

throughout the organization of the conference and its implementation in Chetumal and in the preparation of this volume. Elizabeth Platt has lent her considerable editing skills to the project, and her work has improved every aspect and every chapter in this volume; her familiarity with the Maya Forest region has been crucial to this volume and the TED/USMAB project from the beginning. Barbara Dean, Barbara Youngblood, and Cecilia González of Island Press have shown the skills that have helped make Island Press the leading environmental publisher that it is, and we thank them.

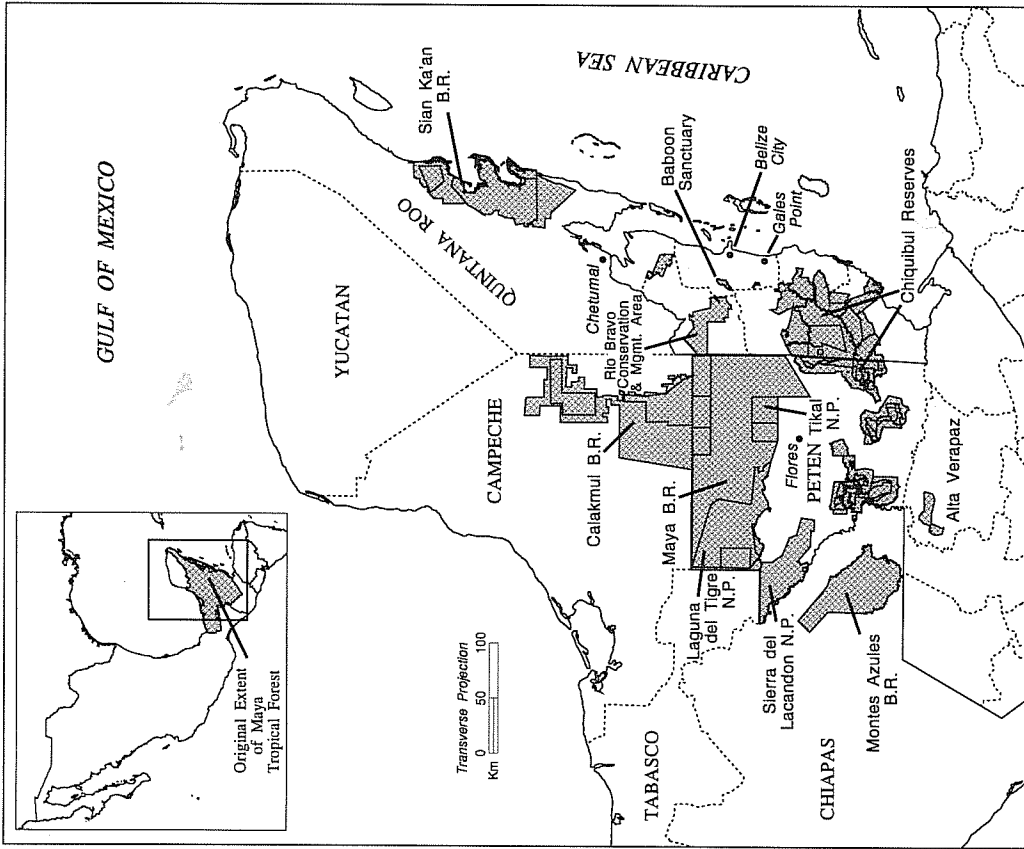
Introduction: The Maya Forest

James D. Nations, Richard B. Primack, and David Bray

Every 16 days, a LANDSAT satellite passes silently and swiftly over the Maya Forest of Mexico, Guatemala, and Belize (Map 1). Viewed from the vantage point of space, this combination of forests, rivers, and savannahs is a single swath of green spread across the midriff of Mesoamerica. It stretches from the Mexican state of Chiapas across northern Guatemala, into the southern Yucatán Peninsula, and across the Central American nation of Belize.

On the ground, human history has divided the Maya Forest, or Selva Maya, into three sovereign nations. As if in defiance of political borders, though, the flora and fauna of this mosaic of ecosystems are remarkably similar. The natural biological systems of the region include montane and lowland tropical moist forest, large, seasonally flooded scrub forests called *bajios*, oxbow lakes, and the largest freshwater wetland in Central America. Wildlife is rich and varied, with jaguars, pumas, tapirs, monkeys, potos, and peccaries among the larger mammals, and macaws, toucans, harpy eagles, and jabiru storks among the hundreds of species of birds. Every year, the region also becomes home to up to 1 billion migratory birds escaping winter in Canada and the United States.

The three nations that share the Maya Forest are also tied together by the rich cultural roots of the Maya peoples who have lived in the forest for millennia. The ancient Maya turned this seemingly intractable wilderness into the biological foundation for a society that flourished for more than 1,000



Map 1

Map of areas mentioned in the text, in particular Biosphere Reserves (B.R.) and National Parks (N.P.). National boundaries are solid lines and state boundaries are dashed. The inset shows the original extent of the Maya Forest.

The Maya Forest provided the ecological fuel for one of the most developed civilizations of its time—the classical Maya period of A.D. 250 to 900; the Maya practiced mathematics, astronomy, water control, sophisticated writing, and a calendric system that measured time more accurately than the modern Gregorian calendar.



Figure 1

An ancient Maya temple towers over forest at Tikal National Park in Guatemala.

Today, the modern descendants of the ancient Maya mix the traditions of the past with contemporary technology to forge new adaptations in a rapidly changing environment. But the ancient Maya also left their modern descendants two other valuable legacies: a forest filled with species useful to humans and one of the world's premier ecotourism destinations. Within the Maya Forest grows the raw material for one of Latin America's most promising systems of extractive reserves: a rich mixture of renewable species, such as xate palms, chicle resin, and allspice, that produces employment for thousands of local families and millions of dollars in income for the governments of Mexico, Guatemala, and Belize.

The region's income from tourism is even greater. The Maya Forest is one of the few places on earth where visitors can look up from a stone city ten centuries old to watch spider monkeys turning somersaults through a tropical forest canopy. This combination of tropical wildlands and ancient ruins brings hundreds of thousands of tourists to the Maya Forest each year, providing the basis for a multimillion-dollar tourism industry that could well be one of the chief elements in the Maya Forest's survival.

The Maya Forest's cornucopia of biodiversity, cultural heritage, and economic benefits is countered by the immediate, real-world threats the region faces. A 1995 satellite image of the Maya Forest shows huge blotches of deforestation spreading out from human settlements in concentric rings of destruction. In Mexico's Selva Lacandóna, PEMEX oil roads spread across the forest like spider webs, multiplying the number of cattle ranchers and *ejidatarios* (cooperative members) clearing land for beef production and corn farming. Population in the Guatemalan Petén is growing at 7% to 10% per year, bringing new influxes of land-hungry colonists into the region's national parks and biosphere reserves. In Belize, Salvadoran refugee farmers and Guatemalan Kekchi Indians are clearing forest for subsistence agriculture, while Mennonite farmers rip hectare after hectare of trees from the ground using giant anchor chains dragged between two bulldozers. The current rate of forest destruction in the Maya Forest surpasses 80,000 hectares (ha) per year.

At times, efforts to ease ecological threats in one country are hindered by environmental damage in another. Mexicans from deforested areas of Tabasco, Chiapas, and Campeche are poaching timber and wildlife in core areas of the Maya Biosphere Reserve of adjoining Guatemala. Deforested slopes in southern Belize are creating flash floods in communities of the southern Petén. And acid rain from Mexico's Coatzacoalcos oil refineries is threatening ancient Maya ruins in the Guatemalan Petén and in Mexico's own Yucatán Peninsula.

Just as the national economies of the Maya region are increasingly tied into a larger, regional economy, so also are their national environments inextricably bound to those of their neighbors. Increasingly, the threats to the Maya Forest are being recognized as regional problems that demand regional solutions. Nonetheless, one of the primary tools in maintaining the biological integrity of the Maya Forest is the creation of biosphere reserves, national parks, and other protected areas within the individual countries. In Chiapas, the government of Mexico established the 3,300-square-kilometer (km²) Montes Azules Biosphere Reserve in the Lacandón rainforest in 1978. In 1992, President Carlos Salinas added 550 km² to the reserve, and the indigenous inhabitants of Chiapas recently created a community reserve, La Cojolita, that connects the Montes Azules Biosphere Reserve to a similar reserve in Guatemala.

On the Guatemalan side of the Usumacinta River, which serves as the border between Mexico and Guatemala, lies the 16,000 km² Maya Biosphere Reserve, a protected area the size of the country of El Salvador. Guatemala's Maya Biosphere Reserve connects in the north with the Calakmul Biosphere Reserve of Quintana Roo, Mexico, and to the east with the Río Bravo protected area operated by the Programme for Belize.

Just south of this connection, two frontier parks focus on the watershed of

the Chiquibul River. The Chiquibul is born in the Maya Mountains of Belize, but passes almost immediately into the Guatemalan Petén, where it runs for 75% of its length before crossing back into Belize as the Río Mopan. In Belize, it merges with the Belize River and travels through the San Ignacio Valley, Belize's breadbasket, then on through the two largest cities of the country, Belmopan and Belize City. In 1991, Belize created the Chiquibul National Park and Chiquibul Forest Reserve to protect this vital watershed. In 1995, Guatemala followed suit by declaring the Chiquibul Biosphere Reserve on its side of the border, creating a mirror-image frontier protected area. Today, 80% of the common border between Belize and Guatemala's Petén lies under protected status.

Together, this complex of protected areas in Belize, Guatemala, and Mexico creates what conservationists call the Maya Arch, providing legal, if not actual, protection for more than 25,000 km² of tropical forest and related natural ecosystems.

The building blocks of the Maya Arch and of the Maya Forest itself are the region's five biosphere reserves: Montes Azules, Maya, Calakmul, Sian Ka'an, and Chiquibul. This remarkable constellation of protected areas makes the Maya Forest the second largest complex of biosphere reserves in the Western Hemisphere, second only to the Rocky Mountain complex of biosphere reserves along the border between the United States and Canada.

Like biosphere reserves throughout the world, those of the Maya Forest were created with the combined goals of conservation, scientific investigation, and sustainable economic development. The purpose of a biosphere reserve is not to exclude people from the protected area, but to identify ways in which people and nature can coexist to the benefit of both. All biosphere reserves have core areas that are designed to remain inviolate except for visits by scientists and, sometimes, ecotourists. Many reserves have multiple-use areas inhabited by indigenous peoples and other communities that, ideally, practice sustainable harvesting of natural resources. And all biosphere reserves have buffer zones intended to provide a transition zone between the protected reserve and activities of the outside world.

Conservationists know that the nuclear zones of the biosphere reserves of the Maya Forest must be protected from destruction if the region's wealth of biodiversity is to survive. But the most important step in preventing this destruction may well be what happens in the lives and communities of the families who live outside the reserves' boundaries.

At its peak of population around the year A.D. 700, the Maya Forest was probably home to as many as 5 million Maya people. Today, there are fewer than 1 million people in the region—only a small percentage of them Maya—yet the area is being transformed from forest to pastures and wasteland. This transformation is bringing little benefit to the people of the Maya Forest, many of whom continue to live lives of poverty and desperation. Solutions to

this situation have been suggested, but too few politicians and decision makers are focused on implementing them.

The most serious challenge the Maya Forest faces is caused by poverty. Poverty impels individuals with no other options to clear the forest for pasture and croplands, simply to keep their families alive. Because many of the region's traditional, and sustainable, systems of agriculture have been eradicated, the expansion of extensive *milpas* (fields used in shifting agriculture) and pastures across the forest is jeopardizing the ecological systems that sustain human life, wiping out the economic future of generations of Mexicans, Guatemalans, and Belizeans yet unborn.

The expansion of the agricultural frontier is abetted by the construction of roads through forested areas and, sometimes, national parks and biosphere reserves as well. In many cases, these roads benefit only a few individuals who make large profits selling petroleum or timber on international markets. As the profits flow out, the roads bring in families who have nowhere else to go and no economic alternatives to turn to beyond destroying the natural resources on which their own lives depend. Identifying viable economic alternatives to this pattern of destruction has become the single most important action for the survival of the Maya Forest and the people who call it home. Our strategy must be to keep alive as much of the biological foundation of the Maya Forest as possible, for the benefit of the three countries that share it, the people who live within it, and the other species of animals and plants that create its web of life.

The chapters contained in this volume are an outgrowth of efforts on the part of many people to achieve this goal. The origins of this book took shape in 1991, when the U.S. Man and the Biosphere Program's Tropical Ecosystem Directorate first contemplated supporting projects in the region. As they investigated possible means of encouraging conservation in this region, Directorate members discovered that this prospect was very complicated. Not only were there intricate social and political issues among the three countries of the region, there were also complex scientific and management problems to be worked out.

As a region rich in biological and historical treasures, the Maya Forest has attracted attention from researchers of many disciplines from many nations. The sheer quantity of information generated by these researchers staggers the imagination, yet they have barely begun to scratch the surface. Directorate members, sifting through the available information, realized that one vital piece was missing: a method by which the various people who needed the data—researchers, managers, conservation advocates, and policy makers—could pool resources and exchange information. Researchers studying the natural and cultural history of the Maya Forest work in three separate countries—each with its own procedures for acquiring permits, all having occasional disputes with one another as neighbors always do, and each pos-

distinctive linguistic and cultural traditions. These factors contribute to insularity: information tends to stay within national boundaries, where, even if it is put to good use, it is by definition limited in its impact. But to conserve an ecosystem of the size and complexity of the Maya Forest, it is imperative that this information be available to all of the parties contributing to the conservation effort.

Realizing that few avenues existed to encourage communication across borders, the Tropical Ecosystems Directorate initiated the processes that eventually led to the workshops from which the chapters in this volume are drawn. Along the way, the Directorate sought to create lines of communication to promote information exchange, not only across borders, but between researchers of different disciplines, management personnel, and policy makers. The workshops led to fruitful and spirited discussions among individuals who addressed the conservation issues at hand from a multitude of perspectives; thus, the chapters that follow reflect a broad range of ideas and viewpoints.

Despite the international boundaries that divide the Maya Forest, the region shares many features; thus, Part I of this volume discusses data collected using Geographical Information Systems (GIS) and remote sensing technologies—methods that allow us to erase the lines on the map and see the forest as a unified entity. Yet the reality of national boundaries—and the distinctions between nations—cannot be denied, as each nation has its own perspective on how best to manage forest resources. Thus, Part II of this volume contains chapters that introduce these perspectives to readers who may be unfamiliar with the policies of one or more of the three nations. In addition to general introductions to each nation's forestry and conservation policies, several chapters focus upon specific projects examining techniques of forest management and sustainable resource use that are being developed by all three countries. In particular, several chapters highlight efforts by communities to manage their forest resources for conservation and sustainable timber harvest.

Part III takes up an issue that has generated great excitement and heated debate in the conservation community. Nontimber forest products are considered by some to be a promising source of sustainable alternative income for local people—a way in which standing forests can become profitable enough to discourage forest residents from cutting them down for farmland and pastures. These chapters, drawn from examples in all three nations, show just how closely tied is the conservation of species and ecosystems to the behavior of the people who make use of their products. Part IV highlights research projects that seek to integrate baseline biological research—sorely needed for both timber and nontimber species—with assessment of impacts of resource extraction and human activities upon forest species.

The last part of the volume focuses upon what is perhaps the most crucial

aspect of conservation in the Maya Forest: the need to involve local people in the conservation of resources. Past experience has taught a sharp lesson about ignoring the needs of local inhabitants, informing us in no uncertain terms that it does no good to designate an area as off-limits to human use or habitation when there are people in need of land, housing, and food. Local inhabitants may be quite well educated on the issues and problems of tropical forest conservation, but may be unable to act upon this knowledge because their economic circumstances dictate otherwise. But this situation is hopeful: it is far easier to preserve a forest with the cooperation of those who live in it than to try to police it against the depredations of people who, disregarding external mandates that ignore their day-to-day well-being, have no alternative but to use the land as the source of their sustenance, albeit only for a short time. By assisting grassroots efforts at forest preservation, creating alternative sources of income for communities, and increasing the economic and social value of the forest itself, it may be possible to halt the ongoing destruction of the Maya Forest.

We can keep alive this unique and wonderful ecosystem by ensuring the stability of the region's protected areas, by intensifying agricultural production in areas that have already been deforested, and by creating economic alternatives through microenterprises, ecotourism, and the sustainable harvesting of renewable forest products. Some of these alternatives are described in the chapters that follow. As the reports indicate, confronting the challenges we face in the Maya Forest will not be easy, but for the future of the forest's biological diversity, and for the future of the families who depend on it for survival, there is no task that is more important.

Part I

A Regional Approach to the Maya Forest

Scientists working in the Maya Forest generally limit their research to sites within the boundaries of one country. The reasons for this practice are mainly pragmatic: it is difficult enough to obtain permission for research from one government without looking for additional headaches. Crossing international borders requires obtaining additional permits, paying additional fees, and completing additional time-consuming forms such as passport applications, customs documents, and inventory forms. When two nations are involved in political conflict, as happens from time to time in the region, these difficulties increase exponentially, particularly for scientists who are citizens of the quarreling countries.

In short, working across national borders is arduous, demanding work, so it is not surprising that few have attempted it. What is surprising is that some multinational projects have been attempted and have produced far-reaching results. Two examples are highlighted in this part. The first, a series of workshops sponsored by Conservation International, brought together specialists from all three countries as well as international experts to produce a regional assessment of the Maya Forest's characteristics. As reported by Rodstrom and colleagues, this project pooled Geographic Information Systems (GIS) data for all three countries to develop a perspective that encompassed the Maya Forest as a whole, freed from the limitations imposed by national boundaries.

The second example illustrates the ways that national governments can work together to achieve conservation goals in a shared ecosystem, even under circumstances of international conflict. Belize and Guatemala, historically not the friendliest of neighbors, created mirror-image reserves in the