and composition of many forests. This has resulted in maintaining single-product, manicured forests and imposing too strict a pattern of use on too narrow a set of forest resources, mainly commercial timber. India needs more than this. The myriad of cultural interests and traditional uses of the wide variety of forests and their products in India demands a different approach than traditional European forestry provides. The forests need to be maintained for a diversity of products and uses.

I have visited the utterly hygienic Black Forests of Germany. I also have seen how the teak, sal, and eucalyptus plantations of India have been managed similarly to the scientific European systems of forest (timber) management. Such management intentionally eliminates the immense variety of plants and animals inherent in older forest stands. I have seen similar spartan conditions in tree farms of Southeastern U.S. pine forests and in hemlock plantations in southeast Alaska. Such intensive forestry has its place in appropriate portions of the landscape. Our challenge is to define the appropriate contexts and uses.

I believe the losses of forests and other wild lands of India, with their associated and unique communities of wildlife, are caused by a combination of two factors. First is the past focus of scientific forestry on producing forests of single tree species. In fact, the objectives stated in past national forest policies of India have been to increase tree crop production, which invariably results in drastically reducing biotic diversity. Second is overexploitation of forests by human populations too large to use the resources at a sustainable rate. It seems time to institute a new era of forestry to foster biotic diversity, to restore and maintain land productivity, and to ensure sustainable economic and cultural use of the multitude of wild land resources.

One of the challenges will be to incorporate traditional land uses into a new era of conservation in India. With a countrywide literacy rate of only 36 percent and nearly 75 percent of the country in rural living conditions, simply getting the word out will be a challenge. But it is essential because otherwise a new era of encroachment and destruction of the last forest remnants will begin, and the bold policies implemented in the present and previous decades will unravel. At the same time, India must avoid the risk that a new conservation philosophy will be used as justification to irrevocably mine the remaining wild forest lands. Perhaps the best place to begin is in a simple history lesson, or the past will be replayed. For that, I turn to the books on forests of India by Lal and Agarwala.

The ancient forests predating the reign of Chandra Gupta Maurya of 300 B.C. were subjected to periods of destruction. Losers of the many wars among local kingdoms would flee to inhabit previously undisturbed forests and clear them for new villages. Every war took another forest.

One of the first known official forest policies seems to have been instituted by the Prime Minister to Chandra Gupta Maurya, who appointed a Superintendent of Forests and classified the forests by their products. The most prized product of the forest was elephants, valued for their use in battles and for transportation. In fact, so prized were the beasts that the penalty for killing an elephant was death.

According to Lal, during the Maurya period and under the reign of the Gupta dynasty, forests were classified into five categories:

- Forests reserved for the study of religion
- Forests reserved for the supply of forest produce
- Forests reserved for the grazing of royal elephants
- Forests reserved for hunting by the Royalty
- Forests open to public hunting

After the Gupta empire fell in 673 A.D., small states formed and politically divided the subcontinent. A new wave of battles and conflicts, including the Muslim invasions from the west, caused more forests to be cleared. Political instability caused great losses of forest areas during the 9 centuries from the end of the Gupta dynasty to the formation of the Moghul empire by Akbar at the end of the 16th century.

The Moghuls instituted no forest conservation policy, although a few tree species were considered sacred and a fee was charged for their felling. Later, under British rule, the forests were to suffer substantially greater losses as they were felled for their teak and other products for the Royal Navy. Lal and Agarwala both note that to the middle of the 19th century, the British interest in forests was to obtain and export large amounts of Indian timber for use by the British Navy and to use timber for local construction. Scented sandlewood was exported to various European countries, and forests were cleared for free development of agriculture.

The first real conservation effort came in 1842 when the first teak plantations were established. Other plantations eventually were developed. Still, no regulations were imposed on felling of forests. In fact, in the densely populated region of Avadh, wholesale clearing of forests for agriculture continued into the mid-1800s under direction of the

Crown. Much of the country's forests were cleared during the ensuing period to produce crops and to obtain wood for constructing railway sleepers.

Finally, a methodical process of managing the forests was begun with the appointment of Dietrich Brandis, a German-trained forester, as the first Inspector General of Forests in 1864. (The Inspector General, or I.G., is a Federal position and equivalent to the Chief of the USDA Forest Service. I was to meet the current I.G. over dinner at WII and discuss respective management policies in our two countries.) Under the guidance of the I.G., forests were given to the states to be managed as a biological resource. With the initial Indian Forest Act of 1865 was born the first European application of scientific management of Indian forests Categories of reserved and protected forests were established, which denoted the use of resources in various tracts, an allocation system still in use today. The forest policy of 1894 declared, however, that forest conservation was secondary to clearing for cultivation and that commodity production was still the primary objective of forest management.

In the early 20th century, the application of scientific forestry was grossly interrupted by periods of heavy forest resource depletion to meet needs of the two World Wars. By the time of Indian independence in 1947, much of the country's forest resources had fallen to croplands, economic return to the states, or export, despite periods of well-intentioned forest conservation policy, The new forest policy of 1952 attempted to rectify the serious problems resulting from overuse by mandating that management plans be developed for forest exploitation and that new forest categories be established to provide for production of timber, for use of forests by villages, and for preservation of the more environmentally fragile forests. In 1988, a new and controversial forest policy was written that called for a much greater ecological and humanist foundation for managing forest lands so as to conserve the vanishing habitats and wildlife throughout the subcontinent and also provide for human needs. Our current Wildlife in Managed Forests project, then, is the next phase in the country's long and complex history of forest exploitation, conversion, scientific management, production, and conservation.

What lessons can be learned from this brief historical review? For one, forests have been historically viewed as unlimited sources of products and as requiring few special regulatory and management measures to ensure their bounty. Future growth and availability have been either ignored or assumed, even with the vagaries of wars and concomitant resource depletions. What this new, recent era of conservation has recognized, however, and needs to assert in the form of new resource management techniques, is that the forests cannot endlessly recover from intense exploitation and from ignoring future and cumulative effects of past and current actions. In a new era of forest conservation, resource management practices can and should be attuned to restoring and maintaining the diversity of species and human and ecological communities. Wildlife associated with the forests require habitats that have either competing value for humans, such as use of native grass for livestock grazing, or no direct value, such as with non-commercial tree and shrub species that nonetheless bear important food or cover for many species. The future health of the forest system depends on maintaining and re-creating diversity of species and on asserting moderation in rates of exploitation.

In diversity lies ecological health. In hatha-yoga (a system of physical exercises), the goal is a health of spirit, mind, and body by exercising a power over the body. The body is considered a universe in miniature, a reflection of the cosmos, a focus, and a gate for substance and energy shared with the world. In reaching a state of health in hatha-yoga, one is taught this indivisibleness and the laws of the universe and one's own place in the world. The traditional, self-healing Indian *ayurvedic* system of medicine teaches quite a similar philosophy. In analogous fashion, the goal of a new forest conservation is a healthy and sustainable natural system, attainable by exercising a power and self-control over our patterns and intensity of resource use.

To help advance conservatory practices in India, it may prove essential to tie such a philosophical basis for forest resource management into existing religions and cultural values.

A healthy rapport with the natural world, whether through personal development with hatha-yoga, the philosophy of *ayurvedic* medicine, or scientifically sustainable natural resource management, may impart a communication between self and world to the Indian people. I sincerely hope India can return to the veneration of the forests that the ancient civilizations of the Indus Valley had so long ago.

Into Rajaji National Park. Entrance signs at the locked entrance gate set the rules for visitors:

RAJAJI NATIONAL PARK

Rules at a Glance

- No person may enter the park without a permit.
- Visitors shall be required to pay fees according to the following:

  1 – Foreigner: Rs 15/person for 7 days

  2 – Indian: Rs 2/person for 7 days
- The permit holder shall camp only at place mentioned in the permit.
- Declare fire arms before entry the park and get them sealed.

—Director, Rajaji National Park

and also:

RAJAJI NATIONAL PARK

DON'TS

- Entry in National Park after sunset and driving in the park is prohibited.
- Never try to chase the wild animal with your vehicle.
- Horn should not be blown.
- Do not bring pets in side park.
- Do not follow or approach wild elephants too close.
- Do not remove any fauna dead or alive.
- Transistor should not be played at a high pitch.

—Director, Rajaji National Park

V.B. ("Vish") Sawarkar and a stand of bamboo (Bambusa arundinacea). *Bamboo is an important ecological component of Indian forests, providing forage and hiding cover for gaur, tiger, and many other wildlife species.*

The forests here and in Timley Reserved Forest and other forested areas in north India are dominated by dipterocarp trees (sal and others). Old world bamboo is present in the understory and in forest openings, and grows in dense tall tussles of spreading stalks like some prairie grass gone mad. Bamboo provides important cover for sambar (Indian elk), elephant, and gaur (Indian bison), especially in the southern part of the country. As we will later encounter, the evergreen conifer forests of chir pine (*Pinus roxburghii*) grow higher up on the ridges of some north Indian parks, and forests of deodar or cedar (*Cedrus deodara*) are found from mid to upper elevations of the Himalayas. There, resins from the chir and blue pine or *kail (Pinus wallichiana*) are collected in earthen or tin pots fixed at the bottom of channels cut into the boles. Collection of pine resins is an important forest industry; they are used for a remarkable variety of products, including fungicides, plasticizers, lacquers, varnishes, emulsifiers for rubber, bactericides, surfactants, and corrosion inhibitors. And resins are but one of the vast array of "minor" forest products.

Another of the forest products used by locals is the small red fruit that grows from the shrub *Mallotus pillapenensis*. The round fruits provide a red dye used for marking women's foreheads for cosmetic purposes. (Today, most marks are provided by synthetic dyes or even small plastic disks adhered to the skin.)

Large specimens of the strangler fig (*Ficus benghalensis*) appear sporadically throughout the sal forests. This tree grows by wind- or animal-dispersed seed from the canopies of other species of living trees. It sends down long vines called climbers here and lianas in the New World tropics. Climbers wind their ways around trunks and branches of their host tree, eventually reaching the ground and taking root. Ultimately, *Ficus* climbers strangle their host tree, which then rots out from within the now free-standing cylinder of vines, leaving only a hollow column of merged climbers. In the New World tropics, as I have seen in Central and South America and Mexico, strangler figs can be a major vegetation element in some older forest stands. Here in India, the tree is less common and provides important fruits and canopy shade for many animals. In the New World, the age (actually, time since last major disturbance) of a cloud forest or lowland tropical rain forest can be gauged fairly accurately by the density and diameter of the lianas. In old-growth tropical forests, the climbers slowly grow in girth and become profuse in stands only after a century or more if the stand has escaped major windstorms, major burns, or the axe. I'm not aware that India is using such measures of stand disturbance or age, but perhaps it would useful here as well.

In one sense, the *Ficus* is an indicator species of stand diversity and forest age. It also is an indicator of the religious value of a forest. But, at the same time, it struck me that here was a species of tree performing the same sort of freeloader function as the class of bird species known as nest parasites. Avian nest parasites, such as the cowbird, do not build their own nests, but rather, lay their eggs in nests of other species. The eggs hatch and the host parents such as warblers, unaware that the intruders are not of their kind, raise the adopted young as their own. The nest parasite young typically grow faster and are larger and more aggressive than the young of their hosts, and often have evolved a behavior to push the native young out of their own nest to their death. Strangler figs in feathers. Or, from the other viewpoint, *Ficus* is but a canopy parasite, albeit one that performs valuable keystone ecological services in the forest ecosystem by providing food and cover. If only cowbirds were as gracious.

We are in *bahid* country here, meaning "steep hills" in north India. In southern India, the term is *ghats*. Baban knows the term *bahid* but not *ghats*. Language, geographic names, and so many other aspects of culture and custom differ throughout the country. One must know where one is before using words. They say you can identify the village people are from by the dialect and intonations of their words. Travel 20 kilometers and the speech becomes distinctive. In 50 kilometers, you encounter an entirely new language. Yet despite the apparent communication barriers, the country has, for the most part, remained whole and united. Perhaps it is so because of the vast diversity. No melting pot, this, such as in the United States, where diverse ethnic groups are taught through media example to homogenize into a common language and accent and a similar set of values and way of life.

We cross many wide flood plains of cobble and boulders in Vish's four-wheel drive Maruthi, powering angle-wise over ridges of deep sediment and through washes of mud and silt. There is little free water now except for a few trails of fresh seeps from thunderstorms this past week and from occasional springs and subsurface flows. These flood plains are immense. I can picture deep torrents of monsoon flows undercutting the banks, further eroding the soft hillsides. The river paths parallel each other as they pour out of the Himalayas, their ancient serpentine routes deeply incised like old habits into the newly rising mountains.

Vish shows us many types of forests, including sal plantations and forests heavily lopped for cattle fodder by the Gujar villagers. The Gujars are a tribe of buffalo herders who occupy the forest reserves and have seriously altered the forest structure through extensive grazing and the lopping of the trees. The Gujars are readily identifiable, as most wear a colorful knitted cap with a tall peak. Their villages of thatch and bamboo occupy some of the river sides and bottom lands. To help preserve the forest resources, the Federal Government is engaged in a program to relocate these perennial settlements to sites outside the parks. This is an enterprising maneuver, as some of these villages have been here for many decades, perhaps centuries.

We drive along traditional elephant migration routes and stop to inspect deep tracks along one river bed. Based on the stride and depth of the track, Vish concludes it is made by a bull elephant standing some 10 feet at the shoulders. We warily eye the forest into which the tracks lead and are warned not to follow. Abrupt encounters in dense brush often lead to charges by angry cows or bulls, and neither fleet feet nor the tallest tree lends any measure of safety.

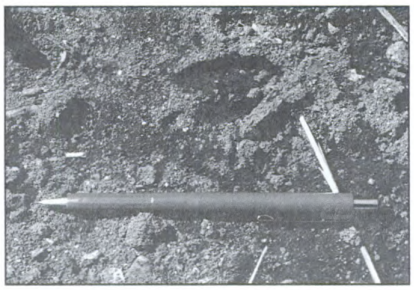
The elephant routes spanning Rajaji and Corbett National Parks are indeed urbanized and developed. There are high incidences of elephant mortality as well as human death from the increasing number of encounters. Improbably huge hydroelectric dams have been constructed to divert the entire Ganga (Ganges) River to an alternate course, thereby creating additional dispersal barriers for the beasts who cannot traverse the deep artificial canals. Solitary elephants do occasionally cross the canals on the sporadic, narrow overpasses, however. Such overpasses could be built wider and with a more natural appearance to encourage herds to pass. I see a parallel to this need for elephant movement corridors to similar problems in south Florida, where highway underpasses have been constructed to accommodate movement of the endangered Florida panther and other terrestrial wildlife.

Vish takes us to a *machan*, a tall hide (a blind, as we say in the United States). *Machans* are constructed as either free-standing wooden towers or, more commonly, as platforms on tree branches, from which to observe wildlife near waterholes or travel routes. Ours is on the banks of the river in Rajaji and overlooks the mixed sal and riparian forests often used by wild elephants. From our lookout, Vish points out drongos, Indian tree pies, red jungle fowl, and other birds. Another Hindi lesson: *machan* is a "tree-hide"; *maccan* is a "house"; and *makkan* is "butter." I'll take care not to announce that I want to view tigers from my house or while seated in butter.

Vish is a soft-spoken, slight man and one of the toughest in the field I have known. Raised in Pune (Poona), east of Bombay in Maharashtra State, Vish is from a family of military officers, a fitting heritage for his career in the paramilitary Indian Forest Service. As part of his official Forest Service training, Vish was subject to intense field experience. Many exercises consisted of long hours on trails in the hot dry forests during which the trainees were denied food and drink; it was seen as incorrect to take water while in the field. As a result, Vish has developed the habit of not drinking while on the trail, in contrast to the quarts of boiled and filtered water that Tom and I would carry and comsume.

With his fedora angled over his eyes and windbreaker half-zipped, Vish looks for all the world like a modern-day hunter-tracker, or *shikari*, as he points out pug marks (tracks) of a variety of species, including barking deer, common langur, and sambar. His ability to identify tracks and other wildlife sign, as well as bird species, with scant evidence is astounding. I carry a field identification guide for birds and invariably he correctly identifies species based on a quick look or incomplete verbal description from Tom or myself. Beyond simple identification, he is profoundly knowledgeable of the vast array of habitats, biotic communities, and patterns of human culture and traditional use of the forest resources. He understands that the complex and difficult challenge for crafting the future of conservation in the subcontinent depends strongly on integrating and meeting human needs, but not to the detriment of wildlife habitat.

His ability to understand and effectively work with a wide variety of people is one of his most remarkable skills. He deals with forest guards, beat officers, and other forest staffs



Tracks of barking deer or muntjac (Muntiacus muntjak), *a mostly solitary species of the thick jungle.*

Tracks of common langur or Hanuman monkey (Presbytis entellus), *which are ubiquitous and remarkably acrobatic primates found throughout India.*

Tracks of gaur or Indian bison (Bos gaurus), which *are not true bison but are mountainous relatives of the domestic cow. Bulls may stand nearly 2 meters at the shoulders.*

in an authoritative yet courteous and respectful manner, as well as with the conservators of forests, the divisional forest officers, the directors of the Wildlife and Forest Institutes, and members of the uppermost ministries and governmental tiers. Yet he also understands Tom and my cultural quirks and assures that we are well cared for in travel, housing, drink, and food. I will never forget the generosity and genuine caring he shows us and always will consider him as family.

Lunch in the *machan*. We haul up a large cardboard box that Baban had prepared for us, not sure what to expect. Inside, we find bone china plates, polished silverware, linen napkins, soft drinks, and several thermos bowls of vegetables cutlets, *chappatis*, fresh fruit, and a meat dish. Vish takes his lunch as if this happens every day, while Tom and I roar over the incongruity of eating a voluminous, finely prepared lunch from bone china while sitting in a wildlife hide over a river watching for elephants. Bless the British influence.

Into Hardwar, with its profusion of temples and ashrams, considered by many Hindus to be the holiest city on Earth. An ancient town, predating my home of Portland, Oregon, by so many centuries and cultures. The broad *ghats* stairways lead from the streets down to the banks of the Ganga, where pilgrims gather to bathe their sins away by immersing themselves in the dangerously swift currents. The Indians call the holy waters *Ma Ganga*, "Mother Ganges," the womb of spiritual healing and salvation.

At times the celebrations become fervent, frenetic. During annual religious festivals, as many as 500 have lost their lives from trampling or drowning. The acceptance of such bodily risk for spiritual purity seems extreme, but that is only from my cultural perspective. We pause for a Thumbs-Up soft drink in a local restaurant, then go back on the road for a long circuit back to Dehra Dun through Rishikesh, another Hindu pilgrim center.

En route, we discuss economics in the Indian culture. According to Vish, the newly passed minimum wage law ensures a payment of Rs 32 or about US$1.88—per day. There is a proposal for passing a child labor law to prohibit use of children for mandatory labor, but that likely will meet with much cultural resistance. Many rural people ignore family planning and intentionally have large families; additional children add to the overall income and help insure a more consistent personal economy. Thus, the ecological need for reducing family size and population growth is countered by the cultural need for more offspring and the simple economic truths of meeting subsistence needs. I muse that this is another of India's inherent cultural contradictions. But it is how this society has evolved to cope with conditions of extreme resource scarcity, a condition which we in the United States should understand and learn from as we move farther along a similar path in our "developing" culture.

The holy city of Hardwar along the Ganges River, northern India. Numerous Hindu and other temples crowd the shores of the sacred waters.

25 March

Cold, clear morning in the Himalayan foothills of Dehra Dun. Frosted breath. Many birds singing in the crisp morning sunlight—bulbuls, yellow-breasted wren-warblers, common babblers, magpie-robins, pied bush chats. To the north, the mountains visible from our house rise to 3000 meters and are silhouetted a muted gray against the gold dawn sky.

The land here along the Himalayan foothills seems much more fertile than I suspected it would be. Long sweeping plains of wheat and sugar cane. Each year, the fields are enriched by the rush of sediments and nutrients from the higher reaches. Each small town appears to be overflowing with shack-shops and vendor carts filled with vegetables, cane, and fruits. Still, I suspect life is substantially harsher than it seems from the plenitude of food. According to Vish, this small foothill community of Dehra Dun has grown dense and dirty and less sanitary in so short a time. Unchecked population growth crowds streets and houses. It stresses medical and sanitation facilities. It eliminates trees, wood, and wildlife. It yields a future of only greater strain on the habitats and native species of the plains, coasts, and mountains. A beautiful but pressing and teeming country.

With our assigned Maruthi and driver, Anwar, we climb into the Himalayas on insanely steep, one-lane roads, up to the hill resort of Mussoorie, that jewel in the night. Hairpins, switchbacks, sheer drops of 300 meters. The cutbanks of the roadway are painted with warnings "Better Late Than Never!" and the eye-catching "Dead Slow." The Indo-Gangetic Plain drops below us as if seen from an airplane, the broad flood plains of Ma Ganga appearing brown and tan in the midday haze. Dehra Dun becomes a toy model of buildings in the broad vista.

Mussoorie grows on the ridgeline above us like a village in the sky, houses and shops hanging by precarious toeholds on the slide-prone slopes. A stop for shopping in the packed marketplace at an outdoor mall called "Library." So many stalls and stores with linens, clothes, rugs, brass goods, carved wooden items, foods, kitchenware. I purchase a beautiful, hand-woven mohair sweater for Rs 500 (about US$29).

Up beyond Mussoorie through lanes no wider than our four-seater Maruthi. We marvel at Anwar's driving skills and how we are able to squeeze past an oncoming truck we meet on the steep box-canyon streets.

Anwar is a young fellow just completing the equivalent of secondary school. He speaks or reads at least five languages and patiently teaches me some Hindi for the road. There is much to respect in this young man, even though his job as driver mandates that he call me "sir" and I address him as "Anwar." I tell him to call me by my first name, and he replies with a smile, "Thank you, sir."

Common babbler (Turdoides caudatus). *Babblers are vocal and highly social birds of wooded areas.*

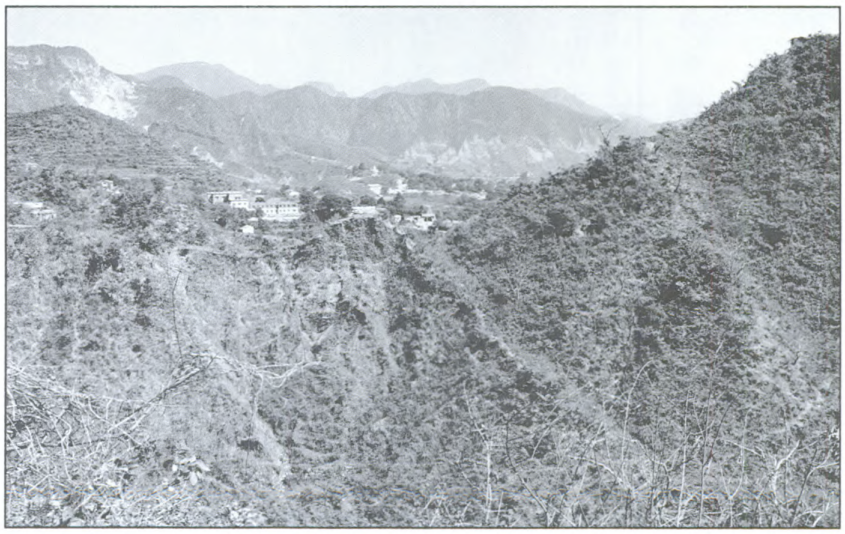
Road to Mussoorie, Himalayas, Uttar Pradesh, northern India. Indo-Gangetic Plain in the distance.

Thirty kilometers past Mussoorie, climbing steeply into the Himalayas on knife-edged ridges, traversing rock-slides, sliding sideways through mud and snow along 600-meter sheer drops. Much of the scant forest cover on the ridges and slopes has been removed or heavily thinned or lopped, or overgrazed and trampled, leaving avalanche chutes of mud and debris fanning to the steep canyons far below. Other slopes have been terraced for rice, the local people cutting the terraces progressively higher and higher on the hillsides as the lower ones erode or lose productivity. Scattered thatch huts and occasional small villages of rock rubble structures hang tenuously to the unstable mountainsides.

Through the small mud and thatch hut towns of Champa and Tieri. Neither the towns nor these roads are on my detailed maps of the Himalayan hill country. Through three check posts on the road where we buy Rs 6 toll fees and are questioned at each stop. I surmise the check points are there for catching illegal visitants from Tibet, just an inch or so on the map but another day-and-a-half drive north into the interior of the Himalayas on roads even worse than these.

We stop past the town of Dhanaulti, a small outpost of buildings on a cliffside ledge. Anwar points to a steep path blasted (or maybe hand-carved?) out of the sheer rock face. We don sweaters and parkas in the crisp mountain air and begin our trek to over 3000 meters and one of the most revered Hindu religious pilgrimages in India: Sacunda Temple, perched on a snowy peak in the cold mountain winds. From the top, we overlook vast terraced basins with bright green valley bottoms 300 meters deep. In the distance, among swirling storms stand the ice walls of the inner Himalayas, the summits of Bandrinath at 7139 meters and Nanda Devi at 7817.

After removing our shoes and socks in the mud and snow, Tom and I cross under the arched gate and onto the sacred grounds of the main temple. We suddenly are greeted by locals and pilgrims, asking from where we have traveled. We reply "the United States," which is known here simply as America. One fellow expresses great pride and says that it is most incredible that we have traveled around the world to end up at their most holy site. We are given a bit of homemade cheese as *prasad,* an offering of food given for the deity and subsequently shared by the followers. We then are offered to be in-



Outskirts of the hill town of Mussoorie, Himalayas, northern India. This is a thriving and popular mountain resort location with many open-air shops.

Typical Himalayan village, Uttar Pradesh, northern India, near Tibet. All native forest cover of pine, deodar, and cedar have been stripped for terraced agricultural fields and for fuelwood. The steep, deforested slopes above the village pose a great hazard during monsoon mudslides, silting rivers below for hundreds of miles downstream. (Photo courtesy Carrie Sakai)

Bandrinath (7139 meters high) and Nanda Devi (7817 meters), Inner Himalayas of Uttar Pradesh, northern India.

troduced to the inner sanctum of the small *mundir*, seen by few outsiders. Seated in the chapel, we are shown the elaborately decorated altar. The vaulted ceiling above opens into the spire of the square tower and is covered within by a multitude of reflecting geometric designs of brilliant gold and blue.

Outside we meet the *pujari*, old men with great beards, the holy, blanket-clad keepers of the temple, whose Spartan, mud-floor huts adjoin the *mundir* on the cold ridges of Sacunda. I cannot understand how they survive year-round in monsoons, ice, blizzards, deep snows, and summer heat in their shacks, which have no insulation, furniture, food storage, or heat source save the small open fires of sticks.

The drive down to Dehra Dun is at insane video-game speeds; we dodge carts, people, bicycles, people, dogs, people, cows, people, sedans, people, motorcycles, people, scooters, and people. I spot alpine choughs and house martins, birds of the mountains. Back to our Dehra Dun guest house, an English dinner with Baban's kitchen wizardry, bottles of Golden Eagle and Kingfisher ale, and bed by 9:30.

26 March

Vish tells us that the majority of the lopping, deforestation, and terracing so pervasive in the Himalayas has occurred mostly during his lifetime, especially in the last 30 years. I find this startling, as I thought most of the heavy land use, such as the terracing of rice fields, had been in place over many centuries or even millennia. But it has been mostly in recent

years that massive erosion, also stemming from tunnel and surface mining for limestone, has created heavy siltation and flood runoff problems in the lower mountains and downstream. In the past few years, rivers have widened, silted, flooded, and undercut to an unprecedented degree. So long as the carrying capacity of the fragile mountain lands is exceeded by population pressure, such problems will only worsen.

My traveling partner has been attempting some phrases in Hindi, mostly for various foods, in his deep southern accent. Surprising to me, Tom's southern English is well understood, often much better than my Yankee tongue, and I give him credit for mastering some of the Hindi words. But, with all due respect, his pronunciation of the foreign words seems to come out with a deep southern accent. I tease him for speaking "southern fried Hindi."

Lunch at the institute with Dr. S. Muttiah, head of the Asian Desk of Forestry Operations Division, Food and Agriculture Organization, in Rome, Italy. We also meet and converse with Dr. J.B. Lal, author of *India's Forests, Myth and Reality*, which I mentioned earlier.

We are being treated royally, as honored guests from a distant land. Our buffet lunch consists of *chappatis*, rice, *dhal*, vegetables, and ice cream. We lunch Indian style, standing with plate in hand, eating with the fingers of the right hand only (the left is reserved for—ahem—other functions). Too much food, my repetitive complaint for the trip. At meals end, we place dirty plates on the floor beneath the table. I just follow everyone else's lead and hope to heaven that it's not a signal for refills.

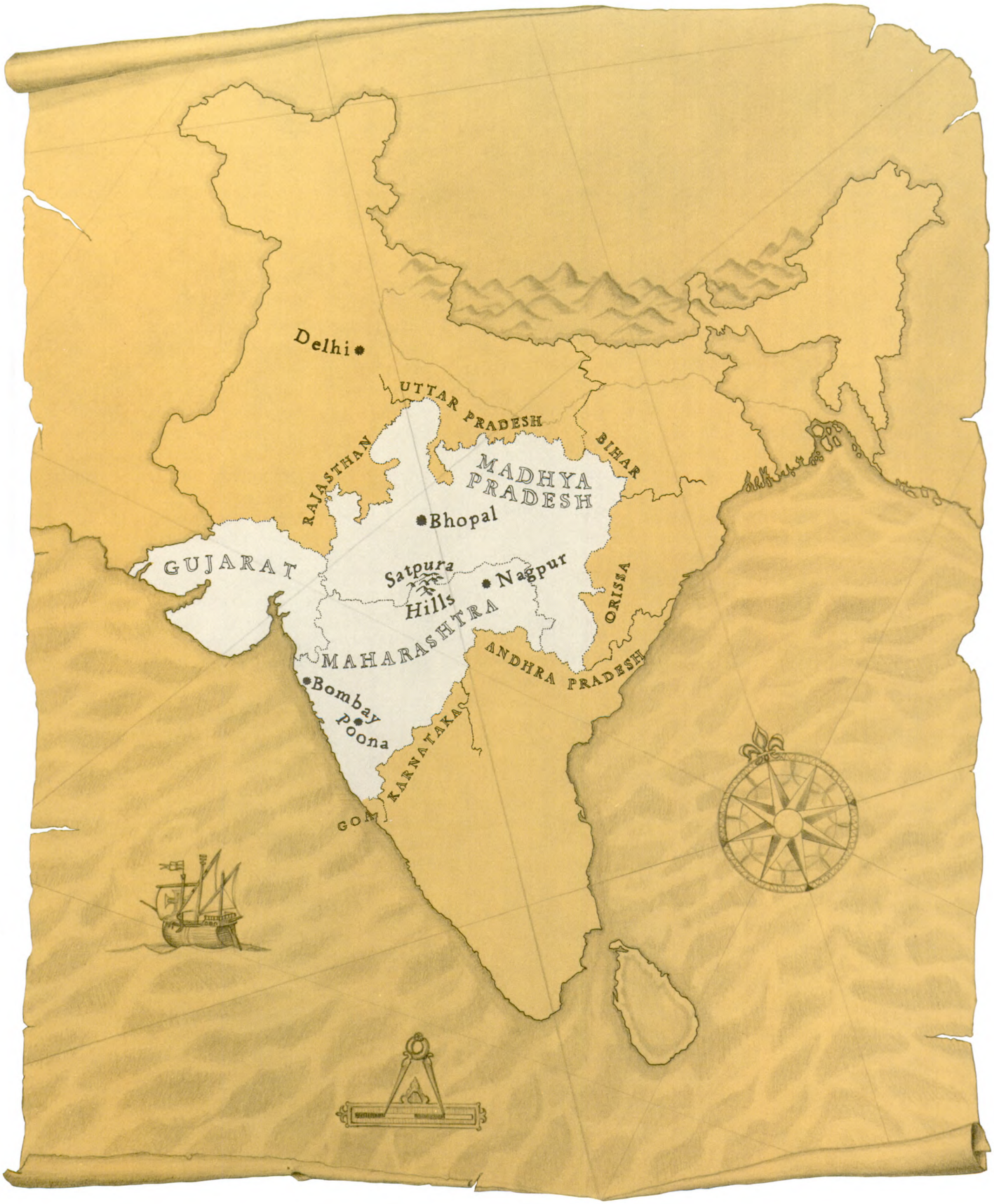
Evening: We host an informal dinner party for the WII faculty. Because we do not have space to accommodate spouses, the revelry gets billed as a stag party. The single female faculty member is unable to attend, and I wonder if in part it is because she knew how colorful the evening's conversation was to become, British limericks and all.

27 March

Spending time this morning with the institute faculty and with a group of young idealist students working on a project out of Delhi to assess the status of reserved forest lands. Specifically, they are assessing the current true state of the forests as affected by human encroachment and by illegal taking of forest resources by local native villages, despite the Federal laws, policies, and rhetoric that the forests are being tightly controlled and well managed. They hope that their findings will be used to rectify lapses in implementation of the forest policies, the forestry working plans, and the wildlife management plans in the forests. I wish them luck.

Tom and I visited the Bank of India today to cash our travel reimbursement checks for a total of Rs 13,600 for our upcoming trans-Indo tour. The stacks of 10- and 50-rupee notes measures at least 2 inches tall, and we feel embarrassingly like the Maharajahs of Dehra Dun upon exiting the bank.

Evening: I pack for the long journey beginning tomorrow. Then, sipping Indian tea, I stroll out onto the balcony to listen to drums and singing from the soldier's camp. Another power outage. Becoming accustomed to candles and kerosene lamps. From the balcony in the dark I hear an eerie descending, quavering whistle. Mottled wood owl (*Strix oscellata*) moving up to the hill country from the winter bottomlands to breed. Having studied a similar species back home—the northern spotted owl (*Strix occidentalis caurina*)—I again find it a strange sensation to be in a country where the forests, wildlife, language, and customs seem partly familiar yet so changed. For instance, English is the primary language of the country, but the intonations and speech patterns render it at times difficult to decipher. The language, customs, wildlife, and resource issues are all new and different and at the same time so familiar. In the coolness of my candlelit bedroom I think of the Bradbury science fiction tale I once read about the time traveler who returned to his own year to find a deviously, subtly changed world, after he had accidentally crushed a single butterfly in a prehistoric era, whose death triggered a cascade of changes throughout the millennia.



Central India:

Melghat Tiger Reserve and the Satpura Mountains

28 March

I leave our comfortable Dehra Dun house at daybreak with Tom and Vish and begin our trans-Indo odyssey. We rent an Ambassador taxi for the 6-hour game of highway dodge to Delhi. We drive south through the Indo-Gangetic Plain, through diverse agricultural fields of sugar cane, peanuts ("ground nuts"), and rice. A stop for a cold drink at the Cheetal Restaurant, with a rather enigmatic sign proclaiming "Order Rich Lasses Here." (Later, I would be disappointed to learn that lasses is a popular milk-based drink.)

On to Delhi, encountering red turtle doves, northern whistling thrushes, and a gray hornbill perched on a tree limb arching directly over the roadway. A common Indian mongoose darts across the highway. Vish had bargained for the taxi drive at a negotiated rate of Rs 700 (about US$41) for all three of us with baggage. Lunch stop for chicken curry and south Indian rice *chappatis*. On across the fertile land, the vast fields of wheat that stretch along the base of the Himalayas and into the Indo-Gangetic Plain, forming the bread basket of the country and producing no less than a net surplus of food.

Our first full exposure to the onrush of traffic on the trans-Indian highways. We see some occasional, horrible accidents and mangles of once-vehicles, nearly all from head-on collisions. One body under a blanket. One ox or horse cart slammed by a truck over a bank into a lake. A bus and truck head-on that killed a bride and groom on return from their wedding. And yet the taxis weave, ox (bullock) carts crawl, and pedestrians refuse to even turn their heads when horns blare at their backs.

The bullock cart shares streets and highways with cars, motorcycles, pedestrians, cows, buses, trucks, bicycles, jeeps, and motorized rickshaws.

"Public carrier" trucks are common on the highways and are consigned to transport any goods on their usually overloaded beds. When they break down, it's usually the front axle that shatters. Licensed by individual states, the trucks are brightly colored and decorated with garlands, paint, and tinsel, proudly displaying hand-written inscriptions in Hindi devised by their owners and drivers. An old shoe often is hung beneath the front bumper and a devil's face is painted elaborately on the rear transmission case, to bring luck and to ward off evil—except for those ferocious head-ons.

Back to the U.S. Embassy in Delhi, and a phone call around the world to my wife, Carrie Sakai, who is to join us in 4 weeks. She doesn't seem to mind the 3:00 a.m. call to hear I'm safe. The Embassy officers are wonderful in helping with logistics for Carrie's visit and in making contingency plans for any possible combination of late or missed flights. Vish, Tom, and I are going on the road to some remote forests and parks, and will return to Delhi the very evening Carrie is to fly in from Hong Kong. Yet, anything can happen to anyone's flights. In case I will not arrive on time—a very likely possibility—I arrange for a U.S. Embassy driver to meet her at the airport, for a room to be reserved at the hotel in Delhi, for the purchase of her airplane ticket for the following morning to Dehra Dun, for a driver to take her to the Delhi airport and another to meet her at the Dehra Dun airport, for Baban to provide her with food and the room at the guest house, and...have I missed anything?? Nothing more to do now but to continue our journey south and relegate the vicissitudes of travel to the pantheon of the Hindu gods.

By 4:00 p.m. we taxi to the Delhi domestic air terminal and catch a delayed flight to Nagpur in central India. We arrive at 9:00 p.m., too late to catch the local entertainment that Vish had so proudly promised and worked hard to arrange for us. Tom and I kid Vish about our skepticism that such entertainment exists in India at all.

Nagpur is flat, with many planted trees, and seems less crowded than Delhi. The taxi ride this afternoon through Delhi was filled with gridlocks soaked in diesel fumes, motor scooters cutting us off at every chance, cows wandering the streets, diseased and crippled beggars on the curbs and at the car windows, and masses of people in cacophonous numbers. Many open fires on the streets, people cooking from blackened pots. Hazy, smoggy, smoky, brash, jammed, chaotic streets.

Eleven p.m. in Nagpur, pool-side in the sultry night air. Drinking and toasting our journey with Vazir Delux Strong Lager, "Pride of Asia," for sale in Maharashtra State only; and with a wheat-based Haywards 2000 Super Strong Beer, "alcohol content guaranteed at least 5.6%."

We are heading to Melghat Tiger Reserve, another day's journey from Nagpur, where we will meet up with an ongoing WII training class of midcareer foresters, the divisional forest officers. It will be an opportunity for us to interact with the people who will refine and implement our new conservation approach for the country. A timely encounter.

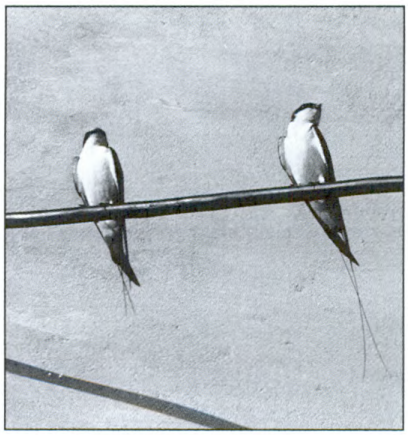
Toasts in Hindi. Then, a large filling falls out of one of my molars. No pain ("alcohol content guaranteed at least 5.6%"), but I must get the cavity patched before we go to the bush in Melghat.

29 March

Slept well in a cool, air-conditioned ("AC," as they say) room at the Hotel Centre Point in Nagpur. Breakfast with Tom. I learn that, last night after I turned in, Tom and Vish had gone into town and with the help of two rickshaw drivers of dubious character awoke a pharmacist at his shop/house at some midnight hour to get pain killers for me. Their "recommended" tip to the drivers exceeded the cost of the medicine by several times. I owe them one.

This morning, Vish scouts out a dentist located next to the hotel, and I attend to my dental needs. The dentist, a young fellow, well dressed and nicely groomed, has an excellent touch with the drill and spends much time meticulously patching the canyon with a temporary filling. His bill, after 40 minutes of work? Rs 50—US $2.94! And the patch would prove to hold solidly for many weeks until I would return home and have the job completed.

Outside at the chemist (open-air pharmacy), I purchase a mild antibiotic. You can purchase most any drug over the counter in India. The merchant pulls out various packages of pills from the shelves, spreads them out on the counter, and I choose what I want. As he writes up the bill (Rs 6), he asks which doctor this is through. Vish, quick-thinking as ever, looks at him deadpan and says, "It's for Dr. Marcot, here." Suddenly my Ph.D. is transmuted into an M.D. degree.



Wire-tailed swallows (Hirundo smithii). *A relative of the barn swallow, this species occurs in pairs or small groups in cultivated areas throughout India. Males (right) have longer "wires" (extended central axes or rachises of the two outer tail feathers) than do females (left).*

Noon in Nagpur. We visit the state forestry personnel at the Office of the Conservator of Forests, Nagpur Circle, where we discuss their conservation program for Nagzira Wildlife Sanctuary. The local sanctuary gets some 65,000 visitors per year and is a prime area for further demonstration of integrated forest management and public education.

Tailor birds and wire-tailed swallows in the trees outside the office. Lunch, then a taxi to the Nagpur train station.

The station is a page out of the 1940s. Forty-year-old, massive, vintage, coal-burning, smoke-belching steam engines thunder by. Passenger trains with sleeper cars that appear not to have been washed since they were built. There are three main gauges of railroad in the country: broad, meter (1 meter wide), and narrow (2 feet, 6 inches; why they mix metric with English units, I don't know). Several other minor gauges are found in south India and in some of the lesser traveled areas of the northeast. All the major trunk lines are electric with overhead power lines. We're waiting for the local mail train on the track that stretches from Calcutta on the east coast to Bombay on the west (the longest track in India). Apparently, all trains run drastically late, but the local mail runs are less late than the express runs, which may not show up at all. I don't even ask why.

Beggars, mostly older men or women. I slip them Rs 2 or 5 notes each. Don't want to be visible and attract more.

Waiting for the ever-delayed train in Nagpur. Coal trains wheezing by in this old station under the bright, hot, dry sun. The center of India. Vish is talking with his Forest Service colleague on the platform, slipping casually between English and Marathi. Marathi is the official language of Maharashtra State and Vish's native language (and the first language to be derived from Sanskrit). His friend,

who speaks little English, brings us handfuls of small, sweet oranges. Vish proclaims Nagpur oranges are the best in the country. He is right. In time, with tongue in cheek but not completely, he would proclaim his home State of Maharashtra to have the best schools, the most beautiful women, the tastiest food, and the most refined culture of the country. As our trip proceeds the claims would become more outlandish, causing my kidding to become more pointed.

A little later, near 7:00 p.m., dusk. We're on the Nagpur mail run headed west. I'm standing at the open door of our car skimming 80 kilometers per hour across the broad, arid plains of central India. The sky is peach, now orange, and a new crescent moon crowns the rushing fields and scattered trees. Occasional villages of mud and thatch, the hazy glow of ground fires in pasture burns, silhouettes of lone figures porting packages and stacks of wood on their heads out across the expansive fields. A surreal feeling. Eating Nagpur oranges in the brisk warm wind. Feet dangling over the sudden emptiness of trestle passes, momentary lights of passing train stations, the brilliance of a cloudless night sky, the startling roar and pull of passing trains heading east back to Nagpur and beyond to Calcutta.

Stops at Wardha, then Pulgaon, Dattapur, Chandur, then to Badnera, where we are to disembark, eat dinner at 9, and hop into a Land Rover bound for Amravati, Achalpur, and into the jungles of Melghat Tiger Reserve. Our destination tonight after a 3-hour ride by train (that was 3 hours late) and a 115-kilometer ride by Maruthi is Kolkaz rest house deep in the heart of the Melghat jungle. En route, we may encounter nocturnal wildlife—there's always a chance for tiger, leopard, jungle cat, or civet. But for now, I have this brief respite on board the rolling, clacking Calcutta-to-Bombay run to meditate on the flood of images this trip has brought thus far.

30 March

Planning and travel in India seldom match initial expectations, which is why it is often best not to have any. Our train indeed pulled into Badnera, but at least half an hour after Vish's calculations and something like 4 or 5 hours later than its scheduled arrival. There was no vehicle to greet us. So, instead, we pile our luggage into three-wheeled motor rickshaws lacking functional headlights and get a harrowing half-hour ride over bumpy highways into the warm darkness, dodging bicycles, pedestrians, bulls, cows, dogs, trucks, and other rickshaws equally bent on getting there first, into some distant and unknown town. Vish took a separate taxi with our baggage, and I wondered where in hell we were being taken and the fate of Vish and our possessions.

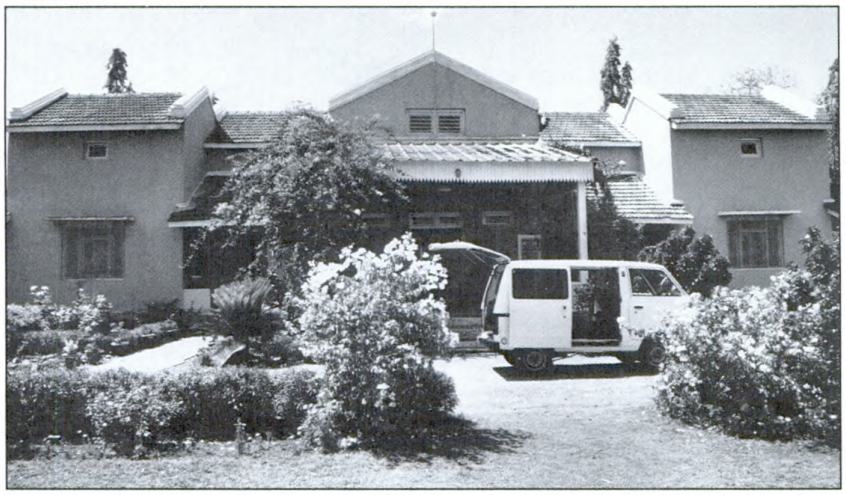
But all worked out. After a maze of streets, we ended up at Hotel Hindustan International in Satidhan Complex, Amravati. Run by Jains, who, according to Vish, are increasingly delving into hotel management, the hotel is absolutely first-rate. Tom and I laugh about arriving at such a clean, well-kept (and apparently empty!) hotel after the long train ride and rickshaw excursion into nowhere. Tom is given the honeymoon suite at the end of the hall, replete with purple walls, dozens of mood lights, and Day-Glo pictures of erotic dancers.

Awake to piped-in sounds of classical Indian music and fog in the head. Where in the world am I? A knock on the door and morning coffee. What service.

Breakfast, then Vish finds and hires a driver to take us to Melghat.

Marathi, the official language of Maharashtra, is different than the scant Hindi I was picking up. In Marathi, *savkash* is "slow" (*dhira* in Hindi), *thamba* is "stop" (*ruku* in Hindi), and *pakshi* is "bird" (*panshi* in Hindi).

Gasoline here is Rs 11.19 per liter, or about US$3 per gallon. Diesel is decidedly cheaper at Rs 4.62 per liter (about US$1.25) and is used by many of the cars and taxis.



The palatial forest rest house at Kolkaz, Melghat Tiger Reserve, Satpura Hills, central India.

En route to Melghat we see new wildlife, including black-winged stilts, Indian robins, bay-backed shrikes, blue-throated flycatchers, rufous-fronted wren warblers, and crested serpent eagles. Into the Satpura Hills, steep relief from the flatlands of central India, and the vast dry deciduous teak forests. The one-lane road winds along the contours among broad valleys of dense deciduous forests now leafless in this rainless season. We pause to watch a group of common langurs spill out of the canopy with suicide dives onto lower branches and the forest floor. A barking deer ambles up an open slope.

We finally reach Kolkaz rest house. Some forest rest houses we are to stay at are quite rustic. Kolkaz is an estate, a palatial spread of gardens and lawns on the cliff scarp above the Sipna River. Numerous planted flowering trees, shrubs, vines, and herbs line the gated approach to the house and surround the veranda and walkways in front. Vish refers to this as "camping at the rest house." Sure, I'll use that phrase back home, too, and skip the specifics. We each take private rooms having single beds with canopies of mosquito netting. Tom's room once was occupied by Mrs. Indira Gandhi during a visit and still has a multitude of buttons and switches on the wall, labeled servant, cook, and secretary. I tell Tom I am most certainly not going to answer his pages for tea in bed no matter how insistently he rings.

On the front lawn of the rest house is a signpost with text in Marathi quoting a remarkably astute and sound forest management policy of a bygone era. Retaining the syntactic quirks of the passage, Vish translates:

A Decree of Emperor Shivaji

In our forests there are a variety of valuable trees such as teak etc. According to the needs of people such trees can be extracted with the prior permission of the Emperor or an authorised official. If a desired species is not available or is rare, the same should be imported. Species like the mango, jack fruit native to our forests are in great demand for ship building by the navy. However these are reserved against felling for they are slow growing and not found in abundance. Forests in the empire have been jealously preserved by people and any act of irrational cutting of trees is a matter of grief. Any person who aims to prosper at the cost of the others stands to lose all the wealth he may accumulate and what is more, such selfish act is a crime against the society. Indiscriminate cutting of trees is calamitous. It is the citizen's duty to guard our forest wealth. Even if a tree is old and has lost most of its value, it should not be cut without the permission of the owner and only after payment of appropriate price.

The source of this wise policy was Emperor Shivaji who ruled from 1630 to 1680! Shivaji was the most powerful emperor in Indian history. He was from the Western Ghats in south India and ruled over the entire Indian subcontinent. His rule constitutes the core of what is known as the Maratha Period. Marathas belong to the Indian State of Maharashtra. From his rule, these forests were spared "indiscriminate cutting" over three centuries ago. May modern-day forest-dwellers also feel it a "matter of grief" over irrational cutting, and their societal duty to protect their forest heritage.

Evening in Melghat Tiger Reserve. We visit a small village in the cooler, wooded mountain ridges, the summer house of Mr. Buit, Retired Chief Conservator of Forests for the country. Our visit is billed as, and I believed it to be, merely an informal chat with this most prestigious and knowledgeable individual. Tom and I are ushered through the house to the back courtyard where we find an audience of the 20 or so students of the WII training class already seated in rows of folding chairs, facing a linen-clad table in front. Tom and I are instructed to sit on either end of the table as honored guests. Presently, two men (house servants, I surmise) close the curtains to the house entrance so that Mr. Buit can make a dramatic and formal appearance. Everyone stands as he enters and greets us. He then gives an uninterrupted talk on the history of management in India's forests and his 50 years of service and perspectives. He shares how he has personally experienced great declines in large wildlife, especially ungulates, in Melghat National Park (a conclusion that Vish was later to question based on other evidence). He feels that invasion of the forests by exotic weedy shrubs, especially a culprit called lantana (*Lantana camara*)—a garden escapee—has seriously degraded range quality. Also, fire prevention, according to Buit, has induced excessive buildups of fuel loads and conflagrations. During the talk, Tom and I are offered tea—with milk—and have to graciously decline, the reason for which Buit could not understand. (He asks, "Do you not cherish the tea as we do?")

Later, we visit Melghat Tiger Reserve Visitor's Center, then take the 1-1/2-hour drive through the night jungle back to Kolkaz. En route in our lurching tank, the Land Rover, we see four jungle cats, a vole, and various bats.

Night at the rest house on the river cliff. Sambar calling with bugle-toots, their alarm call given when they encounter leopard or tiger. The big cats are out there. After a time, another sambar calls to our left, closer, in the adjacent teak plantation. Later, a spotted deer barks its alarm. At cliff edge, an Oriental scops owl (*Otus sunia*) flies shoulder-level a few feet past me, then calls with a rising then declining series of quick hoots. A ground fire glows orange on the dark distant ridge far over the river. Below, the dark expanse of the river gorge and the approach of unseen visitors to the water holes, safe under the cloak of night, except for the big cats. The buzz of Indian nightjars, more alarm calls from the sambar. How I hate to turn in tonight.

31 March

Up at 7:00 a.m. in Melghat. Perfect 75 °F weather. Out on the trail down to the river, photographing white-breasted kingfishers, black drongos, paddybirds, and Tickell's blue flycatchers. Later in the morning we meet with Shri Chobkar, the range officer for Harisal Range within Melghat. He is one of the key links for translating our conservation plan to the ground through implementation of our management recommendations and schemes.

Into the field. Dry deciduous forests of teak and numerous broad-leaf species with such local names as haldu, dhaora, and saj. Higher in the hills on the upper slopes on the plateaus and the terraces above 1000 meters are found the tiwas forests. Dominated by the tree tiwas (*Ougania oogeinensis*), tiwas forests occur in sites with long histories of shifting cultivation with generations of tilling. As a result, tiwas forests often are stunted and contain lush understories of lantana, the invading shrub weed.

The tiwas forests provide a prime example of how the prevalent focus on the timber resource has shaded how we even apply names to the land. Forest openings within tiwas stands provide important wildlife habitat. We are now calling such openings "plateau woodland savannas," which see important seasonal use by gaur and sambar from July to February. Yet the timber stocking maps have traditionally named such areas "blanks," connoting their lack of commercial timber value and belying their valuable function for other resources, particularly wildlife habitat. The lesson is that we should tailor our lexicon to be less judgmental ("blanks") and more descriptive ("savannas") as a step toward a better balance of how we view and manage the land.

Gray tit (Parus major), *Satpura Hills, central India. This insectivorous relative of chickadees frequents less humid forests.*

As Vish comes to teach me, another important forest type in the Satpura Hills are the so-called mixed forests that have a high number of prevalent trees species, including tiwas, dhoman, moyen, salai, ghatbor, saj, sewan, and tendu. Most of these species are deciduous during the dry season, which leaves the canopy open and the forest floor flooded with sunlight. Mixed forests are found in the upper hills and in some valleys, mostly on poor growing sites. They usually are dense with bamboo absent and lantana common. Like the teak and tiwas forests, mixed forests are classified as a mature variation of the southern dry deciduous forests.

Another major type of forest in the Melghat portion of the Satpura Hills is salai forests. These are mostly open forests growing on shallow soils. The major species is its namesake, salai (*Boswellia serrata*), but with other compatriots. In Salai Forests, teak occurs only in small patches, bamboo is mostly absent, grass is scattered with little cover, and climbers are few and mostly confined to the riparian forests along streams. Unlike the teak, tiwas, and mixed forests, salai forests constitute what is called an edaphic climax, a forest whose species' dominance is mostly a function of the less than optimal growing conditions of the soil and site.

Most of the forests—teak, tiwas, mixed, and salai—have long shown effects of plantations, silvicultural treatment, intensive fire management, bamboo harvest, grazing, and exploitation of a multitude of forest plant and animal products. Again, the concept of "natural" holds little meaning here or must be used with the human element as a integral part of the definition. Another lesson for our forestry lexicon.

We stop at a forest nursery expecting to see the usual rows of seedling crop trees being grown for commercial forestry. We do see teak and bamboo being grown for planting,

Local forestry official displaying nursery of fruit-bearing trees to be underplanted within teak plantations in an effort to restore some of the native forest diversity.

but also a multitude of noncommercial fruit trees, important components of wildlife habitat. This exemplifies the conflicts in management objectives: the wildlife range officer is instituting this program of planting native fruit trees for wildlife habitat, but the territorial range officer in charge of the timber resource wants to plant exotic commercial species to meet his targets and mandates. Tom and I agree that this sounds a bit like home, where mixed objectives and unclear priorities sometimes lead to conflicting direction given in forest conservation.

Bamboo (*Dendrocalamus rictus*) is an important species in this area, as well as throughout much of India, and is useful as a wood resource and as wildlife habitat. Wildlife species using bamboo for browse include gaur (Indian bison) and sambar. Species using bamboo for cover (especially when it is regenerated from seed) include gaur, sambar, and other species. In general, bamboo is present on sites protected from grazing and fire, such as in the core areas of the reserve. When these disturbances are present, as in the much more heavily used buffer areas, bamboo tends to be replaced by the mostly useless weed lantana.

Management of bamboo is a bit more complex than planting and thinning for harvest and excluding excessive disturbance from grazing and burning so that lantana does not get a hold of the site. Silvicultural thinning encourages resprouting of bamboo shoots and growth of remaining shoots for production of a wood resource. Such thinning is done by leaving about 10 shoots per clump; however, this greatly reduces its value as browse or cover for wildlife. On the other hand, when bamboo is thinned naturally by wildlife use (for example, by gaur), it acquires a different vegetative structure, tending to have some broken stems, much more than 10 stems per clump, and a rich base of resprouts that often are heavily browsed. But this natural thinning reduces the amount of commercial quality bamboo. An intermediate and deliberate silvicultural scheme of harvesting bamboo would provide these wildlife values and still yield some commercial quality stems for human use. These are the sorts of forestry techniques we are trying to promote in the buffer areas where human use has been designated as part of the land use pattern.

Part of making such changes in forestry here must entail reviewing the staffing norms in the Indian Forest Service. Career success and advancement in the IFS—as in the USDA Forest Service—traditionally has been tied only to meeting targets of producing commodities, not to

Bamboo harvest, Melghat Tiger Reserve, central India. Special silvicultural techniques for harvesting bamboo have been developed to provide both for sustained annual production and conservation of wildlife cover. The state-administered Forest Service oversees all harvest and forestry hauling operations.

creatively solving problems of simultaneously meeting villagers' needs and wildlife habitat conservation. What is required is a different set of hiring criteria for staffing and different avenues of career advancement based on protection and conservation of all forest resources, humans included.

Beyond that, a new way is needed of ensuring that what wildlife requires to survive is integrated into the forests, pastures, cropfields, and village landscapes of the populace. I am reminded of a "modern parable" written by David Ehrenfeld in the book *The Last Extinction*:

> In the Papago Indian country of Arizona's and Mexico's Sonoran Desert, described so beautifully in Gary Nabhan's book *The Desert Smells Like Rain*, there are two similar oases only thirty miles apart. The northern one, A'al Waipia, is in the U.S. Organ Pipe Cactus National Monument, fully protected as a bird sanctuary, with no human activity except bird-watching allowed. All Papago farming, which has existed there continuously since prehistory, was stopped in 1957. The other oasis, Ki:towak, over the border in Mexico, is still being farmed in traditional Papago style by a group of Indian villagers.

Visiting the oases "on back-to-back days three times during one year," Nabhan, accompanied by ornithologists, found fewer than thirty-two species of birds at the Park Service's bird sanctuary but more than sixty-five species at the farmed oasis. Asked about this, the village elder at Ki:towak replied:

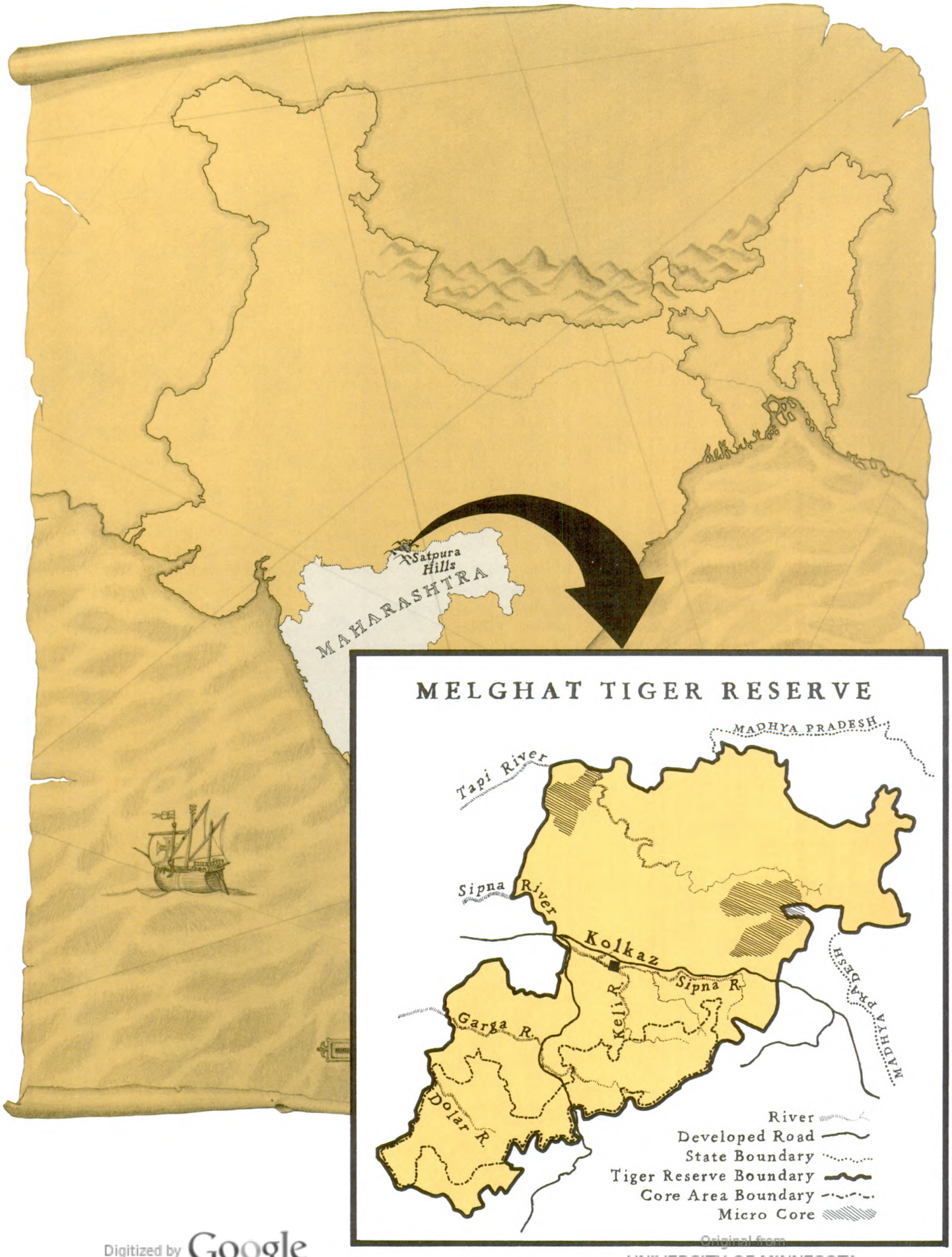
> I've been thinking over what you say about not so many birds living over there anymore. That's because those birds, they come where the people are. When the people live and work in a place, and plant their seeds and water their trees, the birds go live with them. They like those places, there's plenty to eat and that's when we are friends to them.

And that is when conservation becomes reality, when people who are not actively trying to be conservationists play and work in a way that is compatible with the existence of the other native species of the region. When that happens—and it happens more than you may think—the presence of people may enhance the species richness of the area, rather than exert the negative effect that is more familiar to us.

Spotted dove (Streptopelia chinensis). *A common bird of open woodlands, gardens, and towns.*

Of course, the real trick is to craft human use patterns so that the wildlife species that benefit are not only those numerous "weedy" species occurring in highly disturbed habitats, but also those fewer specialist species that occur in undisturbed and scarce or declining habitats of high opportunity value. India probably has enough Norway rats, house sparrows, cattle egrets, and tropical cockroaches.

We visit a water hole, scarce but utterly essential sources of life, particularly during this dry season heat. We come upon white-whiskered bulbuls, spotted doves, a troop of common langurs, Indian tree pies, and purple sunbirds all sharing the rare resource.



I'm beginning to help develop a wildlife habitat classification system for our Satpura Hills demonstration area. With help from Vish and our local forest specialists, Shri Jayant Kulkarni and Shri Ajay Pillarisett, we identify forest types and vegetation elements from the viewpoint of wildlife habitat. For example, a large number of fruit-bearing trees provide essential foods for ungulates, primates, frugivorous birds, sloth bears, jackals, and other wildlife. Such trees include *Medhuca latifolia, Emblica officianalis, Ficus glormerita,* and *Tamarinus indica.* Some of these trees, with their large canopies, also provide shade and nesting cover for birds. The tree *Ougania* forms a local forest type. Its leaves are used for cattle fodder and its strong wood for bullock cart axles. The leaves and fruits of *Zizyphus jujuba* are high-quality foods for wildlife. The bark of *Metragina parviflora* is thin, peels off easily ("exfoliates"), and is eaten by ungulates.

Other trees also have high commercial value for humans. The fruits of *Terminalia bellerica* contain tannin and are collected and sent to tanning factories. The fruit also has high medicinal value and is an important food for ungulates as well. Many other tree species provide important wildlife foods and substrates for cavity-excavating species of birds. With the new 1988 National Forest Policy, the first step in conserving or restoring critical wildlife habitats, and for conserving biological diversity throughout the country, is to identify such important components and the kind of management needed to sustain them.

An interesting case in point in this era of changes in forest management perception is *Dalbergia paniculata.* At an age of 20 years or more, this common tree of the deciduous forest develops a highly fluted bark structure with deep recesses. This structure provides excellent habitat for cavity-nesting birds and mammals, especially spotted treecreepers, which lay their eggs within the flutes behind the bark. It also provides important habitat for giant flying squirrels, which nest in the cavities formed from the first fork of the trunk. The flutes render the tree worthless, however, for commercial forest products. The tree typically has been removed during forestry operations to provide growing space for other species of commercial value. Under a new conservation plan, its presence in the forest would be encouraged.

In the United States, a very similar circumstance occurs with forestry in southeast Alaska, where fluting of the widespread western hemlock (*Tsuga heterophylla*) is traditionally seen as undesirable because it greatly reduces the amount of higher quality commercial wood. Recent studies there suggest, though, that it is not a genetic aberration for western hemlock to develop flutes.[5] Rather, all western hemlock trees seem to have the capability to form fluting structures under the right circumstances. Fluting has appeared in western hemlock specimens grown in England, for instance. Fluting of western hemlock seems to appear when damage to one side of the trunk restricts flow of carbohydrates upward, thereby causing temporary cessation of growth along an upward longitudinal furrow. Fluting also seems to play an important structural role in helping the tree become less prone to breakage, as it appears on trees growing in infirm soils with loose gravelly substrates. In these circumstances, fluting may help prevent hemlock stands from being blown down by the fierce coastal Alaska storms. As well, bark growing over the corrugated trunk sometimes provides hollows and niches in which roosting or nesting birds and bats can find haven, just as in the fluted *Dalbergia paniculata* trees of central India.

A new approach to conservation of the forest ecosystem—in India as well as Alaska and elsewhere—must entail managing for the fuller variety of commercial trees, noncommercial fruit- and seed-bearing trees and shrubs, and the host of other vegetation that forms the diverse habitats so critical to the original crawling and flying citizens. It all begins with changing perceptions of what is of value in the forest itself. This includes its commercial timber, yes, but also the multitude of other forest products that may or may not have commodity value but that have great worth in tradition and ritual and religion and culture. As our friends at Melghat Tiger Reserve Visitor's Center would concur, encouraging tourism is more than simply advancing recreation; it is changing perceptions so that people view wildlife as having simple yet profound rights to

[5] Julin, Kent R.; Farr, Wilbur A. 1989. Stem fluting of western hemlock in southeast Alaska. [Brochure]. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. [Not paged].

exist in their own habitats, that there is value to us to live our lives such that they continue to thrive.

I think of the tree nursery we visited today, where those life-giving non-commercial trees and shrubs were being nurtured for revitalizing the forests that have grown sterile in recent decades from single-purpose use. In the tiny plantings, in the seeds, lies the promise of diversity and health of the forests. And in diversity lies the future viability of the community of wildlife and the future hope for human generations. Seeds of a new century, a new conservation. Seeds for the new and more diverse forests and for the health of our posterity. There at the nursery, I watched small women hoisting impossibly heavy sacks of teak seeds and seedling trees onto carts for transport. I had scooped a few kernels of the minute seeds, sliced one open, and thought of the dialogue between Svetaketu and his father Uddalaka from the Chandogya of the Upanishads, the most sacred of India's scriptures:

> "Please, sir, tell me more about this Self."
>
> "Be it so. Bring me a fruit of that Nyagrodha tree."
>
> "Here it is, sir."
>
> "Break it."
>
> "It is broken, sir."
>
> "What do you see?"
>
> "Some seeds, extremely small, sir."
>
> "Break one of them."
>
> "It is broken, sir."
>
> "What do you see?"
>
> "Nothing, sir."
>
> "The subtle essence you do not see, and in that is the whole of the Nyagrodha tree. Believe, my son, that that which is the subtle essence - in that have all things their existence. That is the truth. That is the Self. And that, Svetaketu, THAT ART THOU."

Night at Kolkaz rest house. Chairs on the lawn, watching the orange fires on several of the distant ridges. Hope we're safe here. Vish has spent much of his field career here and has never seen this area burn so extensively. This year particularly, it has been dry and hot, and the villagers are out burning the forests for leaves and antlers and many other resources. Sometimes the fires just escape accidentally from their camp kitchens.

Jungle owlets and common Indian nightjars calling in the dark. Alarm call of a cheetal (spotted deer) buck, a single loud *heep*. Cats on the prowl somewhere out there. One can use the alarm calls of spotted deer, sambar, barking deer, jungle fowl, langur, and other species—what Jim Corbett called the "jungle folk"—to inform you as to the presence and movements of the big silent cats. Later, drifting to sleep, I hear sambar bugling more warnings, a little to the west of the cheetal's previous alarm. Vague dreams of hazy shapes moving through dark woodlands.

1 April

Visited teak plantations in Melghat with some of the local forest officers. One key player for development and application of this new conservation plan is Shri M.G. Gogate, conservator of forests and field director of Project Tiger at Melghat. His energy and enthusiasm for educating the Indian public is best exhibited in his cleverness and creativity at devising the new Melghat Tiger Reserve Visitor Center. Gogate is designing the center as a focal point for visitors, with sign boards, an interpretation center, cabins, and signed hiking trails. Set in a mature forest of teak along the river banks, the center also is a locus for researchers and foresters to congregate. As a case in point, the WII class is using the site as their base of operations and is holding classes in the open-air amphitheater-auditorium.

The signboards urge the visitor to seek out local natives as guides and counsel that although they may be shy and quiet, they have tremendous knowledge and experience with the local forests and its fauna. This is one of Gogate's very clever tactics, to integrate villagers and tribals into the tourism economy, to allow them to grow and participate as central components in the new sanctuary and tiger reserve system rather than be excluded from exploiting their traditional forest resources.

Another signboard in the compound reads:

KEEP A REASONABLE DISTANCE FROM ALL ANIMALS.

APPROACHING TOO CLOSELY WILL DISTURB THEM.

A LARGE ANIMAL MIGHT SEE THIS AS A THREAT

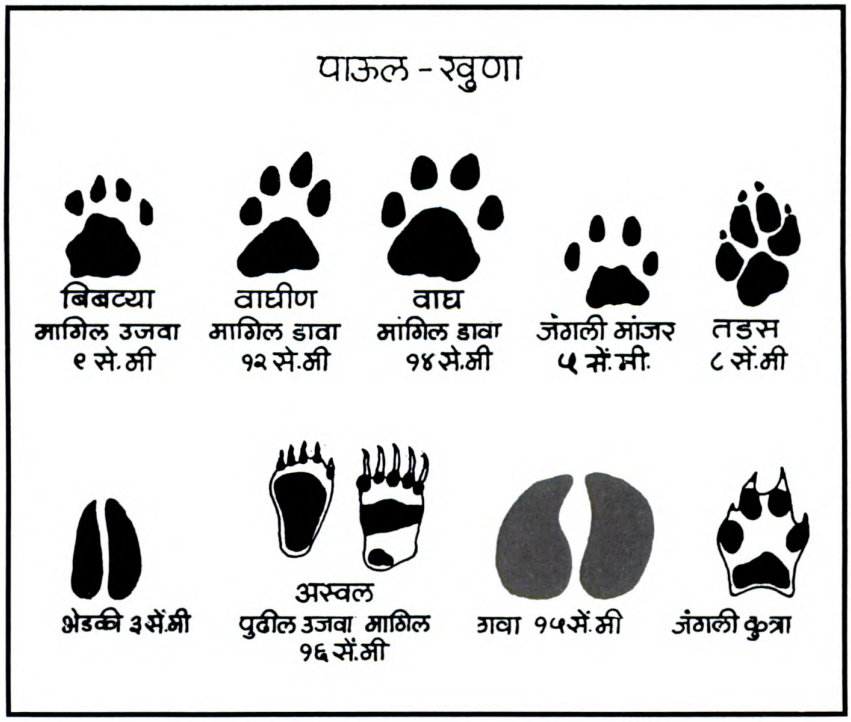
AND BE PROVOKED INTO STRIKING BACK.

IF YOU SEE A GAUR, STAY AT LEAST 50 METRES AWAY.

A cartoon drawing of a panicked man fleeing from an approaching gaur makes the sign particularly effective.

Gogate's nearly finished visitor's center will provide the public with electronically illuminated maps of the reserve and a multitude of photographs, dioramas, and live mounts of wildlife in the area. Various pug marks of tigers and other cats are embedded in the cement walkway that leads to the visitor's center. Outside under a thatch-roofed veranda is a three-dimensional relief map of the reserve. The map measures some 5 by 6 meters and gives the visitor an understanding of the lay of the land and its major roads, ranges, rivers, and allocations into buffer and core areas. Inside the visitor's center is a signboard listing several dozen noncommercial tree species that produce important fruits and seeds for wildlife and showing the peak times of flowering and fruiting. At a glance, then, one understands some of the complexity of the dry deciduous forest. Many trees flower or fruit asynchronously, providing wildlife with an abundance of foods at most any time of the year; that is, if the trees are allowed to grow. Until recently, the noncommercial species had been removed during timber harvest operations and not replanted.

The visitor's center also has full-scale dioramas on human use of the native forests, which show village scenes with families gathering and processing wild nuts, fruits, and other forest foods. In another section, an old set of stairs leading to a dank basement is being transformed into a cavern shaft that one can descend into, papier-mâché rock walls and all. Half way down, a weight-sensitive plate on one stair trips a light, illuminating a mounted sloth bear emerging from a simulated cliff rock shelter, positioned directly across the stairs. The basement is to be developed into a simulated cavern chamber showing the wildlife that occurs in such special habitats; it will have a sitting area for viewing a slide show depicting other wildlife and habitats in the Melghat Reserve. A final door leads from the cavern to an outside compound having other interpretive signs and exhibits.



Tracks of mammals with text in the Marathi language. (Source: Melghat Tiger Reserve, India)

Another of Gogate's brilliant touches occurs on the cabins that visitors can rent while in the reserve. Instead of being identified by numbers, each cabin is named after a different fruiting tree of importance to wildlife or local tribal tradition. The leaves and fruits are painted on the outside of each cabin and a live, signed specimen of the tree is planted near the front walk. In this way, Gogate reasons, the visitors cannot help but learn some of the trees and their importance to wildlife and humans, thus helping to change perceptions that only commercial timber trees are of value.

We joined the WII class in listening to a talk by Mr. Moen, divisional forest officer of West Melghat, on the needs for integrating wildlife conservation with tribal management. He too expressed the philosophy that we must develop management plans that provide for symbiotic needs between tribespeople and wildlife by maintaining the health and vitality of forest cover. He defined such wildlife management and forest conservation as "achieving and maintaining food chains and food webs in the forest ecosystem." This expresses his basic principle that all organic components of the forest are interdependent and must be viewed, understood, and planned for as such. But to protect the very sensitive habitats and wildlife species residing in the deep forest interiors, tribal villages, as well as any grazing concessions, should be excluded. In Melghat, this has occurred; most villages and grazing rights have been eliminated from the park's core areas, but not from the buffers, which were allocated for such human use.

We visit one of the heavily protected core areas within Melghat Wildlife Sanctuary and Tiger Reserve. They are serious about protecting the very rare remaining wild areas. We pass through no less than three locked gates, some with guards posted 24 hours.

Entrance sign, in English and Marathi, to Melghat Tiger Reserve, Satpura Hills, central India. Many forest reserve wildernesses or core areas in India are gated with access allowed only by special concession or Government pass.

Vegetation in the core areas, which are established much like the wilderness areas of the United States, differs conspicuously from vegetation in the more heavily used buffer areas. In the core area, bamboo is much more prevalent and lantana is weak or absent; the reverse is the case in the buffers where the weedy shrub lantana predominates. Also, native grass is tall and lush in the core, providing cover for leopard, tiger, wild boar, jungle fowl, and a host of other species; such cover is sparse or absent in the grazed and burned buffer.

We visit a moist riparian evergreen forest along a small waterhole in the core area. Yellow-throated sparrows, red-wattled lapwings, green bee-eaters, yellow-fronted pied woodpecker, and 15 gaur share the resource. Gaur often travel in herds, although we also saw several solitary males, but at sufficient distance so as to not provoke them. The bulls are mountains on legs, with high humped backs and white stockings down to the hooves. Gaur actually are more closely related to wild ox than to buffalo.

Further into the core area and along the unpaved road, we track the pug marks of a male and female tiger. Vish points out where one had sat in the road and then moved on. The male had gone first, as the female's smaller track was superimposed over his. The tracks are fresh. As I wander from our team along the thick grass

to photograph birds I keep a sharp eye and ear for any movement. Far out of sight, alone in the hot dry teak forests with fresh tiger sign about, my growing uneasiness suddenly seems very sensible and to have high adaptive value. I have not felt as anxious as this in a natural outdoor setting since I encountered grizzly bear in the arctic tundra. A hike into the forest, then back onto the road, and I discover a set of tiger tracks I hadn't noticed before, these overlapping the old ones and going in the opposite direction. Why would they be doubling back on themselves, unless... I scan the dense brush and rock outcrops that fill this small valley. They could be hiding in wait anywhere. A few more photos and I hike the slopes back to our group who didn't realize I was gone (er, let's rephrase that to "temporarily absent").

Along the trails to other waterholes and hides, we encounter remains of two predators' meals. Gogate and Vish concur that one carcass was a barking deer taken by wild dogs (*dhoal*) and the other was an Indian hare taken by a crested serpent eagle. I was hardly in a position to argue in either case. Back home I could decipher the same kinds of clues, but here the fauna is still new to me. Further on we find tracks of common langur, jungle cat, barking deer, sambar, and gaur. We also encounter termite nests taller than head height and dug out by sloth bears, and the strange nest of ground ants with its symmetric, concentric rings of mud.

Tracks ("pug marks") of tiger (Panthera tigris), *Melghat Tiger Reserve. In India, tigers have been rescued from imminent extinction by a 1970 ban on their shooting and by designation of a national system of Tiger Reserves.*

Tracks of jungle cat (Felis chaus), *Melghat Tiger Reserve. Jungle cats are small (body 0.6 meter), long-legged felines of drier jungles and forest edges.*

Dusk at the core boundary. Giant flying foxes wing overhead like some great Triassic flying reptile. At first I was about to point out the winged silhouette, saying "Look up, there's a heron," until I looked closer and realized in amazement "Wait, that's a *bat*!" We stop for me to photograph with strobe flash an Indian giant flying squirrel in the leafless canopy, spotlighted by one of our guides.

As we discuss project funding, I receive a lesson in the Indian counting system. One lakh is a hundred thousand and is written 1,00,000. One million is 10 lakhs and is written 10,00,000. A crore is 10 million. The simple mnemonic from my travel book is most helpful for remembering this system: a **lakh** is 10 times **less** than a million, a **crore** is ten times **more**. Still, it takes a pause to translate their citing of operating budgets of so many rupees crore into an equivalent U.S. dollars.

2 April

Fresh morning coffee in bed at Kolkaz rest house in Melghat. Each rest house has an assigned staff of cooks, houseboys, and servants. Because we are traveling with Vish Sawarkar, the joint director for the Wildlife Institute of India and a high-ranking and well-respected official in the Indian Forest Service, we are treated with utmost care by the uniformed officers, who snap salutes upon encounter. I never know whether to salute back, offer a handshake, or just ask for another cup of coffee. In the bush, not very many local Forest Service employees speak English, or they speak it with differing degrees of clarity to my ear.

But in the end, a warm smile and greeting are all I need for soliciting a smile in return.

The mosquito netting canopy in bed helps. We're on our guard for rodent friends, as just 2 months back this was the rest house in which others in our team had found Norway rats in their duffel bags. One rat apparently ate our colleague's bar of soap and then drowned itself in a bucket of water in the bathroom. I'm sure a bucket-shower seemed less appealing that morning.

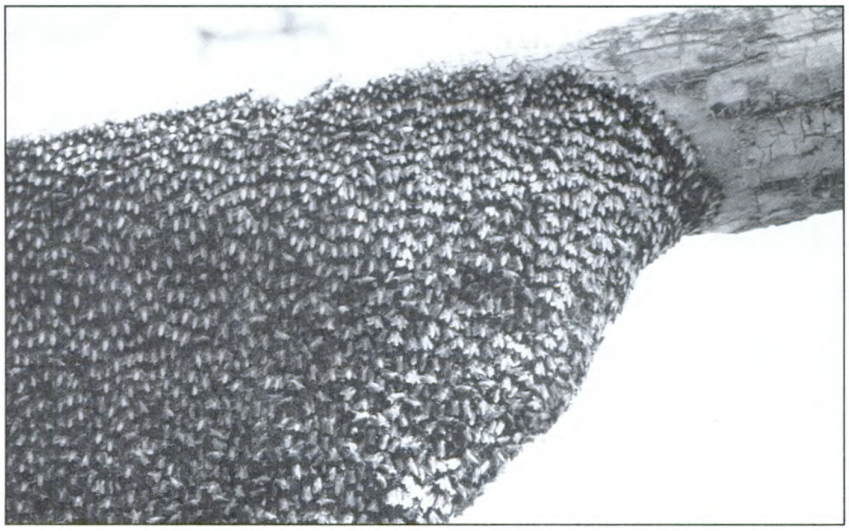
As we discover throughout the country, power outages at the rest house are common. The power last night failed at midnight (when we finished dinner) and was still out when we left this morning. Had to take a brisk, wakeful cold bucket-shower, but at least without dead rodents.

Other friends around the house include the omnipresent and translucent house gecko, rapidly running cockroaches, and a variety of large nocturnal beetles. Outside, the fauna is rather astounding. In half an hour at sunrise, I catalog 20 bird species including crow pheasant (*coucal*), stork-billed kingfisher, common iora, Franklin's wren-warbler, and a shikra, a small *Accipiter* bird of prey.

Visit to another core area in Melghat Tiger Reserve. Again, the overlapping designations of reserve areas is perplexing. I think I've finally sorted out that the largest core area of Melghat Tiger Reserve is also designated as Gugamal National Park. To add to complexity, two other moderately large core areas are proposed for Melghat Tiger Reserve, called, unique to this park and for some obscure reason, "micro cores."

We stop to pick up Mr. Jagtap, range officer in charge of the core area (Gugamal), who is joining us for the day. We often stop along these back forest roads and pick up forest officers or plain-clothes locals who are waiting there Lord knows how long. I never seem to catch how it's planned to pick them up, who they are, why they're riding with us, where they're going, or if they're highranking officials, forest guards, local villagers, servants, or hitchhikers. Most of the time when I greet them and introduce myself I have no idea of their identity. Of course, in this culture, one does not introduce oneself in this manner, with smile and handshake, to servants. I'm sure I made some serious blunders along the way, but darned if I could tell. Luckily, it never seemed to matter and, hopefully, it never made anyone else uncomfortable.

At 9:30 a.m. we stop at a small village settlement called Kaoha within the reserve, and I discover in time that it's for breakfast under the veranda. We eat *chappatis* and omelettes with our fingers, while watching purple sunbirds and white-spotted fantail-flycatchers in the garden hedges.



Large rock bee (Apis dorsetta) *colony in central India. Hives are commonly raided by sloth bears* (Melursus ursinus) *and are used as an important source of income for local forest-dwelling tribes.*

Spending the day in the core of Gugamal, hiking and traveling the narrow switchbacks in the Sherman tank called a Land Rover. The dirt roads are better suited to trail bikes or hiking, as we had to take some turns on four points. The access roads are steep, windy, and accessible only during this dry season—at places we need the four-wheel drive of the Rover even now—and are impassable during the monsoon.

It's amazing what flourishes when intensive grazing and burning are excluded. Lush understories of *Sorghum* grasses grow 7 feet tall. We hike along more riparian areas, cool shady streamside forests of evergreen broadleaf *Terminalia arjuna* trees 40 to 60 inches at breast height, with a flaky light bark, a broad canopy providing much shade, and winged seeds that catch the wind. High in the *Terminalia* branches are large living hives of the Indian rock bee, *Apis dorsetta,* and the tree trunks show claw and climb marks of sloth bears that take the honeycombs. Further up the draw we see giant mango trees and wild banana, which grow only in these uncommon riparian areas. More fresh tiger signs—droppings and tracks. We also discover a tree that a tiger had used for a scratching post, much as a house cat will use chair legs, except the claw marks extend some 2-1/2 to 3 meters—that's 8 to 10 feet—up the trunk. Not an unusual stretch, considering that an average healthy tigress can measure 1 meter high, over 2.6 meters from nose to tail, and weigh 150 kilograms, and that males grow substantially larger.

This protected core area is visibly more lush than the surrounding buffer areas. The core has substantially less lantana cover, a tall (2-3 meters) lush understory of grass, a greater diversity of tree species, and a greater diversity of fruits. These are the sorts of habitat attributes we must maintain to some degree in the buffer areas by developing and asserting management guidelines regulating the timing and intensity of grazing, burning, and other forest uses.

We pause for lunch with Sawarkar and Gogate, who discuss the spiritual merits of the forests. I am impressed that they readily accept intangible, spiritual values of forests as equally valid attributes and descriptors as the scientific ones. The conversation wanders to a discussion of the old rest houses that were built to accommodate Forest Service employees and trekkers in the denser and more remote jungle areas. Vish tells us of his experience in an abandoned rest house supposedly occupied by spirits.

This particular rest house originally was occupied by a Muslim family. The young daughter fell in love and illicitly eloped with a young Hindu boy. When she returned to her family, her father, so enraged with her sacrilegious actions, poisoned her. Another version of the story relates that the father had her burned alive, but Vish doubts that variation. It is said she is heard walking through

the house on some nights as a white-robed apparition, jingling the ankle bells commonly worn as decoration or jewelry. The house cook claims to have been slapped hard when no one was there. A highly skeptical and reliable Indian Forest Service officer asserts that while he was sharing a room with a colleague, in the early morning hours he watched his friend's bed, with his sleeping friend in it, crumble into the ground, until he shouted for help and instantly all returned to normal. Vish relates that he had slept there once and had his covers slowly pulled from him at night as he watched, with no apparent physical explanation for the incident.

Up a far slope, a troop of bonnett macaques warily dash from our approach. They seem much more guarded than the rhesus macaques of northern India and have a much greater flight distance.

Hiked to the highest point in the core area on an old basaltic plateau. With grazing recently having been excluded here, the grasses have returned to their 8-foot height. Black-winged kites and red-rumped swallows dash overhead.

A long 4-hour drive back to the main entrance gate of the core area, down interminably bumpy and windy forest roads. We encounter sambar, gaur, a white-eyed buzzard-eagle, and gray jungle fowl. The Tapi River here forms an interesting example in biogeographic patterns. North of the Tapi River are found rhesus macaques and red jungle fowl. These species are replaced south of the river by bonnett macaques and gray jungle fowl. The river apparently has served as a major dispersal barrier for a long time for the original genetic stocks to have differentiated into related but separate forms. I wonder if other wildlife species show such abrupt distributional patterns here and how management of the habitats should account for the different wildlife communities on either side. Although the Tapi River passes through a gorge within the central Satpura Hills, it does not seem more than 100 to 200 meters wide. What is somewhat puzzling to me is that this does not seem to be a major terrestrial barrier to dispersal of these wildlife species.

Vish points out a colony of false vampire bats darting in the late dusk sky just overhead. Then, the long night drive in the rhinoceros, the Land Rover, back to our Kolkaz rest house. Although Vish has his assigned driver with us, the driver is feigning illness but still is spending the day with us and riding in the back. Later I learn that Vish berated him earlier for his drinking on the job. As I think about it, his driving yesterday was abnormally erratic, very slow on the straightaways and sliding around fast turns. Today, though, Vish is driving. And our Land Rover has the left headlight out, sabotaged, says Vish, by one of the servants whom Vish had ordered to remain with the vehicle at the stops we made today.

We keep our eyes sharply focused on the dim single pool of light ahead in the tunnel of dirt road and tree trunks. Indian hares dart in zigzag patterns across the highway, a behavior evolved for successfully evading predators faster than themselves, apparently including one-eyed Land Rovers. Indian nightjars dash from their road perches at our approach, their eyeshine leaping up in the dark like some frenetic spectral image. Suddenly, we see the shape of a large cat bound onto the road some 40 meters ahead at the edge of the headlight's vision, limp across the road, and disappear into the brush off the right side. "Tiger, tiger!" shouts Vish. An eerie white figure in the pale light, no markings of stripes or spots. In an instant it is gone. We pull up to its crossing point, and out the windows we hear a large form rustling in the brush below us in the dark, then silence.

Five hundred meters ahead we stop at a forest guard station and assess the situation. The forest guard comes out of his small, dimly lit house by the road to join us. Bright stars, quiet night. A small village just down slope with someone's dog barking. Vish lights his pipe, leans on the Land Rover, and we compare notes on what we saw. Probably tiger, says Vish, or an unusually large leopard. He talks to the guard in Marathi and tells him to inspect the tracks first thing in the morning to determine which species it was.

Vish and I both saw a discernible limp in a hind foot, and Vish saw that the tail was broken, bent at an odd angle. Tigers often go after porcupines and at times receive a painful dose of quills in their legs or mouth. In some instances, this has been the cause attributed to some tigers turning to man-eating, as they cannot bring down their usual quarry of deer or bison. Other possible reasons for a man-eating habit have been cited as loss of the canine teeth with advancing age or damage to the paws or retracting claws. But some tigers have adapted the habit with none of these adverse health conditions evident. Vish is concerned for the safety of the villagers below and instructs the guard to inform them, but not alarm them, to keep indoors at night, to keep watch, and to lock up their livestock after dark.

Back to the rest house and dinner by 10:30.

3 April

To aid management of the area, we are developing systems to classify the habitats and wildlife species of the Satpura Hills. I am learning how little is known about the biology, ecology, and habitat associations of most wildlife species in the area, and that virtually no scientific field surveys or studies of the wildlife communities have been conducted here. But I am equally impressed at how much the local experts—especially Vish and the local research officer, Jayant Kulkarni—know about the wildlife and habitats. I am trying to capture their expert knowledge in a structured approach of depicting wildlife-habitat relationships for the area. One part of that approach is to develop a classification system for the wildlife species.

For management purposes, plant and animal species can be categorized by their ecological functions in the forest ecosystem and their utility to humans. I have developed similar classification systems back home, and it helps focus management activities and objectives. Accordingly, several main categories of plant and wildlife species in the Satpura Hills can be identified as follows.

The first category is species with social value. This includes species used as products or for consumptive demands. With cessation of virtually all sport, subsistence, or commercial hunting throughout the country, many species that would have qualified for this category no longer apply. Currently, this category consists of those species used by local tribespeople who still retain such concessions or rights. Examples include fish, especially maliya, taken by tribes for food. Other examples are red and gray junglefowl, red and painted spurfowl, jungle bush quail, button quail, and freshwater white crabs and black crabs, all taken for food.

Another subcategory of species of social value are those with religious significance. The principle example is common langur, which is associated with the god Hanuman in the Hindu religion. Hanuman is the monkey-god of the epic *Ramayana* who brings success to military ventures.

Also, Gogate has identified several tree species, including *Ficus,* that play special roles in the worship of the indigenous peoples. Such species have what may be termed basic existence value. Another species used by locals for traditional rites includes the *Mahola* tree from which flowers are processed by local tribes for a special and potent brew. Society in general also is concerned about the overall existence of large, charismatic species such as tiger, leopard, and bison, which therefore also fall under this category of identifying species with existence value. Ultimately, all species have existence value, as no one species can be conserved in the long run in isolation of all others.

If all this sounds uniquely Indian, it is not. In our own forest management plans in the United States, there is equal room for identifying and providing for religious and philosophical values when managing for wildlife and their habitats. The religious significance of *Ficus* in the Satpura Hills of central India is no less authentic than the worship of forests and mountains by some of our own Native American tribes, or even the interest in the welfare of individual animals shown by animal rights activists. The difference is in how the eastern Indians view such values. Natural resource management in the United States has not provided well for such abstract forest values. There is much we can learn about the values and needs of the native citizens and other minorities and managing lands to meet those needs.

Another category of species with social value includes those that inflict damage or that compete with humans. These species include dangerous species, those causing crop depredation problems, and pest species. Examples include wild pig, tiger, leopard, and sloth bear. Although not a wildlife species per se, free-ranging cattle might be included in this category as a species that can greatly and adversely affect vegetation conditions, particularly by decreasing grass and forb cover and understory regeneration such as we observed in the buffer areas of the reserve. Such disturbance has important ramifications in providing for wildlife requiring such habitats.

A second major category includes species that serve major ecological functions. I classify these as ecological keystone species: those whose function in the ecosystem directly affects the presence and distribution of other wildlife species. Ecological keystone species can be categorized as pollination vectors, seed or spore dispersers, obligate commensals or symbionts, and key decomposers or transporters of nutrients and substances. All are major roles in the ecosystem and together determine the type and structure of the biotic community.

Pollination vectors include animals that facilitate pollination of plants which in turn are critical for supporting other wildlife species. Examples of keystone pollination vectors include rock bees and other bee species; some bats; and the sunbirds, specifically the purple sunbird and purple-rumped sunbird in the Satpura Hills region. The sunbirds pollinate *Erythrina* and *Bombax*, although these plants may also have other pollination vectors; *Woodfordia*; and numerous plants with tubular corollas that secrete nectar, which serves as food for other wildlife. Pollination vectors keep the forest ecosystem diverse and healthy by ensuring the continuation and genetic diversity of major plant species and the availability of plants and plant communities as habitats for other wildlife species.

Seed or spore dispersers include several wildlife species: the sloth bear, which disperses propagules of many fruiting shrubs and trees; jackal; civets, including in a minor role the small Indian civet, which is mostly insectivorous, and in a major role the palm civet, which is mostly frugivorous; ungulates, including sambar and barking deer; bats, especially flying fox; bonnet macaques; possibly common giant flying squirrel; three-striped palm squirrel and five-striped palm squirrel, which cache seeds; and gray hornbill and pied hornbill. Such seed or spore dispersers play vital roles in the forest ecosystem by ensuring well-distributed patterns of important plant species.

Obligate commensals or symbionts are species providing functions that other species depend on for their survival. In the jungles of central India are a number of interesting examples of such highly evolved relations. One example is that of symbiotic feeding. As common langurs and bonnet macaques feed on fruit in tree canopies, they drop branches to the forest floor below where the branches provide a reliable source of fruits and leaves for spotted deer, sambar, and barking deer. Barking deer, in particular, principally select fruit, as the deer are not grazers but browsers. This symbiosis of feeding behavior is an important ecological function that helps keep populations of associated species viable.

Another example of a symbiotic relation is when burrows created by one species are used by another, fossorial (underground-dwelling) species. Principally, hyena, wild dogs, and Indian rock pythons use burrows created by Indian porcupines. Burrows dug by black-tailed prairie dogs being used secondarily by the endangered black-footed ferret in the Great Basin Plateau of the Northern States are a North American equivalent. (As well, the black-footed ferret had value in early settlement days in the Western United States by keeping prairie dogs from expanding on grazing lands. Native Americans—particularly the Sioux, Blackfoot, Crow, Cheyenne, and Pawnee—used black-footed ferret hides for decoration, for signifying tribal and chieftain status, for sacred tobacco rituals, and for food. Thus, the species played multiple roles in its ecological community and in human societies.)

A related symbiotic relation we also see in North America is the use of tree cavities created by primary excavators and later occupied by other, secondary cavity-using species. In North America, the primary cavity excavators are the woodpeckers, with some excavation also being done by a few species of the smaller nuthatches and chickadees. Primary cavity excavators in the Satpura Hills include woodpeckers, barbets, and parakeets, which provide cavities required by such secondary cavity users as mynas, some small owls, and other parakeet species. Throughout India are some 166 species of cavity-nesting birds, including 35 primary cavity-excavating species. Some 25 mammal species also depend on tree cavities. One, the secretive binturong or bear-cat—neither a bear nor a cat, but a member of the civet family that resembles a wolverine found in wilderness areas of North America—depends on hollows at the broken-off tops of trees. In contrast, the mouse deer uses hollows at the base of the trunk.

Another major ecological role of wildlife species includes that of decomposer or transporter of nutrients and substances. These species play vital roles in maintaining the health of the forest ecosystem by decomposing organic substances and transporting quantities of organic material. These functions in turn provide nutrients and organic material to promote forest productivity. Examples of species in this category include termites, a key prey item for sloth bears; and dung-rolling beetles, the dung balls of which also are eaten by sloth bears. Examples of vertebrates in this category include carrion-feeders such as jackal, hyena, Indian white-backed vulture, and long-billed vulture.

Certainly, a major category for management concern must include species for which continued existence is threatened. Such species of viability concern constitute, unfortunately, a highly varied group, as many diverse factors can affect the viability of wildlife populations. To identify species for which viability could be at risk, we can use the following criteria. Viability risk species are those:

- With small and isolated populations.
- Highly dependent on particular habitat types or components, especially those scarce or declining.
- With threatened or endangered status, as from past legal hunting, illicit trade, or poaching.
- With a narrow geographic range, especially endemics (species found nowhere else).
- With low density, including species using large ranges.
- Having a low reproductive rate.
- Subject to intensive human exploitation.
- Probably extinct but might occur or could be reintroduced.

Examples of reptiles with potential viability problems in the Satpura Hills include mugger (freshwater crocodile) and Indian rock python. The Indian monitor lizard also qualifies, as it is killed for its medicinal value. Its essential habitat of large hollow trees is becoming scarce under intensive forest management. Most turtles, especially the Deccan softshell turtle, also are viability concerns, as they often are taken by villagers for food; they become vulnerable to such hunting when they concentrate in scarce aquatic habitats during the dry season.

Bird species probably suffering viability problems include stork-billed kingfisher, black woodpecker, Malabar whistling thrush (a migrant associated with moist-riparian conditions), most owls (except the more common spotted owlet) especially Blewitt's owl (also called the forest spotted owlet, which may be extinct), gray hornbill, and pied hornbill. Mammals of viability concern include wild dog (endangered), chinkera (in Bori), cheetal (in Melghat), Indian tiger, leopard, mouse deer, common giant flying squirrel, Indian fox, rattel (in Bori), possibly hyena, possibly otter (which is subject to endrine poisoning used in tribal fishing and to insecticides), four-horned antelope, Indian wolf (in Bori), Indian pangolin, and Indian giant squirrel. The lengths of these lists themselves should be cause for great concern.

To understand how these species use the various available habitats, we also have to know something about their occurrence across seasons of the year. This tropical world does not run on the four seasons of temperate ecosystems. Rather, seasons are ruled by presence or absence of water, mostly coming from monsoon rains and made available as free surface water in rivers, springs, seeps, and waterholes. The seasonality of rain and free surface water rules the loss and gain of the deciduous forest canopy and use of the forests by humans.

We can identify three main seasons in central (and most of the rest of) India: monsoon, winter, and summer. The monsoon season in the Satpura Hills region generally begins by about 7 June and is in full force by the end of the month and the beginning of July. During the monsoons, deciduous trees and shrubs are at full canopy, and grasses and fungi reach their maximum growth. Free water is common, and there are few or no fires.

Cattle grazing within forests decreases during the monsoons because water and grass are available outside the forests, although the livestock usually are kept out of cultivated areas. Wild boar are active, however, around the cultivation fields. Grazing is mostly restricted to lower parts of valleys and near riparian areas during this time. Thus, the structure of habitats and patterns of livestock grazing and its effects are markedly different during the monsoon rains than during the drier parts of the year.

There is little direct human disturbance and encroachment into the forests during the monsoon season. The exceptions are the weeding and replacement of tree casualties in plantations throughout the rainy season, and the gathering of white and black crabs by local villages from freshwater habitats during the late rains.

The major monsoons start in south India, travel north and northeast from the Arabian Sea, reach parts of India further north later in the season, and then recede the same way they came. Thus, the tropical forests in the south are the first and the last to feel the rains. Our central Indian forests are intermediate in this annual cycle.

Next comes the winter season, lasting from October to February. During winter, grasses remain green, although there is a decrease in the flow and availability of free water. Deciduous trees and shrubs generally are still at full canopy. There are no fires as much of the vegetation is still green.

Winter season sees the start of tourism but in very low numbers and with low impact on habitats. During winter, there are still some crops in the fields and some cattle grazing. Forestry activities begin by November; these include mainly forest stand surveys, bamboo harvest, and preparations for road repairs. Forestry laborers camp in the woods during this period.

Finally the summer season appears, reaching from March to June. During summer, grasses become dry. At the start of the summer season, even as early as February, vegetation changes slowly. Leaf loss occurs first with teak on dry sites with shallow soils, exposed areas, and plateaus and then works down slope. Water sources in summer become scattered and very scarce, remaining only in perennial springs and seeps and in natural and sizable depressions; large numbers of many wildlife species are attracted. That is also where the big cats and other predators lie in wait for their prey to succumb to thirst.

Cattle are grazed during summer, typically up to 3 to 4 kilometers from villages and inside the forests; this involves daily movements to and from villages across these distances. Human activity within forests is at a maximum. Forestry activities include tree felling, tree transport, and bamboo harvest. A sudden increase in human presence and activity often occurs within forests during the short season of bidi leaf collection. Bidi leaves are used as the rolling material for making small cigarettes, which is a major industry in the country. Bidi leaf collection is a prominent use of the forest during this time. The bidi leaf trees (*Diospyros melanoxylon*) are scattered and randomly distributed, drawing people throughout forest areas on their gathering expeditions.

A number of human activities have considerable effect on habitat conditions during summer. Fires are at a maximum during the summer season; the orange glows on distant ridges at night seen from our Melghat rest house was due testimony to this. Fires are started inadvertently or deliberately for various reasons, including during cattle grazing activities, during periods of collection of mahua (*Maduca latifolia*) flowers (full flowering occurs by about 3 April), and during bidi leaf collection. Tribespeople collecting the mahua flowers typically underburn in forest areas, but fires often escape and burn substantially larger areas than intended. Bidi leaf collectors illegally set fire to forest areas and often take entire bidi trees. This leads to good resprouting and rapid leaf growth for subsequent harvests.

During summer, people also begin (illegally) collecting gum (*Sterculia urens*) by injuring the trees and using fire to prepare the site for future gum sproutings. There also is illegal collection of antlers shed by ungulates for sale in the cities. Collectors start fires to clear the ground so they can more easily find the antlers, and sometimes the fires escape. People often make camp near the scarce waterholes and use cooking fires, which become another source of wildfires. Human presence at the waterholes also deters use by the larger wildlife.

Tourism is at a maximum during summer, but it is still a very minor activity compared with all other human activities. As well, trees may be felled and split, or climbed and smoked, to collect bee honey, but this is a relatively minor activity and impact on forest resources.

The very structure and composition of habitats here are heavily influenced by the types and intensities of human activities. It is clear that these and other human activities must be integrated into any system for predicting how plants and animals respond to management in core, buffer, and outside forest areas, and therefore for prescribing how such forests should be managed.

Integrating needs for livestock grazing, timber harvest, fuelwood, and the host of other forest products with needs for protecting habitat conditions for wildlife obviously is far from a trivial task. How does one maintain long-term productivity of lands used for cultivation? The ancient practice of shifting cultivation has been cited often as the desired approach, but recent increases in human populations have rendered this solution untenable. The practice of shifting cultivation still persists in some of the hilly and remote regions of India and, by some estimates, has been used for some 9000 years. In this practice, a forest is cleared, the woody debris is burned, and crop seeds are broadcast to raise one or two crops. Then the practice is shifted to another forest and the land is allowed to remain fallow for 20 to 30 years. Some tribal communities still practice shifting cultivation as an inherent facet of their identity and heritage. Lands are chosen for clearing by the village, and specific cultivation plots are then allocated to individual families, which gives them a sense of belonging and community. Lal suggests, however, that shifting cultivation causes declines in soil fertility and increases in erosion. The tidal wave of human population density is likely the culprit, causing some lands to remain fallow for only 2 or 3 years instead of the required 20 to 30. It is not shifting cultivation per se that causes loss of soil productivity, but rather the greater intensity in cultivation and decrease in the fallow period demanded by increasingly dense human habitation.

Further exploration today of the core areas of Melghat, and again fresh tiger sign. This spurs Vish to share several favorite tiger stories:

- It is not uncommon for a typical 270-kilogram male tiger to take a 900-kilogram gaur.
- In some parts of the country—such as here in Melghat and in Dudhwa National Park, which I will visit later—man-eaters have been known to attack people traveling on foot, on motorcycle, and even on elephant back. In one incident, a tiger chased two

Tom Darden (right front), V.B. ("Vish") Sawarkar (left front), and local forestry officials hiking tiger trails in Melghat Tiger Reserve, Satpura Hills, central India.

men on a motorcycle, grabbed and mauled the passenger while the rider sped off, and then chased, caught, and killed the rider.

- Man-eaters have been known to attack the local villagers, as in one incident here not long ago of an indigenous woman found in the brush, mauled, and half-eaten. The man-eater was never identified. It may be making one of the tracks we have been encountering and following.

Vish knows of my penchant for birds, especially owls, and thus shares with me the tale about David Hunt, an owl expert from the United Kingdom, who visited Dudhwa National Park a year ago. The ornithologist was on safari on elephant and dismounted to chase an owl a short distance into thicket cover. When he failed to return or respond to calls, his native guides went in and discovered a large tigress sitting on his mauled, dead body. They called the local forest officials who appeared with rifles and fired warning shots into the air, scaring the tigress off in the brush and out of sight. She never was identified.

Why some tigers or leopards turn to man-eating has been a perennial mystery in studies of the behavior of this species. Some have speculated it is because the cats become injured and unable to take their usual prey. Others have proffered that the young learn from their mothers who may have attacked a person once or may have adapted a more habitual attraction to man-eating for whatever reason. Regardless, the situation is very real and very deadly.

In the presence of a man-eater, forest officials warn villagers to always move in groups, never singly, and to make a loud noise when traveling through forest or low dense cover, so as to avoid suddenly confronting a tiger in hiding. It takes at least three attacks on humans, confirmed to have been made by the same animal, for an individual tiger to be declared a man-eater. Once declared, it can be shot by local forest officials, who are charged with both maintaining the declining tiger populations and protecting the people. Presence of a man-eater can serve a positive influence, however, by dissuading illegal taking of wood and encroachment into forests for illicit grazing of cattle and gathering of forest products.

Many local villagers at once fear and revere the largest of cats. In typical religious ceremonies, offerings of incense, coconut, and alcohol are made to the tigers, along with prayer to dissuade attacks. Claws, bits of fur, and whiskers are used as talismans in jewelry and charms. This immense respect certainly has survival value.

The most dangerous areas seem to be in the Sunderbans of the Bay of Bengal along the border of Bangladesh where tigers have evolved a semiaquatic lifestyle. It is believed that all Sunderbans tigers are potential man-eaters or at least should be

considered as such. Tigers there take their usual quarry of spotted deer and wild boar, but also fish and crabs. And humans. The cats are known to swim the creeks and lurk in thick bushes of the *Phoenix* palm to ambush the honey collectors. There, local fishermen paddle into densely reeded marshes and, with poor visibility, suddenly encounter cats at close range. The fishermen often stay overnight on the water in small, narrow dugouts. Tigers swim silently in the marshes, climb onto boats, and take the men. Each year they take a heavy toll of fishermen, honey gatherers, and other villagers. Such encounters occur commonly but are seen by the locals as a necessary risk in their lifestyle.

The Indian Forest Service tries to regulate the number of people allowed to enter the tiger-infested areas by issuing permits to fishermen and honey gatherers. Also, firecrackers are given to those entering the tiger areas, but they are hardly effective against quick and stealthy attacks.

Studies are being conducted under Project Tiger to learn more of the strange and unique estuarine habits of the Sunderbans tiger. In one experiment to dissuade their man-eating habits, humanlike manikins wired with high voltage were set adrift on boats. Electrical power is not always reliable in the area, and tigers were observed ripping the decoys to shreds during periods of power outages, serving only to reinforce their search image. Some decoys were wired to more reliable 12-volt car batteries and a step-up transformer to boost the power to a respectable 300 volts. Before initiation of the project, some 400 people had been killed in 10 years. After the project, only 9 per year were reported mauled, a substantial decline and a significantly lower injury rate than that from snake bites or road accidents. But in 1990, over 30 were to be reported killed by Sunderbans tigers. The reason for the apparent increase is not clear.

As to how tigers in the Sunderbans are able to thrive in semiaquatic estuarine conditions is unknown. One hypothesis is that they are not truly adapted to the brackish water conditions, and that the saline water they drink damages their liver. Holes of fresh water were dug to observe the tigers' reactions, but the cats rarely visited the waterholes. The local subspecies apparently has adapted physiologically to the saline conditions. If so, such an adaptation confers on the local race the status of a true ecotype, a locally adapted and genetically unique variation of the general species. Understanding the physiology of its adaptations might some day provide knowledge useful in helping humans to inhabit saline environments. Much remains to be learned of the Sunderbans phantom.

The lion, too, has been known to turn to man-eating as a predatory habit, in India[6] as well as Africa. The nearly extinct Asiatic lion is found in western India only in the Gir Forest in the State of Gujarat. There, human habitation has crept to the fringes of the Gir. According to one of the WII scientists studying the Gir lions, one-fourth to one-third of the lion population has wandered out of the boundaries of Gir Forest onto adjacent lands, especially to the south of the reserve along a peninsula of park land, where they have taken up permanent residence. There, they also have taken to man-eating. It is a serious and frightening problem for the local townspeople. As with the tigers, the question is how to dispose of the man-eaters to ensure greater safety for the local people, while not putting the threatened lion population in greater jeopardy. To better understand the situation, I had recommended that this small satellite population of lions be studied to determine if and how frequently its breeding recruitment actually contributes to the viability of the main Gir population. If it contributes little, if anything, to the main population, then it may be possible to trap the aberrant cats and transport them to controlled, captive breeding situations dispersed among several zoos. (Locating them to several different zoos would help avoid excessive

[6] Seberwal, Vincent. 1990. Lion-human conflict around Gir. Wildlife Institute of India Newsletter. 5(3):28-30

inbreeding and loss of the captive stock from any single catastrophe, such as outbreak of disease.) Any zoo adequately equipped would be delighted to receive such a rarity.

But the problem would remain. The vacated area likely would become quickly recolonized by other subadult males wandering from their parent prides. In time, contact with humans again would become inevitable. Perhaps a long-term solution is to develop a buffer for the park area, encompassing this arm of the population, within which human habitation is precluded. As long as intensively cultivated and developed land adjoins the wilderness of Gir, there will be potential conflicts. And disasters.

I am spending time these several days with an enterprising fellow by the name of S.L. Debral, conservator of forests, from Nagpur. Debral is developing a vegetation classification system and a series of maps of the Satpura Hills from Indian satellite imagery data. An old friend and classmate of Vish's, Debral correctly sees the future of his venture as an integral link to our Wildlife in Managed Forests project. He is very much up on current technologies of satellite image analysis and computerized geographic information systems. More than that, he fully recognizes the need for integrating timber, wildlife habitat, and human resources into his mapping information base and land use classifications. Debral and I met each other one morning on the cliffs above the Sipna River at Kolkaz. We discussed the future of the project and of India's immense human population, while watching the sun rise over the dry hills and dissipate the mists from the river below, and as local tribespeople made their daily pilgrimage from their villages to fill water vessels, wash clothes, and bathe in the still pools.

Evening: We drive out into the forest with the intention of spending part of the night in one of the wildlife hides near an isolated waterhole. As we slowly approach the hide from the trail, we encounter half a dozen gaur already scattered near the entrance. Can't access it. We wait half an hour, but they just mill about, the huge bulls stamping and snorting. So we decide to approach the hide from behind, over the back of the hill along a small game trail. As we follow the contour, through the dense brush in an adjacent field, we hear the stomping of heavy footfalls and the crunch of grass. We freeze and wait and the sound continues. Eventually, the two local guides with us stalk back around the way we approached and walk down the road for a clearer view. More gaur, they signal, and at close range. Time for great caution.

We continue to the hide, keeping as silent as possible. A charge by a bull in tight quarters would be exciting but hardly desirable. Moving slowly, we drop down onto the top of the hide from upslope, the other gaur below warily eying our approach. Vish and the others depart in the increasing darkness, leaving Tom and me with a local forest guard who speaks no English. Before he leaves, Vish tells us the guard will help keep an eye open for tigers while we wait in the hide. Preoccupied then with getting past the gaur, I now have time alone in the darkness to ponder what the unarmed guard was going to do if a tiger suddenly did appear.

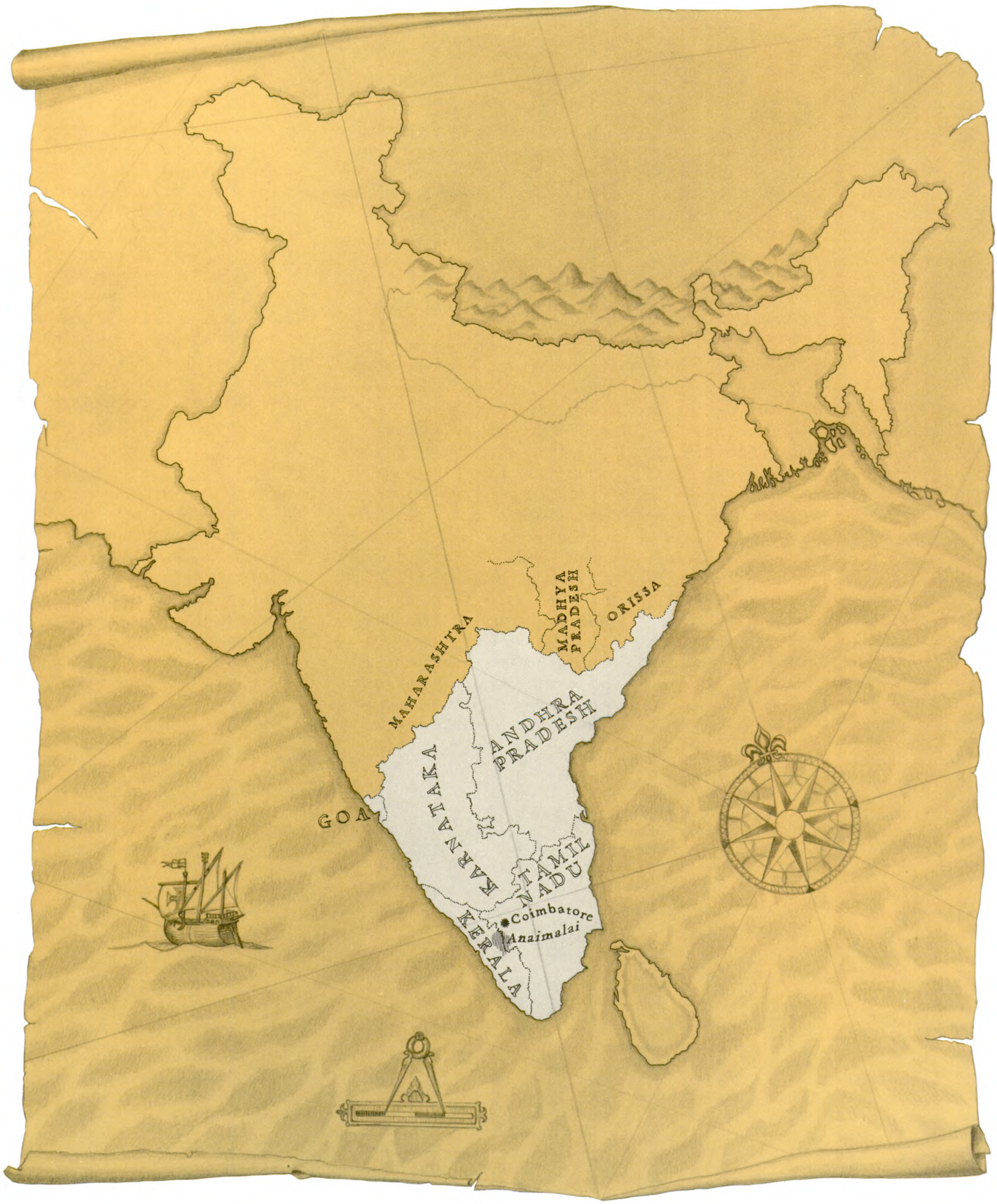
The hide is a concrete bunker dug halfway into the side of the hill. We squeeze down the square opening on the top after first checking inside with flashlights for rats and scorpions. From within, we can see the water hole and the bison below through the narrow windows. The entrance above, however, is blocked by neither bars nor a cover, an unfortunate and dangerous oversight in

the construction design. If a tiger were to slip into the hide with us, we would be caught in an instant death trap. And the waterhole is likely to be a familiar hunting area for the big cats. So after a time, and with the limited visibility from within the structure, Tom and I silently climb back onto the roof of the hide and observe the bison herd from there. As long as we stay quiet and still, it is no more risky than being trapped in the cave below.

The bison finally wander off and another herd slowly approaches. The light of the quarter moon filters through the leafless forest canopy, and by its dim illumination we count at least 15 gaur in the first herd and at least 12 in this second. As I move to attach the flash to my camera, a bull either hears or catches sight of my movement, and snorts, stomps, and bellows a weird long howling wail. The herd jumps back a few steps and stands facing our way. For a long time, we all sit perfectly still, and I can hear only a nightjar and scops owl calling far off. The thought enters my mind, what if they were spooked by something else behind us?

Back home, researchers seldom have to be concerned with dangerous wildlife in the course of our work, never mind being caught in a squeeze play between two aggressive species. For good or bad, the American culture has evolved to be utterly intolerant of any dangerous interaction between people and wildlife. When every few years a grizzly bear attacks a hiker in some of the remote parks or forests of the West, we respond by eliminating the animal. True, India has had a colorful history of paid hunters of man-eating tigers and leopards, such as the remarkable tales of Jim Corbett, probably the most famous of the *shikiris*. Still, such Government-commissioned hunts were specifically aimed at animals habituated on attacking humans, not those engaged in isolated kills. To manage wildlife, to successfully provide for long-term viability of top carnivores, society must accept that humans cannot always travel or live risk-free in the species' habitats. For management, it is a matter of changing cultural perceptions and principles to accept other life forms as valid and legitimate heirs to the forests. If environmental stewardship means that we are merely renting the land from our grandchildren, who in turn are renting it from theirs, this new attitude of respect and provision must equally apply to all tenants of the land. Again, I suspect we have much to learn from some of the Indian examples.

After much time we finally hear the lurch of the elephantine Land Rover and a horn blaring out on the road behind the hill. Shaking the hand of our forest guard "protector," we hike out the way we came, uphill, leaving the bison herd to their drinking and feeding below in the dark.



South India:

Tropical Forests of the Western Ghats

5 April

The sad day has come to leave our haven in Melghat Tiger Reserve. My room bill at the Kolkaz rest house for 4 days, three meals a day with coffee delivered to my room in the morning and tea in the evening, is Rs 210, about US$12.

Before we leave, we receive word from the forest guard that the large cat we saw dash across the road the other night was indeed a tiger, identified positively by its pug marks. Vish again expresses concern for the villagers, although apparently there has not been a recent problem of attacks on people or livestock in the area. It is best to be aware and prepared, says Vish, and he instructs the guard to have the villagers stay on alert and round up their livestock after dark.

For our departure, our new friend Gogate provides his Ambassador, replete with window curtains and uniformed driver. On our way out, down the long curvy route through the Satpuras, we stop at his house at Paratwada for coffee and a large breakfast spread of *paho*, mashed rice and peanuts, and *thai*, a yogurt curd. Joining us is a locally famous wildlife author, Shri Chitampalli, who has won awards for his popular books on birds of Maharashtra State. In a thick Marathi accent, he tells me about another book of his on "jungle craft," which I first interpret as the use of forest materials for producing baskets and handicrafts. A little further into the conversation, I discover that "jungle craft" refers to the reading of wildlife signs in the jungle, such as pug marks, droppings, and browse. His heavy accent does not conceal his enthusiasm for the subject. I urge him to translate his writings from Marathi to English so that interested professionals such as myself can enjoy them as well.

Taxi back to Nagpur. En route, Vish points out the curve in the highway where, during the previous visit in February by our American colleagues, their taxi trip along this same route abruptly ended because the car's fan pulley fractured. We pause for a Limca, a lemon-lime soda that seems to have the corner on the national market, in the same little roadside village where our friends had previously gotten stranded.

As for our visit, I find that when I am not with Tom, who sports curly brown hair and blue eyes, I can blend into the street crowds with little difficulty. My Mediterranean heritage, dark hair and beard and brown eyes, does not offer as obvious a contrast. I tell Vish that, before we return to Delhi where we will greet my wife at the airport, I want to don local dress, including a turban. He concurs that I probably could pass as a bearded Sikh. Would Carrie be surprised to see that I've converted!

Lunch in Nagpur, excellent and spicy mutton, *rogan josh*. Then to the Nagpur airport for the start of our journey south. First stop for the evening is Bombay. On our approach, Vish finds great humor when our female flight attendant advises us in halting English to "please return yours to an upright position." We taxi to a local hotel and toast our journey in the "permit room" (bar).

6 April

Early morning in Bombay, and we grab a shuttle to the domestic airport terminal. Check-in at Indian airports often entails as many as half a dozen examination points beginning with entrance to the terminal itself; you must present a current, valid airplane ticket to even enter. Other check points include metal detectors, baggage searches, and personal body searches. More than once they have inspected the back of my belt buckle, felt the toes and heels of my hiking boots, and felt along the seams of my carry-on baggage. This is sensible, and I don't mind the tight security, for daily papers are filled with front-page headlines on terrorist violence in Jammu and Kashmir to the north, Punjab to the northwest, Nepal to the northeast, and Assam to the far east. Also, several days later we were to read about a terrorist's bomb that exploded in a passenger train in Bombay just hours after we left, killing several people and wounding many more. A similar incident also was to occur in Delhi during our visit.

In fact, during one of our shopping outings in Delhi as we prepared to descend into the underground bazaar shops, a "bomb squad" van quietly drove up and, without a word, several uniformed police wielding bomb detecting devices marched down the stairs to the shops. No one else seemed concerned, as if this occurred daily. Tom and I looked at each other and, given all the other wild events of our journey, we laughed and simply accepted yet another strange incident. We followed them into the shops, and I was most concerned when I lost track of which shop they had entered. Luckily, our shopping visit ended without a bang.

The morning flight takes us south over the long string of steep mountains bordering the edge of the country, to the city of Coimbatore in

Tamil Nadu State, just a few hundred kilometers from the very southern tip of India. Hot and humid ("just sultry," as Vish describes it). A mob scene for the luggage, but Tom and I have at least half a foot height advantage over the average citizen and are able to quickly spot and retrieve our bags.

Taxi to Hotel Suryo in Coimbatore: rooms with A/C, a restaurant, all the conveniences. We make arrangements for a room for our return trip in a week or so and move on for now.

House crow (Corvus splendens), *Coimbature, south India. A familiar bird of towns and villages. The four races are told by the paleness of the gray collar, the darkest individuals occurring as far east as Burma (Myanmar).*

The local language is Tamil, with some English also spoken. The Hindi I had labored to grasp and the few words of Marathi are worthless here. In fact, the south Indians somewhat resent Hindi being spoken, as the Hindi northerners historically forced their cultural influence on the south. The prevalent language or culture of the north is Hindi, which has no relation to the Hindu religion.

Some 83 percent of Indians are Hindu, followed by Muslim (11 percent), Sikh and Christian (2 percent each), and Buddhist, Jains, and others (the remaining 2 percent). But even the Hindus are a disparate and intriguingly diverse lot, as nearly each temple is designed for devotion of a different god, and in Hinduism there are droves. I would like to see a study summarizing the species of trees and animals that the various religions and Hindu sects have revered over the centuries. Such an orientation might help identify focal management species in various forests of the country. For example, the reverence of *Ficus* trees, langur monkeys, and other life forms by the Hindus might aid in setting local priorities for species management and provide an entrance point in public education of people of that faith about the value of forest conservation.

Afternoon, we push south from Coimbatore (locally pronounced something like "Comb-ture", as Tamil Nadu seems to be pronounced "Taminad"). Hot plains of red soil, crop fields of sugar cane, and large expanses of coconut palm plantations. As with central and northern India, all land outside the formally designated parks and forest reserves seems to have been converted to food production. Although India feeds itself adequately, it leaves little land for native forests, grasslands, and other wild habitats. With the human population exploding in spite of Government programs to curb the growth, in another decade or two even the food surpluses from the vast arable land base may not be enough, and the remaining wild areas will be in even greater jeopardy.

It was Malthus who warned so long ago that populations grow exponentially (multiplying numbers every generation) whereas food production can grow only arithmetically (only adding numbers). Even with advances in agriculture, including the fertilization and irrigation that Malthus did not foresee, there must come a time when the capacity of the land is outstripped by needs and demands for its products. We see this simple principle in action with the demand for, and loss of, down wood for fuel. Lal had tabulated that in the rural household sector, over 68 percent of energy used is in the

form of fuelwood. Although it fares poorly in thermal efficiency when compared with charcoal, kerosene, or propane gas, fuelwood is the most heavily used because it is either free or a relatively cheap commodity. Fuelwood also is easily gathered by individuals and, except for the cities, does not need a distribution system. And its depletion from the land has been accelerating in all years it has been tracked since the middle of the 20th century. In 1975-76, for example, the total consumption of fuelwood from all Indian forests was estimated at 133.1 million metric tons, whereas the recorded production was a paltry 19.0 million tons. And the gap is widening. The total quantity of wood cut in excess of the silviculturally permissible limit has totaled a staggering 3244.5 million cubic meters from 1953 to 1987.

Lal proposes that solutions must include pricing fuelwood at a market price equivalent to other energy sources. He also feels that the answer is not a spiraling increase in growth of available fuelwood, because it could never meet demand. Instead, the answer lies in developing and promoting better ways of using fuelwood, such as using more efficient stoves in place of stone and cement hearths, which could reduce demand by nearly a third. Even that seems to be a short-lived technological solution to the ultimate source of the problem: too high a population density on a finite land base.

The Government's population control program seems mostly voluntary at this time. Unlike China's program, there are no tax incentives for smaller families or financial penalties for large ones. And India's remarkably diverse set of cultures and religions poses special problems. One culture, such as the Hindus, might agree to the family planning, but another, such as the Muslims, might declare that it is against their religious beliefs, and decline to comply. This, the Hindus then might claim, is unfair and inequitable treatment of their kind, for over time they will be outnumbered. So they too fail to comply.

Just as bad a quandary is the effect on the land from the vast numbers of cattle that roam the hills and plains and towns. The cow is revered, which means it is not directly slaughtered and is not used as a food source or for leather. Indeed, to enter Hindu temples, Tom and I were requested to remove articles made of cow hide. The ungulates roam free to graze in grass fields, along roadsides, in towns, and in the forests. The beasts are common property, which means in open range they generally belong to no one. Thus, no one controls their numbers or behaviors. One often sees animals starving or dying in the city streets, as it is against religious code and civil law to put them out of their misery.

Grazing lands in India are not established by management decree but rather by traditional use patterns. Despite calls for control of grazing in forest lands in the 1952 National Forest Policy, and even as long ago as the Government of India's 1893 agricultural assessment, there is no national grazing policy or set of guidelines except for short-lived or outdated grazing fee standards set in several of the states.

Our drive south takes us into small villages. We stop at one town in the tropical heat for refreshment. From a typical open-air food vendor, Vish and Tom buy us freshly cut coconuts, which provide excellent drink. When the liquid is gone, the vendor slices the giant seed in two, and we scoop out and eat the moist, chewy white meat lining the seed cavity. Doesn't taste at all like the strong, dried coconut back home used for confections and cooking.

Meanwhile, I engage in a little conversation with a young man, who, through our driver-translator, asks where I am from. Apparently the only English word he knows is

"*Amrika*!" I worry that the United States has the unfortunate reputation of being the land of dreams. So many other people I have talked with on this journey expressed a great desire to someday visit America, with the expectation of finding a land of wealth and many material goods. I suppose much of that image is true, as I look at the expensive camera gear, high-tech hiking boots, and state-of-the-art travel packs and camping gear I am sporting. Even the simple light-weight flashlight I carry has been the focus of interest. There is no way I can convey to this young man my sense that India has so much to offer as well, especially its determination and success at self-sufficiently determining its own fate, its independence from oil cartels, its ability to feed itself, its forward-thinking programs at least attempting population control, and its acute desires for forest conservation with a moratorium on clear-felling and cessation of sport and commercial hunting. These are remarkable and bold programs, ones I doubt the United States could achieve without dire social dissidence. But standing here in this south Indian heat, swatting flies, in the dried mud of this narrow street, Nikon camera bag slung over my shoulder, even if I spoke the language how could I be convincing to this fellow who just wants to look for the first time through a pair of binoculars?

Back on the road, driving south to the rest house at the crest of the Western Ghats in the threatened tropical forests of south India. Rising like green monoliths, the abrupt slopes of the mountains creep closer. In the jostle and heat of the long drive, Vish and Tom nod off, leaving the driver and me to the afternoon sights. Traveling with us on this taxi ride is a friend of the driver's who also falls asleep. Seems that no matter what taxi you rent, or which driver you retain, invariably at least one other person will climb into the vehicle when you're ready to depart. Vish never questions it, but I can't tell if they are additional passengers, friends of the driver along for the company, freeloaders getting a gratis ride, or, especially in the middle of the night, someone threatening our personal safety. But that's how it all seems to be done here. In the front seat, for this ride of several hours, Vish is crushed to his door by the two men but declines to join Tom and me in the back where it would also be jammed.

Most of the occasional road signs in south India are in Tamil or other local languages, but even some of the English ones take a little interpretation: "Petrol Bunk 7 KM" (gas station) and "Speed Breakers Ahead" (speed bumps).

After a time, I carefully watch in the rear view mirror the driver's eyelids dancing, and soon his head begins nodding. My God, after all this traveling, I'm not going to let it end in a ditch or with the kiss of an oncoming public carrier truck! I grab his shoulder and say with a start, "How're you doing up there?! All right? You're not nodding off on us now, are you?!" His head springs back up as the others awake, and

with a sheepish smile he mumbles something in Tamil. For the rest of the trip we stay on the road, and in the mirror he watches me watch him.

It is commonplace for drivers to not stop at the scene of an accident. On a previous visit, my colleagues Richard Holthausen and Wini Kessler witnessed a young boy on a bicycle being hit by a truck on a crowded, rushing highway. The boy probably died on the spot, but the Indian guides refused to stop to administer aid. My friends urged them to at least stop at the nearest hospital or town to call in for medical assistance, but they drove on, explaining that "someone probably has already called." As I learn, those who report such accidents frequently are brought into the police stations for endless questioning, are tied up in the legal aspects of the case, and often are even implicated in the incident.

Finally, a slow, long ascent of a thousand meters into the high country of the Western Ghats on switchback roads climbing the steep eastern face. The southern plains drop below into haze as we enter a zone of thorn *Acacia* scrub woodland, then into the extensive moist deciduous forests of the mid and high elevations.

By early dusk we pass several small settlements and take the final turn up a high grassy knoll to Anamalais Wildlife Sanctuary and to the rest house on top. The British logged this hillside long ago, sliding the large old tropical trees down the slopes, thus imparting the name Top Slip. We pay the driver, and we both smile and shake hands as I admonish him, "Stay awake on your drive home, now!"

We are delighted to be greeted at the house by Mr. Mukherjee, our friend and an assistant director from WII, who has traveled far south to spend this part of our journey with us. This being his first visit to these hills as well makes our joint adventure all the more special.

Top Slip rest house is to be our domicile for the next week or so as we explore the tropical forests, parks, and wildlife of south India. It is a bit more rustic than our Kolkaz estate but has overhead fans in every room, which will offer relief from the night's heat should the electricity actually function. We drop our gear and I go exploring before darkness falls. To the north and far below I can see the vast rust-colored plain country of the southern lowlands and the hazy lights of a few distant and small towns starting to wink on. To the east, the enormous scarps and high sheer cliffs of the Ghats front range, ideal roosting or nesting sites for falcons. Behind us to the west, under the gathering salmon clouds in higher elevations, the overlapping ridges of dense canopies of the tropical moist deciduous forests. Directly below our knoll, the warm yellow glow from several buildings housing the small visitors' center and a few of the staff. Top Slip is actually a small community of local villagers and forest officers who work in this, the Ulandi Range of the Western Ghats.

A last flurry of diurnal wildlife before the day's end. Through binoculars and with sharp eyes, Tom spots several forms moving slowly on the distant, high grassy slopes. Nilgiri tahr, Vish announces, a shaggy, dark-haired goat of the southern high country and an endangered species. We count 16 from here.

Red-whiskered bulbuls perch momentarily in the scattered, large-crowned trees on the wide rise below the house. We also spot green bee-eaters, an Indian treepie in the

tree canopy, and a large green barbet darting into a branch cavity, and we hear the incessant tooting of another species of barbet, the coppersmith or crimson-breasted barbet. Suddenly there is a conspicuous whoosh of wings and a magnificent great pied hornbill, larger than a vulture, flies low overhead, the flash of black and yellow under the wings and the long hollow horn ("casque") on the upper bill unmistakable. A few slow, massive wingbeats and it disappears over the ridge.

Another late-night dinner of rice *chappati, dhal*, vegetables, and pepper soup. Our dark-skinned cook, N.K. Balan (not to be confused with our northern cook Baban), wears the usual south Indian *longhi*, a sheetlike wrap men wear around the waist, bare-chested. His assistant, N.B. Sudhesan, is a friendly young man, tall and thin, who seems to know most of the birds in the area. Indeed, he is a local villager who hires out his services as a wildlife guide. He had earned a degree as a civil engineer and worked in that field for a short time. But he realized he was not happy building bridges and roads and dams, so he abandoned that career to return to his Tamil Nadu high country to work in the Government rest house and offer jungle treks to the visitors.

Old-growth hardwood tree in wet evergreen forest, Kerela, south India. This extremely knowledgeable wildlife ecotour guide, N.B. Sudhesan, has returned to live with his village and the forests of his childhood, after abandoning a degree and career in civil engineering.

Late at night we bring the wicker chairs onto the front grass to sip tea in the warm dark. The evening is "just sultry," here, well below the Tropic of Cancer and close to the Equator. We hear the two-part trilled whistle of a southern scops owl over the night insects, and the *click-click-click* of house geckos in the building's walls behind us. A common Indian nightjar buzzes its call somewhere over the fields and forest canopy below.

7 April

Morning at Top Slip, the mists of dawn rising from the moist deciduous forests below. I hear a bizarre call in the bushes of rising single whistles followed by a maniacal three-note series increasing in pitch and tempo. Brain-fever bird, it is named, because its song sounds demented and because its three-syllable series sounds like it is repeating "brain fever! brain fever! brain fever!..." over and over, ever faster and higher. The species is also called the hawk-cuckoo, as it is a member of the cuckoo family but bears a strong resemblance to a small woodland hawk, with a long brown barred tail and a curved raptorlike beak. Seldom seen and rarely photographed, brain-fever birds often are heard calling in the midday heat when all else is silent or well after dark when other diurnal species have had the good sense to go to roost.

Nilgiri langur (Presbytis johni). *This endangered primate is endemic to the Western Ghats of south India. Their most used habitats are* sholas *or dense wet evergreen forests. Heavy persecution has greatly reduced their numbers, as they are sought after for their fur and for the supposed medicinal value of their blood, flesh, and organs. They are highly wary, difficult to approach, and seldom photographed.*

In the trees by the house, as around these south Indian forests, appear a troop of Nilgiri langurs, an endangered species of monkey endemic to these parts. A beautiful specimen, the Nilgiri langur is jet black with a long thin tail twice its body length. The tail is not prehensile as in New World monkeys, but it is used for balance during grand leaps of 20 feet or more between tree crowns. The black face is ringed in a silver white, rendering the primate one of the most beautiful in the country. I take a number of photographs of a female with young and of others in the group leaping spread-eagle among the branches. Throughout the day, their calls of *hoo-hoo-hoo-hoo-hoo* can be heard from many forest canopies a long ways off.

The nilgiri langur occurs only in South India and inhabits *sholas* of dense evergreen forests. Its endangered status has resulted from large-scale loss of its forest habitat and from constant persecution. They have been hunted more extensively than any other Indian primate for their beautiful fur and for the supposed medicinal value of their flesh, blood, and organs. Thus, they have become quite wary and most unapproachable. With loss and fragmentation of their forest cover, they must resort to scampering across open ground, as I observed them do. When typically hunted with dogs, they become most vulnerable to capture.

Wildlife this morning at Top Slip is exceptional. As I watch the langurs, two wild boar appear from the forest and dash along the grassy edge no more than 20 feet from me before darting back into the thickets. Boars can be quite vicious, but they show no awareness of my presence. While all this is occurring, several herds each of 10 to 15 cheetal (spotted deer) appear just downslope on the knoll and slowly wander up toward the house. Cheetal are the most attractive of deer with both sexes retaining a coat of deep cinnamon and a profusion of bright white marks. Several bucks with wide racks direct the herds onto the grass slopes just below our porch.

We are in Anamalais Wildlife Sanctuary, recently conamed the Indira Gandhi Wildlife Sanctuary, along the Pollachi River in the south of India and situated just 10°12′ north of the equator. Rainfall varies according to aspect and topography,

Nilgiri langurs are remarkably agile and acrobatic denizens of tree canopies of tropical wet evergreen forests of south India.

up to an astounding 5000 mm—that's up to 5 meters, or over 16 feet—per year. The sanctuary harbors some 800 of the 2,000 species of plants found throughout India, distributed among the sanctuary's 958 square kilometers and its montane wet temperate forests, wet and semievergreen forests, thorn scrub jungles, and other habitats at elevations of 350 to 2400 meters (nearly 8,000 feet). Some of the older preserved forests still contain a few trees of rosewood and teak several hundred—perhaps up to 600—years old.

After we scoop up a quick Indian breakfast, our local driver appears with a field vehicle to take us for the day across the State border into Kerala to the small settlement of Thunavadaun, some 12 kilometers away on semipaved single-lane roads, where we meet with the local forest officers. Then, on to Parambikulum Wildlife Sanctuary in Kerala state, where we meet with Mr. Verghese, the sanctuary's wildlife warden.

Verghese takes us on a four-wheel-drive and hiking tour into parts of his sanctuary, which spans some 89 square kilometers and was established only in 1985. The boundaries of the sanctuary have captured many teak forest plantations originally developed decades ago, and tended silviculturally until the recent

Cheetal or spotted deer (Axis axis). *Cheetal are found throughout Indian forests near water and forage. Always sporting a rufous pelage with white spots, they are one of the most beautiful of all the ungulates and are commonly the staple diet of tigers. They are often heard at night within forests giving barking alarm calls in response to hunting forays of the big cats.*

establishment of the park, for the purpose of intensive timber production. But now the plantations are allocated to forest preservation.

He shows us several older teak plantations that have been untouched for some time and are slowly being converted back to "natural" conditions of the moist deciduous forest type. His prescription for restoring the forest is to remove about 20 percent of the standing trees on each 10-year silvicultural entry. This large-scale restoration project is nearly unprecedented in the country, at least in the south, and marks an important turning point for the nation to declare its intention to conserve, salvage, and even restore its forested ecological resources.

The restoration project is proceeding, however, as much on assumption and hope as it is on good intention. There are really no truly natural (that is, untouched) forests existing with which to compare community structures. Moreover, the development of this forest under the restoration project is not being monitored scientifically. Thus, what appears to be a return of a lush undergrowth and a dense tree canopy might be the flush of substantially fewer native plant species than otherwise occur in a

Diverse profile of a wet evergreen forest, Tamil Nadu, south India. Wet evergreen forests have been largely converted to teak and other forest plantations and have been reduced to small, isolated patches. Some of the patches are now protected in newly formed wildlife reserves and parks. They hold a vast array of endemic and highly endangered wildlife, including hornbills, eagles, and lorises.

less disturbed moist deciduous forest. Worse, it could signify the flush of undesirable or weedy species. But I hardly can criticize this well-intentioned and much-needed project. I hope it serves as a model from which to institute other similar forest restoration projects.

As a case study, a more detailed description of the stand helps reveal its value as a baseline for monitoring change in forest structure and composition. The plot was established in the 1930s and covers 5 hectares. The stand does not represent a perfectly undisturbed forest, because some selection felling was done over 50 years ago. Then in 1981, a few large overstory teak trees were removed. This resulted in large gaps in the overstory canopy, some felling damage to understory trees and shrubs, and creation of roller cutting and hauling tracks. The stand has not been subjected to grazing, pole or firewood cutting, or fire at least since 1987.

W.A. Rodgers, V.B. Mathur, and Vish Sawarkar studied the stand in February 1988.[7] They measured forest structure, species composition, tree diameter distributions, and woody species regeneration. They reported that the rather open stand consists of two tree layers. Seven tree species reached the overstory canopy up to 40 meters high, and an additional 14 species were found in the lower layer from 10 to 25 meters high. The stand overstory is dominated by teak and *Lagerstroemia lanceolata* with an understory of mostly *Randia dumetorum* and *Wrightia tinctoria*. The shrubs, up to 3 meters high, are almost all *Glycosmis pentaphylla*. A third of the overstory teak trees measured over 3 meters in girth and the largest was 5.4 meters.

Several pieces of evidence from this study suggested that the stand is not in a static state. No overstory tree species occur in the stand as pole-size individuals; that is, there has been virtually no teak replacement in the canopy for at least 40 years. Thus, the stand likely will change in overstory tree species composition as the current understory grows to complement or replace the overstory. Some tree species, such as *Actinodaphne* and *Cinnamomum* that indicate development of a semievergreen community, were not seen as seedlings in the stand. The stand, then, is not in a state of climax equilibrium, but is likely to undergo substantial changes in structure and composition, even if it is left unmanaged.

This case study raises the question, asked by the above researchers, as to how "natural" evergreen and semievergreen forests can be restored from teak plantations. Can management depend on natural development of a moist deciduous teak forest into evergreen conditions by natural regeneration, or must there be some level of artificial planting? The authors noted that the preservation plot does not provide an optimistic picture for natural restoration, but this may be atypical. Much more needs to be learned of

[7] Rodgers, W.A.; Mathur, V.B.; Sawarkar, V.B. March 1988. Report on status of Parambikulma Preservation Plot. Unpublished report. On file with: Wildlife Institute of India, Dehra Dun.

Diverse sal (Shoria robusta) *forests of Dudhwa National Park, northern India.*

Typical terai (*marshland) habitat along the foot of the Himalayas in Dudhwa National Park and Tiger Reserve, northern India bordering Nepal. Large, sluggish rivers and broad lakes or tals characterize these threatened terai habitats, home to many endangered and endemic wildlife species.*

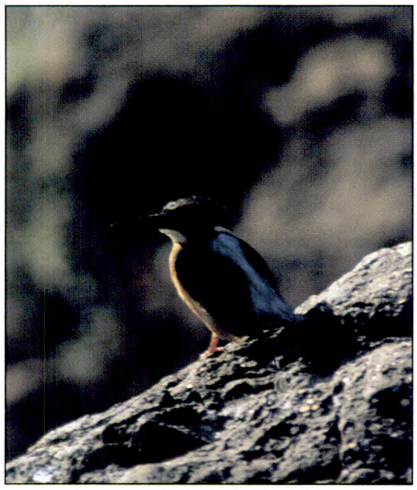
Blossom-headed parakeet (Psittacula cyanocephala) *pair. The male's face is scarlet with a violet to green head (top), whereas the female's entire head is plum-colored bordered by a yellow collar (bottom). Several pairs might nest in neighboring trees in a loose colony in self-excavated cavities.*

Common giant flying squirrel (Petaurista petaurista) *emerging from a cavity in a live tree in Melghat Tiger Reserve, Satpura Hills, central India. Seldom photographed and poorly known, this large squirrel is strictly nocturnal and can glide up to 100 yards.*

Sarus crane (Grus antigone), *Dudhwa National Park, northern India. Sarus Cranes stand over 1.5 meters tall. Here, a red-crowned male in breeding plumage is performing the leaping display described by Ali (1979:37) as consisting of "ludicrous and spectacular dancing displays, bowing mutually, prancing with outspread wings and leaping round each other." The orange-crowned female seems to be ignoring him for the moment.*

Dry deciduous forest, Satpura Hills, central India, in dry (leaf-off) season when water is at a premium and fire dangers are at the maximum.

White-breasted kingfisher (Halcyon smyrnensis) *is a resident of riparian forests throughout India.*



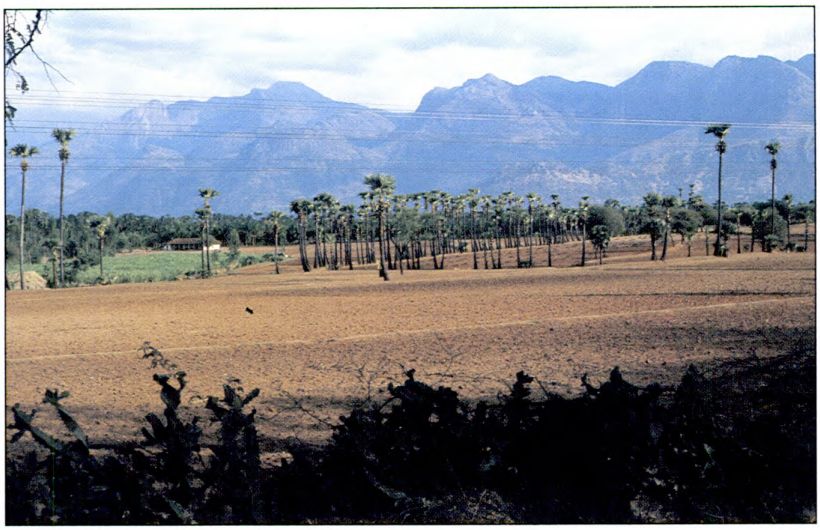
Small blue or common kingfisher (Alcedo atthis) *occurs along streams, swamps, mangroves, and ponds.*

A rare wet evergreen riparian (riverside) forest of Parambikulum Forest Reserve, Kerela, south India.

Moist deciduous forest of the Western Ghats mountains of Tamil Nadu, south India. S. Mukhergee of the Wildlife Institute of India (left) discusses forest management alternatives with a local forestry official.

Tickell's blue flycatcher (Muscicapa tickelliae) *is found in moist deciduous or evergreen forests and often frequents shady glades and riparian bamboo thickets.*

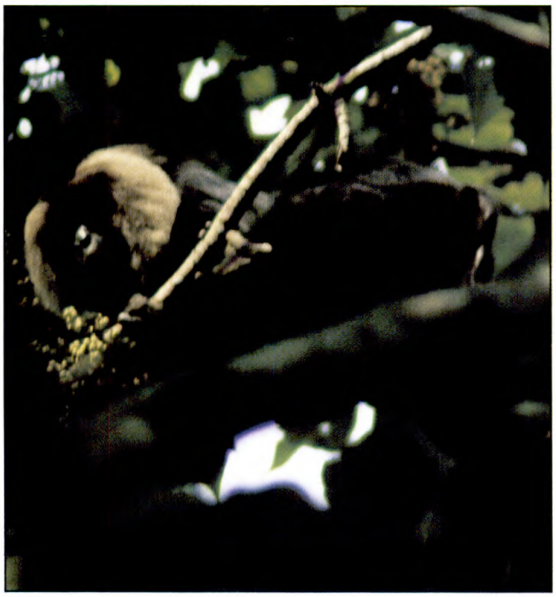
Rose-ringed parakeet (Psittacula krameri) *occurs in moist and dry deciduous forests. Like other parakeets and parrots of India, this species feeds mostly on fruit and seeds and nests in tree cavities occurring naturally or created by themselves.*



Landscape of the south: the Western Ghats mountains rising precipitously over lowland coconut palm plantations. Much of the lowland rainforests of south India have been cleared for cultivation, often resulting in red, sometimes laterized soils leached clean of nutrients.

Lesser golden-backed woodpecker (Dinopium benghalense). *Found in dry and moist forests in mango topes, groves of ancient trees, and coconut plantations.*

Rufous-backed shrike (Lanius schach), *a denizen of lightly wooded and scrub country. Also called "butcher birds," shrikes often maintain a larder of surplus insects and small vertebrates by impaling them on thorns.*



Lion-tailed macaque (Macaca silenus). *This highly endangered primate is endemic to the wet evergreen forests of the Western Ghats in south India and is rarely photographed. The males' silvery mane projects a striking appearance.*

Old-growth wet evergreen forest, Kerela, south India. The true original rain forests of the Western Ghats highlands, wet evergreen forests now occur as fragments amidst moist deciduous forest plantations and human habitations.

Indian robin (Saxicoloides fulicata), *a bird of arid, semi-desert country near cultivations and habitations. The male pictured here is the brown-backed subspecies* S. f. cambaiensis *of northern Himalayan foothills and plains country.*

restoration of such forests and their successional pathways during stand development. Specifically, the authors propose to conduct a broader analysis of the stands, to more accurately study tree regeneration, to monitor seedset and seedfall, to test viability of seeds and naturally regenerated seedlings, and to track a sample of seedlings over time to monitor their fate and the effects of herbivores, particularly sambar and elephant.

I think of the lowland Caribbean rain forests in which I recently had hiked at La Selva Biological Reserve in Costa Rica. Even small openings of only a hectare or two right in the middle of the virgin old-growth rain forest responded with the regrowth of only a few tree species. At most, six to eight tree species regrew in these openings out of the usual 200 to 300 that are found over an equivalent area within the old forests. In addition, many hundreds of shrub and herb species also were absent in those Costa Rican forest openings even after a decade or more of rapid tropical forest growth.

This dearth of regeneration generally results from the thin tropical soil that erodes rapidly and provides a poor nutrient base for newly established seedlings. As well, the soil contains a sparse or nonexistent seed bank from which the plants can reestablish themselves on site. The plant propagules, the seeds and spores, must be brought physically to the site by wind or in the droppings of birds or mammals. But if there is no cover or food to entice the animals into the bare openings, there will be little regeneration by that means. This vicious cycle can leave an area unvegetated or poorly regenerated for years or decades. Whether the same factors affect natural regeneration in these recovered Indian teak plantations is poorly known but deserves further study.

Over the past century or more across the globe, there have been many cases of forest restoration projects. Such projects typically are geared toward developing forest plantations of one or a few tree species on sites that have been burned, cut, mined, or otherwise greatly disrupted. But what is of major significance about this south Indian experiment is its attempt to restore the diverse wet evergreen forests to a form not unlike the original old-growth conditions. I am aware of no scientifically controlled project in forestry that has ever been conducted to successfully regrow an old-growth forest with all its attendant biota. An old-growth forest is more than a stand of big trees. It is a complex of diverse life forms—animal as well as plant—complete with the myriad of ecological interactions among species of flowering and other plants, birds, mammals, amphibians, reptiles, insects, and other invertebrates. Creation of old-growth forests at times has been the rationale used to justify harvesting of ancient forests in the United States. But our ability to replicate such complex and diverse ecosystems is thoroughly untested and hypothetical, even here in India where harvesting and planting of forests date to early historic periods many centuries ago.

In these Indian teak forests, the tree *Lagerstromia* is one of the first Sun-tolerant, aggressively growing species to return to an opening. This

A wet evergreen forest stand in Parambikulum, Kerela, south India. This stand is notable for its intense use as a source of "minor forest products" (that is, nontimber resources such as fruits and resins) by an adjacent tribal village. Although the forest is no longer pristine, many of its characteristics have nonetheless been protected by careful use at a mostly sustained-yield rate. It is an example of how forest "buffer areas" can be conserved for both human use and for providing some attributes of forest cover for wildlife.

may be a useful first stage in restoring old teak plantations to the more natural moist deciduous forests or wet evergreen forests. It is unknown and unstudied, however, as to what size forest opening the tree species will invade, and what the next stages of plant succession will be. *Lagerstromia* also is considered a pest in maintaining central Indian grasslands because it is highly fire-tolerant and remains on site for long periods. With these tendencies, it might inhibit further natural regeneration of a site by other moist deciduous or evergreen forest plants that are less Sun-tolerant and more apt to grow in deeper forest shade. The degree and duration with which *Lagerstromia* dominates a stand might depend on how often the site is disturbed, as with burning, which in turn might be a function of how intensely it is used by humans. Thus, if the forest is in a buffer area and is intended to be burned for any one of several reasons, this might favor the long-term dominance by such fire-tolerants as *Lagerstromia* and the weedy shrub lantana, rendering it difficult or impossible to more fully restore the site to original moist deciduous or wet evergreen forest conditions. Some multiple objectives, such as restoration of moist or wet evergreen tropical forests and intensive use by humans, probably are incompatible for the same site.

Indian shag (Phalacrocorax fuscicollis). *This member of the cormorant family is most easily identified in breeding plumage, as shown here (right), when it develops white feather tufts behind the eyes and white speckles on the head and neck. Parambikulum Reservoir, Kerela, south India.*

Understanding such dynamics of forest regeneration, plant colonization, and intensities of intended human use is critical to setting feasible objectives and to developing realistic prescriptions for successfully restoring a natural forest ecosystem with its full complement of plant and animal species. Remember especially the need for maintaining the keystone species, the symbionts and commensals, the decomposers and transporters, the pollinators, the seed and spore dispersers, and the key prey species. What kinds of resources do **they** need to survive? What food, cover, and breeding or nesting substrates do **they** require? How are these affected by various kinds of human use of the forests? Only by answering such questions with scientific study, if need be, can effective and successful planning for restoration of large areas to native forest conditions occur.

Some of the problems inherent in restoring these forests include the invasion of the thick shrubby weeds lantana and *Eupatorium* that inhibit

natural regeneration of native shrubs and trees. Also needed for restoring the forest ecosystem is recruitment of snags, the dead standing trees that provide key habitats for the wide variety of cavity-using species. Down trees on the forest floor are essentially lacking in this south Indian sanctuary, and most others in the country, as well. Down trees provide habitat for a host of other wildlife species, as well as nutrients and organic matter to keep the soil stabilized and productive over time.

One critical and uncommon habitat in these south Indian mountains are the *vayals. Vayals* are wet basins in local valley bottoms having luxuriant growths of shrub cover and browse. One excellent management scheme being implemented is the active removal of the exotic weeds lantana and *Eupatorium* from these areas.

8 April

Morning coffee at Top Slip, Anamalais Wildlife Sanctuary, in Tamil Nadu State. Then *junglat jelo,* "let's go to the forest." By 7:30 a.m., seven of us climb into the back of a flat bed lorry truck and drive to a remnant grove of wet evergreen forest set among a landscape of older teak plantations and moist deciduous forest, for a trek in the dense jungles. The route takes us gingerly across an old narrow bridge of creaking, splitting timbers that spans a small river. Downriver, local villagers are bathing in a pool, and a young boy is giving his buffalo a scrub bath. Ancient wet evergreen forests once dominated the Western Ghats, but many decades of intensive land use, including conversion to village and crop lands, have reduced the old forests to remnants of scattered patches.

From the perspective of providing wildlife habitat, the forests of these mountains differ from those in central India in several ways. The dominant vegetation is moist deciduous forest, which includes a large component of evergreen broadleaf trees, unlike the fully deciduous trees of the dry deciduous forests of Bori and Melghat in the Satpura Hills of central India. This means that the southern forests nearly always provide some canopy cover, which provide hiding protection for bonnet macaques, Nilgiri langurs, common langurs, a host of bird species, and other wildlife. The light interception of the partial canopy also means that deciduous and evergreen shade-tolerant shrubs and trees can flourish in the understory, thus creating a more diverse structure of foliage than in the simpler dry deciduous forests. And a diverse and partially evergreen foliage provides cover and foods for a wide array of wildlife.

Moreover, at lat. 8 to 10 degrees N. here, sunlight is nearly vertical and day length varies by barely more than an hour or so year-round. This near constancy of photoperiod and temperature provides for equable habitats, which in turn have encouraged the evolution of many endemic life forms and the preservation of some other very ancient ones. Indeed, the Western Ghats host wildlife species also found in the distant wet evergreen rain forests of northeastern India and other southeastern Asian countries, in quite disjunct distributional patterns.

This area differs from the dry deciduous forests of the central regions in the presence of more perennial rivers with dense riparian gallery forests. Because the major monsoons sweep across the peninsula from the south, the great storms arrive earlier in the Western Ghats and remain later in the year than elsewhere, all the time feeding the rivers and springs. We visit several verdant riverine forests and hike along the lush banks and shoals having highly diverse vegetation structures. Some rivers contain extensive growths of thin-stemmed reed, which provide hiding cover for ungulates and nesting cover for many water birds. In contrast, during these dry summer months most rivers of central India are rather bare or at best are narrower and have more open riparian woodlands than do these rivers of the south.

The tall grasslands in the southern high elevations are important habitat for Nilgiri tahr and are associated with the uncommon dry deciduous forests that are still found this far south. The tall grasslands are fragile sites with thin, erodable soils and

stunted trees. Although they provide important seasonal habitat for gaur, sambar, and tahr, conflicts over land use (especially that involving burning) have impaired growth of the grasses here.

We spend the morning hiking along the shady floor of the tall galleries of an ancient wet evergreen forest. Wildlife communities here are exceptionally different from those in other forests we have seen. We spy emerald doves, crested hawk eagles, yellow-throated bulbuls, black eagles, crested swifts, and hill mynas. The black eagles are a particularly sensational sighting, as the species is endangered throughout India. A loud, slow hammer nearby in the dense canopy tells us that an Indian great black woodpecker is at work, and we also discover its oval-shaped, apartmentlike cavities stacked three or four high in the trunk of a nearby tree. A group of velvet-black Nilgiri langurs dive and crash through the canopy. A wary troop of bonnet macaques dash up a more open slope at our approach. Vish points to a nearby understory tree, and I see a huge squirrel with a bright rufous-colored back and cream-colored underparts—a Malabar giant squirrel, the local subspecies of the Indian giant squirrel.

One of the objectives on this outing is to approach and photograph the lion-tailed macaques, which, like the Nilgiri langur, is a highly endangered species of primate found only in these remnant wet evergreen forests of the Western Ghats. With a forest guard—the guards are always dressed in crisp, snappy uniforms—and a local native guide, I leave the dirt roads and trails and thread my way through the dense understory in quiet pursuit of a macaque troop. We make our footfalls as silent as possible, but at this time of year the forest floor is dense with fallen leaves from the deciduous trees, and we hardly can avoid announcing our approach. I think about the various venomous snakes, especially the cobras and kraits, that blend so well into the leaf litter and branches. The tree vipers hang at face level or drop onto you from above. Vish and the forest officers also warn us about the multitude of ticks and other biting insects in these woodlands. On his last trip, Vish received many tick bites, swelled up, and incurred a severe case of tick fever for several days. This area is also infamous for its great density of land leeches that surface during the rainy season. I marvel that our native guide, with his winning, shy smile, is clad only in a *longhi* and thin *chappals* (sandals). He walks at times through the forest looking down at the ground. This behavior puzzles me until I realize that he has an ear cupped for the lion-tailed macaques' soft, unmusical, single grunt, and that he is watching for freshly dropped mango fruits or jack fruits from the primates' foraging activities, signaling they are overhead somewhere in the dense canopy.

Then I spot them. They have moved farther back into denser canopy. A group of perhaps 10 lion-tailed macaques, moving deliberately and quietly, staying in the highest portions of the darkest foliage. They are remarkably difficult to observe, and photographing them is even more of a challenge. Quite unlike the tan and cinnamon of the bonnet and rhesus macaques, the lion-tailed macaques, or LTMs as both the locals and researchers call them, have a beautiful deep black coat. The large males also carry a dense silvery mane surrounding their face and throat. The LTMs are much thicker bodied than the langurs. And whereas the langurs typically plunge throughout the canopy from tree to tree in acrobatic leaps, and the bonnet and rhesus macaques run along the ground in tight groups, the LTMs mostly move silently and in single file along canopy branches, only seldom descending to lower parts of the canopy or to the ground. Occasionally, when no other route presents itself, they may take a great leap across space between trees, revealing their splendid athletic agility.

We discover them feeding on jack fruit, a pineapple-sized fruit now ripening on the jack trees. Although they spot us from their 50-meter height, they remain well concealed by the canopy foliage, continue their feeding, and only slowly move off. We follow deeper into the jungle, wary of encountering venomous snakes (remember the kraits!), insects, stinging vegetation, wild boar, or elephant. The forest guard and native guide fan out, and I take the rightmost angle of our arc and spot another troop of 10 or 12 LTMs in a different part of the canopy. Much too high for flash photography, they are staying just under the canopy in the dark underside and deep shade of the foliage. Frustrating.

The guard and guide continually signal to me with hisses as they spy the animals, and they rush to tap me on the shoulder and pull my arm as I aim the big lens and wait for a good picture. Finally, I station myself on a large down log (yes, good to see that there are some down logs in this stand), brace my elbows on my knees, and photograph a group warily crossing one by one on an open, sunlit branch horizontally 50 meters up. Wonderful! I was amazed at how wary they were to our presence, even at that height.

Apparently, there are only about 3,000 LTMs left in the wild and only 70 in this local isolated population. We see three groups totaling perhaps 20 animals, about a quarter of the total local population. The forest guard tells me in a thick Tamil accent that the forests here used to be much wetter and denser and have many elephants. But, the last 8 years have seen a long drought that has reduced the understory vegetation drastically. He says the forest we are in used to be known as *ani cundi*, "elephant sitting," because the beasts would be found sitting and bathing in the mud of wet wallows. The combination of tree harvesting in these wet evergreen stands, converting the native evergreen forests to deciduous teak plantations, the increase in intensive human use of the surrounding forest stands constituting the elephants' travel routes, and the recent drought has caused the local elephant population to greatly decline to threatened levels.

We pause, deep in the evergreen jungle. Deafening cicadas. The forest guard asks if I am married and where my wife is. I tell him she is joining me in a few weeks, and I show him the wedding ring I designed with interlocking images of many wildlife species, which delights him. Meanwhile, the guide is gathering handfuls of the small green wild mango fruits for us to eat. They taste strong and sweet, and we sit for a time in the hot deep shade, insects chattering, sharing the same forage as the macaques overhead.

In 1976 a fellow by the name of Steven Green studied the lion-tailed macaque and noted only about 500 animals in the Western Ghats. Although this population estimate proved to be low, it did point out the plight of their small population size. There ensued heated arguments over management and policy needed to sustain the populations, despite the paucity of basic information on ecology, diet, social system, home range, densities, dispersal movements, and habitat.

The first intensive scientific research on the LTM began in 1978 by Dr. Ahjit Kumar of the Wildlife Institute.[8] Kumar studied the demography of five groups, visiting each at least once per month. He used the colors and patterns of eyelids, fingers, and tails to try to identify individuals, although he found such individual identification very difficult. I certainly now understand the obstacles in making even simple observations among the shadowy, dense, high canopies. He did find, however, that the large males tend to move away from the female groups when not breeding. Overall, there is high site fidelity, which speaks of the need to maintain forest conditions in traditionally used stands. Kumar also studied the vegetation conditions of their habitat and the seasonality of fruiting of some 25 tree species important to their diet.

He found that the LTM birth rate is very low, perhaps on the order of one offspring every 3 years. This is one-third the birth rate of other macaque species. Adults have a high annual survival rate and, at least in captivity, are long-lived. Females do not become sexually mature until at least 6-1/2 years old, whereas other macaque species first breed at 4 years. Also, the females have a 172-day gestation period, longer than the 160 days of other macaque species. After a 15-month period of lactation, the females go some 3 to 4 months without ovulation, again reducing the overall potential population growth rate and increasing time between generations. All this results in a demography that responds slowly to the abrupt kinds of changes in habitats and surrounding environments we see in the south Indian forests. And the high site fidelity contributes to local groups being more susceptible to dangers of disruption to their habitat.

The species is mostly frugivorous and also takes a few insects but no vegetation. Its preferred diet is ripe seeds and ripe fleshy fruit with simple sugars. Insects are taken when fruit is low in availability. Thus, there is a need to maintain sufficient area of contiguous wet evergreen forest, their essential habitat, so that a year-round supply of fruits and seeds of various plant species are continually available in sufficient quantity to sustain the population. With the recent fragmentation of wet evergreen forests into small, isolated patches scattered among the teak plantations and moist deciduous forests, such sufficient area to accommodate their large foraging range and the diversity of food sources is seldom to be found. As a result, the LTMs have vanished from smaller patches of seemingly suitable forest habitat.

The LTMs are confined to the evergreen forest patches, in which grow 4,000 to 5,000 species of angiosperms, the flowering plants. The wet evergreen forests receive over 3 meters of rain per year. It is important to have prolonged rain throughout the year, as generally occurs in south India, so that fruits and insects are available in all seasons. The evergreen forests in lower elevations once provided a wider diversity of plant species and better habitat conditions with greater quantities of fruits and other foods than did the evergreen forests of higher elevations and steeper slopes, but those rich lowland forests have been the first to yield to the axe. The best wet evergreen forest habitats were at about 300 meters elevation, but these are long gone. The remaining evergreen forests now are found only above 500 meters in the southern states of Kerala and Tamil Nadu, and these higher elevation forests may be less than optimal habitats for the LTMs. This has created the present difficulty of managing for an endangered species in residual forests that do not provide the optimal conditions in which the species evolved.

Especially in Tamil Nadu, the LTMs' preferred habitat of wet evergreen forest stands has become highly fragmented. In Karnataka State just to the north, there is good protection of evergreen forests but the vegetation is less diverse and rain is less prolonged. As a result, habitat there is less suitable and the density of LTMs is substantially lower with one group per 200 square kilometers. In Karnataka, there are perhaps 14 groups

[8] See: Kumar, Ajith. 1990. IIIrd international symposium on lion-tailed macque. Wildlife Institute of India Newsletter. 5(3): 13-14.

totaling about 300 animals, although one study extrapolated to an unlikely population estimate of 3,000 LTMs there. Kumar estimates no more than 800, although no systematic survey has been conducted. In Karnataka, also, home ranges seem to be very large. Evergreen forest stands occur in long linear patches higher on the steep slopes of the Western Ghats, so the animals cannot spread out and populations cannot interchange except along a narrow elevational belt. This most likely has an adverse affect on restricting gene flow among populations and constraining population numbers.

Here in Anaimalai Wildlife Sanctuary in Tamil Nadu State, some 170 LTMs recently have been counted out of the projected 300 for the entire Anaimalai Range. Even here, stands of wet evergreen forest occur in small isolated patches and have become highly degraded from a long history of human use. The population estimate for Kerala State is perhaps 1,000 to 1,500 animals, with higher densities in Parambikulum Wildlife Sanctuary.

A recent finding of interest, according to our wildlife warden, has been the discovery of LTMs in the eastern part of Tamil Nadu in wet evergreen forest patches close to moist deciduous forest stands. This is further east than any previous sighting of the species. Rather than feeding strictly on fruits in the canopy, individuals there have been observed to descend to ground level to feed on agave fruits in these drier habitats. This is likely an isolated population, perhaps a relict from earlier, more contiguous distributions of the species, rather than a recent invasion into previously unoccupied habitat. Conclusions about the species' habitat use, dietary requirements, or geographic distribution, or the long-term viability of a population of such a small size and isolated occurrence should not be based on this relict situation. This situation seems similar to that of the northern spotted owl in the Pacific Northwest United States, which also has been discovered in "atypical" situations and habitats and with abnormal diets. Other examples can be found among many other wildlife species around the world. Also, just as this isolated LTM group has been found in the old wet evergreen stands adjacent to the much less suitable moist deciduous forest, northern spotted owls are at times observed in remnant stands of old-growth conifer forest adjacent to young-growth forests that provide much less suitable habitat conditions for breeding, feeding, and cover.

Eventually the LTMs move to higher ground in the stand and our own lunch time approaches, so we weave our way through the tangle back to the trail and to the others. During lunch, Mukherjee has the guide cut a meter length of thick climber, from which flows a surprising amount of clear cool water. The climber is understandably called "friend of the forest," and we pass the specimen around for all to drink.

Back to Top Slip rest house, and we receive a visit from an indigenous tribal member whom we had invited for discussion. The local forest officer translates the tribesperson's native tongue into English for the rest of us. We discuss for several hours how his tribal customs have necessarily changed as a result of creation of the wildlife sanctuary from the previous intensively used forests. He is the fifth successive generation of forester aid. But in 1973, the local forest reserve closed its doors to timber harvest and was redesignated as Anaimalai Wildlife Sanctuary. (In a parallel change in forest status, Parambikulum Wildlife Sanctuary just across the state border in Kerala was so designated more recently, also affecting tribespeople there.) This change in forest status has precluded his working in forestry and field timber operations, as he was trained. The tribespeople skilled in forestry have had a difficult time recently in finding consistent and reliable sources of income. Redesignation of the forests as sanctuaries was necessary, however, to protect the vanishing tropical evergreen forests and their unique and endemic life forms, such as lion-tailed macaques and Nilgiri langurs. Such redesignation of forest use has its parallel in the current timber controversies in the northwestern United States There, declines in available

timber from many years of overharvesting on public and private lands have led to recent moratoria on timber operations, many legal appeals of the National Forest management plans, lawsuits, and changes in land allocation. This, unfortunately, has had a perceived or real adverse affect on local communities, just as the local tribespeople of south India are feeling the pinch of the forestry closures. Some of the local people, such as our engineer-turned-guide, have shifted to wildlife tourism as a major income. Likewise, the communities of the U.S. Pacific Northwest must diversify their economies to survive, and tourism also seems to be one such channel.

According to Lal, the tribal population in India in 1981 numbered some 52 million, mostly in hilly and forested locations. Studies have concluded that the economic dependence of tribes on forests range from 15 to 84 percent, depending on the community and the region. Sale of forest products other than timber and firewood can account for as much as half of the total tribal income. But with the advent of single-species silviculture, such as with teak plantations, and with the concomitant increases in human populations, much of this income has been compromised. As a result, at least some tribespeople have resented the forest management policies of recent administrations. Such policies that have converted forest reserves to sanctuaries often exclude local indigenous peoples. Other policies aimed at scientific forestry entail use of silvicultural techniques that ultimately produce more sterile woodlands lacking the diversity of forbs, grasses, shrubs, trees, fruits, and other forest products necessary for supplementing the tribal economy.

I must recount, however, the perspective of Christina Noble who spent a year traveling with the nomadic Gaddis of Himachal Pradesh in the Himalayas. She pondered over the fate of these people in the face of governmental interests to restore the overgrazed pasture lands and to reduce populations of both goats and humans. In her account in *Over the High Passes* (see "For Further Reading"), Noble sharply disagreed with the Indian Government's proposal that the Gaddis would gladly take the opportunity to turn away from nomadic shepherding and take up other vocations, and that this should be the solution to the problem.

> I dispute it because, as I see it, the income from their flocks is increasing, and has the potential to go on increasing. At the moment the greater part of that increase is derived from the officially despised goats. For that reason I cannot believe that the government's present efforts to restrict goat numbers will be a success....
>
> Even supposing that shepherds recognize the goats' detrimental effect on the environment, they would be unlikely to take any action; to make a sacrifice for the benefit of grandsons yet unborn is to them a meaningless concept.... If the government and the ecologists really want to see a shift away from goats and towards sheep, they should make every effort to boost the comparatively depressed value of sheep....
>
> I believe the government's anti-goat policy would be more likely to succeed if, rather than vainly attempting to restrict goat numbers, it turned its attention to encouraging wool production from sheep. But it would have to be careful to stimulate it in a way which ensured that the benefit went to the wool-producers themselves.

I see a very strong parallel between Noble's Gaddis, with the problems of their livestock degrading the mountains and pastures, and these Anaimalai natives whose livelihood from traditional forestry skills is being threatened by the new conservation policy. The answer is not just to substitute one resource or one skill for another. The answer is to initiate a change in their patterns of resource use as a natural economic advantage and one that is not contrary to their accustomed cultural habits. Eliminating clear-felling in Anaimalai must be accompanied by a program to replace the forestry activities with equally profitable, economically viable tourism ventures or other, nondegrading uses of other forest resources. And it must be to the direct and immediate economic advantage of the local native folk for such a shift to succeed.

Night on the lawn at Top Slip. A full moon floats over the dark scarp walls across the valley. Out in the vast south Indian plains, small towns and occasional pasture fires flare with dots of white and orange. The local herd of cheetal reappears on the

Indian wild boar (Sus scrofa) *in Dudhwa National Park, northern India. These highly prolific wild pigs are widely distributed in the subcontinent. Males reach 1 meter at the shoulder and may weigh up to 225 kilograms. Its smaller and rarely seen cousin, the pygmy hog* (Sus salvanius), *is endemic to the terai habitats along the Himalayas.*

edge of the grass below. I pull a chair to the forest edge in the dark, alone, in the moonlight shadow of a large bamboo cluster spreading its feathery wings into the night sky. A wild boar nearly runs over my feet in its sprint along the forest perimeter. Just inside the forest cover, a sambar stomps and barks an alarm; I wonder if it is in response to the boar, to me, or to some large predator. A few minutes later, farther off, a barking deer coughs out its alarm call. Something is on the move out here.

Earlier in the evening I had hiked downslope to the wildlife visitor center. There, local villagers had gathered to view a movie, filmed in their local native tongue, on the only videotape machine in the area. On down the road, I had observed an Indian roller with wings of brilliant turquoise stripes and watched a Montagu's harrier tilt and dart its way over the grassy knoll above.

Further along was the local Hindu temple, brightly colored on the domed peak with deity figures of men, cobras, and cows. A tranquil setting on a woodland slope; I was the only one at the temple. Within were icons of the elephant-headed god *Ganesh* and a serpent god, both represented by gold-colored statues bedecked with garlands and brightly tinted decorations. Ganesh has become my totem for the trip; he is the son of Shiva and Parvati and is the god of learning. I am trying hard on this journey to suspend expectations and preconceptions of cultures and peoples I am encountering, lest I close my mind to listening and understanding. I paused in the shadow of the temple door, thinking

of the millions of others who have entreated Ganesh for the gift of learning. An eerie but somehow peaceful and settling scene. I slipped a few rupees under the temple door and departed quietly.

Later, Mukherjee, Vish, and Tom join me on the Top Slip lawn. We sit sipping coffee and discuss our next travel plans. Our hosts tell us stories of Indian religious customs and festivals. Mukherjee asks to see my right hand—must be the right hand, not the left, he asserts—and reads the lines of my past, present, and future. He sees a long life line (he must tell that to everyone) and critical decision points in my career. I smile; that must be what brought me here. I don't doubt that I have chosen this particular path wisely.

Southern scops owls and other unidentified owls are calling from the forest down below. Behind us we hear a southern house gecko's *chuck chuck* in the walls, and a brain-fever bird still singing its comical and berserk aria in the dark forest. I also have been seeing the low-flying image of a bird skimming over the grassy knoll in the dark, calling a screechy *ee-eew ee-eew*, and tonight finally got a good enough look to identify it as a red-wattled lapwing out on a night foray.

After a time, we depart in the back of a flat-bed truck to go spotlighting wildlife in the night jungle. The full moon bathes the moist deciduous canopy in a soft glow. We encounter three herds of gaur, several sambar, and a common giant flying squirrel gliding with great parachute leaps from tree to tree. We discover leopard pug marks in the road dust. At one point we bang on the canopy roof for the driver to stop. As he shuts off the engine, the night pauses, then resumes its *chirr* of insects. In the brush just a dozen meters away we hear the crush of heavy feet and make out a dark shape in the pools of shadow and moonlight. Through the binoculars, I see clearly the form of trunk, tusks, and large flapping ears. Fearing a charge, the driver coasts silently down the road away from the bull.

Back at the Wildlife Institute, I had conducted a literature search on several species of native owls, particularly the brown wood owl (*Strix leptogrammica*), that occur in the dense old tropical forests of India. Much (too much) of the controversy on forest resource use in the U.S. Pacific Northwest centers on the fate of the northern spotted owl, which similarly inhabits dense temperate old-growth conifer forests. The brown wood owl is found only in dense semievergreen and moist deciduous forests in south India, the eastern Himalayas, and elsewhere in Southeast Asia. Understanding its habitat associations and ecology may help put the ecology, management, and fate of the northern spotted owl into better perspective. Other species of owl that can be instructive in this way include the bay owl (*Phodilus badius*), which occurs in dense evergreen submontane forest, and the southern scops owl (*Otus spilocephalus*) that we have been hearing, which is confined to the denser moist deciduous and evergreen forests.

Another species of interest in this regard is the forest eagle-owl (*Bubo nipalensis*). According to the great Indian ornithologist Salim Ali in his hard-to-find *Indian Hill Birds* (see "For Further Reading"), the forest eagle-owl roosts during the day in a large tree in deep forests or *sholas*. It is a bold and powerful raptor and forages with a perch-and-pounce technique to grab the large peafowl and junglefowl as they roost at night in trees or bamboo brakes. It is also said to kill hares, jackal, and even young barking deer, a remarkable and fierce accomplishment for so light a predator. Its cry has been described as a low, deep, and far-sounding moaning hoot and a blood-curdling shriek as of a woman in grief, earning this creature the name of "devil bird," although some references claim that the true identity of the devil bird remains unproven. (Ali and Ripley noted that a subspecies, the Ceylon forest eagle-owl [*Bubo nipalensis blighi*], found only in Sri Lanka, is "probably the authentic Devil Bird." They described the calls of the Ceylon forest eagle-owl as

"shrieks such as of a woman being strangled" but that "the dreadful shrieks and strangulating noises are merely its 'mating love-song', which would also account for their rare and periodic occurrence.")

The origin of the name "owl" itself is worthy of some attention here, as it helps explain the owl myth. My etymological research has revealed that the word "owl" goes back to the Middle English word "oule," which derives from the Old English "ille," which is cognate with the Low German "ule," going back to the German "eule," derived from the Icelandic "ugla." The Icelandic "ugla" is cognate with "uggligr," which gave rise to the Scandinavian "ugly," which led to the Middle English "ugly," which in turn led to the modern English word "ugly." Now, the Icelandic "uggligr" does not mean "ugly" in modern connotations (that is, unpleasant to behold), but rather it means "fearful or dreadful." This is precisely the connotation of owl symbols and totems in myth and legend—including the apparition of the devil bird of which Ali wrote. Thus, the very names that we use often speak of a deep history of traditional viewpoints and cultural perspectives.

I should also add that in Hindi, owl is *ul* (similar to the German "eule" or Low German "ule"), or *ulu* if the bird is very large. (Interestingly, Baban also uses "ulu" to refer to a foolish person. I'm not quite sure how to interpret this usage! He also uses *coscoot* in reference to owls, although I believe this is Urdu in origin and is used to refer to the smaller *Otus* scops type owls.) The Nepali name for the forest eagle-owl is *huhu*, an obvious onomatopoeia.

During one warm evening back in Dehra Dun, I had sat on the front porch steps with Baban. While we shared a bottle of Kingfisher beer under a rather eerie night sky filled with silent and continual strobes of heat lightening, he told me some of the owl lore of his childhood. The *coscoot*, the small owls, are very good. They come to the house and take the mice and the bad insects. But the large owls, the *ulu*, are very bad. They will come and perch on the house at night, and that is bad, because if someone comes to the house and says your name, *ulu* will catch it and have it. It will then wait until all is dark and quiet, and call you with your name, "Baban! Baban!" and you will come out to see, and there will be no one there, and then it will call you out again, "Baban! Baban!" Then in 10 days, 20 days, by repeating your name over and over, your life will slowly ebb and death will surely follow.

Vish noted that this tale is remarkably similar to an owl myth he was told as a boy while growing up in Pune. In that version, the culprit is the spotted owlet (*Athene brama*). Instead of catching your name, it will catch a stone you throw at it and slowly grind down the stone. As the stone decays, so does your life.[9]

Baban continued that, if you should find the owl, it will appear to befriend you, to tell you things. It will be obliged to tell you how to prepare itself for cooking. Little by little, over the nights it will appear on the roof and will teach you how to prepare its claws, its feet, its legs, its back, its wings, its neck. In its instructions, when it finally reaches its neck, on the 39th day, you must grab it and slice its head off, or you will be dead the next morning. From his descriptions, I surmised that *ulu* is indeed *Bubo*, the devil bird.

[9] For remarkably similar owl myths from around the world, also see: Holmgren, Virginia C. 1988. Owls in folklore and natural history. Santa Barbara, CA Capra Press.

In Hindi, Baban had told Vish that the "devil owl," as Baban put it, can be found in graveyards and big dead trees—more evidence, albeit cultural rather than scientific—that the species associates with old forests. Graveyards often contain old-growth trees. The Muslims, especially, revere everything in a cemetery, including the vegetation, and there, untouched, the trees can grow quite old and gain tremendous size. If fits, then, that the eerie cries of the devil owl are heard in the cemeteries, the home of the dead, portending death. Myth, culture, and biology converge into a consistent whole, as they ultimately should in our overall conservation strategy for the forests, their wildlife, and their people. For example, I have encountered similar owl lore in the Native American tribes of Western United States. Their attitudes toward owls seem to differ markedly, however, from tribe to tribe. Some of the coastal tribes in Washington State have strong taboos against owls, as do the Navajos. The Apaches lack such taboos, and the consortium of Yakima tribes in Washington even use the owl as a powerful totem. Such taboos or totems serve to guide where and how the forests are used and managed, even to this day and even with the Native American's adoption of "scientific" forestry.

Furthermore, Baban tells me that the tiger, the *ulu,* and other animals of the *junglat* that themselves prey on animals are very bad, but the ones that eat only vegetation are very good. I think this relates to the undesirable habit of carnivory and that herbivores fit better with the Hindu vegetarian philosophy.

My local search of the scientific literature, unfortunately, came up rather thin on biological facts about all these Indian owl species. Apparently, there has been virtually no focused scientific study of any of them. The scant information on nesting and foraging habits, forest habitats, and diet tantalizingly suggest that the species indeed have evolved in tight association with big trees of ancient tropical and subtropical forests. The only available scientific information comes from the general species accounts in the field guides and bird lists of Ali and Ripley. In these books, the various subspecies of the brown wood owl are denoted as inhabiting deep evergreen and moist deciduous forest during the daytime, but in the evening occasionally appearing in glades and more open areas of the forest. Various vocalizations have been reported as a low double hoot like that of a male domestic pigeon; a low sonorous squawk, possibly an alarm note; and a loud snapping of the bill when annoyed. Other noises include "a variety of weird, eerie shrieks and chuckles," and a scream "like that of a demented person casting himself over a precipice." (How I love some of the vivid descriptions and personifications found in the older natural history literature!)

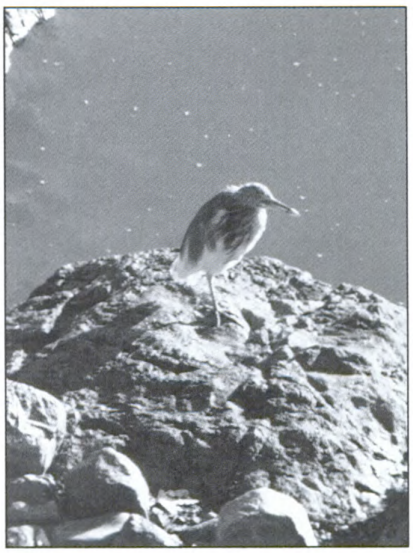
The issue of the scarcity of ancient forests and northern spotted owls in the U.S. Pacific Northwest often has been radically oversimplified and depicted merely as a problem of how to give the bird a home. The cultural, social, recreational, economic, and ecological values of conserving the remaining old-growth forests run vastly deeper than the need of a single species, although that, too, is certainly worthy of our best attention. More than once, someone has contrived a well-intentioned (sometimes not-so-well-intentioned) "solution" to this artificially simplified problem. Such revelations have included stocking clearcuts with mice so that spotted owls can have enough to eat and will remain healthy and viable; raising juvenile northern spotted owls in the nests of their competitor species, the barred owl, so that the spotted owls will learn their more aggressive ways and be equally able to compete for food and nests; and raising all spotted owls in captivity and transporting them to second-growth forests, so that they will never have time to associate with old growth and will "learn" to thrive in young forests. I have neither the time nor the immense patience necessary for describing why each of these tactics is utterly preposterous. Suffice it to say that each ignores the most basic biological principles and the many other social and ecological values of ancient forests.

But I was especially amused at finding in Ali and Ripley's book an account of another inane scheme, involving the owl genus *Strix*, based on equally ignorant and foolish rationale that ignored biological fact. It seems that in the 1870s, the brown wood owl was introduced in the Laccadive archipelago off the Indian peninsula to rid the islands of rats (*Rattus rufescens*), which probably also were previously introduced by humans. As Ali and Ripley wrote, this was a "hare brained government plan.... The grossly incompatible ecological conditions on these unforested coral islands, which the planners seem to have overlooked, soon brought an end to the birds but not to the rats!" I hope we have the wisdom to learn from such past follies.

In all, during my travels from the Himalayas to the southern tropical forests, I would personally encounter some seven species of Indian owls out of the over 200 species of birds and 27 species of mammals. If owls are fearful, dreadful devils to be treated with respect and care, may they and their kind continue to find harbor in the dense, old forests of the country.

9 April

A spectacular sunrise over the cliffs this morning from Top Slip. It's now 10:00 a.m. and I'm sitting in a cane chair on a deck of bamboo and teak, in a thatch-roofed tree house overlooking the shores of a reservoir in



Pond heron or paddybird (Ardeola grayii). *Pond herons frequent marshes and rivers, fishing along edges.*

At rest pond herons appear earthen-brown, but in flight they explode with brilliant white wings, tail, and rump.

Parambikulum Wildlife Sanctuary, Kerala, south India. An Indian great black woodpecker hammers across the lake. Pond herons, yellow wagtails, and common mynas pick for food down by the bank. I hear the clear ascending whistle of a magpie-robin. Vish explores the shoreline for leopard tracks as Nilgiri langurs call from the far shore, *hoo-hoo-hoo-hoo.*

We drove this morning to meet the section officer of Parambikulum Wildlife Sanctuary in Thunacadavu, Kerala. He had local business to attend to, so he directed us to this jungle perch to spend the late morning until he returns. This most unique Forest Service rest house is built some 5 meters above the ground and is supported at four corners by live teak trees. During our wait, I explore the surrounding forests and reservoir shoreline and spot gray-headed fishing eagles, bronzed drongos, greater and lesser racket-tailed drongos, golden-fronted chloropsis, and the white throated subspecies of the orange-headed ground thrush. My field notebook is starting to read like a trip on Noah's Ark.

Presently our section officer arrives and we take our four-wheel-drive vehicle to a moist deciduous "preservation plot," one of the oldest stands in the region with the least disturbance from fire, grazing, and other human encroachment. Old-growth teak forest; the codominant species is *Lagerstromia parviflora*, a large overstory tree, which is highly Sun-tolerant and probably climax on this site. Teak dominates even unmanaged stands when fire is present; thus it is referred to as a fire climax species, much like the lodgepole pine or sugar pine of our North American conifer forests. But we see no natural regeneration of teak in the understory here, telling us that the species eventually will be phased out unless fire occurs.

It is interesting to compare the structures of the old-growth forests of India—including the sal forests of the north, the dry deciduous teak forests of the central part of the country, and the moist deciduous, semievergreen, and wet evergreen tropical forests of the south—with those of the tropical old-growth forests I have visited in Mexico and Central and South America. The old-growth moist deciduous forest in this preservation plot seems to lack some of the structural attributes, principally the climbers, commonly found in the old-growth wet evergreen forests and in the New World tropical forests. But none of the tropical forests of India seems to compare to the lowland rain forests or highland cloud forests of the New World, which are profusely decorated with lianas and hundreds of epiphyte species, including orchids, bromeliads, and fern vines. Also missing here are the vast tree ferns of the New World tropics, although I did discover cycads in the understory of a wet evergreen stand. Other attributes typically defining old-growth forests, however, are certainly evident here: large old trees with deep spreading crowns, diverse foliage in the understory, multiple foliage layers, dead standing and down wood, and unique assemblages of wildlife with advanced coevolved relations. These are also attributes found in the old-growth forests of the temperate world, such as the Douglas-fir/western hemlock forests of the Western United States. Because of the dominance of deciduous and hardwood trees, these south Indian old forests are more redolent of the scarce hemlock and hardwood forests of protected coves of the southern Appalachian Mountains of Southeast United States than of the conifer forests of the West.

We drive to see the oldest and one of the largest teak trees known in Asia, set aside for tourist interest. The section officer proudly displays the specimen and stands alongside for photographs. The tree measures about 1.4 meters in girth at breast height and 45 meters tall and is called the Kannimara Teak, meaning "virgin teak." The specimen is indeed impressive, although some of the old-growth trees in the preservation plot approach its height and feeling of mass. It hardly compares though to the giant redwoods and sequoias of California, which can measure over 9 meters girth, 105 meters tall, and 3,800 years old.

On to our next temporary home, the rest house on the banks of Thunacadavu Reservoir in Kerala, in mixed forests. Lesser pied kingfishers dash into the water as we approach the site across the narrow dam. The combined cook-house boy-servant greets us on arrival, a handsome, strong young man and hard worker eager to please his guests. The others nap while I hike the shoreline, photographing lesser racket-tailed drongos and watching cheetal herds on the far shore leisurely approach the water to drink.

Lesser pied kingfisher (Ceryle rudis), *found along reservoirs, lakes, and open-water marshes.*

Late afternoon, and another typical power outage at our rest house. We drive off into the hills to a gallery riparian forest with dense copses of reed along a tributary to the Chalakudy River. We stop along the unpaved road and hike into the brush to visit the foundation site of the southern home of the great Indian ornithologist Salim Ali. Ali was probably the most prolific and prodigious natural historian of the early to mid 20th century and wrote the major treatises on birds of India and Pakistan and many provinces therein. His work still stands as the best and most comprehensive surveys to date. Standing on his home site, I try to imagine how the original forest appeared back then, not yet cut and planted with the now-tall second-growth teak I see before me. He wrote of this area as one of the most diverse in wildlife of all the country. With vision and commitment, we can restore those images from the past and resurrect the woodlands and wild communities that Ali described and to which he dedicated his life.

Then, a long drive through deep forests, and just after sunset we pause at the crest of a valley stretching below to a marshy *vayal*. The sky is an indigo velvet with a late full moon rising through the canopy, the air still, caught for a silent moment between the diurnal world of birds and the teeming night of insects and predators. Below, herds of gaur mingle in the lush grass, the high-backed bulls keeping to the fore of the group. A small herd of cheetal warily eases into the edge of the clearing, one buck with a full spread of antlers. Dusk is gaining momentum as an orange moon peers through the still-leafless teak. Flanking one side of the valley are two enormous, steep pinnacles of rock; an evening fog, phosphorescent from moonlight, is pouring through the saddle between. Cicadas begin churring, someone excitedly whispers "elephant!" and the silhouette of a large bull is seen standing quietly, listening, close by in the dusk forest. I know we are to pay close attention, because when I step further into the forest shadows for a clearer look, one of the local guides firmly grasps my elbow and whispers for me not to move, don't make a sound, just back up very slowly and get in the vehicle. In short order, we are back on the road coasting down to the clearing below with the engine off, the driver warily watching behind in the dark to see if our vehicle is being charged by the beast.

10 April

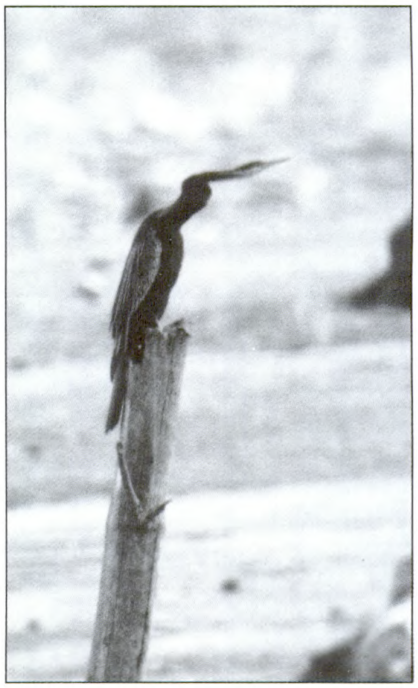
Morning at Thunacadavu Reservoir in Parambikulum Wildlife Sanctuary, Kerala. As usual, I am up by 5:30 or 6:00 and out exploring with camera, notebook, and binoculars, while others sleep. Vish and Mukherjee approach the day with the traditional

Indian morning: arise, take morning tea in their rooms, wash, dress, breakfast, and prepare for the day's outing by 9:00 a.m. or so. This suits me, as it provides several morning hours by which to hike alone and explore the land in solitary meditation. Up slope, a blue and white male paradise flycatcher with a vast ribbon tail flutters onto a tree directly in front of me, then darts off into the forest. Out on the water, two large crested terns plunge for small fish. These forests of the Western Ghats, as I alluded to previously, share many affinities with those of Malaysia. I am in the Indo-Malayan Biogeographic Realm, as it is called. This area differs in geologic origin, geomorphology, climate, dominant vegetation, human culture, and wildlife communities from the Indo-Gangetic Deccan Plateau region of central India (our Satpura Hills study area) and the Himalayan temperate forests of the north.

After everyone arises and we down our morning meal of rice *chappatis* and *dhal,* the staple in the southern states, we travel via four-wheeler to Parambikulum Reservoir. There, we are greeted by Mr. Appukuttan, the wildlife assistant helping to conduct research on the Indian mugger, the freshwater crocodile. A soft-spoken and learned man, Appukuttan takes us out onto the reservoir in a stubborn kerosene-driven motorboat.

After we finally coax the engine to life, we explore many coves and much of the vast shoreline. We are told there are some 200 mugger in this river and lake system, and our guide has been studying their distribution and response to reintroduction. Skimming along the late morning waters, we encounter Indian cormorants nesting in dense colonies on the few dead trees still protruding through the water surface. We also cruise past medium egrets with dark bills and ruffs of breeding plumage, darters with serpentlike necks and narrow heads, and large egrets as big as our great blue heron back home. A hike onto an island rewards us with a discovery of an abandoned mugger nest and eggshell fragments, evidence of recent breeding activity.

We then drive to an isolated patch of semievergreen forest, yet another forest type, that has elements of both the moist deciduous forest and the wet evergreen forest. The village adjacent to the forest stand has been using it as a source of firewood, fruit, and a host of other resources, and the composition and structure of the stand evidently are affected by the heavy use. The local tribespeople are holding a harvest festival in celebration of the Hindu New Year and we are fortunate to be here for some of the revelry. I suddenly realize I am literally hiking a path in dense evergreen jungles of south India, listening to drums beating in celebration from the local native village. I thought this happened only in Tarzan movies.



Darter or snake-bird (Anhinga rufa). *Aptly named, this relative of the cormorant has specially adapted bones in the neck to allow it to shoot out its bill and impale its quarry, often fish. They are found along reservoirs and lakes.*

Back in the village, we discover that for the festival the locals have built an outdoor altar with brightly colored deities and a veranda where they have congregated to listen to the loud, complex, shifting rhythms of the drums. Many friendly children mill about in small groups, attracted to Tom's kindly smile. His warmth and good nature need no explicit translation. As soon as he displays his point-and-shoot camera, the kids mob for a picture.

This small evergreen stand holds important lessons for our conservation plan. Once much more extensive, the stand is currently only 5 hectares and still is shrinking in size and changing in structure and composition from heavy encroachment and use. The tribespeople use the forest for, among other resources, cane and tree resins. Resin is taken from the trees with a series of slantwise cuts scored into the trunks. The resin is sold and processed as a fumigant and any other secondary products. The villagers also use the forest for fuel wood, timber, and herbal medicines for their *ayurvedic* (natural and herbal) cures. Such use can be made of these forests in a sustainable fashion if the forests are extensive enough and if the local population pressures are low enough. This stand, though, has been reduced to its fragmentary size mostly because of previous timber harvests and the conversion of adjacent, highly diverse evergreen forests to teak plantations.

Lion-tailed macaques once occurred in this stand before the dam was built and the reservoirs of Parambikulum, Thunacadavu, and others were created, before the once-extensive evergreen forests were cut and converted to deciduous teak, and before this stand became an isolated fragment. Now, the macaques are gone, but the slightly more tolerant Nilgiri langur still occurs; indeed, upon our initial approach, we observed several Nilgiri langurs on the edge of the forest by the village beat a hasty retreat for cover deeper in the stand.

What could be the minimum critical size of a stand of tropical evergreen forest that could still support a flagship species such as the lion-tailed macaque? One forest patch nearby measures some 10 to 15 hectares and still holds a group of 15 to 20 animals. But over several generations time, even that stand might prove to be too small and unable to consistently supply food and cover, especially during periods of stress such as a prolonged drought. And the more isolated the local population, the greater the risk that inbreeding and chance events will threaten their long-term persistence. The key to the long-term survival of flagship and associated wildlife species lies in connecting the various fragments of evergreen forest by denser forest not heavily occupied or exploited by humans, and to provide for some larger core stands where macaque troops and other species can meet their long-term resource needs. But, with ongoing use of the forest by several overlapping human cultures for a combination of resources and at the currently increasing intensity, it will not be long before the more tolerant species, such as the Nilgiri langur, slender loris, and others, will follow the moribund trend of the more skittish lion-tailed macaque.

Last night in our rest house we were warned by our cook to seal the doors to our room because of severe rat problems. I was hoping to sleep on the front porch because of, well, someone's snoring, but hearing that the rats climb anything they find, including cots, and gnaw on whatever they encounter, including flesh, I succumbed instead to another night of audio entertainment. The bottom of the door to the bathroom on the other side showed major incisor-caused damage, so I concluded that the warning was in earnest. Hot, stuffy, noisy, sleepless night. But I guess better that than waking with rabies.

Tonight we return to our familiar rest house at Top Slip in Tamil Nadu. Like going home. After dinner we go on another spotlighting tour of the jungles, this time in an old tank of a van that seems to be missing every other bolt. This is not the best planned outing, as the spotlight supplied by the local office fails to function and our paltry hand-held torches (flashlights) produce only a pathetic hint of light. So we pull into the forest office at the periphery of the core area, and four men spend half an hour rigging up a new light.

Now, as we arrive at the forest office with only one functional headlight, the four of us pull the light from its casing and tape it to long electrical wires that they run up from the engine compartment, through the window, to the roof of the van. Then, one of the native guides climbs onto the roof and hand-holds the headlight as a spotlight. And off we rumble into the darkness of the forest on twisty one-lane dirt switchbacks with steep dropoffs, our guide above sweeping our only light source around to spotlight gaur, sambar, black-naped hare, common Indian nightjars, common giant flying squirrels, and occasionally the road.

When we finally return to the rest house, the guide spotlighting all the way back, I mention that someone should help the fellow off the roof rack he was clinging to all this time. I suddenly realize there is no roof rack, and the man has been sliding around on the smooth domed surface of the roof itself. I wonder how our safety teams in my office back in the States would view such an outing. But then I remember all the crazy, risky outings I have taken over the years, sliding pickup trucks sideways off forest roads at night on rainslick leaves, rolling vans with bald tires on muddy hillsides, free-climbing up ice-coated waterfalls in the dead of winter to look for limestone caves and bat colonies, encountering marijuana growers and gold miners wielding shotguns in the middle of the night while out alone calling for owls in old-growth forests....

11 April

On the trail before 7:00 a.m. to another remnant stand of wet evergreen forest. These seasonally rainy, tropical forests have a high diversity of tree species in the overstory. The very dense shrub and sapling understory, mostly under 4 meters in height, consists of shade-tolerant species where the forest has not been heavily or recently disturbed. This particular wet evergreen forest patch is about 30 square kilometers, one of the larger in the Anaimalai Range, and extends several miles to the Kerala border on the crest of the range.

I encounter more of the unique assemblages of wildlife in these remnant old forests: rufous warblers, white-bellied tree pies, giant squirrels, imperial pigeons, barking deer. At one point I thought we were being paced by someone whistling a beautiful, complex tune, until our native guide casually identified the source as the quite uncommon Malabar whistling-thrush, a species characteristic of the wet evergreen forest type. The trails lead under closed canopies of dark foliage and climbers and eventually wind around to the Kerala border and into a forest clearing of perhaps a hectare or so. In the opening, the fauna suddenly changes from interior forest species to a new assemblage associated with the exposed environment and the small marsh trickling to the north. From the south of the opening flows a river, now mostly dried gravel, but an old dam still holds a substantial pool that extends back into and beneath the forest cover. Out in the field, several larger trees fill some of the space between the dense patches of shrubs. Tom, Vish, and our engineer-guide explore the pool while I wander downslope among the shrubs and the thin meandering stream trickling from the base of the small dam above.

Common mynas and common babblers decorate many of the lower branches of the scattered trees in the opening. Suddenly we all spot a large black shape flying overhead with an asthmatic sound of great laborious wings, flashing white below, and carrying a long casque above the bill. A Malabar pied hornbill, Vish declares, and of course the book proves him right. The Malabar pied is an endangered species and one of the largest hornbills in India, second only to the great pied hornbill we saw several days ago at Top Slip and will encounter again further up the trail. In a few minutes, it reappears over the edge of the opening just above the forest canopy, its loud squawks carrying widely, this time accompanied by a mate. For a time they screech back and forth, skimming the tops of the forest like some great improbable kites, then vanish somewhere into the green sea. Their deep roars and screeches are responsible, wrote Ali, for their Malayali name *Malamorakki*, which means "mountain-shaker." After what I heard, this seems appropriate. Meanwhile, our guide is anxiously whistling and hissing to me to join them on the dam. I slog across the marsh and climb the dam wall just in time to see a brown fish owl drop from its perch in the understory of the forest overhanging the water and disappear into the vegetation beyond. As we retrace our steps on the dam, someone points up, and a Malabar gray hornbill, yet another species of this strange family, alights 15 meters up on a branch and begins to regurgitate seeds to feed his mate.

Hornbills have the remarkable breeding behavior, as described by Ali, of excavating great oval cavities in soft-wooded trees. The female then lays the eggs in the bottom of the cavity and proceeds to wall herself in with her droppings; she uses the flat sides of her huge bill as a trowel to plaster the barrier, which hardens to the consistency of cement. Only a narrow slit opening is left, through which the male passes morsels of food during the incubation stage. The young hatch, and the female escapes her cell, again walls up her young, and helps the male in

feeding the offspring. When the young reach the flight stage, the parents remove the wall one final time, freeing their captives. It is unclear why this strange behavior evolved and what its adaptive advantages could be. I suspect that the wall might act as a deterrent for predators, although I can imagine many arboreal snakes being able to easily pass through the opening. Perhaps the wall helps the young avoid falling from the nest, but this seldom happens with cavity-nesting birds. At any rate, during the incubation period, the adult male of the pair is highly suspicious and seldom approaches the nest site directly. Thus, we are lucky to witness the male Malabar gray hornbill feeding through the cavity wall opening. In all, he makes several trips with a gullet full of berries and seeds until we quietly depart.

We observe a number of other species in the little clearing that we did not see in the forest interior, including a pair of heart-spotted woodpeckers working tree bark for insects. Heart-spotted woodpeckers are aptly named, as they are decorated on their yellow-cream wings with several rows of black markings each in the perfect shape of hearts. Sporting a tall black crest, the female with a yellow forehead, they are one of the most striking of the woodpeckers. Another common woodpecker species that rivals it in beauty, and that we had seen both within the forest and in openings, is the lesser golden-backed woodpecker, with its brilliant gold back, black tail and nape, bright tall red crest, long pale bill, red eyes, and black-and-white striped face.

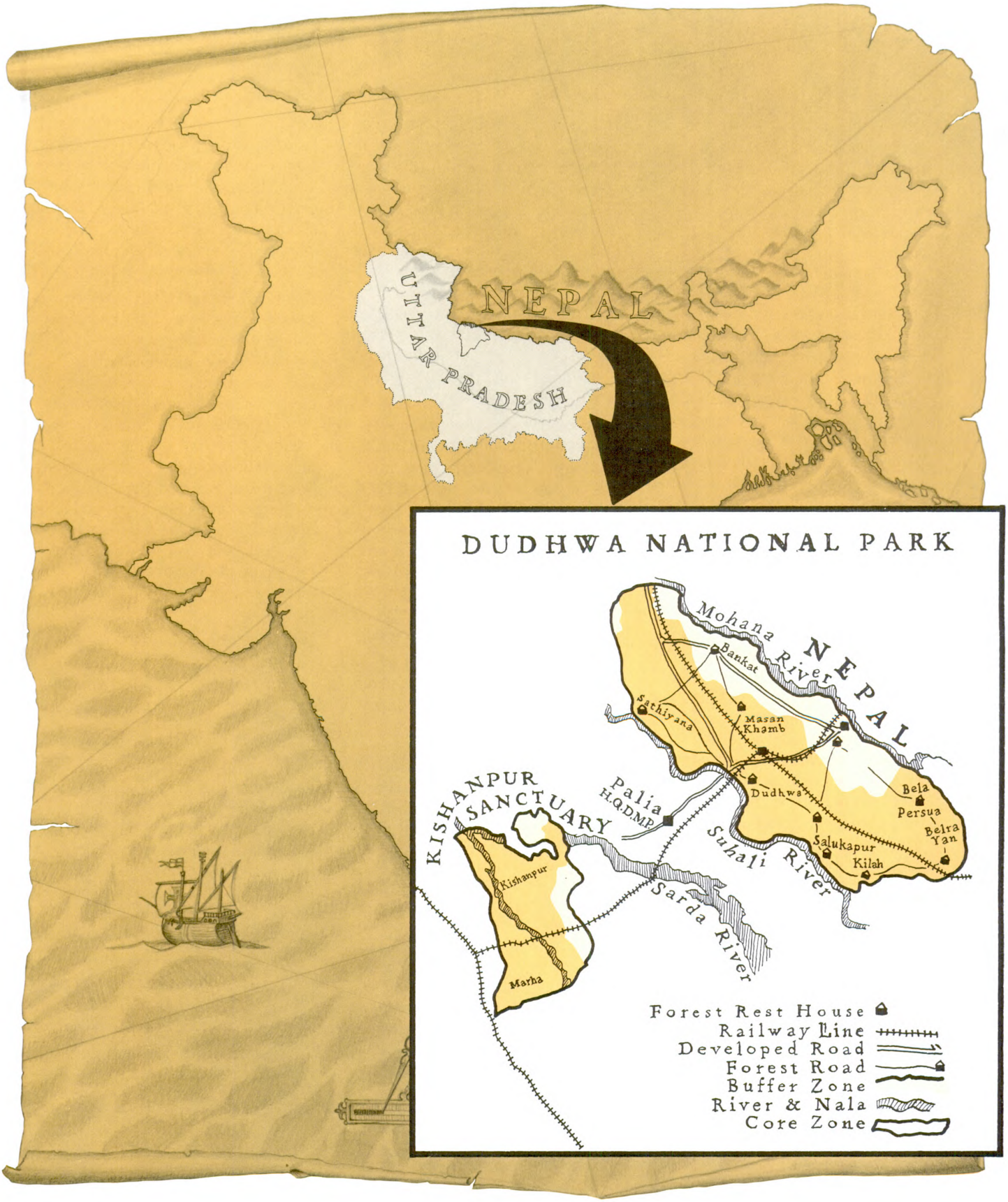
The greatest wildlife surprise is the close look we get at a pair of foraging brown-capped woodpeckers, a very small, nuthatchlike species with a short stub tail, brown head, white facial stripe, and ladder-striped back. Our field books denote the range of this tiny, inconspicuous species as Malaysia. This is yet another species showing the affinity between these south Indian tropical forests and the Malaysian biogeographical province. According to our books, this one is undocumented here—until now.

Back into the dense wet evergreen forest stand, heading further uphill and west, discovering paradise flycatchers and scarlet minivets. We enter another clearing, an old harvested teak plantation, and we encounter a pit some 5 meters deep and 4 across, which Vish explains was used by the villagers to trap gaur. Not far from the pit, I find the skull of a gaur with horns intact.

Our tracker says a large tiger has been commonly seen in the vicinity of this old plantation. Vish corroborates the story with his recounting of finding fresh tiger pug marks on this same trail 2 years ago. This makes me somewhat uneasy. In our small band of explorers, I am continually bringing up the rear, lagging behind to photograph birds and the forest habitats, and I know that tigers quite often attack the last person in a safari from behind. Earlier I was told of how in the Sunderbans the last man in line would wear a face mask on the back of his head so that it would appear to the tigers that he was on constant guard. So as I hike, I continually watch over my shoulders, and when the others are out of sight, I even walk backwards.

Eventually we reach a break in the forest and the crest of this Ulandy Range. Our native guide tells us we are now on the border of Kerala State. We shortcut it back to Top Slip through a low-lying basin filled with thorny shrubs and vines and spend the rest of the day picking minute ticks off our skin and clothing. Luckily, as in the forests at home, I never received a single bite and found only one of the beasts, on my shoe. However, Tom and Vish showed the more typical signs of abundant red rashes and stings for many days to come.

Late afternoon, back at Top Slip, and we must take our leave of this south Indian garden. As a parting gift, one of the house staff gives us a toddy palm fruit, highly prized here in Tamil Nadu as the state fruit. The fruit is covered with a peelable brown skin, beneath which is a transparent, somewhat tasteless but juicy pulp. A gift of respect and camaraderie. We tip our cook, houseboy, and guide, and I make a promise, which I fulfill, to our engineer-tracker to send him a few field guides to the wildlife of North America upon my return. Our taxi sedan arrives from the lowlands and we are off to Coimbatore, down the boomerang first-gear turns, through the thorn scrub woodlands, dodging occasional coveys of gray partridge, into the world of hot, arid red soil.



Back to the North:

The Grasslands of Dudhwa

12 April

I awaken in Hotel Surya International in Coimbatore and shower with hot water from a real shower head, not a bucket. I order coffee and bottled mineral water for the room, clear a weeks worth of ants from my packs and gear, sweep the roach from the sink to brush my teeth, and step outside onto the tiny second-story porch to photograph pariah kites and house crows dashing past, two of the most common birds seen throughout the country. Dawn seems hazy, disoriented. I cannot see the steep Western Ghats as I could yesterday evening. Hope a front with its typically heavy rains is not approaching. We've gotten rain only twice on this trip so far, one evening in Dehra Dun when that great cold front slammed into the southern face of the Himalayas, and a brief shower in Parambikulum Wildlife Sanctuary in Kerala.

Since their 1947-48 independence, and as envisioned by Nehru, India has become fiercely autonomous. Every product—soap, autos, motorcycles, beer, everything—-is manufactured within India and typically is state-specific. Although you can see what appear to be imported products, such as occasional Yamaha or Honda motorcycles, they actually are manufactured here in India under "technology transfer" license. Even their remote sensing information is not taken from European satellites or the U.S. Landsat, but rather from the Indian remote sensing satellite. This remarkable degree of independence may at first seem isolationist, exclusionist, overly nationalist, but it was a necessary and successful tactic to ensure that India did not drown in dependence on others, as occurred during British occupancy. India's current gross national product is growing annually at a rate of 4.8 percent, thereby providing a healthy economic base relative to many

other "developing" countries. A term I disdain is "third world." India, like Egypt and many African nations, was here first and long into it's history when our modern European and North American societies were not yet even conceived.

Nearly all raw materials are now produced within India's own borders: steel, copper, cotton, resins, food, wood, oil, and energy. Other major natural resources available within the country include coal, iron ore, manganese, mica, bauxite, chromite, limestone, barite, natural gas, and even diamonds. Their agricultural base is funded by nearly a third of the annual gross national product and includes rice, grains, oilseeds, cotton, jute, sugar, tobacco, tea, and coffee. The major industries are textiles, food processing, steel, machinery, transport equipment, cement, aluminum, fertilizers, mining, and oil products.

Indians have a greater reliance on what the United States would call "a diversified energy base" of hydroelectric, oil, coal, kerosene, diesel, wood, and, in much of the rural parts, cow dung. Of course the massive population, nearly four times that of the United States and occupying one-third the land base that the U.S. has, is greatly stressing the productivity of the land. Fuel wood is becoming increasingly scarce everywhere, causing greater problems of encroachment into the remaining forests.

Cattle dung is commonly collected from agricultural fields and is artfully stacked into covered cones or kups *as a source of fuel for fires throughout the year, as little firewood is available in much of agricultural India. This practice, however, robs the soil of much-needed nutrients. In this vicious cycle, the soil is then less capable of supporting crops and fuelwood trees.*

Rural families must trek many kilometers daily to gather bundles of small sticks and to lop branches from live trees for even a 1-day supply of fuel or livestock fodder. Thus, many villages throughout the country have evolved a system of using cow dung as a fuel source. They build 6- to 10-foot high cones of dung piles, carefully arranged in a geometric spiral design. The cones are covered with a mud stucco for shedding rain. Through a small opening in the base, individual pieces of dung are extracted as needed. Villages seem to set aside a common area for these cones and during this dry season we saw many cones in various stages of construction.

The problem with such usage is that this often leaves little dung available for fertilizing the crop fields, which then suffer from lack of nutrients. To counter this, factories manufacturing artificial fertilizer have been built. But this is less than an ideal solution, as the products must be transported, thereby adding to their cost, and purchased by rurals who have little spending capital for such luxuries. The factories degrade air quality and use other scarce natural resources, as well. Worse yet is the still-widespread use of DDT and other insecticides toxic to wildlife.

Yet in spite of the heavy toll of the teeming human populations on soil productivity, I am seeing a remarkably fertile land with an abundance of food. Contrary to the typical American image of India, starvation and disease are not evident in the small villages or cities. Villages commonly have many food carts with grains, corn, vegetables of many kinds, and fruits. For the most part, India is feeding herself.

Our flight from Coimbatore airport is, typically, 2 hours late, as a fleet of Airbuses has been grounded after a recent crash of one of the planes. As we check our luggage and cram through a doorway for the usual baggage checks and body searches, it is announced that only one carryon is allowed. I'm carrying two bags—my diverse 35-mm camera gear with multiple lenses, and a day pack with filtered water, field notes, travel books, passport and wallet—so I loosen the back straps to the pack and tie them tightly around the camera bag so that both can be carried with one handle. At the checkpoint, I am told by the airport guard to undo it all for a thorough search. She smiles at me and keeps asking "Two in one? Two in one?" I show a sudden, intense interest in the overhead lighting as she continues her search. The searches are remarkably thorough. Rather than inspect the contents of my packs, as I expected she would, she feels along the seams and sides and bottom, looking for hidden pockets or items sewn into the lining. Likewise, the gruff fellow who does the body searches also checks the back side of my belt buckle and feels the ankles and toes of the hiking boots I'm wearing. They know a lot of tricks that I'm oblivious to.

Domestic flights within India are actually well organized, although passengers forgo orderly lines for mob rule when passing through security points and during boarding. As you board the plane on the air strip, you first identify your check-in luggage, which is sitting in rows outside on the tarmac. They mark each piece you point out—sometimes requiring your claim check as corroboration—to ensure that all bags get on board and no strange pieces become mixed in (carrying bombs? drugs?). A good system that makes us feel protected.

Into Bombay airport and a 3-1/2-hour wait for check-in for our next leg to Delhi. Our timing is getting very tight. We are to fly into the domestic terminal at Delhi by late evening, and a quick 30 minutes later my wife Carrie is to arrive from Hong Kong at the international terminal, a half-hour taxi ride from the domestic terminal. And our flight out from Bombay is now starting to become delayed, again. During our previous passage through Delhi, I had been concerned that Carrie would arrive for the first time in this foreign land at midnight when I would be held up God knows where across the country; it looks like it will be in Bombay. I had arranged for the U.S. Embassy at Delhi to send a driver to the airport for her, but still I feel uneasy as the clock ticks and we sit in Bombay staring at our carryons and munching on Indian "veg" (vegetarian) fast food.

Finally, our Bombay-to-Delhi flight boards, but we sit for another half-hour as the passengers mill about restlessly. At one point a fellow opens the overhead storage compartment to stash his bag, and the corner of a hard-sided suitcase lands squarely on the head of the fellow sitting directly in front of me, causing a laceration. Harsh feelings are quelled with apologies and eventually the flight attendant leisurely shows up with a small bandage and first aid kit. Tom remarks that, with lawsuits an ever-present threat in the United States, if this had happened on a plane back home, the entire airport staff would be instantly at the man's aid.

At long last, the plane is pushed back, taxies, and begins its takeoff. As the engines roar and the plane surges forward, several other luggage compartments fly open and bags come tumbling out into the aisles, and just as suddenly the engines shut

down and we brake hard at the end of the runway, barely turning just as the concrete gives way to marsh. We slowly taxi back to the terminal and sit for another 20 minutes until the pilot leisurely informs us of "a snag" that had developed. I begin reading the *Times of India* newspaper from the seat pocket, and the front page is spread with news of terrorist violence and bombings in Assam, Punjab, Kashmir, and bombings of trains in Bombay and Delhi. An hour and a half later, the pilot announces with no additional explanation that "the snag is rectified" and we finally take off without further incident.

On board, sitting between Vish and Tom, I notice the music playing is a classical Indian piece. I ask Vish what it is, and he says he doesn't know, he doesn't understand it or even like that kind of music. "What kind do you like?" I ask, and he responds "Country-western and 50s and 60s popular songs"—Nat King Cole, Dean Martin, Burl Ives. At one point earlier in our trip, Vish had quoted several lines of a somewhat familiar-sounding rhyme. When I asked him about the poet, he replied "Chubby Checker, 1962."

Street scene, town in Uttar Pradesh, northern India. Fruit stands and open-air shops are common in such towns. (Photo courtesy Carrie Sakai.)

Luckily, Carrie's flight out of Hong Kong is also late by nearly 2 hours, so after our arrival, I grab a taxi to the international terminal just in time to greet her in the warm Delhi night. As promised by the Embassy, our hired driver is here diligently searching for her, and takes us to the Claridges Hotel by 2:00 a.m., where we sleep exhausted for 2 hours until we rise like zombies to taxi back to the airport to begin it all over again for the flight to Dehra Dun.

13-14 April

Into Dehra Dun airport by 8:30 a.m., lucky to dip in below the clouds before the weather changes. Feels like returning to an old, familiar home town.

We nap, then tour the WII grounds and some downtown shops along the narrow, rushing, crowded "Suicide Alley," as Vish's daughter calls it. Brilliant silks, *sarees,* and scarves. Stacks of bright brass jugs, slender shops stacked ceiling-high with *kurtas, pajamas,* and bolts of glistening linens and wools.

Dinner: Baban's great cookery! Carrie is still running on Oregon time, and I sympathize with her ordeal in getting from Portland to San Francisco to Hong Kong to Delhi to Dehra Dun in essentially one continuous voyage. Now she can sleep like the living dead.

I didn't realize how much the past several week's travels were wearing on me until we have this chance to relax in our Dehra Dun home. With early mornings out hiking and exploring, with late dinners and nighttime spotlighting expeditions and wildlife-watching from hides, I've been getting substantially less sleep than I usually need. Feels good to catch up.

At Bombay, I had bought a book entitled *Teach Yourself Hindi*, a simple introduction to this surprisingly logical language. For the first time, the cryptic loops and swirls of the Hindi script begin to make sense, although I would certainly need many months of study to master even the fundamentals of effective writing or conversation.

What I find most fascinating, however, is the syntax of the language and how it differs from that of English. In Hindi, the verb is always found at the end of the sentence. For example, "I go to school" will be in Hindi *mai makan jata hun*, "I to school go." Other examples are *mera nam Marcot hai*, "my name Marcot is," and *mera ghar bara hai*, "my house big is."

Also, in Hindi the preposition is actually a postposition. For example, in English one would say "the book is on the table." In Hindi, it is *kitab mez par hai*, "book table on is." In the same way, one would say *gilas men pani hai*, "glass in water is." To inquire "where do you live?" one asks *ap kahan rahate hain*?—"you where live?"

This transposition of verb and preposition in the sentence structure is remarkably like the function of "parsing" taught in formal logic and in computer programming. Parsing is the reordering of elements in a formula so that the entities are listed first, followed by the function that relates the elements. A simple example is the formula "1 + 2." This would be parsed as "1 2 +," just as Hindi puts the action word, the verb, at the end of the sentence. Parsing is used in most computer programming in this same way for structuring individual formulae and logical relations or for sequencing logical sections of entire programs. For this reason, I hypothesize that the very structure of the Hindi language itself lends to thinking easily and readily in formal logic, mathematics, and computer programming languages. Indeed, Indians have emerged as world leaders in mathematics and programming computer software. I suspect that other native languages in India are similarly structured. We with English as our primary language have had to learn such convoluted means of threading nouns, adjectives, and verbs in our sentences that it takes special training to unlearn these habits and think with logic when programming computers.

As in English, questions in Hindi often are indicated by tone of voice rather than a change in sentence structure. Thus, *apka nam kya hai*?—"what is your name?" (transliterally, "your name what is?") is clearly denoted by the interrogative *kya*, "what." But the declarative sentence *apka nam Ram hai*, "your name is Ram," also can be the question "is your name Ram?" simply by changing the inflection. Between subtleties of inflection and the cultural norm of slightly tilting the head for "yes," it takes a little readjustment from American English to slip into the local culture.

But in my book tutorials, I find no trace of the mysterious *jacum-jum*.

15 April

Feels good to sleep in the coolness of this northern country, again in these Himalayan foothills, after the humid heat of the far south. Up at 5:30, coffee from Baban by 6:00, a quick breakfast by 6:15, and our driver Anwar promptly appears with our Jeep-like Maruthi by 6:30. Our plan ("program," as they say) is for Carrie and me to travel overland to Dudhwa National Park along the border of Nepal, some 12-14 hours southeast of Dehra Dun. Tom will remain at the institute to complete his trip report and draft syllabus chapters for the Wildlife in Managed Forests of India textbook on which we are all collaborating. Vish must attend to duties and also cannot accompany us on this venture.

Joining us on this travel is Qamar Qureshi, the brilliant doctoral research student we met earlier at WII who is conducting a world-class study on the endangered swamp deer or barasingha of Dudhwa. He will serve as our personal escort and scientific guide. Baban packs us a couple gallons of boiled and filtered water and lunches of vegetable cutlets and sandwiches, and we stuff the Maruthi with gear for several days. (As on many other journeys, it seems like I'm endlessly packing, sorting, unpacking, and repacking gear.) Carrie is still suffering jet lag, and Anwar is ill with fever and a bad headache, but off we go on our 13-hour, 370-kilometer drive to Dudhwa National Park and Nepal.

The "highways" along the flanks of the Himalayas, our route for the day, are at most a lane and a half of the most corrugated surface we have driven on yet, with 1- to 2-foot wide "shoulders" of uneven brick pavement and dirt. Again, we see long stretches of fertile croplands of wheat and sugar cane and pass many sugar refineries filling the air with thick sweet fumes. For 13 hours, we dodge public transports, trucks, buses bursting at the rivets with people, bullock carts tilting from their loads of fodder and cane, cattle, bicycles, women carrying bright brass vessels of water and stacks of firewood on their heads, rickshaws, motorcycles, scooters, and taxis. We careen through potholes, bounding over roads as rough as the frost-heaved paved ribbons I have traveled in interior Alaska. Anwar drives as fast as possible, and then faster still, managing to pretty much keep you airborne in the back seat. He reminds me of myself at about 19 when I took summer-long solo travels across the back roads of the United States and Canada on motorcycle, the quickness and precision of my reactions and eyesight and anticipation of the road ahead at a peak.

We pass many brickyards, which are vast pits carved out of the mud along river banks. I imagine the monsoon floods would render such areas unworkable for a good portion of the year. Older brickyards are abandoned, as once the workable alluvium is spent, there is no attempt to restore the fragile riparian vegetation, and yet another habitat is degraded for want of commerce and meeting daily subsistence needs. I do not wonder what higher technology substitutes there could be for making bricks. Rather, I ponder how this traditional backbreaking, brick-making enterprise can be supplemented by inducements to maintain the riparian vegetation and water quality. Government subsidies—even minor amounts—to reward such habitat protection measures might serve as inducements. But then there would be costs for the Government to monitor environmental conditions and assign appropriate rewards or fines. As in many other countries of the world, internalizing the external social and environmental costs of resource production and commerce would itself entail additional revenue.

The weather is definitely changing. All day long, and for the rest of this trip, we would not see the nearby Himalayas for the vast amounts of dust and soil whipped into the atmosphere from the wide agricultural fields. An amazing variety of scents fills the air along the way: sweet ferment of sugar cane processing plants, flower blossoms, open sewers, charcoal kilns, cooking fires, exhaust from a thousand vehicles, fresh cut fodder, and the musk of dung piled by the roadside and onto carts and vehicles.

At the end of the day my hands are red and raw and my arms sore from bracing myself every kilometer of the way, lest I continually smack my head on the roof or crush my wife. But for her, the back of a Maruthi for 13 hours is no place for jet lag. Although Carrie fared well on the trip, she was certainly haggard and long overdue for rest. But not a word of complaint.

Established only in 1977, Dudhwa National Park is unlike any of the habitats I have yet visited. Initially, through great administrative manipulations, Vish had arranged for special clearance from the Government of India for me to visit the Indian State of Assam in the northeastern corner of the country. Assam is mostly lowland valley along the grand Brahmaputra River and is surrounded by Indian states and other countries that are generally closed to foreign travelers: the Indian State of Sikkim and the tiny kingdom of Bhutan to the northwest, Bangladesh to the southwest, and other "closed" Indian states and the country of Myanmar (Burma) to the east and southeast. Assam is home to several national parks and wildlife sanctuaries whose fauna reflects true southeast Asian influence. I especially wanted to visit Kaziranga National Park in eastern Assam and Manas National Park by the Bhutan border.

Civil unrest prevented that trip, however, and I have Vish to thank for my not getting caught in a terrible situation over there. I would have flown from Delhi to Calcutta then to the Assamese capital of Gauhati, which was now under siege with snipers and antigovernment terrorists. Vish had just escaped from the city not long ago as roads, railways, and airports were being closed down. For several days, he sat in his hotel in Gauhati, waiting for the violence to clear and for transportation back home. I took to heart his insistence to avoid the area on this trip. Before leaving the United States, I could get no information on such happenings from the national news, from the Indian Embassy in Washington, DC, or from any of the international travel offices of our Federal agencies. Thus, it was impossible to gauge the likelihood of incident-free travel. Similarly, just during the early part of our visit to India, outbreaks of antigovernment violence also prevented Tom and me from traveling to Kathmandu, Nepal's capital, and to parks and forests within that country.

The base of the Himalayas runs from the Indian States of Jammu and Kashmir, Himachal Pradesh, and Uttar Pradesh in the northern part of the country, through Nepal and Bihar, and into Sikkim, Bhutan, and Assam in the east. Between this vast mountain base and the Indo-Gangetic Plain once ranged the sweeping *terai*, the hillocky, alluvial marshes of the wet grasslands. Technically, this habitat is dominated by the lofty *sabai* grass, and in the easternmost parts of its range, the *terai* is referred to as *duars*. The *terai* and *duars* are interspersed with dense woodlands of *Acacia*, sal, and other tree species. The *terai* and its eastern variant are home to an enormous diversity of wildlife, many of which are found in no other habitats.

Swamp partridge or kyah (Francolinus gularis). *Little has been studied or written of this seldom-photographed species. It is endemic to the vanishing* terai *(marshland) habitats along the border of Nepal and the Himalayas.*

Much of the *terai* has now been drained, burned, grazed, and converted to pastureland or cultivated tracts, leaving only scattered remnants in the small and isolated national parks. Dudhwa National Park is one of the largest areas of *terai* remaining. Thus, although I cannot safely visit the *duars* of Assam, the *terai* of Dudhwa provides a nearly equivalent experience.

Just outside the park boundary at sunset, we encounter the first marshes and pause for photographs and observation. From one spot, I count 13 species of marsh habitat birds, including small, medium, and large egrets, open-billed storks, white-breasted waterhens, chestnut-headed and green bee-eaters, and purple moorhens. A group of 29 giant sarus cranes, standing up to 2 meters, tower over their associates. I photograph several males, with their long gray-white necks and bright red heads, leaping high with vigorous, flapping descents in courtship display.

Vegetable vendor in small town outside Dudhwa National Park, Uttar Pradesh, northern India by border of Nepal.

We stop at the last village before entering the park and buy food for the next several days: squash, beans, and fruit, but no meat. One *longhi*-clad food vendor with gray flowing whiskers sits cross-legged on a blanket with his food neatly arranged in a multicolored circle around him. Clouds of flies cover the vegetables. He weighs our selections on a crude, hand-held brass balance and announces the price in Hindi to Qamar. For a few cents, we are supplied for the duration.

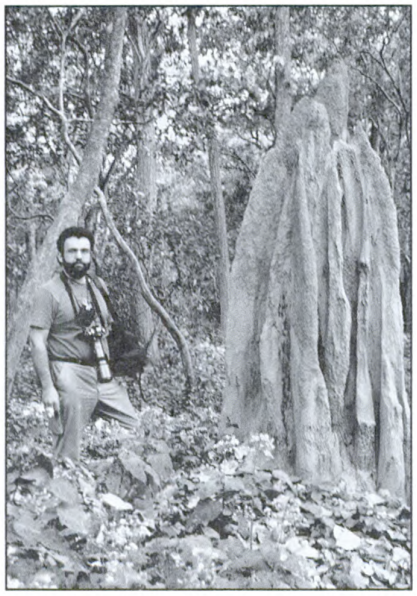
At dusk we reach the park boundary from the south and stop at the tourist center, a series of rustic cabins with a central mess hall, where we eat a dinner of *chappati,* vegetables, and omelette. Carrie is frazzled and sleeps in the Maruthi, and Anwar's enormous headache has turned to pains shooting through his left eye. Outside we are approached by a semitame *nilgai* or blue bull, a gawky horselike relative of the antelope, this one brought in at 2 years old as a stray. In many parts of their range, from the base of the Himalayas to Mysore, nilgai enjoy complete protection, being regarded as a near relative of the cow and therefore sacred.

A half-hour later, Qamar gets on the "wireless" and calls his associate, Dr. Satya Sinha, Senior Research Fellow, at our rest house destination 15 kilometers further into the park and sets up our arrival. The wireless has just recently been installed and every hour on the hour all local park offices tune in to share messages. There is no phone and until recently no direct communication within the park. The wireless is confined, however, to stations only inside the park. There still is no communication with the outside.

We eventually reach the rest house well after dark on roads deep within the dry deciduous sal forest. Spectral forms of termite nests 2 meters tall glide past in the dense roadside foliage. The rest house we are driving to is usually off-limits even to forest officers, so we have been granted special permission to stay there.

Maybe I'm just tired, but the scene at our final stop seems rather eerie. Dr. Sinha greets us with a staid but earnest "welcome," and with a candle and kerosene lamp shows us through creaking, large wooden double doors into the shadowy rooms to our chamber and then disappears. Several *longhi*-clad men (cooks? servants?) follow us silently at the edges of the light. In the soft yellow kerosene glow, this rest house looks like it hasn't been swept or cleaned or painted for decades. The window to our room has thick bars set into the concrete frame, built, I correctly assume, for protection from the man-eating tigers that frequent the com-

Access road within Dudhwa National Park through a forest of sal (Shoria robusta), *lined by conical termite mounds. There be tigers here.*



The author alongside an active termite mound within sal forests of Dudhwa National Park, northern India, along the Nepal border.

pound and roam the woods. Vish had warned us to be absolutely sure we double dead-bolt the outer and inner doors at night and not to wander the compound after dark because of local man-eaters. Earlier, a tiger had gained entry to the house, climbed the stairs to the open loft overhead, and clawed several other visitors in their sleep who were using the loft for the cool night breeze.

No running water, no electricity. This is the typical arrangement, as with the tourist cabins at our last stop. A large bucket of well water was left for us in one corner of the bathroom, with another empty bucket for shower and washing purposes. I skim off the floating insects and scoop out a few handfuls to wash up.

Especially at night, dense colonies and stringers of large red ants coat the bathroom walls, winding their way through the sink and across the floor to the toilet. I caution Carrie to be careful where she steps and washes. We find large brown spiders in the corners of the room and on our sandals, and a 2-inch scorpion on the wall next to the bed. Carrie used to work for the Forest Service and as a California state park naturalist in a variety of quite rustic conditions before her phenomenal career-shift to computers, IBM Corporation, and the world of business suits. I also have spent many years traveling and camping, including rainy journeys to Mexico, Costa Rica, and various Caribbean islands. We both are used to sharing quarters with a variety of wildlife, vertebrate and invertebrate.

I pull a chair and small table to the center of the room and stack our belongings off the floor and away from the walls, somewhat out of reach of whatever crawls. "Watch for Friends" becomes the byword, as I empty another spider from my recently dropped boot.

Dudhwa Park, located in Lakhimpur-Kheri District of Uttar Pradesh, is comprised of dry deciduous sal forests, sal forests mixed with grassland, pure *terai* grassland, and a number of marshes and wetlands. The park thus offers an amazing variety of habitats and therefore wildlife and is a great attraction for tourists. Lying in the *terai* belt of the Indo-Gangetic Plain, the park is the main strong hold of the relict population of twelve-tined "Bara Singha" swamp deer, a species of deer evolved to a semiaquatic

Swamp deer or barasingha (Cervus duvauceli) *are endemic to India and may be the most world's most endangered ungulate. Swamp deer of* terai *(marshland) habitats are highly gregarious and usually found in water. Most of their marshland habitat has been drained and altered.*

existence. In all, five species of deer—spotted deer, hog deer, barking deer, sambar, and swamp deer—are found here, thereby making the park utterly unique.

And very few places contain such large populations and high densities of tigers as Dudhwa. Accordingly, Dudhwa National Park has recently been designated as one of the tiger reserves under Project Tiger. "Reserve" is a safe-sounding title unless one is camping in the middle of the forest, barricaded behind old doors and windows with iron bars.

Carrie falls asleep in the bed, surrounded by an improvised curtain of musty, yellowing mosquito netting. I turn the kerosene lamp down to low and join her in the dim orange shadows. Writing these trip notes by candlelight. Hear doors squeaking open in the outer room, no voices. Ours is locked here. I think I forgot to lock the outer door, but I'm not going to go out to check. After a time, just outside the window, I suddenly hear three loud catlike *reoww* calls, deep and forceful. Peafowl, I reassure myself, and finally fall asleep.

Lesser adjutant stork (Leptoptilos javanicus), *a bird of the terai marshlands of northern India.*

Water birds, Dudhwa National Park, northern India. Much of freshwater habitat in India has been lost to civilization. Seasonally flooded grasslands provide key habitats for many species such as spoonbill (Platalea leucorodia), *smaller egret* (Egretta intermedia), *and large egret* (Ardea alba).

16 April

Began our day's visit at Dudhwa with a cup of coffee at 6:45. Soon our "taxi" arrives, a young female elephant ridden by the local native expert. Following his slightest command, the elephant drops to the ground on its hind knees, front legs stretched straight out. We climb up from the rear, stepping on her hind legs and pulling ourselves up with the ropes used to lash a grass bag and cot-saddle, like a short *charpoi*, to her back, and we situate ourselves on her shoulders behind the driver. Up she stands, and down the trail we go into the forests of the park. Shortly, we are called back, however, because we had not been formally admitted into the off-limit areas by the park director. Formalities.

Instead, we go by Maruthi to several *machans* along the marshes and wet grasslands with Anwar and our forest guide who speaks no English. I do not have my field books with me, so I point to some marsh birds and get an earful of incomprehensible Hindi. All I can respond with is a tilt of the head and a simple *ha, bahut panchi*, "yes, many birds," and *Hindi nahin janta*, "I do not speak Hindi," which only serves to trigger yet another wave of one-sided conversation from our kindly escort.

Out across the marshes we see the diverse wildlife of the *terai*: open-billed storks, three species of egret, gray herons, comb ducks, shovelers, swamp deer, hog deer, spotted deer, and wild boar. A gray-headed

fishing eagle leaves its perch and the waterbirds scatter at its pass over the *tal* (pond) surface as it searches for its swimming prey. The profusion of wildlife also includes Indian spoonbills, white-necked storks, Indian cormorants, darters, purple herons, lesser adjutant storks, Indian ring doves, spotted doves, small flocks of Alexandrine parakeets, and white-headed stiff-tailed ducks, endemic to the large lakes of Pakistan and northwest India.

By midmorning we return to the rest house as a pair of Indian pied hornbills fly over. We nap until 1:00 and then have a late lunch of *chappati, dhal bhat* (rice and lentils), pickled vegetables, pickled onion, and water. The menu of breakfast, lunch, and dinner would be precisely the same every day.

I'm not sure about the safety of the water here for Carrie and me. Although it comes from a recently dug well, it still should be boiled and filtered. I go out back to visit with our cook-servant and see that our "kitchen" is an open-air tarp strung to cover a corner of the back courtyard, with a ground fire of small sticks and at most three or four pots scattered about. I ask him for *garam pani,* "hot water," and he boils a small pot full. I then filter the water through a coarse strainer (who knows how and if it has been washed) into another vessel (same question), let the water cool there for a short time, and then transfer it into Carrie's plastic water bottles. The process proves to be effective, as Carrie never got ill.

This process of purification is so time-consuming and bothersome, I do it just for Carrie's supply and choose to risk drinking straight from their filter, rationalizing that I probably have built up some degree of immunity to the various strains of microflora, microfauna, bacteria, and water parasites by now. I was wrong. Luckily, it was not until we would return to Dehra Dun that it would hit me, not the typical "Delhi belly" of diarrhea and nausea but instead 16 hours of intense migraines, very high fever, chills, convulsions, nausea, and vertigo. Later, one of our WII friends suggests it was malaria and that I should get my blood tested upon return to the States. Although we have been taking the standard chloroquine pills as a malaria preventative, the recent World Health Organization book lists India as having a "chloroquine resistant" strain of malaria with no known effective prophylactic.

For now, though, we sit on the front porch of our Dudhwa rest house after lunch in the 40-°C heat, continually swatting clouds of flies that we wear like a wrap. *Bahut garam,* "very hot!" As Dr. Sinha takes his Enfield to the field director's office to get clearance to travel into the core area of the tiger (and rhino) reserve, Carrie and I climb the 24-meter-tall *machan* built into a tree near the rest house compound to view the broad grasslands and forest edges of inner Dudhwa. We spot the tall fence Sinha has built to enclose some 30 square kilometers of grassland and woods for his rhino reintroduction

The author's wife (Carrie Sakai) at an unusually high machan *or tree hide (blind) in Dudhwa National Park, overlooking a vast enclosure for a reintroduced population of endangered great Indian one-horned rhinoceros* (Rhinoceros unicornis).

project. The 4.5-meter-tall fence itself is a marvel of hard work and ingenuity, as it is constructed of seven 2000-volt pulsating-current strands of wire to keep the rhinos in. And it works, keeping the rhinos from wandering into cultivated fields and villages that border the park and its core area.

There are actually two kinds of grassland present in Dudhwa, the original *terai* wet grasslands and what Qamar calls "derived grasslands" that resulted from tree felling, burning, and plantations. As well, the moist deciduous sal forests are complemented by more open sal savannas, dense *Syzigium* woodland communities along the riparian flood plains, and moist savannas dominated by the shorter trees of *Acacia catechu* and *Dalbergia sissoo*.

Some of the sal forests had been harvested and replaced by plantations of teak and eucalyptus. Teak is introduced here and not native to northern India. The teak plantations have not taken well, as the trees have grown slowly and often are stunted. Although the exotic eucalyptus have done well, neither type of plantation offers much in the way of wildlife habitat. Teak and eucalyptus plantations lack the variety of fruits, seeds, foliage, and cavities provided by the native shrubs and trees. They rob the park of area otherwise usable as native forest, woodland, savanna, or the wet grassland. Eucalyptus, especially, offers no value as cover or food. Both plantations also tend to be structurally simple with trees planted at even spacing along grids and virtually no understory shrub, tree, or ground cover otherwise so important as cover for the native swamp partridge, black partridge, peafowl, hog deer, and many other species of the *terai*.

Sinha is experimenting with the response of grasslands to fire. Fire is an important element in the *terai* ecosystem, as it aids in returning nutrients from last year's grasses back to the soil for this year's growth. Sinha is tracking productivity of grasses in experimental grids over six permanent study plots and observing how the timing and intensity of fires and mechanical removal of grass affect grass regrowth. This study in particular, and others of its kind in general, will provide invaluable and necessary information for devising management plans for conserving wildlife values in these increasingly rare grassland and savanna habitats.

Sinha had come to the Dudhwa project literally by way of the Himalayas, having spent a number of years tracking and studying the rare snow leopard throughout the high country. He shows me maps of his earlier study. His treks for the leopard covered hundreds of kilometers of roadless wilderness into the inner Himalayas at mountain heights that commonly cause altitude sickness in those not well acclimated. The lines on the maps demarcating his travel routes belie the steep ascents and descents his routes took, as every new ridge was spanned by deep valleys and chasms. In the early days of his studies, he said his small team invaded the inner mountains ill prepared for the blizzards and enormous changes in temperature, and they found themselves sequestered in camps for weeks in deep snow, wrapped in thin bedrolls under tarps whipped ragged by the winds.

Sinha is a quiet, lean, solidly built man accustomed to living under the simplest and most remote field conditions. He occupies one wing of the rest house at Dudhwa as both office and bedroom. A modest set of shelves is filled with volumes on park management, wildlife, and botany, and his desk is littered with books and writings in progress. He works by the light of a kerosene lamp, and with no power, he has neither electric lights nor fans with which to keep cool during the torrid rains and midsummer heat. His main transportation throughout his territory is his Enfield motorcycle, and he has no communication with the world outside the park. To ensure that Carrie and I could visit him, Vish had sent a wire to the WII in Dehra Dun to have someone drive all the way out here to Dudhwa and hand-

deliver a message to Sinha announcing our planned dates of visit. The days of message carriers and runners sent across the Himalayas and Ganges plains to deliver news are essentially still here. As I remarked on the simplicity of his lifestyle, which at times I have shared in my own career during field studies, Sinha merely replied, "Simple is best."

He works in the office and field here year-round, including during the heavy and continual monsoons. Such extreme conditions do not keep him indoors. To the contrary, that is a unique time of year when habitats change drastically and wildlife shift to new territories within and outside the park. Understanding how wildlife use their habitats and resources during all seasons is necessary for crafting management plans and policies that provide for their continual survival. During monsoons, insect populations grow to ghastly numbers, invading shelves, books, food, and bed. It's all just part of the natural system, he says, and accepts the conditions happily.

Still, he asserts that the park with its heavily used buffer areas and habitats may indeed provide for needs of both wildlife and humans if the management policies were strictly enforced and if a few of the local forest guards did not accept graft. Thus, Sinha hangs on his wall a picture of a tiger with the caption "No politics." Later, I would snap a portrait of him on his Enfield out in the park and hang it framed, with the same caption, on my den wall back home.

By midafternoon, he returns from his trip with a single sheet of paper, an already-used copy of a form rather cryptically titled "The Registration of Foreigners Rules 1939 Hotel Arrival Report Form C Rules 10 and 14." As it is already filled out by some other previous visitor from Germany, I simply copy the form longhand onto a sheet of notebook paper and then fill in the blanks and sign at the bottom. He tucks it away in his office and announces we are now free to visit the inner park area. This is what had held us up this morning. I guess bureaucracy is universal, and both Sinha and I disdain how it too often gets out of hand. Without the paper, however, he would be held personally liable for any mishap. And with free-roaming tigers, leopards, elephants, rhinos, cobras, kraits, and other potentially aggressive species, such a risk here is much more than trivial or academic.

Late afternoon, we travel to several wetland habitats in the park, including rivers, *tals*, and marshes, which collectively comprise only 2 percent of the park but are critical habitat for a wide variety of wildlife using the aquatic and shoreline habitats. Additional species found in the park include sloth bear, otter, mugger, Indian fox, jackal, and 375 species of birds. Along a couple of trails to some of the *machans*, we find droppings and pug marks of fishing cat and leopard cat, small, seldom-seen felines.

Qamar remarks after we pass one particularly dense, brushy stretch, that, a week before, this is where he encountered a fully grown king cobra. According to J.C. Daniel's book on Indian reptiles (see "For Further Reading"), king cobras can reach over 5 meters (that's over 15 feet) in length and stand nearly eye-height, flaring its wide hood just before spitting venom at the victim's eyes and striking. The snake is unique in that it can attack unpredictably and without apparent provocation. The bite is firm and the snake hangs on tenaciously, pumping large amounts of venom into the victim with a chewing motion of the jaws. Experiments in the laboratory have revealed that the quantity of venom injected with a single bite amounts to 10 lethal doses to a person. Death usually follows in 15 to 20 minutes and is essentially inevitable. India does not even manufacture an antivenin, although Thailand does, but that's rather far to travel in only 20 minutes.

Now he tells us.

At one point along the trail a small herd of cheetal crashes through the brush 10 meters away. Carrie looks up with a start and through the foliage sees only large orange forms moving parallel to us. She later says her heart began racing as the thought "tiger!" flashed through her mind.

Some of the wildlife is endemic to the *terai*; that is, found in no other habitats. These include the hog deer, so named because it runs flat-footed, unlike other deer, with its head held

low like a boar. Another endemic is the Bengal florican, a species of bustard (large terrestrial birds) inhabiting open grassy plains. The hispid hare is a very rare and seldom seen endemic of the grasslands. Sinha proudly describes the photograph he recently snapped of a hispid hare, surely the best and quite possibly the only photograph of the species in its natural habitat.

Worthy of special mention is Sinha's reintroduction program for the great Indian one-horned rhinoceros. The Indian rhino is now confined to the few national parks with *terai* habitat in the northeastern corner of the country, principally Manas and Kaziranga National Parks in Assam and Royal Chitwan National Park in southern Nepal. The last rhino in Dudhwa National Park was shot in 1878, and the species has been extirpated from most of the rest of its range.

In Dudhwa National Park, Sinha has constructed a rhino enclosure fence, and for the first time in over a hundred years, half a dozen animals are now living in the Kakraha Chaur area of the park. In all, Sinha has reintroduced nine rhinos, including two adult males and five adult females, but two have died, leaving only one bull. The natural sex ratio is about one male for every two females, but in this tiny population, it is currently one-to-five with an additional three calves. Although comprising a tiny population that may not be self-sustaining over the long term, the remaining seven rhinos seem to be faring well.

The original proposal was for an introduction of 90 rhinos, but politics in Assam and Nepal stopped this more extensive project. Essentially, the local governments of these other areas are concerned that restoring the species to other parts of its former range will detract from their local tourist interest. A total of only 1,750 great Indian one-horned rhinos currently exist in the wild, 1,300 in Kaziranga, and the rest in Royal Chitwan and Manas. Eventually, though, if the tiny Dudhwa population shows signs of increase, the fenced area could be expanded to 90 square kilometers from its present 30 to allow the population to expand.

Other purposes of the project are to study patterns of the rhinos' habitat use and seasonal movements and the health conditions of the calves and cows. During the dry season, mud baths and low-lying wet areas are important for the rhinos to stay cool and feed. During the monsoons, these areas become flooded and the high grass areas then become important. Thus, a balance of both kinds of habitat and sustaining the hydrologic balance of runoff and flooding must be provided for year-round survival.

To capture, inspect, tag, and transport the animals, Sinha has ingeniously invented a tranquilizer gun from a modified motorcycle pump that he shoots while on elephant-back. As well, he is tracking movements of three male and two female tigers within the rhino area, as tigers are known to feed on rhino calves up to 8 months old. I can't help but think that would be a quite remarkable sight.

Qamar Qureshi, our other young traveling companion and scientist-in-residence at Dudhwa, has a comprehensive expertise of local plant and animal species, habitats, human customs and traditional use of resources, management issues and opportunities, and technical aspects of scientific data collection, analysis, and interpretation. More than that, his extensive knowledge of the variety of cultures and religions of northern India is most impressive, and rather necessary for successfully knitting habitat management plans with local human needs. Qamar listens well as you speak, then answers always with a broad smile and directly to your question or comment. His good humor and attention to our needs makes our journey seem familiar and relaxed.

As we visit on foot another of the *machans* along a dense trail of brush and riparian woodland, he casually relates how the last time here he accidentally encountered a bull elephant at close range. After a mad dash and frantic climb, he sat in the tall hide while the bull trumpeted

and waited below, and he thought he'd have to stay up there all night. Eventually the bull disappeared from view and he warily climbed down and snuck along the trail back to the Maruthi.

Qamar probably is the only scientist to conduct broad-based surveys for swamp deer in the remaining *terai* remnants all along the Himalayan range from Uttar Pradesh through to northeast India. He recounts the recent time in Assam when he was on a survey outing with four specially trained armed guards, when they suddenly came upon five rhinos, including a large male and a female with young. He turned to motion to the guards to stand ready, only to see that all four had dropped their weapons and were off in a dead run for the woods where they climbed the nearest trees. As the rhinos began their charge, Qamar said he ran like he never ran before for 200 meters, never looking back, until the beasts broke off their pursuit. Afterwards, the guards were relieved of their duties and Qamar was just happy that the incident ended without loss of life—human or rhinoceros.

Early evening: Our elephant-taxi arrives once more and we sling cameras, climb the gray mountain, and shuffle off into the deep brush. Through the colossal rhino fence, the grassland takes on its pristine form devoid of excess trampling, livestock grazing, and other unrestrained exploitation. Rare, unspoiled *terai*. At this time of year, the elephant grasses or *sabai* are beginning their annual race upwards and in time will reach an astounding 8 meters (25 feet) in height. Stems from last year tower 2 to 3 meters over our heads even when we are on the elephant. This must be one of the fastest-growing grasses in the world, second to the bamboos. In Dehra Dun, we saw examples of giant bamboo that reach 15 meters or more in height with stems half a meter in diameter. (Remember, this describes a single blade, as bamboo belongs to the grass family.) Vish said that during the early rainy season you can actually hear the seams of the giant bamboo creak as it grows.

Our elephant has a Hindi name meaning "lover of the wind." She had been taken from a circus and retrained here as a mount only in the past year. She minds well, but our diminutive, Hindi-speaking native driver—a *mahout*—is firm of hand. He wields a meter-long wooden stick or metal bar that he firmly applies with a smack to either side of her head to keep her from getting out of hand. Apparently, once she has the liberty of straying from the directed course, she is very difficult to redirect.

With the frequency of tigers, rhinos, cobras, and other carnivorous friends, elephant-back is one of the less risky modes of transportation into the tall grass country. It is hardly risk-free, however, as tigers have been known to pull riders from their elephant mounts with great leaps. Unarmed, there would be virtually nothing we could do should one of the big cats choose to have one of us for lunch.

Early evening across the grasses, a quiet time on the *terai*. The rhythmic swish of elephant grass at our thighs as our mount sways through the dense brush. Orange sunlight slanting through the scattered savanna trees. A covey of black partridge, another *terai* species, scurries into brush cover across an opening. One of the pied hornbills flaps overhead.

We have seen several species of hornbills with confusingly similar names: common gray hornbill, Malabar gray hornbill, Malabar pied hornbill, Indian pied hornbill, and great pied hornbill—the last the largest of all. The differences are in their overall size, amount of white edging on tail and wings, and size and coloration of the large hollow casque that rides above the top mandible and extends to the forehead. The purpose of the bizarre casque is not well understood. Some speculate it serves in sexual or species recognition. It may very well serve as a resonating chamber for the species' loud honks, squeals, raucous cackles, deep hoarse grunts, and loud barks, as Ali described the various vocalizations. After hearing

the timbre and vibration of their calls, I suspect that even if the casque serves other purposes, it likely also acts as a built-in megaphone.

We pass several of Sinha's experimental grassland plots and flush up some large grass warblers and collared bush chats, sparrow-sized birds of the *sabai* grasses. Further on, the *mahout* guides the beast down toward dense grass thicket, and suddenly I spot a curved, gray shape nearby on the ground. We identify it as a 20-foot python, with a tremendous bulge a quarter way down its length. Sinha announces it is the same snake he observed earlier consuming a barking deer that it had captured probably in ambush and had suffocated with its massive coils. The elephant nervously stamps in circles as the driver tries to edge it closer for a better look. The bulge of its dinner is probably a good third to half a meter in diameter. The elephant is all too happy to finally leave the site. The snake will probably lay in the same area for several days, slowly digesting the massive meal, and would not have attacked unless accidentally approached too close. Had we been on foot, we would not have been able to spot the beast until we were within close striking range.

Further along the open woodland down the grassland stream, we spot Indian white-backed vultures sitting on high nests in the trees. Most vultures lay their eggs on bare ground or rock ledges on cliffs or scarps, but these species build and maintain stick nests on the tops of the taller trees.

We finally reach a point where Sinha had left his Enfield in the brush. He and Qamar slide off the mount, retrieve the machine, and vanish down the dark trails bouncing behind their scant pool of dancing headlight, the whine of their motorcycle engine fading into chirring insects. The shadows blacken in this heart of the *terai* country as stars begin to peer through the broadly spreading *Bombax* and scrubby *Acacia*. Carrie, our *mahout,* and I pass another elephant mount in the dusk and our drivers exchange a few quiet, casual words in Hindi until the others are swept into the jungles and shadows. At last light of dusk, the characteristic silhouette of a stringer of 30 spoonbills wing over, then the strangely elongated form of a male peafowl darting across the darkening violet. Soon we are traveling in silence by starlight, the massive piston legs of our mount swinging in a rhythmic and steady and mesmerizing pace. Brilliant stars, calls of Indian nightjars, and a cool breeze follow us down the long dark woodland tunnel. I think of the tigers on hungry prowl, but the night is too alluring to feel apprehensive at the danger. I wonder if that is how so many others have met their fate.

17 April

Sunup, and another elephant outing with Sinha, Qamar, Carrie, and Anwar to explore the tall morning grasslands. We wind our way along riparian courses of open woodland among the dense forests bordering the broad prairies.

Later, we return to the rest house, and Sinha and I tour the wider reaches of the park on his Enfield. We wind through the narrow woodland foot trails, unimproved dirt roads, and across shaky remnants of trestle bridges stretched over rivers running low in the dry season heat.

Management of both the Dudhwa core and buffer areas is quite different than that I have seen in central and south India. The Dudhwa core area is not a *sanctum sanctorum.* Instead, it is transected by two railway lines and numerous roads. The core area is some 200-plus square kilometers in area including part of Dudhwa National Park, which itself includes two buffer areas. The core area is conterminious with the park with buffers of 120 square kilometers to the north and south. The buffer areas are particularly disturbed with settlements and heavy land use.

The core area seems disturbed in part because of land allocations made before, and retained during,

Boundary of Dudhwa National Park, northern India, showing protection of some of the forest resources in the buffer area (right) and open, overgrazed cattle pastures (left) just outside the park boundary. Grazing even within the park's buffer area has severely altered native vegetation and associated wildlife communities.

establishment of the park. These allocations include tribal villages along the Nepal border in the northern buffer area along with their intensive use (through assigned rights or concessions) of the buffer area forests. This intensive human use of the buffer areas both north and south also is felt inside the assumedly protected core area. I suspect this will greatly limit our opportunities to try creative forest management in the buffer areas to conserve wide-ranging wildlife species in the core area. Such forest management could include manipulating forest and woodland stand composition, structure, and distribution to provide better and more extensive habitat for ungulates, bears, jackals, and other species. Also, because of the shape of the park and core area boundaries, the core area is a long thin strip with much edge. This probably greatly limits the proportion of core area that is free from adverse influence from the heavily impacted buffer. Just how far this edge influence is felt into the core area is not well known. The distance of influence probably differs with species or habitats of interest.

The buffer areas north and south of the Dudhwa core area are essentially open to public use for grass, grazing, and firewood collection. I see few snags and few large down logs, habitats vital to a wide variety of wildlife, in either of the two buffer areas in the park's core area. The grass component is grazed to a very low height in the buffer areas I explore, in contrast to the wet, tall grasslands in the rhino protection area within the Dudhwa National Park core.

There is a nearby satellite sanctuary to Dudhwa National Park, called Kishanpur Wildlife Sanctuary, separated from Dudhwa by some 20 kilometers of cropland. There currently does not seem to be a grassland, savanna, or forest corridor connecting the two sanctuaries, and I fear that populations of swamp deer, hispid hare, and other *terai*-specific species may be isolated in one or both of the parks. And the next closest park with such habitat is a long ways off. Such isolation can serve only to increase risks to long-term population viability. Indeed, during our visit to Dudhwa, Qureshi conducted another census of swamp deer, results of which again suggest a decline in their population size. As to how much of this decline is attributable to poaching, habitat isolation, or other human disturbance in the core, buffer, and cropland areas is presently unstudied and unknown. Qureshi suspects similar trends of population declines in recent years for hog deer, hispid hare, and other species, although no monitoring program currently is funded.

The geography of Dudhwa and its satellite sanctuary is such that animals often wander from the core areas into buffer areas or croplands. Hog deer, wild boar, cheetal, and

swamp deer are poached in the non-core areas. During late summer season when grasses within the core area are very tall and nutritive value for browsing or grazing is quite low, ungulates move at night through the buffer areas into adjacent cropfields. This is when they are taken. Some villagers have hung loop type wire traps from trees for 100 to 200 meters to catch spotted deer, hog deer, and any other species that succumb to the snares. Some illegal taking of peafowl occurs in the buffer, and villagers also set nets for black-naped hare and inadvertently catch hispid hares, an endangered and little-known species endemic to the *terai*.

Intensive human use of the buffer areas is officially sanctioned, and humans often are present day and night. Illegal tree felling apparently also occurs. Thus, the animals are constantly disturbed and are not allowed time in the buffer for dispersing or for using food and cover resources. Accordingly, they have changed their natural habits of habitat use and activity patterns. In areas heavily used by humans, for example, tigers resort to mostly nocturnal hunting, whereas in undisturbed areas they also are active during the day.

Another problem is animal depredation on croplands adjacent to the buffer areas. I visited one sugar cane field in which a migratory herd of wild elephants had recently raided and crushed a portion of the crop. According to Sinha, three herds 4, 13, and 35 strong are known culprits. There is no compensation given to the farmers for depredation damage. This policy contrasts with the compensation policy I learned of in Melghat Tiger Reserve in central India, where Government compensation was paid to villagers when livestock was taken by tiger. As a result, local farmers at Dudhwa have resorted to erecting electrical fences and light bulbs in their crop fields in vain attempts to stem the depredation.

Wild elephants wandering to crop and village areas also pose threats to human life. In a recent incident, a man, his wife, and child were killed when a stray elephant attacked them on their bullock cart.

The two resident scientists, Sinha and Qureshi, both have substantial expertise and personal experience with the *terai* habitats and species. They could guide a much more extensive research and monitoring program specifically aimed at management questions, if more fully funded and staffed. Some of the key questions management should ask include:

- What is the long-term effect of the intensive human use of the buffer areas and adjacent croplands on habitat quality and distribution and abundance of scarce or endemic wildlife species? Specifically, what are the effects from intensive firewood gathering and illegal taking of deer and small mammals?
- What is the effect of the lack of a habitat corridor between Dudhwa National Park and Kishanpur Sanctuary on the distribution and abundance of scarce or endemic wildlife species, or species of special human concern, especially hispid hare, spotted deer, and elephant? What kind of habitats would best link the two reserves? What general lessons about reserve linkage can be learned from this case study?
- What are the population trends of scarce or endemic species of the *terai*, including hispid hare, rhino, pygmy hog, swamp deer, hog deer, swamp partridge, Bengal florican, striated marsh warbler, and red-capped babbler? If any show decline, such as the swamp deer have, what are the reasons, and what management actions should be taken to stem the declines?

Later, Carrie, Qamar, Anwar, and I go by Maruthi to several *machans* overlooking the wide curves of ox-bow *tals* isolated from their riverine sources by years of grassland growth. I count some 28 species of birds. At one point, using the vehicle as a moving hide, we slowly coast up to a herd of nearly a hundred swamp deer resting in a tight group in the low orange glow of the sun. I try to imagine this *terai* scene as it might have been merely a few decades ago, with dozens of such herds dotting the marshes and lake margins.

We stop at what seems to be two isolated buildings—an office and a small house—and pick up a local native guide who has worked with Qamar on his deer projects. The guide takes us several kilometers down dirt trails to a spot where he has seen many owls. We come upon a stand of moist deciduous sal forest with a dense evergreen component.

Almost immediately we spot a brown wood owl (*Strix leptogrammica*) flying from the dark understory, alight, and call with a characteristic and unmusical *pdd-pddd-ddddd-pdd*, quite different in tonality than other species of *Strix* I have encountered here and in New World forests. Further down the road, the deep *oo-HOO* of the eagle owl (*Bubo bubo*) announces its presence. The devil bird himself! The squeal of a red jungle fowl and repetitive toots of a large green barbet join in the dusk chorus.

It is dark and during the drive back to our rustic rest house the Maruthi's headlights catch a jungle cat, two jackals, and three Indian nightjars.

Another long night back in the rest house under the musty and rather ineffective mosquito nets. The moon is rising late now and the early night jungles are particularly dark. Outside our porch in the dark, I hear rustles of feet in the wall of vegetation. Barking deer, perhaps, or cheetal, or just maybe the pad of a hungry night stalker.

A recently abandoned forest rest house in tiger habitat (second-growth Shoria *jungle), Dudhwa National Park.*

18 April

Morning at the Dudhwa rest house. The dawn chorus of birds is staggering, with metallic pure two-tone songs of drongos, harsh screams of peafowl, staccato screeches of red jungle fowl sounding so much like the familiar morning calls of domestic roosters, and a dozen or more other species whistling, singing, and calling.

Time to pack the Maruthi and take the grueling drive back home to Dehra Dun. This time, both Sinha and Qamar will join us, making maximal use of the Maruthi space. Actually, that's not quite true. There was one outing in south India where we began a Maruthi tour of the forests when several locals suddenly appeared, and everyone exhaled so eight of us could cram into the small vehicle. Bounding along the dirt road that I could no longer see because of the bodies, bumping hips and shoulders, I smiled at Tom and joked "Well, the only way we could fit any more people is if they cut a hole in the roof!" and suddenly we slow down and two more men hop in, one riding the back bumper and

hanging half out the door. Thereafter, Tom and I agreed that "10-to-a-Maruthi" qualified as a new form of transportation for our trip list. But looking at the density of bodies on some of these flatbed trucks, vans, busses, and even tractors that we pass on the highway (10 to a tractor!), this was hardly an unusual occurrence.

On our drive back to Dehra Dun, we stop at the ancient town of Moradabad, named for its founder in the 1600s, a brass artisan named Morad. Morad had perfected unique skills of brass work that are still taught and used here today. His art often was given as gifts for the *rajas* who once ruled the local states that subdivide Uttar Pradesh. The town still is known for its fine brass and silver crafts. We find narrow, busy back streets filled with shops and buy a few brass items, including candlesticks and a perpetual calendar in the form of an ornately decorated brass wheel. Sinha surprises us with a gift of a black hand-etched brass vase, and Qamar gives us a brass hanging plate, remembrances of our friendships and travels throughout the grasslands for many years to come.

The States in India had once been divided into smaller dominions, each ruled by a king. At a lunch stop, Qamar talks with the owner, and they usher Carrie and me through the back door that quite surprisingly opens onto the platform of an old train station once built for and used only by the local state king. Two travel cars still sit at the station as if waiting decades for the engine to reappear and haul their royal passengers to distant destinations.

All along the highways, motor rickshaws and public carrier trucks have personal mottoes and sayings painted on their sides and backs, mostly in Hindi. Qamar translates a few as "make love," and "beauty to see not touch." The backs of the trucks typically read "horn please" (to pass); in proud bold letters, one mistakenly was spelled, "horan please." They also urge "use dipper at night" (again, to pass; at night, a flash of bright lights is much more effective than a horn in the dark). Most trucks read "OK" on the passing side (the right side in India) and "Ta-Ta," the truck brand, on the other. We begin to refer to the speedy vehicles as "OK-Ta-Ta's."

We pass many farm fields with 3- to 5-meter tall *kups*, stacks of wheat chaff shaped like giant onions. At dusk, we stop once again at Hardwar, the ancient and holiest of Hindu cities, and walk along the *ghats* by the swift Ganga and along the narrow shop-filled streets further up the riverfront. Pilgrims bathing in the chilly, rushing, sacred waters. Carrie and I dip our arms and shoulders in, realizing that one is not considered truly and thoroughly cleansed of sin unless the entire body is immersed many times. For a few rupees, we purchase a floating flower cup made from the brilliant petals of flame-of-the-forest tree, light the wick, and send it down river in the fading twilight to honor saints and ancestors of ancient times.

We pause at an elaborately designed, three-spired temple colored rust red and overlooking the very banks of the Ganga, the tallest of the many temples crowded along the sacred river bank. Inside, a service in progress includes chanting in unison to the sounds of gongs and drums beating out complex rhythms. Through one window into the temple interior, I see a priest clad in flowing white robes conducting a rite honoring one of the ancient saints. In his right hand he waves a cup of fire in a specific pattern, and in his left rings a brass bell, all the while chanting. He does this around and before an effigy of the saint—not a statue but a manikinlike image of an elderly man with shaved head, clothed in bright scarlet robes, and seated on a throne.

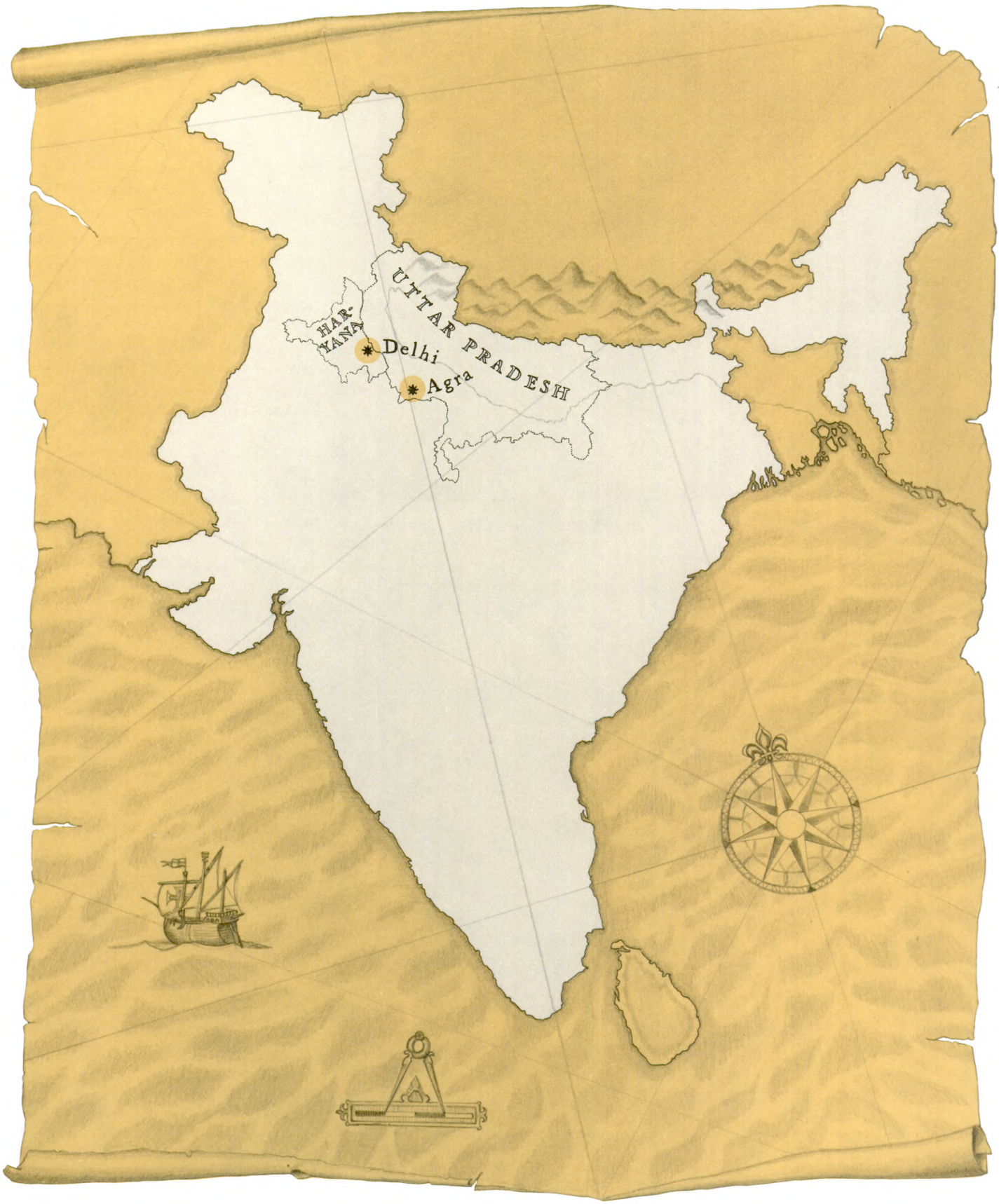
Floating candles made from flame-of-the-forest tree blossoms set afloat down the holy waters of the Ganges River, Hardwar, Uttar Pradesh, northern India, in honor of saints and ancestors. (Photo courtesy Carrie Sakai)

The ghats *(riverside steps) of the sacred Ganges River in Hardwar, northern India, the destination of many pilgrims seeking spiritual purification. (Photo courtesy Carrie Sakai.)*

The priest passes from chamber to chamber for 30 to 45 minutes, while drums sound and chants continue, to honor other saint images in turn. This is done each day at dawn and dusk.

We stroll the dark smoky streets and Qamar tells us about the natural school of medicine he subscribes to that holds self-healing as its basic tenet. Sinha asks if we had originally entered Indian with a specific image of the country and its peoples and if that has now changed. He smiles and says that all visitors find India to be richer, more diverse, more forward thinking, and altogether different than they imagined. I agree.

Back to Dehra Dun by 10:00 p.m. after a 15-hour road journey, with one of Baban's dinners awaiting us. A meal, a recounting of our Dudhwa adventures with Tom, a hot shower, then sleep.



Delhi

The Final Tour

22 April

Earth Day 1990 and the 20th anniversary of the famous day of environmental awareness. What more fitting way to celebrate the spirit of this day than on a pilgrimage across India to help further forest conservation.

It is time on my journey to begin to summarize concepts of forest conservation that will serve our Wildlife in Managed Forests project. Our U.S. project director, Hal Salwasser, has offered the following framework for a strategy to conserve biological diversity (see footnote 2). He defined biological diversity, or biodiversity, as the variety of life and its processes. More specifically, it is the array and dynamics of all plant and animal species and communities in an area, including humans. As applied to our Satpura Hills demonstration project in India, Salwasser listed eight principles for a successful conservation strategy. I cite them here and add my own interpretations in relation to managing Satpura forests for diversity.

1. Understand the larger context of local actions; that is, local actions should be taken only in context of how they fit with meeting stated objectives over a broad landscape area. For example, How does underplanting of fruit trees in specific old teak plantations in Melghat Tiger Reserve provide for needs of wildlife species over a broader geographic range in the Satpura Hills? What are the seasonal foraging patterns and home ranges of fruit-eating species such as langurs, sloth bears, and jackals? How will they or their predators be benefited by such management actions?

2. Embrace complexity. The change in scientific forestry from planting and nurturing stands of single tree species to one of providing for the diversity of structures and species found in more natural forests adds complexity to management. But it should be a complexity that entices, excites. For example, ensuring that the teak plantations now also contain fruit-bearing trees and shrubs once eradicated in the name of forestry should be seen as an exciting management challenge.

3. Work with the political aspects of biodiversity. Providing for the biological needs of all biota desired in an area entails more than scientific and technical questions. It also conjures the need to act politically on behalf of the inhabitants of the area to ensure that they complement, understand, and support the biodiversity planning program. For example, the local villagers should see the reintroduction of fruit trees to coppice and planted stands of teak as desirable. If managed properly, they provide in part for sustainable use of such resources by humans as well as by wildlife. They also provide for sustained employment, for such mixed-species stands thereafter need tending and monitoring. Through education, social priorities would change; instead of taking the fruit trees for their short-term provision of timber, they can be maintained on site and provide other forest products indefinitely. Thus, local people will become the most important links and proponents of such programs, helping to ensure their success.

4. Coordinate plans and actions. Chances of success of a biodiversity management program are greatly enhanced when potentially opposing factions are united in their common goal of conserving the resources. To achieve success, social and natural objectives should be melded. Local governments and private citizens should understand each other's needs and objectives. Scientists, managers, universities, and researchers should work in unison. Foresters and wildlife biologists should cross-train and work together. For example, the timber working plan and the wildlife management plan for an area should jointly specify how restoring fruit trees to teak plantations can help meet long-term productivity of the site for local economies, for growing commercial timber, and for helping maintain viable populations of fruit-eating wildlife species in the area.

5. Involve the people in planning and management. Local people should play a most important role in helping define and implement local management objectives. For example, locals can be trained and employed as ecotour guides and as forestry aids to help underplant teak plantations. At a broader scale, local people should be made aware how their village or grazing area fits into the broader landscape patterns of land use and forest conditions, and into the broader set of objectives for maintaining human use as well as

Sustainable Forest Conservation Strategy

- Protect and restore forested areas
- Protect and restore soils, waters, biodiversity
- Provide for tribal subsistence, livelihood, and economic development
- Balance livestock grazing with fodder production
- Balance fuelwood use with annual production
- Balance timber consumption with annual production

Source: Salwassar and others (1991)

biological diversity of the forests. The purpose and role of land classes should be understood and supported by local residents. All classes of land allocation, including revenue land, croplands, forest buffers, and parks and forest core areas, should be viewed as essential to meeting overall economic, social, forestry, wildlife, and biodiversity goals in a region.

6. Integrate science with management. Managers must encourage scientific study of all facets of biological diversity at various spatial and temporal scales. Beyond studies of forest growth at the stand level, researchers should ask questions about how management activities affect habitat patch patterns and landscape dynamics, and how these in turn affect viability of wildlife populations, communities, and ecosystems. Researchers must also become skilled in developing their scientific knowledge into analysis tools and management recommendations.

7. Market biodiversity as a desirable goal. Changing cultural norms will likely be the greatest challenge in asserting a new era of biodiversity conservation for India. People must be made aware of how maintaining diverse forests benefits both wild and human populations alike. They must understand and support management efforts by seeing direct increases in amounts of fuelwood, available water, natural fibers and fruits, timber, quality of grazing lands, and even access to game and fish. For example, Gogate's outstanding visitor center at Melghat Tiger Reserve teaches how conserving plant diversity in forests also provides for wildlife needs.

Teaching that maintaining biodiversity is a desirable social and forest conservation goal may entail radical changes in personal outlooks on resource use and daily living. It must be taught that the future has value, economically, socially, and in a familial way; we merely rent the future from our children, who in turn rent it from theirs, and so on. Progeny are thus more than just additional laborers to ensure successful crop production or other labor-intensive tasks. They are the future recipients and judges of our present actions. This shift in attitude toward valuing the future might be a most difficult, but essential, social adjustment to a new daily conservation philosophy.

Finally, use all the tools available. Every component of a forest has an ecological function and contributes in some way to the overall diversity of the ecosystem. Every kind of land use has an important role in providing for human and wild populations. Biodiversity can be best conserved by an approach that explicitly guides and marries scientific understanding, management techniques, changing social values, new cultural norms of resource use, and a vision of the future of forests and human well-being.

I might extend Salwasser's concepts to a set of steps to derive an actual on-the-ground plan of action for identifying and conserving biodiversity. I have worked with National Forests in the United States to develop such a planning process, which entails seven main steps.

1. Identify biodiversity indicators. Components of biological diversity must be specified as indicators that can be directly measured and monitored on the ground over time. The key to successfully using biodiversity indicators is to estimate, measure, and quantify. This first step is where the broad and fuzzy concepts of

biodiversity take specific form. As an example, specific indicators for measuring wildlife communities might entail estimating the number of wildlife species using teak stands with fruit trees, and comparing actual species composition to that of other communities, such as more natural or unmanaged communities.

2. Set biodiversity goals. General objectives must be set for biodiversity planning. It is not possible to set management direction or to measure success if you don't know where you're going. For instance, one goal might be to restore to a particular watershed the full complement of wildlife species dependent on tree-borne fruit.

3. Envision the future. Specify the desired future conditions that would conserve the specific attributes of biological diversity described in step one. These entail clear statements of both current conditions and feasibly attainable future conditions to meet the goal specified in step two. The conditions should be stated precisely and unambiguously as values of each of the biodiversity indicators. An example of a desired future condition might be to provide for fruit-bearing trees at a rate of at least a specified percentage of stand basal area within teak plantations, because research will have demonstrated that that percentage correlates with presence of fruit-using wildlife. The anticipated wildlife response to this action, coupled with other habitat management activities and guidelines in the same area, would be stated as the continued presence or restoration of self-sustaining populations of common langurs, sloth bears, and jackals within specific watersheds.

Draw a picture, literally, of the desired future condition. How would the forest stand look, in profile, with underplanted fruit trees? What should be the end result in terms of understory and overstory tree stocking and tree crown coverage? How would the subbasin look with various stands so planted? What would be the access to such stands for some of the more mobile and wider ranging wildlife species dependent on fruits? How would access and use of such trees by local peoples fit into this plan? What travel routes would they use to access the stands?

4. Set management guidelines. Standards and guidelines for regulating management activities should be developed that ensure that the various components of biodiversity and their desired levels are attained and maintained over time. One example of a guideline is that during any given silvicultural entry into a teak plantation in specified watersheds, removal of trees must result in at least 10 percent of the basal area of the residual stand consisting of fruit-bearing trees, otherwise the silvicultural activity may not proceed.

5. Evaluate alternative actions. There should be an assessment of a range of alternative management plans for the area with an analysis of effects of each alternative on future measures of each biodiversity indicator. Examples might include providing a range of management alternatives for various proportions of teak plantations restored to fruit-bearing trees. Results would be modeled to predict effects on presence and estimated density of common langurs, sloth bears, and jackals, as well as on volume growth of teak trees and future harvests of timber and fruit.

6. Decide on a course of action. A set of explicit evaluation criteria should be developed to help select the best management alternative.

The decision is made to select, fund, and implement one of the alternatives that meets the overall biodiversity planning goal and the specific desired future conditions for each biodiversity indicator. For example, evaluation criteria for selecting a planning alternative might include a high likelihood of providing for at least presence of common langurs, sloth bears, and jackals in a watershed in which fruit trees are restored to teak plantations; and production of at least a specified volume of commercial teak timber over the next four decades. The alternative that accomplishes the general biodiversity planning objectives stated above, that meets the specific outcomes stated in the decision criteria, and that also meets other criteria such as minimal social or ecological costs would be chosen for implementation.

7. Monitor, evaluate, and adapt management to new information. Accompanying implementation should be an explicit plan to monitor key indicators of biodiversity, to reevaluate effectiveness of the chosen management direction, and to redirect management direction should evidence suggest it necessary. Monitoring should track how well the chosen alternative is actually implemented on the ground ("implementation monitoring"), and how well its implementation has the desired effects on biota and people ("validation monitoring"). For example, implementation monitoring would track the progress of underplanting fruit trees in teak plantations, as well as how much of stand basal area remains in fruit trees after silvicultural entries. Validation monitoring would study behavioral and population responses by common langurs, sloth bears, and jackals after fruit trees were reestablished in the teak plantations. As a result of the studies, the management guidelines might be altered to specify more or less fruit trees per hectare to achieve consistent presence of the wildlife species within the watersheds.

Implementing such a biodiversity planning process means having a good inventory of the land base; understanding its capability to produce forest habitats, wildlife communities, and forest products and services; being able to set realistic management goals to maintain or restore specific components of the forest ecosystem; and being able to monitor and study effects of management and readjust management direction over time. Tools for conducting spatial analyses (geobased information systems) and for modeling forest structure and composition (stand growth and yield models) eventually will be needed. Much planning can proceed while such tools are being developed and refined.

Much remains to be done in the Satpura Hills—and throughout India and in many forests of North America, as well—to ensure success of this program. We have assisted in beginning a new era of integrated resource management that would combine forestry and wildlife management plans into one process and document. Collection of inventory data on habitat conditions, development and mapping of ecological land classes, fostering changes in public perceptions and social expectations of forested areas, and a host of other technical and social programs wait to be further developed. Many of these tasks have been started by the WII faculty, by the remote sensing laboratory in Dehra Dun, and by the field level Forest Service managers in central India. I am confident, given the outstanding set of scientists and field managers I

have encountered, that with sufficient will and Governmental blessing, the program can succeed in meeting all its objectives.

Time has come for our final farewells at Dehra Dun. After several evening visits to our new friends' houses for dinner and conversation, we are sad to leave this strange land. We will always feel indebted to our colleagues and traveling companions for their remarkable warmth and generosity. Aside from tips to each of our house staff, as a special token of our appreciation we present Anwar, our driver and guardian angel on our northern travels, with a volume by Salim Ali on birds of the country, written in Hindi script, with our inscription thanking him for his friendship and skillful hand at the wheel. I also give Baban, our cook and mother hen, two of my shirts and my flashlight, which he admired.

It is most difficult to bid farewell to Vish, our brother and prime benefactor in our conservation mission. Although I am to see him again by year end on another visit to Dehra Dun, and on several other upcoming reciprocal visits, I will miss him most of all. He has helped renew my respect for the wild lands and those devoted to its future. Through his friendship, I return to my own conservation tasks with a greater sense of affection, exigency, and honor.

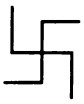
By 8:00 a.m., Carrie, Tom, and I are on our way in our hired Ambassador taxi. Long hot ride to Delhi. Limcas and Thumbs-Up colas at the Cheetal rest stop amidst the Indian tourist crowd. We still see remarkably few western visitors, although a group of Germans occupy the next table.

I feel, in these waning days of my stay in this frightfully distant place, a kinship with the people and with the tragically rare wilderness in this beaten, crowded land. I feel a tie to the Hindus and Buddhists who view life and land as one, not in the agrarian philosophies of Steinbeck or Jefferson or Leopold, but in the fuller, universal sense. The ferocity of the Indian wildlife and the wild forests are but part of both the ancient history and the future salvation of these cultures. Somehow, for preserving the heart of religious and cultural values and wisdom and for protecting the health and improvement of future generations, the natural areas must continue, must not be further degraded. They must be restored. We must learn from the wild lands and from the simple and profound religions here that hold the land and its denizens as sacred. We must learn from the past and think of the needs and the rights of generations to come. "May Ganesh follow us all on our journeys," I would enter into the public log book of a Hindu temple in Delhi.

We check into the hotel in Delhi and for 3 days tour the city and surrounding area. Out of the forests and wilderness, the city is a blaring reminder of the density and diversity and press and needs of the populace that overruns the country. We tour a number of sites including parliament and Government buildings, embassy and ambassador quarters, Buddhist and Sikh and Hindu temples, the Old Fort of Delhi at night, and remnants of the colossal gates and walls of the 12th century Walled City outside Old Delhi.

A visit to Lakshmi-Narayana Hindu temple, a vast complex of colorful spires and chambers each housing effigies of saints or gods. I find my friend Ganesh in one small outdoor *mundir*, and I take a pause to consider my Indian education. On some of the outdoor marble walls are etched various symbols of the Hindu faith, emblems of prosperity and piety and prudence. One is the swastika, and a marble signboard etched in both English and Hindi explains:

SWASTIKA



May All-Mighty God of infinite glory be auspicious to us.

May the all-knowing Lord of the universe be of auspiciousness to us.

May the all powerful protector of the universe bring auspiciousness to us.

May the Lord of Lords, the Supreme Being, bring fortune to us.

This (Swastika) symbol is most sacred and ancient. At least for more than (the) last 8,000 years it has been the mark of Aryan (Hindu) civilisation and culture.

This symbol signifies an implied prayer for success, accomplishment, and perfection in every walk of life under the guidance of the Almighty. It is found not only in India but in the Buddhist and other foreign countries.

All the Aryan scripts, i.e., Sanskrit, Pali, Tibetan, Chinese, Japanese, Burmese, Siamese, Sinhalese, Roman, Greek, Latin, etc., are believed to have originated from this very symbol,

Swastika.

It was the Third Reich of Germany that corrupted the symbol as a logo of their power and self-determination by rotating the image 45 degrees.

We also see the Arch of India, built to commemorate unknown soldiers, and we shop in the bazaars of Connaught Circle in the downtown district and Chhata Bazaar, the famous covered market in the Old Fort. At night the tall onion-shaped towers of the Jami Masjid Congregational Sikh Mosque in Old Delhi look phantasmic, outlined in floating arched stringers of pale incandescent lights.

We pass many wedding parties on the streets, with grooms in uniforms astride decorated white horses, and throngs of people celebrating and dancing to brass bands (Indian sousaphones!) blaring impromptu tunes. At one point, Carrie approaches quietly and raises her camera. Someone in the procession spots her, yells out, and in an instant the entire procession stops and turns for her to snap the image, laughing and waving. The groom looks utterly haggard on the horse as if he's been there for hours but nevertheless attempts to pose for the picture he'd never see.

In Old Delhi we pass among the infamous and heart-breaking street poverty with families living under low-slung black tarps and old men limping up to us for a few rupees. What in the world do they do when the monsoons flood the roads?

Up at 4:00 a.m. for an obligatory taxi tour 4 hours south of Delhi to Agra with our Sikh driver and tour guide. South, past the holy city of Mathura, birthplace of Lord Krishna and now a site of Hindu pilgrimages. Agra is a tourist mecca and hawker habitat. I have little interest in visiting there, but it is part of the experience. It is rather ironic to be ending our vast tour into the deepest forest and wilderness recesses of remote Indian reserves with a touristy view of the "must-see sights." Or perhaps it brings it all back into perspective as to how the tour trade must function in this crowded land to help ensure economic stability in the long-term protection of the parks and forests.

The Taj Mahal: Blinding white marble in the hot dry sun. We are incessantly bothered by the mosquito-hordes of con artists and sellers from the moment the taxi door opens until it closes. The Taj is an impressive, illogical monument to one man's sense of self, a mausoleum to one man and his wife for all to admire amidst the plenitude of poor and homeless just outside the gates in the streets. I can't help but think this should be a monument to the poor instead, a tomb of the unknown peasants. Or perhaps to the little known

species of the vanishing forests. Rich white marbles inlaid with colored stones agonizingly shaped into scrolls of script, filigreed borders, and designs of flowers. From the rear of the marble courtyard we see the dry-land farms below on the river bed with swirls of dust blown into high columns by the hot winds. Beneath the main dome of the monument we descend steeply into a stifling and damp underground chamber to the two true crypts; the elaborately decorated ones above are counterfeit and empty.

Next, a 20-kilometer drive to Fatephur Sikri, the ancient walled Mulghal city and capital of Akbar. A local historian, an elderly gentlemen with a long gray beard and flowing white robe, guides us on a lengthy walking tour among sundry courtyards and building complexes. At one point, we come upon the sacred inner grounds of the temples where we may not tread in shoes. For a few rupees, we can don cloth wraps over our shoes or risk going barefoot on the searing stone. The wraps tie around the ankles and are colorfully patterned. As we approach the temple inside the grounds, I look down closer and notice the wraps are decorated with various images of Disney characters. Tom's has Mickey Mouse. To me, this is yet another bizarre contrast in this land, to be walking the ancient holy grounds, in reverence and awe in this venerable landmark city, wearing Pluto overshoes.

Then the long, hot, dusty drive back to Delhi. We cut through waterless landscapes in Haryana and Rajasthan States. Dust storms become so thick that all visibility is obscured and traffic on the highway halts. Slightly further west from here begins the vast desert, growing annually from overgrazing, where along the borders large areas of trees are being planted every year in a dire attempt to stave off the advancing sands. I remember that one objective of the new National Forest Policy is to check the expansion of the Rajasthan desert, although in this area I see no new fields of seedling trees and only old windbreaks along the highways.

A quick sunset on the crowded, rushing highway, and we discover the sedan has no lights of any kind. In the moonless night it will be only a matter of time until a head-to-head encounter with an onrushing public carrier truck or one of the numerous other vehicles also lacking lights. So we proceed at 30 or 40 kilometers per hour with me holding a tiny flashlight out the window trying in vain to signal the oncoming rush of motorists. We search in the dark for a shop and dive to the shoulder of the road in several narrow escapes from meeting our maker all too soon.

Eventually we find a rest stop with a small mechanics shed. The overhead street light gives an occasional flicker of light, the power compressor or generator chugging around back of the open-air shack. Truck drivers chatting, sitting, or sleeping on *charpoi*, woven mesh cots. An outdoor cooking area; locals say the food is great and very spicy. A small group of men crowd to watch a 12-inch black and white television blaring a morality play in Hindi.

India seems to have essentially one television channel and it is State-run. On Sundays from 10:00 to 11:00 a.m., the entire country comes to a dead stop to watch the *Mahabarahta*, the "Epic of India," a soap opera tracing the history of the country. Seems that with such a captive audience the Government has an outstanding opportunity to convey conservation messages, to explain the changing national forest policies or to assert existing guidelines and resource use laws.

The mechanic pulls wires, jiggles connections, scratches his head. It seems like technology in India is perhaps 10 to 25 years behind that of the United States. Personal computers, for example, are a generation behind those in the States. But they are all manufactured here in India, and that's the important thing. Too much technology and automation could be harmful in this labor-rich land. If it takes substantial human labor to keep things operating, such as computers or financial accounting systems or car headlights or forest management, all the better.

The usual audience of onlookers gathers in the dark. Eventually, we get one headlight and one taillight repaired and then dodge all manner of vehicles, conveyances, and pedestrians on the long road back to Delhi.

I have been trying for weeks to decide the best way to describe the driving in India. At first it seems utterly chaotic, maniacal, even suicidal. It is certainly all that, but it is really neither defensive nor offensive. Descriptions might include "evasive," "aggressive," or "opportunistic." To our limited western eyes, pedestrians here seem to have absolutely no sense of danger, no caring for their own safety. They walk across crowded streets and do not even turn their heads to see what is bearing down on them. There could be a screech of tires and blaring of horns right at their backs and still they do not turn. But it's not egoism, or arrogance, or apathy, or stupidity, or masochism, or ignorance. Each person seems to assume that the other will watch out for their well being, that it is the other's *dharma*, not their own (an interesting operating philosophy if applied to conservation policy, I would think). Therein lies the central paradox: If each expects this, then who does watch? But the vehicles dance, the bikes weave, the pedestrians proceed, and for all potential encounters, seldom do they meet. This should result in continual and massive waves of collision and catastrophe, but it doesn't. What is remarkable is that the drivers anticipate when a gap will open in traffic or when passing on the highway and will rush toward a solid wall of vehicles to be there just as it invariably opens.

I have developed a simple set of guidelines for getting along in India: the Two Laws of Indian Travel. The First Law is of the road: Big Goes First. This is the first law because it's the most critical Law of the Road. In fact, it is the only apparent Law of the Road. It also is the only law of physics that seems to apply on Indian highways.

The Second Law is: Go With the Flow. Accept all the apparent contradictions. Slip quietly and confidently into the cultures and languages. And perhaps the religions. Accept the use of Indian stretch time. Leaving for an appointment set for 8:00 a.m. might mean leaving before 8 a.m. (rarely), at 8 a.m., or perhaps 9:30, 12:00, or never. Or you may end up at a totally different appointment on a moment's whim. It's a different and much more human way of living.

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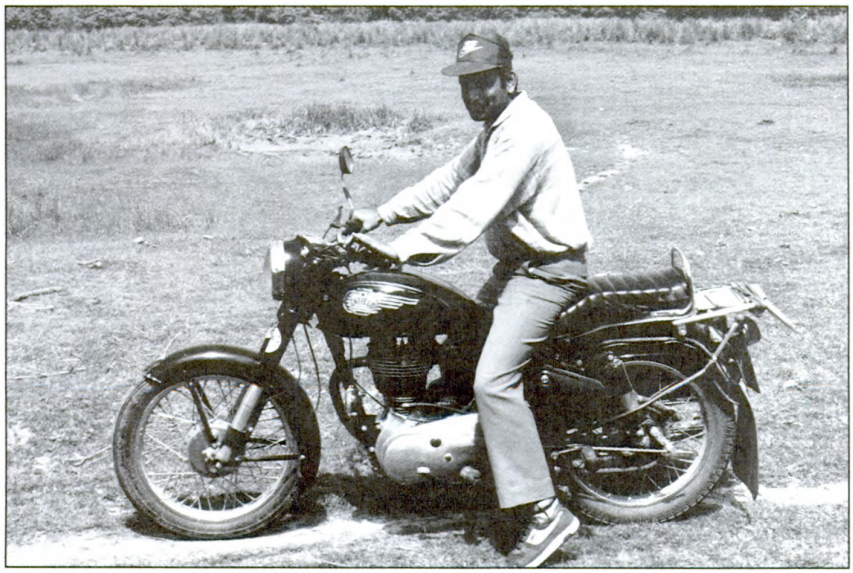
Finally, without fanfare, the last taxi ride to the Delhi airport, at midnight. We check in through no less than eight pass points for ticket inspections, luggage examinations, body searches, and more baggage checks. Long wait. The flight out is delayed 2 hours, nothing unusual. Stretch time. Go With the Flow.

Into Frankfurt, Germany, by 9:00 a.m., and a 3-day tour of the utterly manicured Black Forest and snatches of Switzerland and France. Then, the long, exhausting flight to a home with orderly roadways, fast food, high tech, and reliable electricity, a country still blessed with vast and mostly uninhabited prairies and forests, a home with familiar customs and traditions that in short order seem less logical and reasonable, a home that now feels transformed by a distant land whose future so precariously quavers on the conservation of the community of all creatures and their environments. I will never again feel a provincial sense of home and posterity without perceiving the curvature of the globe and the struggle of the friends I left behind in that desperate, dear land.



Wildlife scientist S. Sinha of Dudhwa National Park, northern India, on his typical conveyence, despite local occurrences of tigers chasing and attacking motorcycle riders. The quest for successful management of forest wildlife of India is shared by dedicated and talented scientists, such as Dr. Sinha and his colleagues at the Wildlife Institute of India and the Indira Gandhi National Forestry Academy.

Acknowledgments

My expeditions among the diverse lands and many cultures constituting the singular national entity known as India have been part of a joint United States-Indian Government project entitled "Wildlife in Managed Forests of India." The major entities, and those who I thank for hosting me as part of this project, include the USDA Forest Service, the U.S. Department of the Interior Fish and Wildlife Service, the Wildlife Institute of India, and the Government of India. My appreciation goes to my U.S. colleague Hal Salwasser, USDA Forest Service, Washington, DC; and to H. Panwar, director of the Wildlife Institute of India, for establishing our team effort. I am grateful to the others of my U.S. team for their excellence in and dedication to forest conservation on both sides of the globe: Richard Holthausen, Wini Kessler, John Lehmkuhl, Martin Raphael, Jack Ward Thomas, Robin Vora, and, of course, Tom Darden, my traveling partner on my first Indian journey. My thanks, too, to Fred Bagley of the Fish and Wildlife Service for helping coordinate the project and attending to logistics of the international travel.

My colleagues at the Wildlife Institute of India in Dehra Dun provided the most hospitable introduction, and I am grateful to B.C. Choudhury, Lewie Dekker, A.J.T. Johnsingh, Ajith Kumar, P.K. Mathur, S.N. Prasad, Asha Rajvanshi, Kishore Rao, Allan Rodgers, and many others. I also am grateful for the opportunity to meet my new Indian friends and associates, M.G. Gogate and Jayant Kulkarni of Melghat Tiger Reserve, and Qamar Qureshi and Satya Sinha of Dudhwa National Park. Their great expertise and quiet wisdom will certainly contribute to success of the project. Our special friend and Assistant Director of the Wildlife Institute, S.K. Mukherjee, traveled with us to the southern tropical forests and helped show me how scientific and traditional views of the world can coexist and complement one another. This must be one of the cornerstones of the new conservation policy for the subcontinent.

The members of the U.S. Embassy Science Staff in New Delhi, notably V. Nanda, Peter Heydeman, Karen Lavine, and Peter O'Donahue, have been primary links for the success of the joint Indo-U.S. project. They greatly helped in the logistics of our international travel and in support of the project. My gratitude to them all.

My thanks to my wife Carrie Sakai who traveled with me on my first visit. Her good humor, personal respect, and intense interest in experiencing all facets of another culture

helped to make our brief tour inspiring and stimulating. My thanks, also, for her permission to use several of her photographs in this volume.

For production of this report, I appreciate the fine editorial support and guidance of the USDA Forest Service, Pacific Northwest Research Station, notably from Karen Esterholdt, Station editor, who also designed the publication. I also thank Del Thompson and John Ivie for assisting with the graphics and figures and Cheryl Pittman for layout. Thanks to Hal Salwasser, Kent Mays, and Tom Darden for review of the manuscript. My appreciation also goes to Barbara Dean whose editorial comments of an earlier draft helped improve the final manuscript. Of course, all opinions expressed here are my own and are not necessarily those of reviewers, the U.S. or Indian Governments, or the USDA Forest Service.

Above all, I am most grateful to Vishwas ("Vish") B. Sawarkar, Joint Director of the Wildlife Institute and our prime contact and traveling companion, for his friendship and for nearly single-handedly overseeing the immense logistics of our travels within the country. As Vish was to confide one warm twilight while we sat on the banks of the Sipna River in the central Indian tiger country, the tradition of the Indian Forest Service is to open one's home and heart when another of the conservation community visits, to do all one can to tend to their needs and interests, because that is just what is expected and what one does. It is nothing that one speaks of or gives overt thanks for. It is simply one's responsibility and honor. I am heartened that, with such dedication and care, there is hope for the future of wild areas of India.

For Further Reading

Many resources are available on the history and cultures of India, but there are substantially fewer authoritative volumes on the forests and wildlife of the subcontinent.

Introduction to Geography and History of India

Crother, G.; Raj, P.A.; Wheeler, T. 1987. India—a travel survival guide. 3d ed. Victoria, Australia; Berkeley, CA: Lonely Planet Publications. 803 p.

A comprehensive travel handbook to history, sights, states, and major cities with many maps.

Isreal, S.; Grewal, B. 1989. India. Singapore: APA Publications, Insight Guides. 359 p.

Replete with region-specific photographs, this book provides a comprehensive overview of the sights and geography of the subcontinent.

Jhabvala, R.P. 1986. Out of India. New York: Simon and Schuster. 288 p.

A series of short tales of fact-based fictional characters illustrating the Indian experience and cultural mores.

Naipaul, V.S. 1977. India: a wounded civilization. New York: Vintage Books, Random House. 191 p.

A series of personal perspectives that paint a selected history of the country and interpret its diverse cultures and current dilemmas.

Newby, E. 1966. Slowly down the Ganges. New York: Penguin Books. 298 p.

An account of one man's 1200-mile voyage down the sacred Ganges River.

Noble, C. 1987. Over the high passes. Glasgow, Great Britain: William Collins Sons and Co. Ltd. 190 p.

An account of the life of the migratory Gaddi shepherds in the Himalayas.

On Wildlife and Forests

General wildlife

Israel, S.; Sinclair, T. 1988. Indian wildlife. Singapore: APA Publications, Insight Guides. 363 p.

A broad review of wildlife and habitats throughout the subcontinent, with spectacular photographs.

Saharia, V.B. 1982. Wildlife in India. Dehra Dun, India: Natraj Publishers. 278 p.

A factual account of threatened and endangered species and the plight of the vanishing habitats vital for their survival.

Reptiles

Daniel, J.C. 1983. The book of Indian reptiles. Bombay, India: Oxford University Press. 141 p.

The bible and atlas of reptiles of the country. At present, no such volume exists for the amphibians.

Birds

Ali, S. 1987. Indian hill birds. Bombay, India: Oxford University Press. 188 p.

Ali, S. 1988. The book of Indian birds. Bombay, India: Oxford University Press. 187 p.

Ali, S. 1989. Field guide to the birds of the eastern Himalayas. Bombay, India: Oxford University Press. 265 p.

Ali, S.; Ripley, S.D. 1983. A pictorial guide to the birds of the Indian subcontinent. Bombay, India: Oxford University Press. 177. p

Ali, S.; Ripley, S.D. 1987. Compact handbook of the birds of India and Pakistan. Bombay, India: Oxford University Press. 816 p.

Ali, S.; Ripley, S.D. 1988. Concise handbook of the birds of India, Pakistan, Burma, and Sri Lanka. Bombay, India: Oxford University Press. 168p.

All the books by Ali (and these are but a sample) remain the definitive sources for information on distribution and identification of avifauna of the country and its regions.

Ewans, M.; Singh, T.D.; Singh, R. [and others]. 1989. Bharatpur bird paradise. New Delhi, India: Lustre Press. 144 p.

A beautiful photographic essay of many birds found in the Bharatpur Bird Sanctuary located south of Delhi.

Mammals

Chundawat, R.S.; Panwar, H.S.; Rawat, G.S. 1990. The ecological studies of snow leopard and its associated prey species in Hemis High Altitude National Park, Ladakh: First report December 1987-August 1989. Tech. Rep. RR-1. Dehra Dun, India: Wildlife Institute of India. 27 p.

A summary of recent research on the nearly extinct snow leopard.

Corbett, Jim. 1988. The temple tiger and more man-eaters of Kumaon. Bombay, India: Oxford University Press. 183 p.

Corbett, Jim. 1989. Jim Corbett's India. Bombay, India: Oxford University Press. 250 p.

These and others in Corbett's series detail the remarkable life and truly thrilling adventures of India's greatest *shikari,* hunter and tracker of the most infamous man-eating leopards and tigers the country has known.

Prater, S.H. 1971. The book of Indian animals. Bombay, India: Oxford University Press. 324 p.

The bible of biology and distribution of mammals in the subcontinent.

Thapar, V.; Singh Rathore, F. 1989. Tigers: the secret life. Emmaus, PA: Rodale Press. 160 p.

With this book and their companion books, *With Tigers in the Wild* (1983) and *Tiger, Portrait of a Predator* (1986), this team of researchers has produced a definitive series of texts on behavior of tigers. Contains spectacular photographs of tiger behavior never before reported or filmed.

Forests and forest policy

Agarwala, V.P. 1990. Forests in India, environmental and production frontiers. 2d ed. New Delhi, India: Oxford & IBH Publishing Co. 338 p.

A good review of the history and management of forests in India, particularly in reference to human influence and resource use. The role of wildlife is discussed only briefly, however.

Champion, H.G.; Seth, S.K. 1968. A revised survey of the forest types of India. Delhi, India: Manager of Publications. 404 p.

A technical and definitive review of the major forests of the subcontinent.

Government of India. 1988. National forest policy. New Delhi, India: Ministry of Environment and Forests.

The new bold and forward-thinking Federal policy that calls for maintenance of forest ecosystems and their attendant species.

Hawkins, R.E., ed. 1986. Encyclopedia of Indian natural history: centenary publication of the Bombay Natural History Society, 1883-1983. Delhi, India: Oxford University Press. 620 p.

A vast compendium of over 1,000 species of India.

Lal, J.B. 1989. India's forests myth & reality. Dehra Dun, India: Natraj Publishers. 304 p.

A review of forest planning and allocations in the subcontinent.

Puri, G.S.; Gupta, R.K.; Meher-Homji, V.M.; Puri, S. 1989. Forest ecology. 2d ed. New Delhi, Bombay, and Calcutta, India: Oxford & IBH Publishing Co. Pvt. Ltd. 2 vol.

Scientific treatments of many forest tree species and plant associations found throughout the subcontinent. Excellent descriptions of many forest types discussed in this book.

Rodgers, W.A.; Panwar, H.S. 1988. Planning a wildlife protected area network in India. Volume I: The report. Dehra Dun, India: Wildlife Institute of India.

Rodgers, W.A.; Panwar, H.S. 1988. Planning a wildlife protected area network in India. Volume II: State summaries. Dehra Dun, India: Wildlife Institute of India.

The new vision for managing forests and parks as connected pieces of an ecological network.

Salwasser, H.; Sawarkar, V.B.; Darden, T. [and others]. 1991. Conserving biological diversity in India's forests. Washington, DC: U.S. Department of Agriculture, Forest Service; final report; Wildlife in Managed Forests Project—Phase I; rev. Aug. 30, 1991.

The final report on the first phase of the Wildlife in Managed Forests of India project.

Troup, R.S. 1975. The silviculture of Indian trees. Delhi, India: Controller of Publications. 3 vol.

Still the definitive source for information on biology of trees and their forestry. Showing its age, though, as the bulk of the volumes focus on commercially valuable tree species and all but gloss over the non-commercial trees that nonetheless bear food and cover so vital for preserving wildlife.

Marcot, Bruce G. 1993. Conservation of Forests of India: An Ecologist's Tour Miscellaneous Publication. Portland, OR U.S. Department of Agriculture, Forest Service Pacific Northwest Research Station 127 p.

This essay discussed current management status of forests and forest wildlife of India in an informal style highlighting the author's travel experiences in the country. Much of India's forest land has been converted to other uses and remaining forest occurs in small, isolated parks and reserves. The new national Rorest Policy calls for conservation and for meeting people's immense needs for a wide array of forest products. An ongoing project between The Wildlife Institute of India, The Government of India, and The USDA Forest Service is developing and demonstrating a biodiversity approach to forest conservation in the Satpura Hills of central India.

Keywords: India, forest diversirty, landscape, new perspectives, new forestry internation conservation.

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