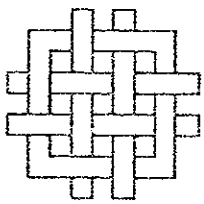
SURVIVING THE CUT:
Natural Forest Management in the Humid Tropics

Nels Johnson
Bruce Cabarle



WORLD RESOURCES INSTITUTE

February 1993

Kathleen Courrier
Publications Director

Brooks Belford
Marketing Manager

Hyacinth Billings
Production Manager

Bruce Cabarle
Cover Photos

ISBN 0-915825-90-2
Library of Congress Catalog Card No. 93-60043
Printed on recycled paper

CONTENTS

ACKNOWLEDGMENTS

In many respects, this report owes its existence to a meeting held in March 1991 to discuss the case for development assistance support for natural forest management in the humid tropics. That meeting, the Colloquium on Sustainability in Natural Tropical Forest Management and subsequent work on this publication were made possible by the financial support and encouragement of the U.S. Agency for International Development's Bureau for Research and Development and Bureau for Latin America and the Caribbean, the U.S. Forest Service Tropical Forest Program, the Environmental Protection Agency's Office of Policy, Planning, and Evaluation, and the Moriah Fund. Many of the facts and ideas in this document come from the 90 participants in the two-day colloquium. Specific thanks go to the speakers, including, Cgouesse Aidara, Peter Ashton, Tos Barnett, Carlos Barrera, Patrick Coady, Marcus Colchester, Marc Duorojeanni, Gary Hartshorn, Aila Kero, Clement Lambeth, Hua Seng Lee, Tom Lovejoy, John Palmer, Victoria Santos, Laura Snook, Anthony Stocks, Hon Tat Tang, Jerome Vanclay, Frank Wadsworth, and Konrad von Moltke.

More than we can possibly express, Dexter Mead deserves our deepest appreciation: he helped organize the colloquium, and his estimable research and writing inform this publication. Cheryl Cort and Anu Sud tracked down literature, compiled data, and provided indispensable research support. Faye Kepner Lewandowski's efforts to organize the colloquium and help produce this report are much appreciated. Julio Vega and Barbara Tykal also provided invaluable support by compiling information on the Timber Certification movement. As editors, Kathleen Courrier and Robbie Nichols have made this report clearer and more readable, while Hyacinth Billings and Laura Lee Dooley deserve credit for the final production of the report.

The report has benefited tremendously from the comments and suggestions of reviewers. In particular, we would like to express our sincere appreciation to Chip Barber, Alan Brewster, Mark Dillenbeck, Roger Dower, Larry Ford, Carl Gallegos, David Gibson, Robert Goodland, David Gow, Gary Hartshorn, Emmy Hafild, Christine Haugen, Owen Lynch, Carrie Meyer, Kenton Miller, Hollis Murray, Robert Repetto, Simon Rietbergen, Ralph Roberts, Ralph Schmidt, and Bernardo Zentilli. Our thanks also go to Richard Donovan, Chris Elliott, Deborah Hammel, Stacy Katelman, Richard Rice, David Richards, and Ivan Ussach for providing us with the benefit of their experience and insights into the timber-certification movement.

Finally, Tom Fox and Walt Reid have been steadfast supporters of the project, intellectual sounding boards, and diligent reviewers. For their patience and support, we owe our tremendous gratitude.

N.J.
B.C.

FOREWORD

Nowhere is the need for a transition to sustainable development more crucial than in the world's forests—and nowhere will triggering that transition be more challenging. In fact, even identifying "sustainable forestry" poses a quandary. Because forests are in constant flux, with natural stocks continually rising and falling even without any human intervention, it's hard to tell whether forestry practices touted as sustainable will actually live up to that billing over the long term.

Meanwhile, forests everywhere are in trouble, from Siberia to Amazonia. With tropical forests vanishing at the rate of 17 million hectares a year and temperate ones seriously degraded by pollution and over-harvesting, the forest principles adopted at the Rio Earth Summit fall woefully short of what's needed. In Rio's aftermath, debate is likely to center on "next steps" toward international agreements on forests, with some industrial countries pushing for a legally binding forest convention and many developing countries dead-set against it. But managing forests better is so important that it must not hinge on the eventual outcome of international negotiations—or resolving hair-splitting arguments about what constitutes sustainability. What the world needs now is sustainable-enough forestry, which demands choosing what's to be sustained—and for whom—and moving in that direction sooner rather than later.

The acid test of whether humanity is up to this challenge may be the fate of forests in the humid tropics—certainly not the only beleaguered forests, but perhaps those whose loss would have the greatest repercussions. Tropical rainforests are home to more than half the earth's species, so their destruction is the main force driving a species extinction rate unmatched in 65 million years. They also play vital roles in maintaining climate, locally through the hydrological cycle and globally through the carbon cycle. Yet, however lush they look, these forests often flourish on such nutrient-poor soils that they are essentially "wet deserts," easier to damage and harder to restore than their temperate counterparts.

One of the most vexing questions facing forestry today is whether sustainable forestry is possible in natural forests. Should we rely on timber plantations for fiber, or can natural forests be managed to yield both fiber and the many other services unlogged forests provide? Pointing to the dismal record of past attempts at sustainable forestry, many now advocate confining forestry to plantations. Others, citing recent research findings, assert that sustainable natural forest management is well within reach—*if* the lessons taught by the past are widely assimilated.

In *Surviving the Cut: Natural Forest Management in the Humid Tropics*, Nels Johnson and Bruce Cabarle, associates in WRI's Center for International Development and Environment, analyze past forest-management failures and blaze a trail toward more productive, more sustainable, and more equitable practices. They argue that a narrow focus on sustained timber yield often leads to failure. A project may be producing trees sustainably, for instance, but if timber is all that counts, species diversity may plummet and watersheds may deteriorate all but unnoticed. To ensure a steady stream of valued forest products and services, they assert, the management goal must be maintaining the health of entire forest ecosystems and the well-being of local communities—whether in the Pacific Northwest or Southeast Asia.

The authors maintain that development theorists and practitioners have paid too little attention to the social, economic, and political dimensions of forest management, making it hard to gauge the sustainability of one practice or another. Besides analyzing the sometimes-counterproductive effects of bans and boycotts, the authors provide criteria for rating various timber-certification proposals. As they note, governments own or control nearly 80 percent of tropical forests, so these forests stand or fall according to government policy.

In the end, the authors call for a redefinition of natural forest management, bidding nations to take these steps toward sustainable-enough forestry and enduring economic development:

1. Redefine the timber concession so concessionaires have greater incentives to guard the long-term health of the forest.
2. Revive and expand community-based forestry schemes, which ensure more rational use of forests and a better life for the people who live near them.
3. Develop criteria to help governments, conservation organizations, and donors recognize "sustainable forestry" when they see it.

They conclude that adopting simple and well-known technologies and management techniques can do much immediately to improve natural forest management and lessen the destructive impacts of logging in humid tropical forests.

The policy recommendations spelled out in *Surviving the Cut: Natural Forest Management in the Humid Tropics* complement and extend those of such other WRI studies as *The Forest for the Trees: Government Policies and the Misuse of Forest Resources*, *Trees of Life: Saving Tropical Forests and Their Biological Wealth*, and a forthcoming study on obstacles to forest policy reform in the United States and Indonesia.

We would like to thank the U.S. Agency for International Development, the U.S. Environmental Protection Agency, the U.S. Department of Agriculture's Forest Service, and The Moriah Fund for their generous support of forest management research conducted by WRI's Center for International Development and Environment. To all four, we owe a debt of gratitude.

Walter Reid
Vice President for Program
World Resources Institute

I. INTRODUCTION

During the past decade, tropical forests have been disappearing at the rate of tens of thousands of square kilometers per year. Over this period, the tropical deforestation rate increased by more than 50 percent,[1] and the world lost 10 percent of its tropical forests. In many parts of the tropics, logging is being repeated in the same "cut and run" patterns that typified North America's expanding agricultural frontiers a century earlier. As the forests shrink, developing countries lose—irreversibly, in most cases—some of their most valuable natural endowments. Forest products are not the only casualties. Tropical deforestation creates widespread social and economic turmoil, drives countless plant and animal species to extinction, and contributes to the atmospheric build-up of greenhouse gasses.

One of the principal challenges facing tropical countries today is finding productive investments to maintain their forests. Frequently, experts advise basing such investments on the sustainable production of timber from natural forest areas--so-called "natural forest management." The ideas behind this approach are that tangible goods and services in humid tropical forests can compete with alternative land uses that require forest clearing. Natural forest management can also preserve environmental and conservation benefits according to its proponents. Yet, natural forest management's critics question whether commercial timber production can be compatible with the preservation of biodiversity, indigenous cultures, and the wide range of environmental benefits that healthy natural forest ecosystems provide. To be sure, most attempts at forest management in the humid tropics have so far been largely unsustainable. The question now is whether experience affords insights that could be used to revamp natural forest management so that it can make the use of humid tropical forests more sustainable.

Of course, forest management failures are not unique to the humid tropics. As more people realize that temperate and boreal forests are also being managed with little concern for long-term consequences, international forestry issues that were once synonymous with tropical forests will take on a broader meaning. Even so, questions surrounding tropical forest management are especially pressing simply because their role in economic development is so great and the resources available to manage them sustainably so limited.

This bind is probably going to get worse before it gets better. Growing populations and their countries' desperate needs for foreign exchange earnings will inevitably increase pressures on humid tropical forests. Recent increases in development assistance for forestry notwithstanding, only a minute fraction of the world's humid tropical forests is sustainably managed for timber production.

To most tropical countries, whether to exploit forests is scarcely even a question.

Already, the role of timber management is among the most controversial in the international debate over tropical deforestation. Faced with great uncertainties about how timber production can be practiced sustainably, the World Bank, USAID, and some other donors now avoid financing projects that involve commercial logging in primary forests. Several European donors have decided not to fund any forestry projects in natural forests. Meanwhile, a growing movement to boycott the use of tropical timbers has manifested itself partly in procurement bans by local governments in Western Europe and the United States. However principled these decisions, some observers fear that they could quash innovative attempts to harvest timber and other natural forest resources sustainably, making the destruction caused by advancing agricultural frontiers or "timber mining" unstoppable.

To most tropical countries, whether to exploit forests is scarcely even a question. Consider, for instance, the following statement by Appanah and

Weinland (1991): "That people have a right to exploit their natural resources for purposes of development and a higher quality of life is axiomatic. A case to cite will be North America, where timber from natural forests fueled much of its early development. Many countries in southeast Asia are currently exploiting their timber-rich dipterocarp forests for the same purposes." On the other hand, without sustainable natural forest-management practices, gains are likely to be limited and short-term and opportunity costs for future generations high.

The need for a firmer consensus on how natural forest management can help maintain humid tropical forests is urgent. The issue dominates current discussions about the International Tropical Timber Organization (ITTO), new multilateral development bank policies on forest sector lending, and the Tropical Forestry Action Plan. It figured centrally in recent negotiations at the U.N. Conference on Environment and Development (UNCED) over "Agenda 21" and a statement on global forest principles, and it is likely to emerge in various trade initiatives, including the General Agreement on Tariffs and Trade (GATT) and free trade agreements.

What should the pivot points in such a consensus be? For starters, governments have to be committed to defending a "permanent forest estate" based on secure, long-term land tenure for communities, concession holders, and forest agencies. Once such an estate is established, governments, conservation organizations and donors must be able to recognize where and when natural forest management projects are appropriate. For this, they need clear criteria, preferably developed in consultation with those who will be most directly affected. Where primary forests are currently inaccessible, human population densities are low, and deforestation is thus not an imminent threat, natural forest management is probably not the right conservation technique. But where the fit is good and natural forest management is embraced, it must become synonymous with ecosystem management—focussed on a variety of products and environmental services, not just timber. When planning begins, explicit management objectives and expected benefits should be spelled out and the appropriate monitoring indicators identified before logging begins.

If production of a commodity is a primary objective, it should be linked from the start to secondary ecosystem management objectives. To monitor progress toward both primary and secondary objectives, "leading" environmental indicators on, for instance, the status of biodiversity, water quality, and soil nutrients must be developed to complement such traditional "lagging" indicators as timber yield, tree regeneration rates and composition, and non-timber forest product yield. (More specifically, leading indicators might include regeneration rates for important successional as well as dominant tree species; the status of key pollinators and seed dispersers; changes in micro-climates; levels of mineral, organic materials, and microfauna in soils; and the quality of water flowing from managed areas.)

Natural forest management affords no guarantee that forest ecosystems will stay healthy and diverse. Ultimately, the institutions that manage forests determine their fate.

Even if these steps are followed, natural forest management affords no guarantee that forest ecosystems will stay healthy and diverse. Ultimately, the institutions that manage forests—communities, concessionaires, and government agencies—determine their fate. Still, the chance that they will succeed can be strengthened. To build community support for sustainable forest use, the keys are recognizing the land and resource tenure of long-standing forest communities, developing organizational cohesion and management skills, and blending local knowledge with technical assistance to promote more sustainable management practices. To get concessionaires to buy into the proposition, governments must set forth incentives, coupled with enforceable guidelines, for sustainable forestry and build the capacity to make sure they are respected. Important incentives to practice sustainable forestry can be provided by voluntary and independent timber-certification programs backed by a scientifically and socially credible international standards board (such as the nascent Forest Stewardship Council). Designed by experienced

foresters, ecologists, and social scientists, in consultation with interested community and commercial forest producers, such certification programs would allow producers of both tropical and temperate/boreal timbers higher prices and other incentives to make the system work.

These recommendations are only a partial list, and getting to the root of tropical deforestation will require initiatives outside the forestry sector. Along with natural forest management, the fate of humid tropical forests will depend directly on more appropriate and sustainable agricultural development, more and better job opportunities for rural and urban poor, and more effective protected areas networks. Indeed, the sustainable use of forests is bedeviled by the same problems that undermine all attempts at sustainable development in tropical countries--poverty, unemployment, rapid population growth, foreign debt, parochial allegiance to sectors within governments, undervalued natural resources, inequitable international trade relationships, and highly concentrated economic and political resources.

Even though any one of these factors can overwhelm sustainable natural forest management, the need to put the use and management of all forests on a more sustainable basis remains. Our best hope for doing so still lies with natural forest management. In the short term, the destructive impacts of logging in humid tropical forests could be reduced by adopting simple and well-known technologies and better management techniques. Over the longer term, such mechanistic changes must be linked to the social and economic needs of the local people for whom the forest means livelihood or home.

II. HUMID TROPICAL FORESTS

Tropical forests are found in more than 80 countries and account for roughly one third of the world's forest cover (WRI, 1992). They encompass a wide variety of forest types found under diverse environmental conditions—from lush, constantly wet rain forests to arid thorn woodlands. Although deforestation occurs in all types of tropical forest, most logging takes place in the humid tropics.

WHAT ARE THEY?

Dynamic, interactive, and self-perpetuating, forests are seen by ecologists as communities of living organisms in which trees dominate the vegetation and interact closely with each other and their physical environment. By this definition, plantations are not forests because indigenous tree species do not maintain themselves naturally or spontaneously.

Natural forests can be either "secondary" or "primary." The difference is defined in Savage (1987):

> A *primary forest* is an ecosystem characterized by an abundance of mature trees. It has been relatively undisturbed by human activity. Human impacts in such forests have been limited to low levels of artisanal hunting, fishing and harvesting of forest products, and, in some cases, to low density, migratory shifting agriculture. So-called virgin, climax, or undisturbed forests are primary forests.
>
> *Secondary forests* are ecosystems that regenerate from a substantial disturbance (flood, fire, land clearing, or extensive logging); they have relatively few mature trees and are generally characterized by an abundance of fast-growing species and a thick understory of saplings and herbaceous plants. Although secondary forests tend to peak in terms of biomass accumulation rates in about 15 years, the transition to primary forest takes at least 75 to 100 years, depending on the intensity of the original disturbance. Irreversible transformation of the underlying soil and nutrient cycle brought about by chronic or intense land use may make it impossible for the original primary forest to return.

The considerable diversity of tropical forest types complicates discussions on forest management at any but the most local levels. Thanks to the range of climatic conditions, soil types, and biogeographic characteristics found in the tropics, forest stands vary widely in composition, structure, function, and productivity. Further complications stem from the use of a variety of classification systems.[2] Indeed, so many are in use that studies on forest cover and deforestation are difficult to compare (Tho, 1991).

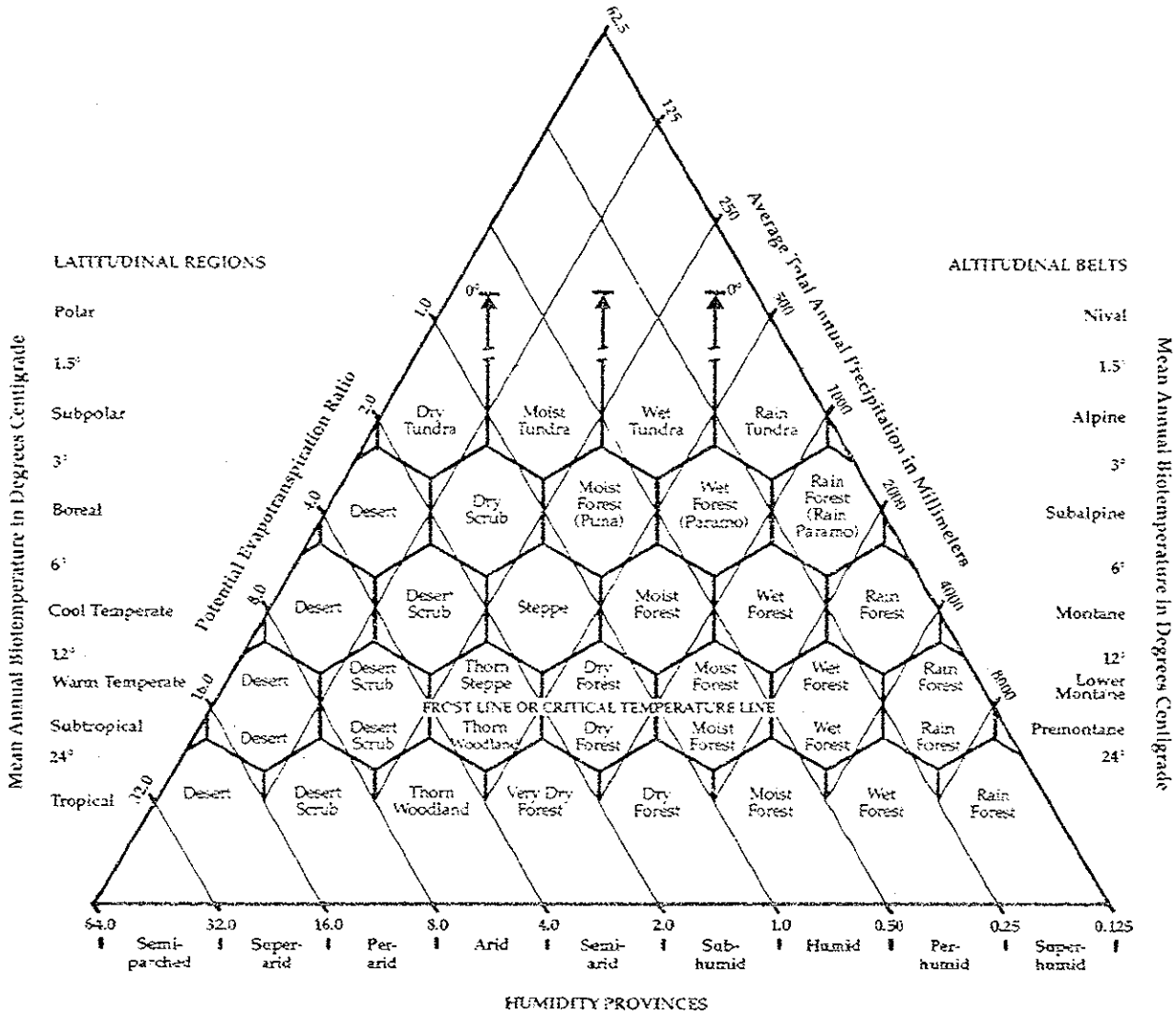
The Holdridge (1967) life-zone system, however, provides a useful way to broadly distinguish between vegetational types.[3] This system, which classifies plant formations on the basis of temperature, precipitation, and elevation relationships, can be used to predict water and temperature stress conditions for plants—a simple but relatively consistent indicator for predicting the composition of plant communities.

To avoid the confusion that can result from the imprecise use of such terms as "tropical moist forest" and "tropical rainforest," the term "*humid tropical forest*" is used here. It covers natural forests found in the life zones described in the Holdridge system as "moist forest," "wet forest," and "rain forest." *(See Figure 1.)* Each of these life zones is found in humid tropical areas where annual precipitation rates exceed those of evaporation and transpiration.[4]

WHERE ARE HUMID TROPICAL FORESTS?

Humid tropical forests constitute slightly less than half of all tropical forest and cover approximately 6 percent of the earth's land surface. The largest forest ecosystems in the humid tropics are concentrated in the Amazon and Orinoco Basins of South America, the Congo Basin of central Africa, and in southeast Asia. Less extensive humid tropical forest ecosystems are found in Mexico and Central America, the Caribbean, West Africa along the Gulf of Guinea, southern and eastern Africa, in parts of

Figure 1. Holdridge Classification of World Life Zones or Plant Formations



Source: L. R. Holdridge, Tropical Science Center, San José, Costa Rica (May 1966)

the Indian sub-continent, Sri Lanka, southern China, Australia's northeastern coast, and the southwestern Pacific islands. Precise estimates of the extent of humid tropical forest vary. Relying on the Lanly (1982) analysis, Lugo (1987) estimates that this type of forest covers about 9 million square kilometers (900 million hectares). Grainger (1990) uses the same information to arrive at a figure of 10.8 million square kilometers. Myers (1989) estimates that there are approximately 8 million square kilometers of closed forests in the humid tropics, which he defines as areas where monthly precipitation falls below 100 mm only once every three years on average and where average annual temperatures are above 24°C.

Tropical dry forest and woodlands by contrast cover approximately 10 million square kilometers.

WHAT IS AT STAKE

What is at stake in humid tropical forests has been unclear until very recently, despite the public's and experts' concern over the fate of this ecosystem. But scientists' notions about what constitutes humid tropical forest ecosystems, what people depend on them for, and what roles they may play in vital global processes are evolving rapidly as new information becomes available.

Upward of four hundred million people around the world are believed to live in humid tropical forest areas or to depend directly on them. This number includes as many as fifty million indigenous peoples, descendants of groups who have lived in or near humid tropical forests for generations—millennia, in some cases (Colchester, 1991). Many possess local knowledge of great help in sustainably managing natural resources in the absence of rapid social change caused by outside forces (Lynch, 1990). Although these people bear most of the brunt of deforestation in the humid tropics, the presence, rights, and potential of indigenous and migrant forest residents are often ignored by the governments that plan and manage many forest areas. In such places as Brazil's Amazon Basin and the Sarawak forests in Malaysia,[5] this indifference has provoked forest residents to defend their territorial rights through such measures as barricading logging roads, waging hunger strikes, and staging mass acts of civil disobedience.

Not only cultures and the acquired knowledge of generations are at stake. The often-overlooked non-timber forest products and other wild products gathered from forest lands are also of considerable economic importance in many humid tropical areas. A few of these products—rattan, for example—are widely traded on international markets. But most—among them, essential oils, fruit, game, gums, honey, meat, medicines, and rope—have large markets at home or in neighboring countries. Exports of these commodities have grown steadily during the past decade. In Indonesia, the share of non-timber forest products has grown from less than 3 percent of total forest export value in 1973 to more than 15 percent by the mid-1980s (Repetto and Gillis, 1988). In India, an estimated one half of all forest revenues come from the sale of non-timber forest products, and more than 70 percent of all forest export value comes from these commodities.

Humid tropical forests also provide invaluable ecosystem services. They retain soil and nutrients, provide perennial water supplies, and moderate runoff during peak flows in the rainy season. Unfortunately, the value of these services to society as a whole is rarely realized until deforestation diminishes or destroys them. Around the world, tropical deforestation is directly linked to severe flooding, sedimentation, water shortages, decreased hydroelectric production, landslides, and productivity losses in such coastal ecosystems as mangrove forests and coral reefs. In addition, forest fragmentation and changes in ecosystem processes (e.g., pollination, migration, disturbance regimes, etc.) have direct and indirect effects on biodiversity.

Although humid tropical forests cover only 6 to 7 percent of the earth's land surface, they contain at least half—and possibly much more—of the world's species (Reid and Miller, 1989). Indeed, humid tropical forest ecosystems serve as the world's greatest storehouses of biological diversity. Species from tropical forest habitats have made contributions to modern health, agriculture, and industry. The cross-counter value of plant-derived pharmaceuticals alone exceeds $40 billion a year[6] (Miller and Tangley, 1991). Considering how few of the millions of species have been put to use so far, the forest losses now occurring in the humid tropics—losses that may lead to the extinction of between 6 to 14 percent of the world's species during the next twenty-five years—are incalculable (Reid, 1992).

Finally, the loss of humid tropical forests may affect climate both locally and thousands of miles away. To the extent that increased levels of atmospheric carbon fuel global warming, tropical deforestation plays a significant role, contributing as much as 15 to 20 percent of all carbon dioxide emissions from human sources—a distant second to the burning of fossil fuels (WRI, 1990). Locally and regionally, deforestation is also associated with declines in rainfall, increased surface temperatures, and the alteration of local hydrology (Salati and Vose, 1983). Loss of the remaining large areas of humid tropical forest (e.g., in the Amazon or Congo River Basins) could also significantly influence global climate patterns.

III. NATURAL FOREST MANAGEMENT IN THE AGE OF DEFORESTATION

Natural forest management is practiced only rarely in most of the humid tropics (Poore et al., 1989). Historical land-use and forestry practices, current trends in forest resources and economic development, and policies both within and outside of the forest sector are to blame.

With the advent of agriculture, some 10,000 years ago, people became more powerful agents of ecological change, creating cultivated frontiers at the expense of forested lands. During the relatively short history of agricultural society (and even briefer history of industrialization), the world's forests and woodlands declined from an estimated 6.2 billion hectares to approximately 4.3 billion hectares (Lanly, 1982). Historically, temperate forests suffered most. By 1950 or so, they had shrank in area by about a third. But even though tropical forests fared much better for millennia (Matthews, 1983), deforestation rates in the tropics have increased dramatically during the past several decades.

Although evidence suggests that some humid tropical forest areas once supported large human populations, (Gomez-Pampa and Kaus, 1991; Mather, 1990; Hutterer, 1988; Meggers, 1988,)[7] these areas have traditionally been highly inaccessible and inhospitable. In recent decades, however, the ranks of landless poor in tropical countries have grown dramatically, pushing many farmers and city dwellers into forest areas in search of a better livelihood.[8] The attractions of small-scale mining, cash cropping, and other economic activities have drawn many others into the forest in search of a quick profit. Dramatic increases in consumer demands in temperate countries for crops, hardwoods, cheap beef, petroleum, and mineral resources from the tropics have planted another impetus. Combined, these factors drive the dramatic deforestation rates now occurring in many parts of the humid tropics.

An increasing number of countries once extensively covered with humid tropical forest (e.g., Bangladesh, El Salvador, Benin, Togo, Sierra Leone, Haiti, and Sri Lanka) have virtually no primary forest left. In others (e.g., China, Viet Nam, Laos, Nigeria, Ghana, Côte d'Ivoire, Myanmar, and the Philippines), primary forests may disappear before the year 2000 (Goodland et al., 1990).[9] Although data on remaining forest area are sketchy, satellite images from numerous countries indicate that tropical deforestation rates worldwide increased during the past decade. For example, in nine countries[10] where closed tropical deforestation was estimated at approximately 3 million hectares annually in 1980 (Lanly, 1982), new studies in the same countries peg annual losses at 4 million hectares, and possibly much higher (WRI, 1992, 1990).[11] Overall, annual rates of tropical deforestation have increased by at least 65 percent during the past decade (FAO, 1991; WRI, 1990). Now, as much as one half of the original humid tropical forest has disappeared,[12] and about one quarter of the remainder is degraded (Myers, 1989; FAO, 1988).

How fast humid tropical forests will disappear is hard to predict. But, if present trends continue, significant—if not catastrophic—declines in the extent and quality of tropical forests will occur within 30 years, especially in the comparatively accessible lowlands. Given current deforestation rates and the expected growth in world population and economic activity, the World Commission on Environment and Development (1987) concluded that little closed primary tropical forest would survive beyond the turn of the century outside of protected areas,[13] except in remote portions of the Congo Basin, South America's western Amazonia, Guianan forests (in Venezuela, Guyana, Surinam, and French Guiana), and New Guinea.

Most humid tropical forests are found in countries where the need for economic development is enormous and a multitude of social, economic, and environmental problems compete with deforestation for attention. Like humid tropical forests themselves, the root causes of their destruction are diverse and geographically varied. Not surprisingly, governments beleaguered by population pressures and widespread poverty, foreign debt, economic stagnation or decline, and heavily influenced by concentrated

economic interests have not invested the financial, political, and human capital needed to maintain forests. To the contrary, such pressures have instead led to investments in risky, short-term, high-yield forms of development that bring in foreign exchange—including the uncontrolled logging of tropical hardwoods for export. Sustainable timber production from natural forests, on the other hand, is considered long-term, low-yield, but still risky. And while international concern about the fate of humid tropical forests is growing, industrialized countries have not put most of their own forests on a truly sustainable footing or helped pay for maintaining those in the tropics.

Inevitably, human interactions with forests will continue to intensify in many parts of the humid tropics. As Table 1 shows, in the ten tropical countries with the most humid tropical forest areas, population growth rates are high, most of them in excess of 2 percent. While GNP growth has exceeded population growth rates in some countries, per capita GNP in most places remains very low. More troubling, nearly all of the ten are heavily indebted. To feed growing populations and to generate foreign exchange earnings, governments and donors have encouraged the expansion of agriculture in most countries, often at the expense of forests. Then too, while forest product exports have grown in most countries, the volume of domestic forest product consumption generally far exceeds the volume of exports.

PUBLIC POLICIES AND DEFORESTATION

Tropical deforestation is much less a matter of silviculture than of public policy, economic pressures, and social conditions. The two most visible agents of deforestation are the conversion of forest to farmland or pasture and unmanaged or unsustainable logging operations. Often these and other activities that lead to tropical forest destruction are catalyzed by government policies.

Agricultural expansion, fueled by population growth and migration, is generally recognized as the leading factor in humid tropical forest loss, though its forms vary considerably from one country to another. Most commonly, forests are cleared for short-term or non-fallow shifting agriculture, though in Latin America making way for cattle ranching is a major impetus. Conversion to plantations for bananas, cacao, coffee, oil palm, rubber, and other export commodities is a third and less important reason.

Tropical deforestation is much less a matter of silviculture than of public policy, economic pressures, and social conditions.

Many national governments have promoted agricultural development in forest areas through incentives, subsidies, and tenurial policies. Such policies often have even more negative, if more subtle, effects on forests than misguided or weak forest policies do. The most obvious destruction occurs when forest lands are converted under government programs to large agroindustrial estates. For example, in peninsular Malaysia, the government has converted 12 percent of its forest area to rubber and oil palm plantations (Repetto, 1988).

More often, tax, credit, and pricing policies accelerate the indiscriminate conversion of forest lands to farming and ranching. Typically, these incentives lower production costs, thus making alternative land-uses more profitable. In some cases, incentives are so high that forests are converted to uneconomic and ephemeral uses solely to realize quick one-time gains. In Brazil, for example, a combination of tax credits, investment credits, low overall taxes on agricultural income, generous income tax holidays, and depreciation allowances during the 1980s effectively sheltered cattle ranch investors from income-tax liabilities while allowing them to write off operating losses against income from other sources (Repetto, 1988). Such incentives may account for 30 percent or more of the deforestation in Brazil's Amazon Basin during the 1980s. At any rate, the cancellation of tax credits for agricultural development in 1988–89 apparently slowed Brazil's deforestation rates significantly from their 1987 peak.[14]

Land tenure policies often encourage deforestation. In many countries, proprietary rights to forest

lands have been centralized in national governments, superseding the traditional rights of peoples who have dwelled in or around the forests for centuries. Although intended to strengthen control of forest resources, these actions have more often than not had the opposite effect, undermining local rules governing access and use, eroding local conservation incentives, and saddling central governments with far-flung responsibilities that exceed their administrative capabilities. *(See Table 2.)* As Colchester (1991) points out, this means that "...relatively tiny bureaucracies charged with administering and policing forests are totally unable to prevent public access and unable to properly regulate timber industries."

After wresting control of forest resources from indigenous peoples, many governments have given private parties the property rights to public forests. Often, this transfer of property rights has been conditional: the private owner must "improve" or develop the forest—which usually means clearing it—to claim benefits. These tenurial rules have helped expand smallholder agriculture, but in some countries they also allow wealthy individuals to amass large holdings (Repetto and Gillis, 1988). They also deprive many of the 400 million people who live in and depend directly on humid tropical forests for their livelihoods of a strong legal basis for tenure on forest lands (Colchester, 1991).

While resettlement and colonization programs can be seen as the result of expansionist agricultural policies, they can also be viewed as manifestations of other policies. In countries with burgeoning populations, concentrated land holdings, and multitudes of landless poor, moving people into forest areas is considered the least expensive and politically disruptive means of addressing social welfare needs. During the 1970s and 1980s, Brazil sponsored massive resettlement programs to colonize forest areas in the Amazon Basin with small farmers, and Indonesia has had similar programs (*see* Bundestag, 1990). Colonization programs, particularly in the Amazon Basin, have also been used to establish sovereignty in areas where national boundaries are in dispute.

Other activities also contribute to tropical forest loss. Infrastructure development, including road and dam construction, not only directly kills or damages large numbers of trees. It also provides easy access to settlers, miners, ranchers, and others with various economic interests in clearing the forest. Mining and petroleum development can be devastating—witness the large influxes of people, the extensive water and soil contamination, and the inefficient use of wood for construction and industrial fuel involved.

Finally, according to FAO estimates (FAO, 1988; Lanly, 1982) logging directly causes 10 percent of tropical deforestation—and facilitates tropical forest losses stemming primarily from other causes. In most humid tropical forest areas, logging practices today are typically "mining" operations that deplete or eventually eradicate tropical forests. While logging in tropical forests more generally tends to be selective, it can be very destructive if poorly planned and inadequately regulated.

Nearly all tropical countries with public forest resources allocate the rights to harvest timber through concession systems. Few of these promote the sustainable use of forest resources. Too often, governments have invited rapid forest depletion by conceding most of the forests' economic benefits to concessionaires whom they scarcely monitor, much less force to comply with sustainable forestry guidelines.

Most of the policies leading to forest loss and degradation were well-intended, but others have been adopted with full knowledge of their destructive consequences. Repetto (1988) provides six explanations[15] for why policies destructive to forests were adopted and why they persist:

> (1) Sustained flows of benefits from intact natural forests have been consistently undervalued by both policy-makers and the public. Forests are exploited as though only two resources matter: timber and, especially in the tropics, the agricultural land thought to lie beneath the forest. Obviously, an asset that is undervalued will inevitably be misused (assuming a demand for it exists).
>
> (2) The net economic benefits from forest exploitation and conversion have been overestimated and many of their costs ignored. Plans to harvest tropical logs every 35 years are made in defiance of fact (many tropical forests need much longer rotations), exaggerating the rate and extent of regeneration. Such problems have plagued forest management in Indonesia, the Philippines, and other countries studied.

Table 1. Forestry and Development Data for Ten Countries with Largest Extent of Humid Tropical Forest

Country	Closed[1] Forest Area (km^2)	Annual[1] Deforestation Rate (Closed) (%)	1990 Population (millions)	Annual[1] Population Growth Rate (%)	Per Capita[1] GNP ($US) (1987)
Brazil	3,574,800	0.5	150.37	2.07	2,550
Zaire	1,057,500	0.2	35.37	3.14	260
Indonesia	1,138,950	0.8	184.28	1.93	490
Peru	696,800	0.4	21.55	2.08	1,090
Colombia	464,000	1.8	32.98	1.97	1,190
Papua New Guinea	342,300	0.1	3.87	2.26	900
Myanmar	319,410	2.1	41.68	2.09	400
Venezuela	318,700	0.4	19.74	2.61	2,450
Congo	213,400	0.1	2.27	3.16	930
Malaysia	209,960	1.2	17.89	2.64	2,130

1. WRI. 1992. *World Resources 1992–93.* Data Tables 19.1, 19.3, 16.1, 15.1, 15.2. Oxford University Press.

Assumptions about the agricultural potential from land underlying tropical forests have been even more optimistic and the results even more disappointing.

(3) Forest agencies and development planners exploit forests for commodity production without first acquiring adequate biological knowledge of their resource's potential limitations or of the economic consequences of losing or diminishing the forest. Large-scale agricultural settlements and livestock operations are encouraged without adequate study of land-use capabilities. Painful and costly failures drive home the lesson that even the lushest tropical forest does not necessarily have rich soils beneath it.

(4) Policy-makers attempt without much success to draw on tropical forest resources to solve a wide range of fiscal, economic, social, and political conflicts. Rather than modifying development strategies to deal with unemployment

Table 1. Continued

Annual GNP[1] Growth (%)	Public[1] Debt as Percentage of GNP (1989)	Annual[1] Increase Agricultural Land (%)	Forest Product Exports 1989[2] (1000M³)	Volume[2] Growth in Forest Product Exports 1979–1989 (%)	Domestic[2] Forest Product Consumption 1989 (1000M³)	Volume[2] Growth in Domestic Forest Product Consumption 1979–1989 (%)
2.7	18	2.9	1,262	37	3,571	60
1.6	83	0.8	144	54	2,821	32
6.5	46	0.8	11,734	(44)	46,457	353
0.1	45	1.3	X	X	1,687	(24)
3.0	38	1.0	X	X	3,359	– 20
1.2	41	0.9	1,408	113	1,383	116
2.3	25	0.1	433	137	4,915	76
(0.8)	61	0.9	X	X	2,294	111
6.1	176	0.3	1,014	395	610	4
5.7	40	0.3	27,638	33	24,454	56

2. FAO. 1991. *1989 Yearbook on Forest Products.* U.N. Food and Agriculture Organization, Rome.

* Forest Products are defined here as: non-coniferous industrial roundwood; non-coniferous sawnwood; and wood-based panels. *See FAO 1989 Yearbook on Forest Products* for definitions.

and rural poverty, for instance, or tackling the politically thorny problem of land reform, many countries use forests as an escape valve to relieve demographic and economic pressures.

(5) Few national governments are willing to invest what it takes to manage the varied uses of forest resources, despite their enormous value. While most sizeable countries have substantial agricultural research programs, few have developed appreciable research capabilities or activities focused on natural forest ecology and management. Furthermore, forest revenues are rarely reinvested in maintaining the forest's productive capacity.

(6) Finally, national governments have underestimated the value of traditional management practices and local governance over forest resources and overestimated their own forest management capabilities. Local communities that depend on forests for many commodities and

Table 2. Forest Area, Forest Department Staff, and Estimated Forest Residents

Country	Closed Tropical Forest Area (ha)	Forest Department Staff	Estimated Forest Residents
Indonesia	113,895,000	17,000	15 million
Thailand	9,235,000	7,000	6 million
Papua New Guinea	35,623,000	445	3.5 million
Malaysia	18,500,000	6,070	
Cameroon	16,500,000	836	~400,000
Zaire	100,000,000	~836	~15 million
Ecuador	14,250,000	823	<2.2 million
Peru	69,680,000	~1,000	<2 million

References: Hafild (1992); Colchester (1991); Lynch (1991); Halpin (1990); Poffenberger (1990); Republic of Ecuador (1990); Winterbottom (1990); World Bank (1990); WRI (1990); Republic of Peru (1987); Winterbottom (1987).

services besides timber have often—though not always—been more sensitive to the forest's protective functions and appreciative of the wide variety of goods that can be sustainably harvested.

LOGGING, DEFORESTATION AND FOREST DEGRADATION

How much humid tropical forest is affected by commercial logging? Lanly (1982) estimates that 4.4 million hectares of undisturbed productive closed tropical forest[16] were logged annually in the early 1980s, mainly in Southeast Asia and Latin America. Illegal logging, according to Myers (1984), annually degraded another 1.1 million hectares of undisturbed forest in the humid tropics. In addition, as much as 7.5 million hectares of previously logged closed forests (secondary forests) were relogged annually (Lanly, 1982). In tropical Asia, roughly half of the productive closed forests had been logged by 1980. Nearly 27 percent of Africa's productive closed forest lands had been logged-over by that year. Latin America—where only 10 percent of the exploitable closed forest had been logged by 1980—will eventually become the world's major source of tropical hardwoods as other sources diminish (Grainger, 1987).

Since most logging in the humid tropics involves selective cutting that leaves a residual forest cover, a logged-over area is usually not synonymous with a deforested area, as defined by the U.N. Food and Agriculture Organization (FAO). If deforestation is defined as the complete removal of tree cover as FAO submits, logging was the primary cause of deforestation for about 1.14 million hectares annually in 1980 (Lanly, 1982). But FAO estimates of logged-over forest do not specify the intensity of logging-related forest degradation, and some lands are undoubtedly deforested in an ecological sense.

As a direct cause of deforestation, logging is secondary to various forms of agricultural expansion in most assessments, (*see*, for example: Tho, 1991; Bundestag, 1990; Myers, 1989; Lanly, 1982). Nevertheless, logging deserves more attention than estimates of its direct role in tropical deforestation suggest. In the tropics, most logging takes place in humid forests, but FAO's deforestation estimate of 10 percent includes all types of tropical forests. If most of the 1.14 million hectares of logging-related deforestation took place in "closed broadleaved" forests,[17]

then logging was directly responsible for about 16 percent of deforestation in closed broadleaved tropical forests. In any event, such difficulties with data interpretation invite caution in accepting blanket claims that commercial logging exacts only a minor toll on forests in the humid tropics.

Difficulties with data interpretation invite caution in accepting blanket claims that commercial logging exacts only a minor toll on forests in the humid tropics.

The relative importance of logging to forest loss and degradation differs considerably from one region to another. In southeast Asia's dipterocarp forests, logging operations generally penetrate previously inaccessible primary forest, and loggers may remove up to 40 percent of the standing timber volume and leave between 15 and 40 percent of the ground with no canopy cover (Bundestag, 1990). By contrast, timber volumes extracted in Latin America are much lower, and logging often follows the advancing frontier of forest cleared for cattle ranching and colonization (DeBonis, 1986; Lanly, 1982).

Even within countries, national level data can obscure regional differences in what causes deforestation (*see* WWF, 1989). Shifting cultivation can severely reduce forest cover when practiced in densely populated areas, such as the inner islands of Indonesia. But it causes relatively little damage in the sparsely populated areas where timber harvesting is concentrated, such as Kalimantan or Irian Jaya, especially since shifting cultivation in these areas generally takes place in secondary forest (for review, *see* Wilson, 1989).

Often, logging catalyzes deforestation attributed to other causes, such as shifting cultivation. Commercial logging frequently triggers the direct conversion of forests to such uses as pasture or agriculture. Roads and other infrastructure built in forest areas in conjunction with logging operations create new agricultural frontiers, greatly increasing the vulnerability of the newly opened forest lands. Lanly (1982) estimates that deforestation rates are eight times greater in logged-over closed tropical forests than in undisturbed closed forests.

LOGGING AND RESIDUAL FOREST DAMAGE

Even without conversion pressures, selective cutting practices that are typical of most logging operations in the tropics can significantly damage the forest. Logging operations often use only a small fraction of the available timber, but damage much of what remains. In Northwest Ecuador, for example, a typical logging operation may harvest only 17 cubic meters (m^3) from a total standing volume of 130 m^3 per hectare (Cabarle et al., 1989). But harvesting this 5 to 20 percent of standing trees can damage 20 to 50 percent or more of the remaining trees. Careless logging can destroy or fatally injure residual trees, especially intermediate-size trees vital for the next harvest and saplings important to subsequent harvests.

While not extensive, most research on logging damage shows unacceptable damage to the unharvested growing stock. *(See Table 3.)* In Sarawak, research has shown, trees representing as much as 40 percent of the residual basal area were damaged during typical logging operations (Marn and Jonkers, 1982). In Brazil's eastern Amazonia, over 26 percent of the remaining trees greater than 10 cm. diameter were destroyed or seriously damaged in efforts to extract a mere 2 percent of the total (Uhl and Vieira, 1989). In Malaysia, 48 percent of all trees greater than 9.5 cm were destroyed to remove only 3 percent of the trees in the selective harvest of dipterocarps (Johns, 1992). A review of logging damage to residual trees in Southeast Asia's dipterocarp forests by Appanah and Weinland (1991) indicates a range of between 10 to 75 percent damage to all stems greater than 15 cm., with the average slightly greater than 50 percent.

Such studies document only immediately apparent damage—not the post-logging mortality that could appear several years later. Eleven years after logging, Johns (1992) documented dramatically higher levels of treefalls in logged forest compared to unlogged forest after a single violent storm hit an Amazon study site. Appanah and Weinland (1991) have documented heavy windthrow damage several years after selective logging in Peninsular Malaysia. If

Table 3. Damage to Residual Trees Following Selective Logging

Location	Damage as % of Stems	Source
Peninsular Malaysia	64–69	Canonizada (1978)[1]
Pará, Brazil	68 +	Verissimo, et al. (1992)
Pará, Brazil	26	Uhl and Viera (1989)
Malaysia	50–20	Griffin & Caprata (1977)[1]
Malaysia	55	Burgess (1971)[1]
Peninsular Malaysia	24–38	Borham, et al (1987)[1]
East Kalimantan, Indonesia	40	Abdulhadi (n.d.)[2]
Indonesia	40	Sumantri (n.d.)[2]
Philippines	64–70	Uebelhoer (1989)[1]
Philippines	50–66	Uebelhoer (1989)[1]
Philippines	57–58	Weidelt & Banaag (1982)[1]
Philippines	46–54	Weidelt & Banaag (1982)[1]
Indonesia	50	Tinal & Palenewen (1975)[1]
Indonesia	50	Abdulhadi (1987)[1]
Indonesia	46	Abdulhadi (1987)[1]
Sabah, Malaysia	68–75	Fox (1968)[1]

Note: The diameter classes of damaged trees were not cited in most cases. Where this information was provided, stems measured were greater than 10 cm or 15 cm diameter at breast height

1. As cited in Appanah and Weinland (1991).
2. As cited in Jonsson and Lindgren (1990).

References: Verissimo, et al., (1992); Appanah and Weinland (1991); Jonsson & Lindgren (1990); Uhl and Vieira (1989).

post-logging damage is factored in, nearly all documented cases of logging damage under the Malayan Selective System (MSS) have resulted in post-logging damage to intermediate-size trees exceeding the 30 percent maximum allowable in sustainable logging in dipterocarp forests using MSS (Appanah and Weinland, 1991).

Nutrient loss, severe soil erosion, soil compaction, and diminished water retention can also hinder the remnant forest's ability to regenerate. These impacts, which vary considerably by site, are linked to the intensity of harvesting. Studies of nutrient dynamics following typical selective logging operations have shown considerable loss of soil nutrients in some instances, with varying rates of recovery (Shariff et al., 1990). Compaction and the erosion of forest soils has also been widely observed, though rarely studied, following selective logging in the humid tropics (*see* for example, DeBonis, 1986). Increased water runoff in the wake of unregulated logging can seriously damage downstream fisheries and irrigation projects, potentially incurring economic

damage far in excess of the extracted timber's value (ITTO/HIID, 1988).

It is widely assumed that controlling logging damage is prohibitively expensive. Some evidence, however, suggests that even relatively modest measures can significantly reduce damage to the forest at moderate or no additional cost (Moad, 1989; DeBonis, 1986). In Sarawak, the use of directional felling and planned skidtrails reduced mortality to remaining trees by 33 percent and to understory seedlings by up to 40 percent (Marn and Jonkers, 1982). These efforts also made skidding efficient and actually reduced harvesting costs by as much as 23 percent. Similar results have been reported in Surinam (Jonkers and Hendrison, 1987) and Ecuador (DeBonis, 1986).

Logging can contribute to other destructive processes as well. In canopies opened by logging, leaf litter and woody debris dry out, substantially increasing their flammability. Mosaics of logged forests, cattle pastures, settlements, and farming plots represent a new patchwork landscape in which fire is becoming increasingly common, particularly during droughts associated with El Niño. Such conflagrations have burned millions of hectares during the past decade, including 3.5 million hectares in East Kalimantan in 1982–1983. Logging in some parts of the Amazon may have created the potential for comparable fires in Brazil (Uhl and Kauffman, 1990). While it is generally assumed, even by scientists, that fires rarely or never burn in undisturbed humid tropical forests, growing evidence suggests human activities may be making this rule obsolete (Kauffman, 1991). The Kalimantan fires affected an estimated 8,000 square kilometers of unlogged forest (Malingreau et al., 1985). Smaller areas of primary forest have also burned on the edges of large tracts of interspersed agriculture and logging in parts of the Amazon Basin (Uhl and Kauffman, 1990).

CONCESSION POLICIES

Further fanning controversies over logging is the recognition that most of the concession systems used to allocate and regulate timber extraction on public forest lands are weak. Most forest revenue systems fail to capture much of the considerable "stumpage value" that mature tropical hardwoods represent. Stumpage values are economic rents that reflect the market value of timber minus the cost of attracting the necessary investment. In theory, governments should capture all rent from timber harvested on public lands through fees, royalties, taxes, and other charges. But few exporting countries collect anything close. In the Philippines, government realized only 16.5 percent of potential logging rents between 1979 and 1982, and Indonesia captured only 38 percent during those years (Repetto, 1988).

In theory, governments should capture all rent from timber harvested on public lands through fees, royalties, taxes, and other charges. But few exporting countries collect anything close.

Of course, any rents not fully collected by government accrue to concessionaires as excess profits. Small wonder that investors vie for timber concessions or that timber "booms" occur as investors try to exploit profitable areas before the competition arrives or concession policies are revised. Many entrepreneurs attracted by the potential profits know nothing about forestry—witness the extensive forest damage they cause as they seek to exploit the most valuable timber rapidly. Worse, failing to capture rent, governments lack the revenue to adequately finance the forest agencies that oversee concessionaires.

Most concession systems have other fundamental flaws as well. As noted, governments typically limit concession agreements to 5 to 25 years, even though most tropical forests require at least 60 years to regenerate between harvests. Since current concessionaires will not be around to benefit from the next harvest, they have little incentive to protect the forest's productive capacity during the current one.[18]

The structure of forest revenue systems also poses a problem. For example, the use of flat charges per cubic meter harvested provides strong incentives to extract the most valuable timber in ways that carelessly damage much of what is left. Trees with a stumpage value less than the flat charge

are worthless to the concessionaire and can be destroyed with impunity.

Recent reviews by the World Bank and the World Resources Institute have identified other problems with timber concessions in West and Central Africa, Southeast Asia, Brazil, China, and the United States (Grut et al., 1990; Repetto and Gillis, 1988). These include windfall profits, inadequate monitoring and policing, inefficient processing (encouraged by log-export bans), enormous waste, and conflicts with agricultural and other national development policies.

Finally, concession systems are subject to tremendous political and economic pressures that have led to widespread graft, corruption, and the abuse of executive privilege in many forest-rich countries. Concession allocation has often been politically influenced; sometimes, it is little more than a mechanism of political patronage (Nectoux and Kuroda, 1989). Even where forest agencies monitor concessions, the profits from timber exploitation are so high and the pay and status of forest officials so low that bribes can be an easy and very rewarding investment.

In 1987–89, a Commission of Inquiry charged by the Prime Minister of Papua New Guinea with investigating the timber industry likened it to "rampage and pillage" and concluded that: ". . . the timber industry, by its very nature, is conducive to acts of a criminal nature and acts contrary to law and proper government administration" (Barnett, 1989). The Commission found prevalent the use of transfer pricing, "front" companies to mask foreign control of large forest tracts, bribery, undervaluation of export logs, false declaration of species, low prices for land owners and inadequate monitoring by forestry departments, tax collection agencies, and the ombudsman office. Of the 20 major timber companies investigated by the Commission, all but one regularly engaged in fraud and transfer pricing (Barnett, 1989).

Such problems with timber concessions are not unique to Papua New Guinea. For years, import records in Japan have shown considerably more hardwood volume coming from the Philippines than export records in that country indicate (Repetto and Gillis, 1988). In some years, the discrepancies have exceeded 120 percent. Export bans on raw log exports in Indonesia and the Philippines have been evaded by smuggling logs to Sabah (which has no such ban), where the cargo is reshipped to Japanese and European markets. Another practice in Indonesia is to minimally process logs into oversize boards, roughly planed with a slight moulding on one side. This practice skirts the Indonesian ban on the export of raw logs and sawnwood, but clearly violates the intent of the law (Nectoux and Kuroda, 1989). In much of Latin America, true mahogany (*Swietenia macrophylla* and *S. maghogani*) is nearing commercial extinction in accessible areas. Physical evidence gathered by environmentalists and investigative journalists (as well as a number of court rulings) indicate that much of the internationally traded mahogany from Brazil is now cut illegally in protected areas and Indian reserves (Monbiot, 1991).

In March 1992, for the first time, a number of tropical timber species were considered for protection under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) at a meeting of signatory countries. One of the species, *Dalbergia nigra* (Brazilian rosewood), was deemed so depleted that it was placed on Appendix I of CITES, which means that no further trade will be allowed. Three other tropical timber species, including *Pericopsis elata* (afrormosia), *Swietenia mahogani* (Central American populations of true mahogany), and *Guaicacum officinale* (lignum vitae), were listed under the less restrictive Appendix II (species that can be traded, but only with permits, documentation of traded volumes, and paperwork confirming the species' conservation status). Under intense political pressure, four species proposed for listing under Appendix II were withdrawn, including *Swietenia macrophylla* (American mahogany), *Schinopsis* spp. (quebracho), *Gonystylus bancanus* (ramin), and *Intsia* spp. (merbau).

The listing of timber species under CITES has provoked considerable debate about the convention's role in regulating trade in commercial timber. Some countries would prefer to leave such matters to ITTO. Others believe CITES does have a role, especially given the voluntary and non-binding nature of ITTO, its limited membership, and its limited capacity to ensure that members provide accurate and detailed information on the trade of overexploited timber species and their conservation status. Members of CITES and ITTO will increasingly face such issues in coming years as the conservation status of tropical timber species becomes better known.

IV. THE ELUSIVE GOAL OF SUSTAINABILITY IN NATURAL FOREST MANAGEMENT

What is natural forest management? To most foresters, it is the controlled and regulated harvest of timber species in natural forests, combined with the use of various silvicultural and protective measures to sustain or increase the commercial value of forest stands that return after the initial logging (Schmidt, 1987). In contrast, the ITTO Council defines sustainable forest management as "the process of managing permanent forest land to achieve one or more clearly specified objectives of management with regard to a continuous flow of desired forest products and services without undue reduction in its inherent values and future productivity and without undue undesirable effects on the physical and social environment" (Cassells, 1992). The ITTO definition is important because it recognizes the importance of non-timber resources in forest management.

Typically, natural forest management entails selective cutting, but some approaches may entail clear-felling in narrow strips or small patches (*see* Hartshorn, 1990). Certainly, sustainable timber production demands that harvests, averaged over time, do not exceed the forest's regeneration rate and that the topsoil, site fertility, and the genetic potential of the desired species are not irreversibly lost. Some forms of natural forest management emphasize multiple-use (*see*, for example, Poore et al., 1989), however, including timber harvesting.[19]

Well before European colonization and the introduction of "scientific" forestry, many cultural groups living in the forested humid tropics were concerned about sustainability. As Poffenberger (1990) has documented, many cultural groups in southeast Asia traditionally try to hold their lands in trust for their ancestors and descendants and have developed customary laws to regulate land use. Some such laws reflect the spirit of what is now called sustainability. As quoted in Poffenberger (1990), one tribe in Irian Jaya believes that "the ancestors made these goods (the land) at the beginning of time. . .and their descendants must be handed these goods in unimpaired condition in the future." Cultural groups living in tropical forests in other parts of the world have held similar views (Clay, 1988).

Even the most experienced tropical foresters admit that good examples of sustainable natural forest management are hard to find.

Current concepts of sustainable management of humid tropical forests for timber come from timber-management techniques developed in Europe. Beginning about 1860, these were transferred, often with little adaptation, to the humid tropics. Several such systems used during the colonial era apparently approached sustainable production levels (Poore et al., 1989). Accordingly, the forestry literature is replete with case studies and technical articles on selection, shelterwood, and strip-cutting techniques that promote natural regeneration in humid tropical forests and, by extension, sustainable forestry. Yet, even the most experienced tropical foresters admit that good examples of sustainable natural forest management are hard to find. (*See*, for example, Budowski, 1988; Wyatt-Smith, 1987; Wadsworth, 1983.) Today, only a minute fraction of the world's tropical forests are being managed sustainably for timber production (Poore et al., 1989). As earlier efforts—such as teak forest management in Burma until the 1950s or the Malaysian Uniform System in the 1960s and early 1970s—fall by the way, the amount of sustainably managed humid tropical forest is actually declining. The gap between the principle and practice of natural forest management on most humid tropical forestlands has never been wider.

A rough consensus now holds that sustainable natural forest management for timber production is technically feasible and may even have been practiced

in very limited areas. But experts don't agree on the socio-political obstacles to sustainable timber management or the likelihood that they can be removed. The biggest bone of contention is over the practice of natural forest management in primary forests, where the non-technical obstacles are so great that it is difficult to judge how serious the technical constraints are.

If more attention were paid to non-technical obstacles, governments and donor agencies would get a better sense of just how sustainable natural forest management can be on a widespread basis. Conversely, if such impediments are not seriously tackled before natural forest management is attempted on a larger scale, critics of tropical logging may be correct that—at least in some cases—natural forest management could hasten the disappearance of humid tropical forests.

What are these obstacles? How can they be overcome? And what policy choices must governments and development assistance agencies make to keep timber production from humid tropical forests viable over time? Recent overviews of natural forest management in the humid tropics afford at least preliminary answers. *(See Table 4.)*

SUSTAINABILITY

Few forestry experts define sustainability explicitly in terms of natural forest management. Instead, the emphasis is on a continuous yield of timber (e.g., Hartshorn, 1990; Keto et al., 1990; Smithsonian, 1990; Poore et al., 1989; ITTO/HIID, 1988; Schmidt, 1987). Some cite the maintenance of other forest values (such as biodiversity and ecological functions) but don't specify what is to be sustained (e.g., Perl, et al., 1991; Goodland, et al., 1990; Jonsson and Lindgren, 1990; Bruenig and Poker, 1989; Wyatt-Smith, 1987).

It is possible that such vagueness about goals results from attempts to gloss over conflicts. As Poore et al. (1989) point out, timber sustainability in forest management is quite likely to conflict with other forest values, such as biological diversity and some ecosystem services. Similarly, Jonsson and Lindgren (1990) claim that natural forests, with all their diversity, cannot be completely protected within the framework of commercial forestry.

Without banning people from forests, preserving all of the forests' attributes is impossible. In forest management, there is simply no free lunch. However, defining sustainability narrowly as the production of a continuous yield of marketable timber is a mistake, even if non-timber forest products are taken into account. By definition, natural forest management should keep human uses of forests at a level compatible with the maintenance of the ecological processes that sustain them. Even if timber production is the primary management objective, sustaining some level of environmental services and biological diversity should be part of the package, along with maintaining the forest's capacity to meet diverse human needs besides those for employment or wood products. Most such "secondary" concerns are actually integral components of the forest ecosystem—essential to the production of the primary product (timber).

Examples of linked forest management objectives are hard to find, but some exist. In Mexico's Quintana Roo's Plan Piloto forest management project, chicle (latex) production is an integral management objective, along with timber production.[20] *(See Box 1.)* In Peru, one of the major objectives of the Palcazú natural forest-management project is to maintain the Yanesha cultural traditions and livelihoods *(See Box 2.)* But, the Palcazú strip-felling system used in the natural forest also mimics natural forest regeneration processes that maintain the forest's original structure and composition (Hartshorn, 1990).

EVIDENCE OF SUSTAINABILITY

In nearly all overviews of natural forest management, the results are marred by land conversion, over-exploitation, or institutional and economic instability before conclusive evidence of sustainability becomes available. Agricultural clearing and timber poaching interfered with natural forest-management practices at the Cartón de Colombia concession, for instance. *(See Box 3;* WRI, 1991.) In Malaysia, sustainable forest practices ended when the forest was converted to oil palm and rubber plantations. *(See Box 4.)* In the Yapo forest in Côte d'Ivoire, agricultural encroachment threatens to interfere with the sustainable practices researchers are trying to document. *(See Box 5.)* In some cases, existence of a

management plan based on the principles of sustained yield is considered evidence enough that a forestry project is sustainable—double trouble when departures from the management plan occur before the methodology's effectiveness can be assessed.

The forestry literature offers circumstantial evidence of sustainability. It abounds with examples of "abundant" or "successful" natural regeneration after the first harvest and contains some evidence of success after a second. But forest managers familiar with several well-known natural forest-management projects are hard pressed to come up with hard facts apart from those on natural regeneration[2] (WRI, 1991). Even impressive cases—especially that of Paicazu, where stripcuts showed abundant regeneration of a wide diversity of species—have their skeptics. Goodland et al. (1990) state that such regeneration may allow foresters to predict how productive a second rotation of trees might be, but warn that sustainability cannot be gauged until after at least the third cut. Poore et al. (1989) go even farther: "It is not yet possible to demonstrate conclusively that any natural tropical forest anywhere has been successfully managed for the sustained production of timber."

Poore et al. (1989) and others suggest that strict "proof" of sustained timber yield is nearly impossible to find and, in any event, of no value in the search for management alternatives to the current "mining" of tropical forest resources. Drawing on perhaps hundreds of years of biomass accumulation, the first cut in a primary forest will usually offer the highest yield. In subsequent cutting rotations, less biomass accumulates and timber yields are lower, making absolute sustainability well-nigh impossible to meet (Moad, 1989). Still, some researchers (Poore et al. 1989 and others) believe that after the initial harvest, yields from second and subsequent rotations can be maintained at a constant level.

Clearly, defining sustainability in terms of the continuous yield of timber alone is a trap. The most important test is whether natural forest management conserves tropical forests in areas with high deforestation rates: a natural forest-management system is preferable to outright forest clearance regardless of whether strict sustainability is achieved since it provides some income and maintains important ecological functions. In addition, timber yield is not a primary indicator of a forest ecosystem's health. Natural regeneration rates better reflect the productive state of the forest soon after a disturbance. Even better is monitoring the health of the ecological processes that underlie forest productivity, which allows predictions of future yields of timber and other goods and services.

Defining sustainability in terms of the continuous yield of timber alone is a trap. The most important test is whether natural forest management conserves tropical forests in areas with high deforestation rates.

Most evidence of the sustainability of natural forest-management systems remains unconvincing. Foggy management objectives, and a lack of project monitoring undermine its credibility, and most projects don't last long enough to use as a basis for judging sustainability. Timber yield and natural regeneration rates are offered as "evidence" of sustainability because most forest managers don't monitor anything else.

Besides better integrating research and monitoring into their projects, foresters need to track and monitor a wider range of ecosystem indicators. These include:

- *Regeneration:* indicators should reflect natural regeneration rates of important successional and dominant tree species;
- *Biodiversity:* indicators should, at a minimum, reflect the status of key pollinators and seed dispersers. However, since so little is known about the role of most species, it would be better to broadly monitor the status of a cross-section of biodiversity (plants, mammals, birds, invertebrates);
- *Microclimate:* temperature, humidity, and soil moisture are crucial determinants of germination and seedling/sapling survival for most tree species and may be dramatically affected by forest-management activities;

Table 4. Sustainability Issues in Natural Forest Management: Summary of Recent Forestry Literature

ISSUES	Wyatt-Smith (1987)	Schmidt (1987)
Definition of Sustainable Forest Management	Forest exploitation that provides a regular yield of forest produce without destroying or radically altering the composition and structure of the forest as a whole.	Controlled harvesting combined with silvicultural practices to sustain or increase value of subsequent stands, all relying on natural regeneration.
Evidence Supporting "Sustainability"	Malaysian Uniform System (MUS) was successful when abundant natural regeneration was present. In Philippines, selective logging shows excellent regeneration of preferred species. Successful natural regeneration in Trinidad, Puerto Rico, CELOS system in Surinam looks promising.	In Malaysia, MUS resulted in successful regeneration in lowland dipterocarp forests; liberation thinnings in selectively logged forests in Sarawak produces a new good quality stand quickly; selective logging in Philippines leaves a commercial residual stand.
Major Achievements (economic, ecological, institutional, social)	Some successful timber management programs have been developed, especially in Malaysia (MUS) and Philippines.	Some success with systems in lowland dipterocarp forests, e.g. Sarawak and the Philippines.
Major Constraints (economic, ecological, institutional, social)	Overexploitation & logging damage; shortage of trained staff & funding (e.g. Africa); desirable species must be present with abundant natural regeneration (MUS); variation among tropical moist forest (TMF) has led to failures when a system is transferred to another area.	Landless poor occupy many cut over sites; liberation thinning requires adequate stock of pole-size trees & much manpower; security problems (e.g. Colombia); short-term thinking by policy makers; low proportion of commercially valuable species; silviculture must be flexible
Conclusions About Prospects for Sustainability	Tropical forests can be managed sustainably, but plans must be suited for particular local conditions.	Asian experience shows that sustainable tropical forest management is technically feasible.
Recommendations for Wider Practice of Sustainable Forest Management	Management plans must be flexible: need to take local conditions into account, as well as medium & long-term effects; need to promote welfare & participation of local people.	Systems must be flexible because of complexity & variability of tropical forests. Need long-term stability; need commitment by national leadership; need effective technical training; need effective legislation & land use planning.

Table 4. Continued

ISSUES	Poore, Burgess, Palmer, Rietbergen, Synnott (1989)	Goodland, Asibey, Post, Dyson (1990)
Definition of Sustainable Forest Management	Forest use in which nothing is done to irreversibly reduce the potential of the forest to produce marketable timber.	Use of natural forest that indefinitely maintains the forest substantially unimpaired both in environmental services & in biological quality.
Evidence Supporting "Sustainability"	Sustainable management system in Queensland; some small scale projects in Africa have begun: sustained management in Malaysia shows promise; sustained production is carried out in Trinidad & Tobago (strictly, however, sustainability cannot be proven until after the 3rd rotation).	True detection of sustainability cannot be achieved until third rotation (at minimum); sustainability "approached" during colonial regimes in Asia & Africa—MUS & other systems fell prey to forest conversion before sustainability could be proved; several experiments underway in Latin America may prove sustainable.
Major Achievements (economic, ecological, institutional, social)	Sustainable production of tropical timber is negligible (approximately 800,000 ha.).	Above mentioned systems in Asia & Africa yielded about 2.5 to 5 m^3/ha/year. Burma teak rotation sustainably managed until 1962 when overexploitation began.
Major Constraints (economic, ecological, institutional, social)	Land use policy, financial policy, logging control, forest legislation, & economic circumstances (e.g. Africa); illegal clearing of forests & overexploitation (e.g. Asia).	Forests overexploited (e.g. Burma); forest conversion; population pressures; institutional instability; sustainable forests are expensive to maintain & produce low rate of return.
Conclusions About Prospects for Sustainability	Management of natural forest for sustainable production of timber is technically possible in many forest types, but current practice is negligible.	"Sustainability of tropical hardwood production has not been achieved, would not be profitable were it to be enforced, & is unlikely to be achieved in future unless major improvements are implemented properly."
Recommendations for Wider Practice of Sustainable Forest Management	Need government resolve & long-term security; need to promote & help facilitate controlled conditions for sustainable management (establish overall land use plans; set standards for allowable cut, cutting cycles, harvesting techniques, etc.).	Improve sustainability through government commitment & system of incentives; use careful selective extractions; deflect logging to secondary forests & plantations.

Table 4. Sustainability Issues in Natural Forest Management: Summary of Recent Forestry Literature

ISSUES	Summary: ITTO/HIID (1988)	Jonsson, Lindgren (1990)
Definition of Sustainable Forest Management	Multiple use management of forests for sustained yield of timber is emphasized.	Forests must be used economically in a way that yields a high production of valuable products in the long perspective, retains fauna, and protects the global & local environment.
Evidence Supporting "Sustainability"	Probable that forests managed under MUS would be producing second-rotation if land had not been converted to agriculture; strip shelterwood system in Palcazu showing abundant regeneration; polycyclic systems with liberation thinning show promise in Sarawak & Côte d'Ivoire.	Land in Costa Rica where *carpaguianesis* was harvested is showing abundant regeneration; regulations in Queensland recognize long-term economic and environmental considerations.
Major Achievements (economic, ecological, institutional, social)	Forest management systems have shown success (at least technically) in a number of countries *(see above)*.	Good planning & careful logging has led to sustainable use in Costa Rica & Queensland.
Major Constraints (economic, ecological, institutional, social)	Main constraints are economic, social & institutional rather than technical (conversion of forests, pressure to accelerate felling cycles, unwillingness to invest in long-term, undervaluation of forest resources); size & complexity of tropical forests.	Pressure to have shorter cutting cycle than recommended; natural forests cannot be completely protected within framework of commercial forestry.
Conclusions About Prospects for Sustainability	Sustained management is technically feasible and examples do exist, however, most forests now receive little or no silvicultural treatment & inadequate protection.	Sustainable management can be achieved in most areas through proper planning, execution & control; inherent ecological mechanisms must not be irreversibly disturbed.
Recommendations for Wider Practice of Sustainable Forest Management	Must have silvicultural data & analysis, and socio-economic & institutional data & analysis to develop management plans; successful transfer of methods from one region to another are poorly understood.	Cost effective & environmentally sound logging practices must be compiled into practical guidelines & disseminated to all parties working with tropical forests.

Table 4. Continued

ISSUES	Keto, Scott, Olsen (1990)	Perl, Kiernan, McCaffrey, Bushbacher and Batmanian (1991)
Definition of Sustainable Forest Management	Sustainable cut is seen as equivalent to the volume of incremental growth between harvests (Queensland); definition should include maintaining level of biodiversity.	The natural humid tropical forests must be managed to provide economic benefits without destroying the forests' long-term productive capacity.
Evidence Supporting "Sustainability"	(Queensland model, which had been promoted as sustainable, is based on a depauperate database & thus inappropriate as a model).	13 examples in Latin America are given, none of which are demonstrably successful in all the necessary elements of sustainable forest management—all need more time to mature.
Major Achievements (economic, ecological, institutional, social)		Make forests a permanent, rather than short-term resource; economic gain for local communities; provide land rights to native peoples.
Major Constraints (economic, ecological, institutional, social)	Timber industry was heavily subsidized by Government (Queensland); logging on a 40 year cycle will lead to structural changes & a reduction in species diversity; sustainable definition usually ignores biodiversity.	Social pressures; lack of technical or financial resources; low stumpage value for timber; government policies that impede national forest management.
Conclusions About Prospects for Sustainability	No valid reason for using the Queensland model as the basis for sustainable timber production.	Natural forest management is technically feasible (can extract timber & non-timber products in ways that maintain forest structure & ensure regeneration).
Recommendations for Wider Practice of Sustainable Forest Management	Industrial forestry should be restricted to less environmentally sensitive areas; large scale timber supplies can come only from plantations.	Need for reform in overall policy management; long-term, consistent technical & financial support; and ability to resolve local political disputes & distribute benefits to local people.

Table 4. Sustainability Issues in Natural Forest Management: Summary of Recent Forestry Literature

ISSUES	Hartshorn (1990)	Summary: Smithsonian Tropical Forestry Workshop (1990)
Definition of Sustainable Forest Management	Sustained yield of timber (based on natural regeneration).	Harvesting that does not diminish the benefits of future generations: this requires protection of soil, water, wildlife & timber resources in perpetuity.
Evidence Supporting "Sustainability"	In Palcazu, natural regeneration on two demonstration strips has been very good (approx. 1,500 individuals over 50 cm representing 132 species were found after 15 months).	
Major Achievements (economic, ecological, institutional, social)	Forests will give a sustained yield of forest products; provides employment for native communities; protects cultural integrity of native peoples.	
Major Constraints (economic, ecological, institutional, social)	Numerous past efforts to manage tropical forests have failed due to the high costs of extracting only the finest wood, the lack of understanding of tropical forests, & harmful government policies; need marketable building-phase species which grow quickly in forest gaps (for this system).	Tropical forests & products are undervalued; logging operations are inefficient; governments do not have sound long-term forest policy; re-cutting too quickly; timber concessions are too short.
Conclusions About Prospects for Sustainability	Palcazu project has potential for sustainable development of the valley.	Tropical forests must be accorded proper economic value if they are to be preserved; sustainable utilization systems can be viable so long as they mimic natural forest dynamics & work within limitations of ecosystem.
Recommendations for Wider Practice of Sustainable Forest Management	Success of Palcazu project would show the opportunity exists for sustainable management of tropical forests; recent market acceptance of a large number of species has helped open the door for better management of tropical forests.	International Hardwood Products Association (IHPA) members should promote guidelines & criteria for defining sustainable management; governments need secure long-term policy; sale of forest products should reflect replacement & environmental costs; proceeds should be reinvested in forest management.

Table 4. Continued

ISSUES	Bruenig, Poker (1989)
Definition of Sustainable Forest Management	Wise use of tropical rainforests for long-term economic and ecological benefits.
Evidence Supporting "Sustainability"	Indicators for sustainable forestry in Congo are positive; SMS system, Malaysia has achieved sustained yield; Quintana Roo: successful sustainable timber production; TSI project in Philippines successful in residual dipterocarp forests.
Major Achievements (economic, ecological, institutional, social)	Several successful examples exist *(see above)*: income of inhabitants has increased; environment is stable.
Major Constraints (economic, ecological, institutional, social)	Political conditions; laws; traditional lack of attention to non-timber products; lack of technical training for local personnel; lack of incentives to manage forests.
Conclusions About Prospects for Sustainability	Rainforests can be managed successfully.
Recommendations for Wider Practice of Sustainable Forest Management	Need adequate political support, involvement of local people, & project-integrated training programs.

BOX 1: Community Forestry

LOCATION: Near the town of Felipe Carrillo Puerto in Mexican state of Quintana Roo on the Yucatan Peninsula (approx. 19°N, 88°W)

IMPLEMENTING AGENCY: Organization of 16 communal groups or *ejidos*. The National Forest Service provides a dozen technical advisors

FUNDING AGENCY: Mexican government, GTZ (Germany), Mexican Bank, World Wildlife Fund

OBJECTIVES: 1. Maintain natural forest with natural regeneration
2. Market new species
3. Increase proportion of mahogany and cedar in forests through enrichment planting

BIOPHYSICAL CHARACTERISTICS OF THE SITE: (Forest type, climate, soils, elevation, wildlife, natural forest regeneration)
- sub-tropical moist forest with dry season
- average rainfall between 1000–1500 mm/yr
- 360,000 ha of land; 155,000 ha for forest production
- 70 + tree species inventoried
- large amounts of mahogany and cedar, although reduced by 25 years of previous logging ("high grading")
- dry, shallow, limestone soils

FOREST MANAGEMENT SYSTEM: (Silvicultural management, species harvested, rotation period, thinnings, extraction method, planting, monitoring, special conditions)
- project initiated in 1993
- selective harvesting based upon diameter limit cut
- 25-year cutting cycle
- *ejidos* take continuous forest inventories, develop plans, harvest, and market product
- harvesting takes place during dry season
- enrichment planting used to increase proportion of mahogany and cedar in forests

MARKETING:
- new contracts with log buyers provide higher prices (mahogany at $150 m³) and ensure purchase of a wider variety of species (including white soft woods)
- some value added processing (sawmill & carpentry shop)
- proceeds from log sales spent on more processing equipment so *ejidos* may eventually sell furnished products
- workers paid for inventory, marking, felling, skidding, and hauling, as well as share in profits from timber sales.

- *Nutrients:* indicators should be used that can reflect mineral nutrients, soil organic nutrients, and soil microfaunal levels;
- *Hydrology and Erosion:* indicators should measure soil-erosion rates, water quality and hydrologic regimes, and;
- *Pathologies, Wind and Fire:* outbreaks of insect pests and diseases, windfalls and blowdowns, fuel loading and fire, and other potential threats to tree species should be monitored.

These indicators should be tracked regularly after and between harvests, and then compared with measurements in control areas. A basic research program to correlate the impact of management activities with forest ecosystem health indicators will help forest managers balance resource-extraction levels, manage their intensities, and monitor forest health. Social and economic indicators should also be monitored in and around managed areas. Such indicators might include: the rate of which full-time employment is created, the level and extent of profit sharing, local development activities, training opportunities, income, and other measure of livelihoods, public health, and education levels.

BOX 3 (continued)

- in many seasons, locals can earn up to US $3,000 a year, topping those later

EVIDENCE FOR SUSTAINABILITY:
- good natural regeneration, but cannot conclude sustainability after only 8 years

STRENGTHS/ACHIEVEMENTS:
- low population density
- secure land tenure (*ejidos* have rights to benefits of production, but do not own land)
- forest is ecologically adapted to disturbance
- multiple yields from forest and strong markets for timber and non-timber
- produces increased income and employment for locals
- high level of community organization and participation

KEY PROBLEMS:
- lack of adequate information and capacity to produce value-added goods
- political and economic incentives are to get timber out fast
- communities have limited access to information, limited legal role and political power
- *campesinos* traditionally do not trust government
- silvicultural system is flawed: 1) selective harvesting with diameter limit assumes multi-aged stands, when, in fact, stands are single or two-aged, and mahogany seedlings are not found in understory; 2) harvesting 1–2 trees per ha does not create openings large enough to stimulate natural mahogany regeneration; 3) limits on annual volume extraction based upon questionable data about growth rate, regrowth, and inventories
- problematic implementation of silvicultural system: 1) calendar of timber harvesting impedes mahogany seed dispersal (trees felled in January, but releases seeds in March); 2) proposed plan of cutting 1/25th of area on 25-year cycle not followed; 3) collection of inventory data skewed towards large diameter trees

POLICY IMPLICATIONS:
- project demonstrates the real value that a sustained natural forest could have to local communities (over 3,000 families now benefit in Quintana Roo)
- as profits are directed back into production and value-added processing equipment during this first stage, the incomes of the *ejidos* should rise
- forest resources must benefit local people, and locals must be integrated into their management
- outside technical and political support imperative to success
- much still needs to be done to improve education, research, technical training, and silvicultural methods

Source: Perl et al. (1991); Santos (1991); Snook (1991).

BENEFITS

Apart from some discussion of continuous timber production and the harvest of non-forest products, few forestry experts have explicitly questioned how equitable the distribution of other economic and social benefits is under natural forest management. Some of the benefits of community-based forestry projects are touted in the literature, including local employment, equitable profit distribution, and the recognition of land and resource rights for local communities (Perl et al., 1991; Harrshorn, 1990; Bruenig and Poker, 1989). In two community forest management cases (WRI, 1991), Quintana Roo in Mexico and Palcazú in Peru, the equitable distribution of income from a variety of forest products and secure land or resource tenure are important management objectives. Yanesha forestry cooperative members themselves view the strengthening of their community's cultural, economic, and resource interests as one of the project's most important dividends.

Sustainability will be hard to achieve unless such benefits as steady local employment, secure land

BOX 2. Pucallpa Forestry Cooperative Project

LOCATION: Lower Palcazu Valley, eastern base of Peruvian Andes, from 9° 50' to 10° 45' S latitude

IMPLEMENTING AGENCY: Yanesha Forestry Cooperative (local), Pichis-Palcazu Special Project (PEPP)

FUNDING AGENCY: USAID (Tropical Science Center (TSC) contracted to design management system)

OBJECTIVES: 1) Create local employment for native communities
2) Manage natural forests for sustained yield of forest products
3) Preserve cultural integrity of Amuesha (Yanesha) Indians

BIOPHYSICAL CHARACTERISTICS OF THE SITE (Forest type; climate; soils; elevation; wildlife; natural forest regeneration)

- tropical premontane rain forest life zone
- average rainfall 6700 mm/yr
- 75% of area in primary forest cover
- tall (45–55 m), species rich (175–200 per ha >10 cm dbh), no dominant species or genus
- 300–500 m elevation, rolling hills, several rivers
- red clay soils, acidic (pH 3.8–4.5), aluminum abundant, nutrient poor (calcium, phosphorus, potassium)
- forest renewal through gap-phase dynamics

FOREST MANAGEMENT SYSTEM (Silvicultural management, species harvested, rotation period, thinnings, extraction method, planting, monitoring, special conditions)

- system began in 1985
- strip shelterwood system; timber exploitation limited to 10 g (200–500 m), narrow (30–40 m) clear cuts bordered on each side by intact natural forest
- new strips will be located at least 100m from recently cut strips
- primary forest excluded from harvesting: steep slopes, swamp, 5–10 m wide buffer along streams, and patches of inaccessible forest
- 30–40 year rotation between harvests of a specific site
- annual rates of logging set at 1/30th of total productive forest area to give constant sustained yield
- reliance on abundant natural regeneration from seed and stump sprouts and high growth rates
- extensive monitoring of tree establishment, survival, and growth
- Silviculture: in second year, sprouts are reduced to 1 or 2 per stump; as canopy closes, climbers are cut; once trees have formed a closed canopy, the competitive equilibrium can be adjusted to favor desirables or eliminate undesirables
- most of biomass is removed and utilized; small branches left behind to provide nutrients for regeneration
- draft animals used for extraction to minimize damage

tenure, equitable profit sharing, and off-season economic alternatives are part of the prescription, and many natural forest management projects no doubt provide some such benefits. Unfortunately, few forest managers specify the benefits and the beneficiaries to be expected from natural forest management. Here natural forest management proponents can help by being explicit about what benefits should be expected and how they are to be distributed. In addition, project managers should monitor such benefits along with indicators of forest ecosystem health.

CONSTRAINTS

The forestry literature identifies the main constraints to sustainable natural forest management as being economic, social, and institutional—not technical or silvicultural. But examples of sustainability

MARKETING:

- primary products are sawnwood and preserved roundwood; scrap wood converted to charcoal
- total harvested wood from first demonstration strip equivalent to 350 m³/ha (150 m³/ha, o saw logs, 90 m³/ha for poles & posts, the rest is branchwood sold as specialty items or converted to charcoal)
- wood processed locally (portable sawmill, preserving equipment, and charcoal kiln)
- limited amount of wood exported
- local processing center expected to produce limited net returns of $3500 per ha of forest harvested; expansion of processing center should increase returns to $27,500 per ha

EVIDENCE FOR SUSTAINABILITY:

- abundant natural regeneration: inventories of two demonstration strips (20 x 75 m at 30 months and 50 x 100 m at 24 months) showed 209 species & 1,983 individuals on the former and 285 species & 6,624 individuals on the latter. Tree species (> 1 m tall) on the first demonstration strip are more than double the number of original tree species

STRENGTHS/ACHIEVEMENTS:

- community land claims legally recognized
- provides employment/income to communities
- buffers communities' social and cultural integrity from effects of colonization
- locals involved at all levels
- national park, buffer zones, and production forest areas created

KEY PROBLEMS:

- for this silvicultural system to succeed, species must be capable of rapid establishment in gaps, grow quickly, and produce marketable wood
- management is highly technical
- project is more profitable than cattle, but less than coffee (thus land use plan must be effectively implemented)
- some difficulty developing local markets
- if the project had to repay debt, it would take up to 15 years (project given US $2 million start-up grant)

POLICY IMPLICATIONS:

- setting an important precedent before signing the loan agreement: USAID required that lands claimed by the communities be officially recognized and legally titled by the government of Peru
- local people have been involved in management at all levels, from harvesting to processing to marketing
- if project is successful, it will demonstrate the potential for sustainable management of tropical forests and the ensuing benefit to local communities
- plan assumed—it seems correctly—that people who live on the land (natives as opposed to settlers) are interested in long-term sustainability
- project also assumed that the government cannot control land use—it will be dictated by the rural poor
- native communities often prove to be more stable and to value forests more than national governments—it would be wise to invest in them

Sources: Stocks (1991); Hartshorn (1990); Jonsson and Lindgren (1990); Hartshorn (1989); Mead (1989); Hartshorn (1988)

failing for technical reasons do exist. In particular, systems developed in one area have failed in others where ecological and silvicultural conditions differ. For example, the Malaysian Uniform System seemed to work on fertile lowland flat soil, but not on steep hillsides (Wyatt-Smith, 1987). Since the 1970's, the Malaysian Selective Management System has been used in steep hillside areas, but it too must be adapted for each site. In general, silvicultural systems are too often applied on a blanket basis because data is inadequate or improperly interpreted (WRI, 1991). To be sure, the inability to adapt management plans to new information or changing conditions remains one of the major uncertainties clouding prospects for sustainable forestry projects.

As a first step, forest managers need to identify potential constraints—commonly referred to as "externalities" after the fact—during planning and

Box 3: Case study: Colombia

LOCATION: Pacific coast of Colombia, north of the port of Buenaventura, 100 km northwest of Cali (3° N, 77° W)

IMPLEMENTING AGENCY: Carton de Colombia, operated by Smurfit/Latin America, a subsidiary of Container Corporation

FUNDING AGENCY: Private sources

OBJECTIVES: Produce 80,000 m³ of mixed hardwoods per year for pulp on a sustained yield 30-year cycle

BIOPHYSICAL CHARACTERISTICS OF THE SITE: (Forest type; climate; soils; elevation; wildlife; natural forest regeneration)

- humid tropical forest
- *very* wet; average rainfall of 7500 mm/year
- average temperature is 27 degrees C
- terrain typified by low hills (50–100 m)
- 61,000 ha; 60% non-forestry (indigenous peoples' reserve & protection forest), remaining 24,000 ha is production forest
- wide mix of tree species (250 per 1 ha) dominated by *Brabantiera gracilipes* and *Carapa guianensis*
- soils are clay, entisols, acidic & infertile

FOREST MANAGEMENT SYSTEM: (Silvicultural management; species harvested; rotation period; thinnings; extraction method; planning; monitoring; special conditions)

- project initiated in 1975; concession ends in 2004
- selective harvesting of 150 species as pulpwood
- cutting cycle is 30 years
- cut 800 ha annually (out of 24,000 ha); 80,000 m³ pulpwood harvested annually
- harvesting accomplished using aerial cables, thus minimizing damage to residual trees
- company researching potential of eucalyptus and pine plantations in Andes; expects to complete move toward plantations by the time concession ends in 2004

MARKETING:

- commercial wood volume is 125 m³/ha: 100 m³/ha as pulpwood & 25 m³/ha as sawlog

prepare a corresponding strategy to incorporate corrective measures into the original management plan as warranted. This should encompass, at a minimum, probable economic, institutional, human resource, and demographic trends.

Economic

Economic constraints are the most frequently cited obstacles to sustainable natural forest management. Pressures to overexploit natural forests are numerous and, often, interconnected. One is the undervaluation of forest resources, which leads to their wasteful use and discourages both public and private investment in their maintenance. Market interventions[22] to restrict exports and stimulate domestic industries can artificially depress domestic timber prices and send the wrong economic signals, thus accelerating forest depletion. Economic pressures from unstable markets for tropical timber often invite overexploitation: many forest managers feel forced for profit's sake to abandon relatively low production, or conservative but sound, natural forest management practices. In Malaysia, experience with both the Malaysian Uniform and Selective Management Systems indicates that external economic forces frequently prompt local managers to accept shorter cutting cycles than those called for by the appropriate silvicultural system.

Another impediment to long-term investment is the low stumpage fees charged to concessionaires. Most governments undervalue their forest resources by not accounting for replacement costs or the loss of non-timber products and environmental services (ITTO/HIID, 1988). What little forest revenue the

Box 1 (continued)

- pulpwood is used to make kraft paper at mill near Cali
- local sawmills buy logs from settlers
- in 1986, Colombia imported 100% of its paper; by 1988, it was nearly self-sufficient in paper (except for newsprint)

EVIDENCE FOR SUSTAINABILITY:

- 40 site studies have indicated that sustainable production can result from natural regeneration

STRENGTHS/ACHIEVEMENTS:

- limited damage to residual stand through use of aerial cable logging
- excellent natural regeneration and evidence of sustained yield on protected sites
- provides local income/employment opportunities

KEY PROBLEMS:

- social pressures have pushed local people into recently harvested areas, thus interrupting regeneration
- people seeking income from enterprise has led to over-population in the area and over-harvesting of wood
- cost of wood to company is high because of careful logging procedures used in concessions; to become more competitive, the company is moving toward plantations
- move toward plantations may upset local economy and result in high local unemployment

POLICY IMPLICATIONS:

- technical aspects of management plan seem to be sound, though expensive
- company unable to control access of concession area due to rapid influx of colonists
- results from short-fiber plantations in the Andes show that a higher yield of pulpwood can be produced at a lower cost than natural forest management
- considering move to plantations, can this be seen as truly successful TFM?
- careful logging procedures could be used as model, but what about their high cost?
- replicability difficult due to few countries having high pulpwood demand as Colombia

Sources: Barrera (1991); Landeth (1991); Pelz et al. (1991); Barrera (1986)

government does collect doesn't even cover management costs (Smithsonian, 1990). Additionally, low rents provide little incentive to concessionaires to invest in efficiency or sustainable harvesting practices (Repetto and Gillis, 1988).

A major market failure is the inability of consumers to distinguish between timber that is produced sustainably and timber that is not. Certainly, the latter is often cheaper to produce,[23] and vastly more prevalent. But flooding the market with unsustainably produced timber brings prices down to levels at which the recovery of investment in sustainable production practices is impossible.

Another problem is that markets for lesser known timber species are limited. Since logging operations typically damage trees with limited or no market value during the harvest,[24] their activities frequently impede or prevent natural regeneration (including that of valuable timber species). If these unappreciated trees enjoyed broader markets, more care would no doubt be taken in logging. As it is, the limited market for lesser known timber species could limit the economic viability of the Yanesha Forestry Cooperative project in Peru and present problems for the Quintana Roo project as well. The Yanesha Forestry Cooperative solved this problem by marketing lesser known species as treated posts. In Quintana Roo, the forestry management cooperative conditions the sale of high-quality mahogany on the purchase of lesser known tree species. Obviously, if broader markets for more species were guaranteed, promising natural forest management efforts, such as these in Palcazú, would be much more attractive financial investments and start-up subsidies

LOCATION: Peninsular Malaysia (2–6° N, 100–103° E)

IMPLEMENTING AGENCY: Malaysian Forestry Department

FUNDING AGENCY: The Government of Malaysia

OBJECTIVES: Obtain an even-aged, higher volume stand of desired species on a rotation basis

BIOPHYSICAL CHARACTERISTICS OF THE SITE: (Forest type; climate; soils; elevation; wildlife; natural forest regeneration)

- humid tropical forest (lowland dipterocarp forest)
- average rainfall >3000 mm/yr; rain throughout year
- forests cover 62% of Malaysian land area (20.6 m ha); 13.8 m ha has been proposed protection forest; 9.1 m ha of this as productive forest (a large part of which has already been logged)
- soils poor, low in organic matter
- forest renewal through gap phase dynamics

FOREST MANAGEMENT SYSTEM: (Silvicultural management; species harvested; rotation period; thinnings; extraction method; planting; monitoring; special conditions)

- monocyclic system with a single, comprehensive harvest of all merchantable species at end of each rotation
- 70-year rotation
- diameter limit set at 45–50 cm dbh
- competitors, climbers, and unwanted trees over 45–50 dbh are poison girdled
- system relies on high seedling densities and species that respond favorably to canopy openings
- species harvested include the red meranti group of the genus *Shorea*, and species of the genera *Dipterocarpus*, *Anisoptera*, and *Dryobalanops*
- heavy equipment (tracks, bulldozers & skidders) used for extracting timber; limited use of draft animals

MARKETING:

- in 1983, the forestry sector in Malaysia accounted for US$2 billion in export earnings (14.1% of total export earnings and 6.8% of the GNP)

EVIDENCE FOR SUSTAINABILITY:

- successful regeneration cited; MUS forests would probably be producing 2nd rotation crops now if they had not been converted to agricultural uses

STRENGTHS/ACHIEVEMENTS:

- some success with system in lowland dipterocarp forests
- existence of a strong, well established Forestry Department

KEY PROBLEMS:

- system not successful in hill forests or other areas with low seedling density or uneven diameter distribution, and most lowland forest has now been converted to agricultural uses
- forestry concessions typically awarded for shorter time than needed for regeneration (which leads to overexploitation)
- pressure to exploit areas exceeds area's long-term capacity
- tendency to accept 25–35 year cutting cycle (assumes—most often incorrectly—adequate stocking and minimal logging damage)
- social unrest; indigenous people have no claim to remaining forest

POLICY IMPLICATIONS:

- tropical forest management must be flexible and take into account the specific local conditions where it is applied
- adequate silvicultural data unavailable or ignored, so harvesting methods are often applied on a blanket basis
- even if an effective silvicultural system is developed, economic, social, and institutional problems can overwhelm sustainable management practices
- future success depends partly on strict enforcement
- areas should be on concession-size to "prove" that stands can be cut on shorter rotation

Sources: Lee (1991); Burgess (1989); Mood (1988); Schmidt (1987); Tang (1987); Wyatt-Smith (1987)

BOX 3: Yapo forest

LOCATION: Yapo Forest in the West African country of Côte d'Ivoire, 50 kms. north of Abidjan

IMPLEMENTING AGENCY: Société ivoirienne de développement des plantations forestières (SODEFOR) and the Centre technique forestier tropical (CTFT)

FUNDING AGENCY: Caisse centrale de coopération économique (CCCE)

OBJECTIVES: Côte d'Ivoire Forestry Master Plan:

1. Preserve country's ecology by maintaining or restoring adequate forest cover
2. Attain a level of timber production that can meet the domestic and export needs of the country
3. Meet the needs of the population for fuel and construction wood

BIOPHYSICAL CHARACTERISTICS OF THE SITE: (Forest type; climate; soils; elevation; wildlife; natural forest regeneration)

- average rainfall between 1500-2000 mm/yr with monsoon season
- Yapo forest area is 10,000 ha

FOREST MANAGEMENT SYSTEM: (Silvicultural management; species harvested; rotation period; thinnings; extraction method; planning; monitoring; special conditions)

- objective is to favor valuable trees >10 cm
- silvicultural practices: traditional exploitation of economic species and thinning by poison girdling

MARKETING:

- forestry accounts for 1% of GNP and 5% of all exports
- cuts in Yapo forest are sold through competitive bidding (14,000 m³ in 1988 and 9,000 m³ in 1991)

EVIDENCE FOR SUSTAINABILITY:

- project in Yapo forest is based on SODEFOR-CTFT experiments, which yielded an annual gain in growth of 50-75% in stems of 73 main species >10 cm dbh (3-3.5 m³/ha/yr versus 2 m³/ha/yr for the control)

STRENGTHS/ACHIEVEMENTS:

- identified permanent forest reserves ("classified forests") which are mapped and guarded
- silvicultural methods have increased the production of good quality timber by as much as 100%

KEY PROBLEMS:

- tremendous pressure on forest resources from migrants' quest for more farmland
- loggers reluctant to abide by forest management measures

POLICY IMPLICATIONS:

- success in tropical rainforest management achievable only if it has high level political support and the necessary human and financial resources
- presence of the Forest Service must increase as the forest escapes to protect against illegal land clearings and irresponsible logging
- stabilization land use in the age after agrarian revolution took over a century, this process needs to be encouraged and fostered in Africa

Sources: Adam (1991); Schmidt (1987)

could be cut back or eliminated. On the other hand, there is the risk—especially in forest areas lacking secure land tenure and controlled access—of stimulating the same sort of run on these trees that has jeopardized the sustainability of valuable tropical hardwoods.

Institutions

Closely tied to economic constraints are institutional impediments to long-term forest security and investment. First is the lack of strong national land-use policies to protect forest areas from conversion and destructive forms of development. Although many countries have national forest policies and laws on the books, most cover only timber production, and few are applied effectively. Even where forest laws cover local tenure and non-timber forest products, as they do in some African countries, Mexico, and Honduras, they are seldom enforced (Rietbergen, 1991), much less integrated into an overall national land-use policy (Wyatt-Smith, 1987). Where no permanent forest estate exists and forest lands are indiscriminately converted, timber concessionaires have little long-term security—a prerequisite for successful sustainable management.[25] In Colombia's Cartón de Colombia concession, promising natural forest-management practices have been thwarted by encroachment on concession areas (WRI, 1991).

Even where forested areas are designated as permanent forest estates, concessionaires still have little incentive to invest in sustainability because nearly all logging concessions are shorter than forest-rotation periods[26] (Smithsonian, 1988). The common practice of awarding logging concessions to political allies also works against sustainability (ITTO/HIID, 1988) since concessionaires move heaven and earth to make a quick profit before the government changes hands and their logging privileges evaporate. And when forests are exploited strictly for short-term gain, the resource is badly damaged, if not destroyed. Forests are also easily and profitably sold off to interested third parties (Poore et al., 1989). Of course, long-term concessions alone can't ensure sustainable development: in colonial West Africa, they did not lead to sustainable management (Repetto and Gillis, 1988) because they were overwhelmed by high-grading, failure to follow felling rules, and poor implementation of silvicultural treatments.

Human Resources

Only flexible management plans based on extensive research, careful control, and thorough monitoring and evaluation will work in the humid tropics' ecologically complex forests. And a sound management plan must be backed up by adequate financial resources and well-trained staff and workers. Yet, training and supervising personnel to carry out the complicated instructions required to manage tropical moist forests is a daunting challenge. As Wyatt-Smith (1987) points out: "Individual workers are to a great extent on their own and have to assess and take action on each situation as it presents itself." Giving them a few pointers and a reading list is clearly not enough.

Where participants and project personnel are poorly trained, the harvest is ill-timed, the wrong trees are cut, logging damage is excessive, and overcutting occurs. In Côte d'Ivoire, this management gap constrains sustainable timber management in the Yapo Forest. In Quintana Roo, those involved with the *ejidos* natural forest-management project fear that a lack of technical personnel and training opportunities work against progress. Yet, the Palcazú project, based on the strip-shelterwood silvicultural system, demonstrates that local people can manage a system at all levels if they participate in all phases—from designing the management plan to harvesting, processing, and, ultimately, marketing.

Another widespread constraint to sustainable forestry management is the inadequate representation of local peoples when forest policies (ITTO/HIID, 1988) that influence their livelihood, rights, and culture are formed.[27] Such neglect, whether deliberate or not, has sunk more than one forestry project. If people living in and near the forest are left out of the plan, they can subvert it by illegally clearing or occupying newly cut-over areas. Indeed, Perl et al. (1991) argue that: "Resolving local political disputes and carefully distributing the benefits arising from forest management often override the importance of purely technical considerations."

Property Rights

Without question, pressures to convert forests and occupy cut-over sites work against sustainable forestry. High population growth, coupled in many

tropical countries with the inequitable distribution of productive agricultural lands, means that ever more people need food and jobs on the lands least able to sustain them. Pressures that push the destitute into the forest are complicated by other factors (among them, mineral extraction and commodity agriculture) that attract the not-so-poor. Indeed, in parts of Africa and other areas, this may be the larger problem (Rietbergen, 1991).

As population pressures on dwindling forest resources increase, sustained timber yield will become ever more difficult. Many areas once considered suitable for sustainable forest management in West Africa and Peninsular Malaysia have already been converted to agriculture (Goodland et al., 1990). In South America, and indeed in many parts of the humid tropics, landless farmers spontaneously move into forest lands first opened by logging roads (Schmidt, 1987). In addition, squatters and shifting cultivators—spurred by economic and social forces beyond their control—often illegally clear the forest to make money or to feed their families. Clearly, alleviating social pressure on forests means exerting better control over forest lands, involving local people in forest planning, and making sure that the benefits of use or conservation are fairly distributed. Just as clearly, the roots of this problem lie outside the forest sector and must be attacked there.

PROSPECTS

Despite extensive constraints, most foresters conclude that sustainable natural forest management is possible if strict planning and control, as well as other major incentives and institutional reforms, are part of the policy package (*see* Poore et al., 1989; ITTO/HIID, 1988; Schmidt, 1987; and Wyatt-Smith, 1987). Even skeptics (such as Goodland et al., 1990; and Keto et al., 1990) do not dismiss the possibility; they simply take a grimmer view of the obstacles and of past experience.

Recommendations for the wider practice of sustainable natural forest management are extensive and diverse. (They are also somewhat contradictory: in the forestry literature, several researchers and other observers give technical recommendations even though they claim that the major problems are nontechnical.) There is some consensus though. Most experts call for the formulation and dissemination of guidelines on cost-effective and environmentally sound logging practices, along with training programs developed to help practitioners follow the guidelines (*see* Jonsson and Lindgren, 1990). Supported by silvicultural data collection and analysis, these guidelines should then, most analysts concur, be fashioned into site-specific working plans[28] that are closely monitored and controlled, and updated as needed.

While nearly all tropical forest observers agree that the major constraints to natural forest management are economic, social, and institutional, most recommendations targeted at these issues are general. Wyatt-Smith (1987) and others suggest that natural forest management projects designed to promote the welfare and participation of local peoples are most likely to overcome the many problems historically associated with natural forest management. Two keys to enabling forest communities to practice sustainable natural forest management are securing land rights (*customary* land rights in long-inhabited areas) and developing market acceptance for a wider variety of timber species. These elements contributed heavily to the initial successes of the Yanesha Forestry Cooperative and Quintana Roo (WRI, 1991).

Others stress the need for high-level political commitment manifested in stronger laws and land-use plans, complemented by more effective technical training (Aidara, 1991; Poore et al., 1989; Schmidt, 1987). This commitment must be long term, providing land tenure for communities and concession security for commercial interests. Many also believe sustainably managed timber should be certified to meet and increase consumer demand for "good" wood. At the same time, governments should capture more rent from stumpage fees and reinvest this money in forest research, management, and supervision.

Finally, some researchers (e.g., Goodland et al., 1990; Keto et al., 1990) recommend that natural forest management in primary forest areas should be gradually replaced by plantation forestry and reliance on secondary forest management (*see Box 6*). Secondary forests near population centers often provide critical environmental services to large numbers of people, though they may be more vulnerable than remote primary forests to complete destruction. Until

BOX: Sustainably Managed Tropical Forests

The development of plantations, secondary forest management, and the rehabilitation of degraded forest areas are often promoted as alternatives to logging in largely intact or primary tropical forest areas. Undoubtedly, the development of such alternatives will be part of the solution to slowing and reversing the loss of primary humid tropical forest. The transition to providing significant tropical hardwood supplies from these alternatives will take considerable research, political commitment, investment, and time. Changes in how primary forests are perceived and valued, however, will ultimately be the keys to any widespread transitions. This means that primary forests will have to become more widely and highly valued for a range of non-timber products and attributes including biodiversity, climate regulation, watershed protection, non-timber forest products, and cultural diversity.

Although there are as many as 18 million hectares worldwide in tropical forest plantations, the vast majority have been developed for the production of softwoods and eucalyptus (FAO, 1988). As a result, plantations have had little effect in reducing pressure on humid tropical forests that are valued as sources of hardwoods. The plantation models that dominate most investments are characterized by large-scale monoculture plantations of industrial wood. These are often intensive operations to produce pulpwood and sawn-wood for distant markets, and fuelwood and poles for local markets. This has frequently meant that large tracts of land have been condemned to biotic impoverishment and provide little benefit to local residents. In humid tropical forest areas (e.g., in peninsular Malaysia), plantation development has often meant the conversion of natural forests to cash crop plantations of oil palm, rubber, and other commodities for international markets.

Tropical hardwood plantations in deforested or degraded forest areas could reduce pressures on humid tropical forests. Unfortunately, tropical hardwood species are notoriously difficult to grow under the current plantation paradigms of large-scale, monocultural (or perhaps two or three species) plantings of fast-growing, highly productive trees. There are several notable exceptions including teak (*Tectonia grandis*), laurel (*Cordia alliodora*), and some dipterocarps (*Shorea spp*). Tropical hardwood plantations are limited because most hardwood species have very narrow environmental requirements that have evolved in highly competitive, polyspecific niches found only in natural forests. Most hardwood trees are late successional species that depend on complex ecological and environmental relationships that cannot be replicated in large open environments with a very simplified ecological structure, so they're left open to insect infestations, deprived of vital soil microbial relationships, and inadequate moisture supplies. With the exception of a limited number of hardwood species, the traditional

From a global perspective, it is difficult to see how natural forest management could be widely and sustainably practiced in the humid tropics. Case by case, however, the prospects for sustainable natural forest-management look more encouraging.

such a transition takes place on a large scale, Goodland et al. (1990) argue, any timber management in natural forest areas should be confined to areas that are not environmentally sensitive or plagued by social turmoil and should rely on the most selective and least-damaging extraction technologies available.

From a global perspective, it is difficult to see how natural forest management could be widely and sustainably practiced in the humid tropics. Case by case, however, the prospects for sustainable natural forest-management look more encouraging. Indeed, successful approaches are likely to be as diverse as the humid tropical forests themselves.

plantation model is likely to provide limited alternative supplies of tropical hardwoods.

A more promising alternative may be to invest in the management of secondary forests—those forests that have regenerated after logging or outright clearing. Secondary forests account for approximately 36 percent of all productive closed tropical forest (FAO, 1988). While primary closed tropical forest shrinks at an annual rate of more than 32,000 square kilometers, the area occupied by secondary forest expands at more than half that rate (Wadsworth, 1987). Nevertheless, secondary forests are rarely managed in the tropics. According to Wadsworth (1987), the overlooked secondary forests have forestry management advantages over both primary forest and plantations. These forests are more accessible, as well as closer to markets and local work forces than primary forests. Compared to plantations, secondary forests contain species adapted to their environment, better conserve soil, water, and biological diversity, and tend to complement rather than compete with agriculture since they do not need to be situated on the best sites (Wadsworth, 1987). Finally, secondary forest management involves less initial cost and risk than plantations.

Rehabilitation of deforested and severely degraded forest lands presents another alternative to timber harvesting in primary forests. In tropical Asia alone, more than 54 million hectares of previously logged forest may be suitable candidates for rehabilitation (WRI, 1988). In Brazil's Amazon Basin, more than ten million hectares of humid tropical forest have been converted to pasture, most of it abandoned within five to ten years (Wil, 1990). Rehabilitation may require little more than protecting degraded forest areas from agricultural clearing, grazing, fire, and log poaching. In other situations, active steps may catalyze natural forest succession. In the Philippines, restoration efforts to cogon grasslands (*Imperata spp.*) on once forested land have shown that both the productivity and the diversity of severely degraded forests can be largely restored using relatively simple and inexpensive techniques (Jensen and Pfeifer, 1992). Similar efforts in Brazil have also demonstrated the potential for restoring forest productivity in abandoned pastures under certain conditions (Uhl et al., 1990).

The potential for any of these alternatives to replace primary forests as a source of tropical hardwoods is not well researched. As these alternatives receive increased attention, however, the role of local peoples must be carefully assessed. Degraded forest lands, secondary forests, and areas targeted for plantation development are frequently called home by many people. If they are not seen as part of the solution in the development of these alternatives, they may very well be a decisive factor in their failure.

V. THE TROPICAL TIMBER TRADE AND THE SEARCH FOR GOOD WOOD

Rampant deforestation and the unabated logging of humid tropical forests have provoked producers and consumers alike to call for the greater use of market forces and purchasing power to halt deforestation. While bans and boycotts are popular mechanisms, such trade restrictions as quotas, tariffs and taxes, are more widely employed—albeit more to protect or promote domestic industries than to answer environmental concerns. Such market interventions are used to discourage certain practices. To fill the need for positive incentives to promote sustainable forest management, tropical timber certification programs have been started in several consumer countries.

BANS AND BOYCOTTS

Dudley (1991) defines a logging ban as "a legally enforceable ruling covering some or all species of tropical hardwood in both raw and/or processed form" and a boycott as "a voluntary rejection of tropical hardwoods, usually by individuals, groups or local government authorities." Bans may be imposed on exports or logging activities within producing nations or on imports by consuming nations. In practice, most such measures are applied selectively and narrowly. Usually, the quantities, types, physical dimensions, or costs of products that can be traded are restricted.

Bans imposed by producer nations usually restrict the export of raw logs. In theory, such bans stimulate value-added processing and increased foreign exchange earnings or protect threatened and rare species. The most extreme examples of logging bans imposed by producer nations have been in Southeast Asia. In 1989, Thailand banned all logging nation-wide after exhausting 57 percent of its tropical humid forest and nearly 80 percent of its tropical dry forests (Paisal, 1989). Since the 1970s, the Philippines has experimented with bans of varying scope (Dudley, 1991; Poore et al., 1989). But even its most recent and drastic measure, declaring logging illegal in 64 of the country's 78 provinces, has not curbed deforestation. In the absence of government actions, forest-dependent communities have also set up roadblocks to halt industrial logging and defend their livelihoods (*see* SAM, 1989). Often, concession systems encourage rapid resource extraction by multinational corporations and only intensify deforestation and the desperation of local communities (Repetto and Gillis, 1988).

Bans and boycotts on tropical timber imports have become political realities in both Europe and the United States (RAN, 1991; Counsell, 1989). While their merits are hotly debated, bans and boycotts appeal to consumers frustrated by government inaction and convinced that their "pocketbook vote" can stem tropical deforestation. Boycotts have raised public awareness of the timber producers', traders' and consumers' roles in deforestation, and helped generate political will for international negotiations over tropical forests.

These concerns are shared by throngs of consumers who are beginning to organize and influence government actions. Some 200 city councils in Germany have banned the use of tropical timbers, and 51 percent of Dutch municipalities have followed suit. In the United States, a growing number of states and cities, among them, Arizona, New York, California, and Minneapolis, have banned or considered banning the use of tropical timbers in public construction projects. For example, the California state legislature may prohibit the purchase of tropical hardwoods, except those from certified sources. In Minneapolis, a total ban on the trade of tropical timbers within city limits from both the public and private sectors has been proposed (Elkins, 1992; Hamilton, 1990; Anderson, 1989).

Although boycotts have not so far dampened the international appetite for tropical timbers, they could eventually greatly influence purchasing patterns in Europe and the United States—roughly two-thirds of the world market by value. According to one recent poll, 61 percent of those surveyed "go out of their way to purchase environmentally friendly products—even at greater costs" (Golin/Harris Communications

and Angus Reid Group, 1992). Large retailers of wood products are responding to this new trend, recognizing that what is good for the environment can be good for business. In the United Kingdom, the largest home improvement chain—B&Q—and an association of over 200 Scottish timber retailers and wholesalers have responded to WWF-U.K.'s call for importing only sustainable timber products by 1995 (Sullivan, 1992). Likewise, in the United States, a major office manufacturer—The Knoll Group—launched a joint venture with an independent organization that certifies marketplace claims of environmental achievements—Scientific Certification Systems—to identify sustainably produced timber from tropical and temperate forests (Knoll and SCS, 1991).

The effectiveness and potential of bans and boycotts in Europe and North America to stem tropical deforestation is questionable. Applied indiscriminately, they could depress an already undervalued resource by making forestry less competitive with alternative land uses, such as agriculture. Also, bans and boycotts influence no more than a tiny fraction of the world's tropical timber production, as approximately 80 percent of all timber is used domestically in the countries that produce it. *(See Table 1.)* And bans do not address deforestation's underlying causes (TFF, 1991b). Indiscriminate bans or boycotts actually stand to undermine the few incentives that fledgling forestry projects have to promote sustainable management: many would quickly wither without northern demand and capital.

The effectiveness of logging bans in producing countries has yielded mixed results too. Thailand's logging ban has increased the pressure on forests in neighboring Burma and Laos (Lintner, 1992), and since restrictions on the export of finished wood products are limited, illegally felled timber is still exported (Dudley, 1991). In the Philippines, the illegal timber trade is an estimated 400 percent greater than the legal trade (EIU, 1991). The recent cancellation of timber concessions in northern Guatemala to establish a protected area has reduced timber extraction by perhaps a third, but has also resulted in the transport of illegally harvested logs to sawmills just across the border in Mexico (Rodriguez and Cabarle, 1990).

While bans and boycotts may appeal to consumers and politicians, their effectiveness is hindered by a lack of political will and enforcement capacity, and their impact will be limited unless positive steps are taken to alleviate the larger economic and social pressures that drive deforestation. Moreover, the legal basis for one country imposing import bans on products from another with different environmental standards has been successfully challenged under international trade agreements. The recent GATT decision overruling the U.S. ban on imports of Mexican tuna has established an unfavorable international legal climate for tropical timber bans. Similar sentiments are reported within the legal framework of the European Community (Dudley, 1991). In this context, certification programs and labelling may do more than bans or boycotts to encourage producers to adopt sustainable timber-management practices.

TIMBER CERTIFICATION

Given the drawbacks of blanket bans and voluntary boycotts, there is a growing movement to employ international commodity agreements and independent "good wood" programs to promote tropical timbers produced from sustainable sources. Although European consumers' concern about tropical deforestation first led to certification programs, they are now taking hold in the United States, and some now cover temperate forests. Several small private organizations are evaluating sources case by case, as illustrated below. Such programs, together with international guidelines for establishing forest policies, hold considerable promise for improving forest management.

How does timber certification work? Certification programs are designed for individual producers and evaluate the performance of a particular forestry operation. In contrast, guidelines are for governments and provide models for national policies on the permanent forest estate, standards for regulating concession systems, and principles for maintaining biological diversity. Certification programs are new, limited, and site-specific. ITTO's guidelines have yet to be implemented by producer countries, although a target date for full implementation—the year 2000—has been endorsed by the ITTO Council.

Such certification programs as Rainforest Alliance's "Smart Wood," Scientific Certification System's "Green Cross," and the Institute of Sustainable

Forestry's "Pacific Certified Ecological Forest Products" promote forest stewardship and sustainable timber production based on ecological, social, and economic criteria. *(See Boxes 7, 8, and 9.)* They offer measurable criteria and a mechanism (periodic site-inspections) for verifying producer performance. In theory, certification rewards certified producers with new markets, premium prices, outlets for diversified products, and more revenues. But experience shows these rewards are elusive (Ussach, 1992). Acknowledging how urgent the need for better stewardship is and how inherently difficult leaping from today's worrisome status quo to absolute sustainability is, several programs offer pre-certification assessments as a stepping stone for willing producers unable to meet the criteria. The idea is to generate "green competition" to improve forest management within a region (Hammel, 1992; Institute of Sustainable Forestry, 1991).

International organizations, such as ITTO and IUCN, advocate guidelines for establishing national policies to regulate industrial logging according to international standards. Establishing such guidelines among sovereign nations and across cultures is not easy—witness the current turmoil surrounding the TFAP reform movement and the fractious UNCED negotiations over the Global Forest Principles. Another problem is the proliferation of certification programs based upon varying criteria and self-verification techniques. Veracity is also an issue. A recent survey in England revealed that "virtually all green claims made by British timber traders and DIY superstores about their tropical timbers are misleading and unsubstantiated" (Pearce, 1992).

In general, whether standards are accepted internationally will greatly influence how widely certification programs are employed. But, certification programs are appealing in their own right because in some cases they can demonstrate the feasibility of sustainable management practices even in the absence of more comprehensive land-use policies and macroeconomic reforms. Then too, such programs are likely to become more important for producers who want to maintain access to lucrative markets as "green" demand for sustainably produced wood from all forests grows.

The various certification programs and guidelines currently in operation or proposed all call for written forest-management plans. Timber production criteria are based on the concept of "sustained yield," meaning that harvests should not exceed the forest's growth rate. Some production rate based on scientific analysis is set before management practices are initiated, and these practices are monitored continuously and revised as warranted. Several programs advocate using the natural regeneration of native tree species as an indicator of a sustainable management system.

Rainforest Alliance and The Institute for Sustainable Forestry provide the most explicit guidelines for technical forest management, requiring that all trees harvested or slated for harvest in the next cutting be physically marked prior to logging. Polycyclic silvicultural techniques, such as selective felling, are uniformly endorsed over other practices that permanently alter the forest's structure and risk overtaxing its ability to recuperate. All certification programs reflect the assumption that the farther the managed forest structure deviates from natural conditions, the more difficult and expensive it will be to attain sustainability, but endorsing a generic silvicultural technique is dangerous since each forest ecosystem requires a different management practice (Donovan, 1992). For example, in some settings the best way to get a certain species to regenerate may be a clear-cutting technique. *(See Box 2.)*

Few certification programs rely on sustained yield alone to ensure ecological sustainability. Often, timber production levels are set to protect soil and water quality, biodiversity, or non-wood forest products. This approach relies on leading indicators of forest health and helps to ensure the forest's ability to produce critical environmental services as well as timber. Such indicators signal when timber production should be curtailed or halted and when the forest ecosystem has recuperated and reestablished acceptable levels of environmental services. As further insurance, most programs require that protected areas be set aside as control areas so that the impact of harvesting on the forest's regenerative capacity and biodiversity can be evaluated. Extremely cautious in this respect, the Institute for Sustainable Forestry will not certify timber from a forest unless its needs for maintaining soil fertility and biodiversity are met first. The Institute's "Ten Elements of Sustainability" spell out criteria for maintaining or

BOX 7: Rainforest Alliance Smart Wood Program

[illegible] of Sustainable Forestry
- Minimize forest degradation
- Promote sustained-yield forestry
- Enhance—or at least not threaten—the interests of indigenous and other long-settled forest dwellers
- Harvest non-timber forest products (NTFPs) on portions of timber concessions set aside from commercial logging
- Make environmentally sound logging practices economically sound

Criteria

General/Environmental
- Harvesting plan (to be compiled before logging begins), including general site description, topographic map, stand-level map, road design, sensitive areas, seasonal activities, etc.
- Research and monitoring plan for harvested sites and control (unharvested) sites to gauge environmental impacts
- Buffer strips along waterways and protect areas on slopes exceeding 25 degrees
- Harvested trees must be marked beforehand, and removed by directional felling technique to avoid damage to remaining trees
- Future harvest trees must be banded
- Logging damage to remaining trees must not exceed 25 percent
- Harvesting machinery must haul logs with front end and any blade lifted off the ground to minimize soil disturbance. Excessive spillage of fuel and other fluids are to be avoided
- Post-logging inventory must occur within six months of completed harvest to evaluate environmental impact
- Non-timber forest products and local economies built around them must not be adversely affected
- Impact on wildlife populations must be minimized (no hunting, trapping, live capture or trade permitted by outsiders)
- Encroachment by colonists is to be prevented

Social
- Socio-economic assessment of concession area including common property management regimes, possible impacts on demographics, employment and local natural resource management systems, and an ethnobotanical survey (especially concerning NTFPs)
- Community land claims and legal rights are to be clearly explained, secured, and respected
- Fair, independent, and democratic mechanisms will be established for community concession regulation, and their compliance, modification, and monitoring
- Substance of all negotiations must be communicated by agreements which specify the rights, benefits, and possibilities and privileges of the involved parties
- Concessionnaire will negotiate benefits with local communities which may include: vocational training and education; employment; organizational development; and health care services
- Community losses will be compensated according to a fair formula subject to a just and full consultative process, including crop and game losses, impaired environmental services, and/or foregone present income and future opportunity costs

Process
- Information search on potential source, including discussions with knowledgeable individuals
- Field evaluations
- Field audits by qualified personnel, including professional foresters, ecologists, and social scientists (local experts, if possible). This will be done on a yearly basis for certified sources
- Determination of certification by Smart Wood program's Review Board after review of field audit report and recommendations
- Recommendations and technical support to producers to improve their operations from "well-managed" to a "sustainable source"
- Linking producers with U.S. retailers through "Smart Wood" programs: "Smart Wood Products" (those who sell products from certified Smart Wood sources, among others) and "Smart Wood Company" (those who only sell products from Smart Wood sources)

Box 8. Principles of Sustainable Forestry

Definition of Sustainable Forestry

- Recognize a forest as an ecosystem within which many forces that affect the biodiversity of flora and fauna, nutrient holding capacity, and regeneration of timber and non-timber species interact.
- Adopt silvicultural management systems to optimize natural regeneration of seedlings and/or saplings (e.g., uniform shelterwood, strip shelterwood, and selection systems).
- Control logging operations to minimize soil erosion, compaction, and damage to understory vegetation (e.g. directional felling, skid trails).
- Maximize utilization of all species in a practical attempt to diversify both management and extraction programs.
- Recognize the basic land tenure rights of local indigenous populations.

Criteria

- Identify and catalogue effective sustainable forest management systems currently used throughout the world.
- Identify consumer and industrial products produced from material obtained from forests managed under certified sustainable forest management systems.
- Establish clear guidelines for competing companies that wish to be recognized for their efforts in management efforts.
- Provide an economic incentive for producers of forest products to adopt and implement sustainable forest management systems.
- Collect data and stimulate additional research to identify specific threatened species, areas of significant biodiversity ("hot spots"), special region-appropriate silvicultural practices, and new sustainable forest management practices.
- Provide retailers with a rational certification system to help their customers identify environmental achievements related to the products they sell.
- Give consumers the power to make clear, informed choices in the marketplace, backed by sound scientific documentation.

Process

- Educational programs to curb inappropriate demand or excessive use of commercial wood species among producers and consumers.
- Certification of sustainable sources.
- Identification of critical control points that require monitoring throughout "chain of custody."
- Establishment of a comprehensive auditing system.
- Development of appropriate checks and balances to ensure compliance and integrity of "Green Cross" label.

restoring natural processes; shunning fertilizers, herbicides, and pesticides; preserving community stability, and respecting ancient forests. *(See Box 9.)*

The current generation of certification programs is as concerned with social as with ecological sustainability. Most specify criteria on local participation in project planning, employment generation, and profit sharing. The Institute for Sustainable Forestry highlights economic stability for local communities as its program's flagship criterion. Rainforest Alliance's standards and the emerging Forest Stewardship Standards of the provisional Forest Stewardship Council mandate mechanisms for negotiating with and justly compensating local communities whose rights are infringed upon by logging operations. Scientific Certification Systems and Rainforest Alliance stipulate that local land claims and access rights must be respected. Rainforest Alliance further requires that local land claims be mapped and their boundaries marked. Likewise, secure legal title and marked boundaries for timber production areas are also required.

Unlike conventional forest concession systems, certification programs highlight the importance of setting realistic fees and royalties, reinvestment, and the value of non-timber forest products.

Tracking "good wood" from the forest to the store shelf and reliable periodic monitoring pose enormous challenges to certification programs. Most tracking systems now employ a mix of mill records, shipping manifests, and metallic markers. Eventually, radio-isotope injections and other chemical or

BOX 3: The Institute for Sustainable Forestry's Pacific Certified Ecological Forest Products

Definition of Sustainable Forestry

- To bring ecological and economic stability back to forest communities.

Criteria

- Forest practices will maintain or restore the aesthetics, vitality, structure, and functioning of the natural processes, including fire, of the forest ecosystem and its components.
- Forest practices will maintain or restore surface and groundwater quality and quantity, including aquatic and riparian habitat.
- Forest practices will maintain or restore natural processes of soil fertility, productivity and stability.
- Forest practices will maintain or restore a natural balance and the diversity of native species of the area, including flora, fauna, fungi and microbes, to preserve the long-term health of ecosystems.
- Forest practices will encourage a natural regeneration of the native species to protect valuable native gene pools.
- Forest practices will not include the use of artificial chemical fertilizers or synthetic chemical pesticides.
- Forest practitioners will address the need for local employment and community stability and will respect workers' rights, including occupational safety, fair compensation, and the right of workers to collectively bargain.
- Sites of archaeological, cultural and historic significance will be protected and will receive special consideration.
- Forest practices executed under a certified Forest Management Plan will be of the appropriate size, scale, time frame, and technology for the parcel, and entail an appropriate monitoring program so as to avoid negative cumulative impacts and promote beneficial cumulative effects on the forest.
- A moratorium on commercial logging in ancient forests will be called to enable the Institute to participate in research on the ramifications of management in these areas.

Process

- Networking among producers, retailers, wholesalers, manufacturers, and craftspeople to promote work with products identified and certified by the PCEFP label.
- Research and development activities; information will be packaged in a handbook.
- Workshops and training sessions on hardwood utilization for timber workers and foresters to promote value-added processing and stronger local economies.

electronic measures may be used. To boost credibility, Scientific Certification Systems conduct periodic site evaluations. Field reports by independent consultants are reviewed by a Scientific Standards Board composed of experts in various disciplines. Once certification is issued, Scientific Certification Systems establishes an on-site evaluation team, preferably with a local research entity, that monitors the impact of harvesting activities on the forest environment (Hammel, 1992). Rainforest Alliance is also establishing a similar system. (Donovan, 1992). To date, these additional costs have not been reflected in the final product price. Instead, they are covered through philanthropical donations and research grants. Another approach, used by the Institute for Sustainable Forestry, employs exclusive licensing agreements with sawmills that process only logs from certified sources. All lumber from these mills is stamped with the Institute's "Pacific Certified Ecological Forest Products" (PCEFP) label at the mill site.

Programs such as these are new. Most originated after 1990. But these young efforts have resulted in the opening of foreign markets, higher profits, and outlets for lesser known species (Hammel, 1992; Ussach, 1992). In turn, this combination of benefits has allowed certified producers to diversify their product line, increase revenues, and enjoy greater flexibility in designing their forest management systems. Certification programs provide producers with unprecedented access to internationally renown experts

through periodic site evaluations and external review of management plans (Donovan, 1992).

At present, however, only a minute fraction of internationally traded tropical timber goes through anything resembling a legitimate program. If certification programs are so promising, why are they so seldom used? First, for marketing lesser known species, the challenge is much greater than just linking producers and consumers. Often, technical information on the mechanical properties and potential uses of new woods is unavailable. Even if a market is established, commercial quantities of consistent quality need to be readily available (Ussach, 1992). For the producer, the challenge is to design appropriate silvicultural systems for mixed species management and to resist the temptation to overcut once market demand increases.

The certification movement must overcome several obstacles if it is to affect mainstream trade in tropical timber. Success will depend on six factors:

1. Producers Willing and Able to Subscribe to Certification

Producers must see subscribing to certification criteria and external monitoring as in their best interest. More often than not, the key incentives will be better prices and the maintenance (or expansion) of market share. Without such incentives, few producers will shoulder increased costs or invite external scrutiny. "Good wood" will be more expensive than unsustainably produced timber, which is more abundant. While it can be argued that sustainably produced timber may not be more expensive when measured over a rotation cycle (20 to 40 years), the planning, training, and monitoring called for by certification programs—as well as the reduced intensity of harvesting often necessary to meet secondary environmental objectives—represent up-front costs and foregone revenues. Some producers, especially smaller and undercapitalized operations, can ill afford these costs and may need additional financing and time to fully participate. Other producers may shy away from such programs because they do not want to disclose internal business intelligence—revealing exclusive partnerships or other components of market advantage—even if they would meet the program criteria (Ussach, 1992). While certification must be open and verifiable, confidentiality must be respected to some extent.

2. Market Access

While demand for "good wood" presently outstrips supply, markets are extremely limited and confined to western Europe and North America. Trade restrictions and barriers imposed by consuming countries on producers—such as bans, boycotts, quotas, levies, or import taxes—will remove the incentive most producers require to incur the extra costs of meeting certification criteria. Clearly sustainable forestry practices that comply with certification programs will not be profitable for producers who internalize these costs unless they have access to markets in which revenues will be high enough to cover the added expense. *(Box 10)* Once market share is established, providing a steady flow of consistent-quality goods is essential to keeping it and, eventually, to commanding premium prices.

3. Secure Land Tenure of Production Unit

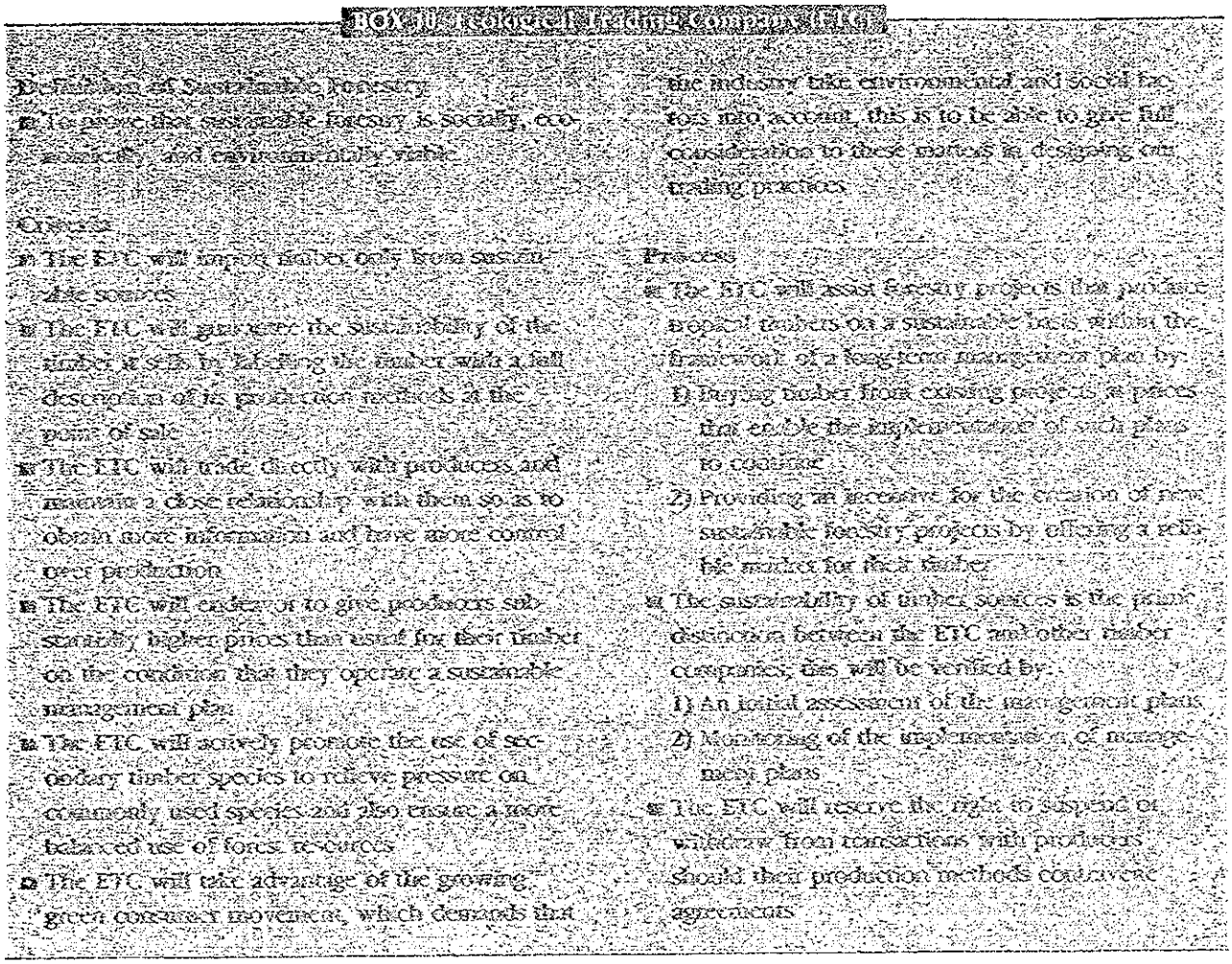
Secure legal title, demarcated boundaries, and controlled access of production units must be part of the long-term commitment of producers and governments alike. Without all, verifying sustainability and justifying investments in the planning, training, and monitoring called for by certification programs will be difficult. However, tenure by itself cannot guarantee performance; adherence to the stipulated criteria should be a condition for continued access, and performance should be reviewed periodically too.

4. A Favorable Policy Environment for Timber Production in the Producing Country

Few producers will make the investment needed to achieve sustainability if the risks associated with competing land uses or financial investments are less than those associated with sustainable forestry. Perhaps more than any other single action, the establishment of a permanent forest estate within a country with designated timber production areas—as proposed under the ITTO guidelines—would create a more favorable environment for forestry and further the influence of certification programs.

5. Tracking System from Source to Market

Certified products must be trackable from source to market, thus building consumers' confidence, and guarding against false claims. Currently, wood products from various sources and sites are commonly



mixed at the port of departure and the port of entry. Timber production is usually a geographically dispersed business, and economies of scale require that goods from different sites be pooled to fulfill orders and meet minimum shipping volumes. Often sawmills receive logs from various sources, making them perhaps the greatest monitoring challenge. Handlers also batch shipments from different sources to a particular distributor, who in turn supplies various wholesalers or retailers. The use of exclusive agreements with sawmills and retailers minimizes the risk of mixing certified and non-certified products and will maximize consumer confidence. But the mammoth size of this task argues for decentralized monitoring and for the creation of local or regional bodies to oversee certification.

6. A Credible and Capable Institution to Standardize Certification and to Set Monitoring Protocols

Sustainably produced timber will not long enjoy market acceptance unless consumers feel sure that they are purchasing a bona fide "good wood." Consequently, a definition of sustainable forestry that is accepted across the industry and based on valid scientific concepts is needed. Also, verification and monitoring will have to be carried out by an institution considered credible by producers and consumers alike. Currently, consumers may be confused by the competing programs, each with its own unique definitions of sustainable forestry, its own criteria, and its own procedures. Until a credible group sets definitions and protocols that certification

programs and timber traders then accept, consumers will be left to their own devices to decide whose "good wood" is better. Indeed, several of the leading proponents of certification programs would welcome the establishment of a "certifier of the certifiers" to set industry-wide standards and bolster consumer confidence (Donovan, 1992; Hammel, 1992; Ussach, 1992). The nascent Forest Stewardship Council, proposed at the founding meeting of the Woodworkers' Association for Rainforest Protection in 1989, represents an important step toward establishing standards and credibility within the timber-certification movement. *(Box 11)* Ultimately, however, representatives from both producing and consuming constituencies must be equally represented within the certifying institution. Further, the evaluation criteria must reflect corsensus, the monitoring apparatus must be controlled by independent entities, and monitoring results must be readily and freely available to all concerned parties.

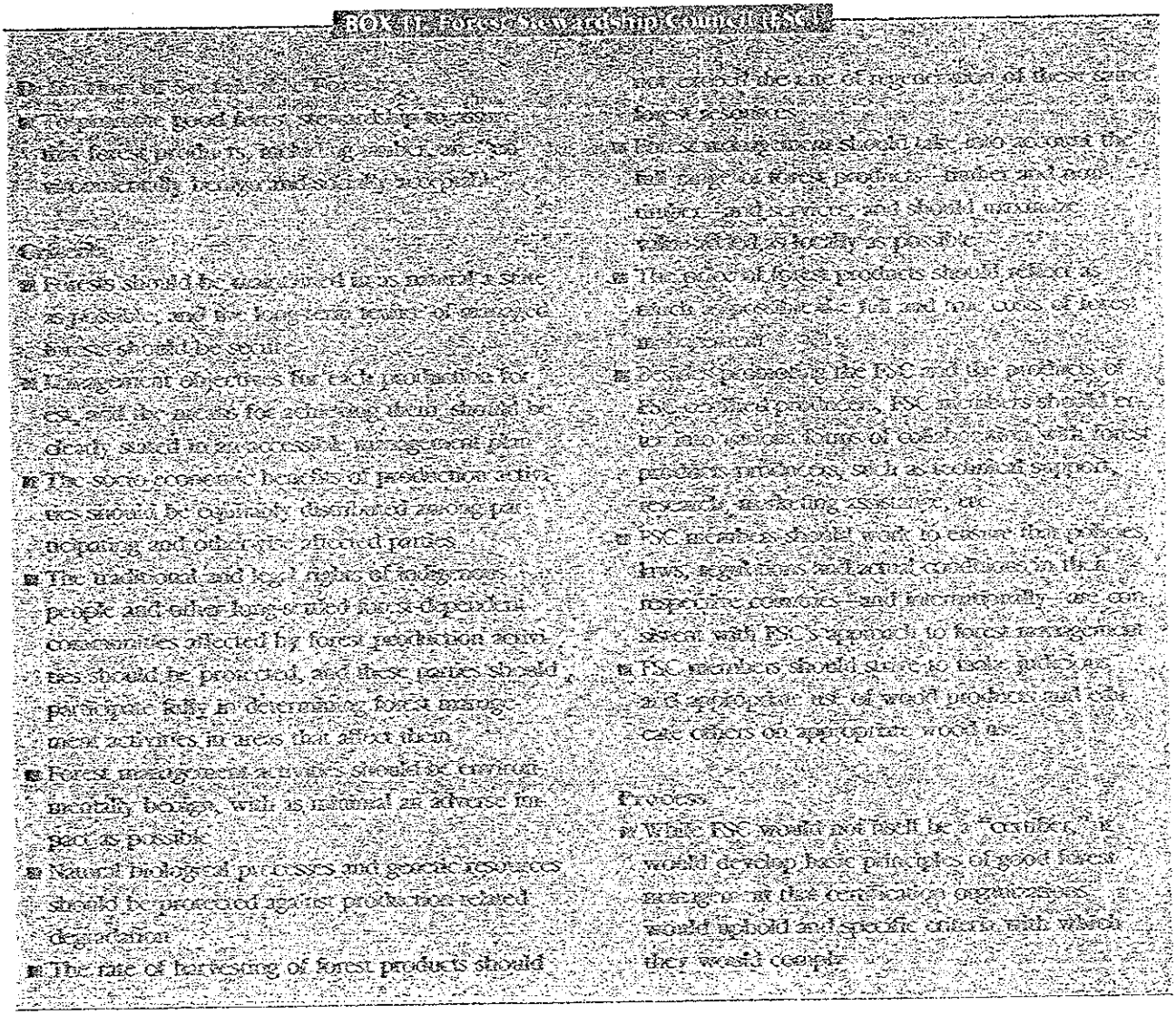
REMAINING HURDLES

The ultimate success of a certification program depends heavily on an emerging and fickle "green" market in industrialized countries that is limited in size, flooded with differing criteria, and barraged with bogus claims. Of the limited volume of harvested timber now exported, approximately 40 percent is sold to Japan (Nectoux and Dudley, 1987), where consumer demands for "good wood" have barely influenced market trends. The green market emerging in Europe and North America—which now represents demand for perhaps 2 to 3 percent of all internationally-traded tropical hardwood—exerts only limited influence over forest management in the humid tropics. Further, though green consumers may be willing to pay a premium for "good wood," exactly how much extra is unknown and untested, and surveys show that only 5 to 12 percent of those who claim to buy environmentally friendly products do so regularly (Richards, 1992).

Yet, on balance, weak demand does not appear to be a major constraint to expanding the use of certified timber. To the contrary, demand may soon outpace the supply of "good wood"—if it has not done so already. How will the certification movement handle the onslaught of producers seeking verification once WWF's Target 1995 and ITTO's Target 2000 programs are up and running? If certification programs cannot respond to higher demand, or do not agree on standards while market demand escalates, false claims of "good wood" will grow and consumer confidence quickly diminish. Rainforest Alliance addresses this problem by reserving the *Smart Wood* label for those retailers who sell "tropical wood products made *exclusively* of Smart Wood." Others that sell wood from a variety of sources (including *Smart Woods*) are designated as "other companies selling Smart Wood products" (Ussach, 1992). The creation of high initial standards with intermediary or probational categories that will allow producers to enter sustainable production gradually merit serious consideration, though raising them may prove difficult once they are set (Colchester, 1992).

Not all producers will be able to comply with certification criteria at the same pace. In economic terms, those who cannot meet the standards are probably the most inefficient producers and should therefore be eliminated from the market. However, small operations demonstrating or approaching sustainability—especially community-owned and managed initiatives that incorporate social development goals—may not have ready access to the capital and technical expertise needed to collect the data, maintain detailed records, and generate the documentation needed to become certified. The Institute for Sustainable Forestry estimates that it may cost up to US$2000 more to comply with the PCEFP criteria than to meet the requirements of the State of California. Acknowledging this hurdle, the Institute has proposed a revolving loan fund to help producers cover the costs of meeting the PCEFP criteria, and it is lobbying to get landowners who obtain PCEFP certification exempt from state requirements (Katelman, 1992). Scientific Certification Systems is considering pre-certification assessments "report cards" for producers who do not meet the *Green Cross* criteria. The hope is that the prospect of high marks will spur competition among producers to produce "greener" wood (Hammel, 1992).

Producers that accept the increased costs and foregone short-term revenues associated with sustainable production must be compensated. But how? Eliminating intermediaries means higher revenues that producers can use to offset compliance costs.



and there may be sound business reasons for making this leap of faith. The Ecological Trading Company has been willing to shave its profit margin to help cover such costs, hoping that this tactic will increase market share and revenues. But the added costs of getting good wood to the market should also be borne by consumers or philanthropic organizations. The need for one or the other type of subsidy is especially great in programs posited on both technical and social criteria since the costs and benefits of social organization and participation are hard to quantify (Richards, 1992).

The process by which producers obtain certification, and the role of local people in reaching this decision, strongly influence a program's credibility. Although independent consultants and expert review panels are usually used, consulting with local people and determining their role in decision-making presents a serious challenge to all certifying entities, and failing to meet it will cost credibility.

On balance, timber-certification programs offer a critical first step toward sustainable forestry. They demonstrate sustainable forestry's feasibility and, more important, show the forest industry's managers the practices that they will have to follow to remain competitive with a reduced forest resource base and an increasingly "green" market. Once best practices have been identified and instilled throughout the forest industry in a given region, certification programs could also help to incrementally raise the level of

performance if continued certification depended on such improvements.

The ultimate challenge, however, remains creating the public awareness and political will needed to amend the macroeconomic and land-use policies that ultimately dictate the forest's fate. If sound forest stewardship is the goal, guidelines and standards must be extended to cover the production of non-timber forest products too. Certification programs, enlightened producers, traders, and "green" consumers alike will remain marginal forces unless they can catalyze these sweeping changes. In the interim, however, they can provide sorely needed examples of forestry that goes beyond today's worrisome status quo and competes as a viable land use and, along with bans and boycotts, keep an international focus on these issues.

Most efforts to promote sustainable forest management policies and practices continue to center on international efforts, such as the ITTO and the UNCED Forest Principles. These and other emerging "official" international forums are crucial for negotiating, designing, and enacting the land-use and economic policies needed to make forest management more sustainable and to get it practiced on an appreciable scale. However, if past experiences with international forestry efforts are any guide, these forums will offer little substantive guidance on how to define and implement more sustainable forest practices locally. The timber-certification movement is critical to filling this gap.

VI. A BROADER MANDATE FOR NATURAL FOREST MANAGEMENT

Natural forest management has so far failed to fulfill its potential for sustaining humid tropical forests. Nor have other efforts to maintain these forests, such as establishing protected areas and intensifying agriculture outside the forest, been fully successful. But past needn't be prologue, and the reasons for trying to use and manage humid tropical forests sustainably are more compelling than ever. Indeed, the diverse problems facing humid tropical forests require a wide array of potential solutions, including natural forest management, and natural forest management's mandate can be broadened and made more effective.

A permanent forest estate must be established and preserved, no matter how intense the political pressure to breach it.

How sustainable natural forest management can be depends on the extent to which new approaches to managing human interactions with the world's diminishing tropical forests are adopted. Incentives that reward poor land-use stewardship and the wasteful use of forest resources must be eliminated. A permanent forest estate must be established and preserved, no matter how intense the political pressure to breach it. The concept of sustainable forest management must be redefined. And community-based management systems must be adopted in the many populated humid tropical forests where their promise is greatest.

In this transition, governments and donor agencies must change too. They must build the capacity to design and implement sustainable forest practices both nationally and locally—a task requiring candid analysis of past mistakes and new approaches to both forestry and to economic development in general. Clearly, political change and commitment, both North and South, is at least as important as technical change to the fate of humid tropical forests.

REDEFINING NATURAL FOREST MANAGEMENT

Natural forest management, in definition and practice, should be more than a set of technical activities aimed at extracting certain commodities from forests on a continuous basis. A more useful way of viewing natural forest management is as the practical application of a land ethic. Although ethical traditions vary throughout the humid tropics, most teach respect for the diversity of life (WRI, IUCN, UNEP, 1992), as well as mindfulness of the long-term consequences of abusing natural resources. If they started with ethical considerations, forest managers would be able to frame their responsibilities more broadly.

Important ecological and social factors suggest that natural forest management should be premised on the sustainability of the forest ecosystem, rather than on the narrower objective of providing a continuous supply of timber. One key to the sustainability of natural forest management is to keep our demands for goods and services—from certain types of wood, non-timber forest products, and biodiversity to water, soil retention, and climate regulation—within range of the forest's ability to produce them.

Today, most logging practices in the humid tropics clearly exceed these limits, either because people take too much of the resource or, more often, because they are extremely careless in extracting and using it. Foresters are trained to manage trees, not people. Frequently the "problem" seems to be with the forest that does not produce enough of what is wanted, when in fact the issue is unrealistic human demand.

Another problem faced by foresters is the difficulty of practicing sustained-yield forestry in tropical forests, which are more complex ecologically and less well understood than temperate forests. Indeed, while in Europe (and to a lesser extent in North America) silvicultural experience spans several

rotations over a hundred years or more, in the humid tropics, few areas have been managed for more than a couple of decades. In this context, determining the types and intensities of harvesting that can be sustained over the long term involves superb judgement and a certain amount of guesswork. Indeed, ecological processes and interactions among species (for example, between a tree and its pollinator) are so poorly understood that how most timber harvest practices will affect the forest ecosystem's sustainability remains a matter of conjecture.

Ensuring that local communities receive a fair share of the benefits and do not shoulder a disproportionate share of the costs is another key to sustainable natural forest management. To those outside of tropical forestry, "natural forest management" seems to imply a broad set of activities related to the varied riches and functions of a natural forest, and in fact, many forest communities and the wider public may value other commodities and environmental services in a given forest more than timber.[39] In such cases, timber should take second priority to the production of non-timber forest products or to watershed management. Of course, the overexploitation of non-timber forest products, or even unregulated ecotourism, can also lead to forest degradation, so, ideally, priorities should be set through consultations with all groups that have a stake in the forest's future.

Finally, natural forest management must take the dynamic nature of humid tropical forest ecosystems and changing societal needs into account. To keep future options alive while meeting present needs, the primary objective of natural forest management, timber for instance, should be linked to such secondary management objectives as maintaining biodiversity, protecting water quality, and generating income from non-timber resources. If the management associated with the primary objective interferes with secondary objectives, management practices may have to be readjusted and resource use lowered.

More generally, tropical foresters should define and practice natural forest management in broader terms than they do now. They should define *natural forest management* as managing human uses of forests at levels compatible with the maintenance of the ecological processes that sustain the forests—meanwhile respecting the livelihoods of people who depend on the forest. While current scientific

Tropical foresters should define natural forest management *as managing human uses of forests at levels compatible with the maintenance of the ecological processes that sustain the forests—meanwhile respecting the livelihoods of people who depend on the forest.*

knowledge of how ecological processes maintain tropical forests in most places is limited, the following actions represent a start toward establishing an ecological basis for natural forest management:

- protect natural regeneration of important successional and dominant tree species by retaining biotic diversity, especially among pollinators and seed dispersers, and maintaining suitable micro-climates for regeneration;
- preserve nutrient cycles by protecting mineral nutrients, organic soil materials, and soil micro-fauna;
- protect the tropical forest from catastrophic disturbances to which it is not adapted—in most cases, this will include fire; in others, it may include significant removal of tree cover and the creation of large edges that result in blow-downs, microclimate alterations, etc.;
- and protect contiguous natural forest areas from conversion or maintain relatively undisturbed habitat corridors to the nearest large similar forest habitat.

REDEFINING THE TIMBER CONCESSION

Many unsustainable logging practices are due more to flaws in the policies governing concessions—and to inadequate monitoring and oversight—than to a lack of silvicultural knowledge. Indeed, all the silvicultural knowledge in the world would make little difference in how logging is practiced on most concession lands, the site of most productive forest lands in the humid tropics. *(See Table 5.)* The

Table 5. Forest Concession Areas in Selected Countries

Asia	Area of Productive Natural Closed Broadleaved Forest (ha)	Area under Concession (ha)
Thailand	3,915,000	19,418,800[a]
Malaysia		
Peninsular	4,360,700	1,060,700
Sarawak	7,018,400	6,400,041
Sabah	3,406,000	2,004,224
Philippines	4,403,000	5,675,358
Papua New Guinea	15,000,000	2,417,000
Indonesia	64,403,600	53,374,000
Total	102,506,700	90,350,123
Africa		
Cameroon	13,852,000	7,200,000[b]
Ghana	1,321,000	4,080,000
Zaire	60,000,000	22,000,000
Total	75,173,000	33,280,000
Latin America		
Bolivia	29,850,000	22,500,000
Brazil	300,630,000	12,598,852[c]
Colombia	39,500,000	1,562,000[c]
Peru	43,320,000	1,454,000
Total	413,300,000	38,114,852

Notes:

a. All logging concessions were revoked in 1989, this ban is still in effect.

b. Area under concessions defined as "logging area."

c. This area is actually "Production Forest Estate" or natural forests designated by the government for logging.

Sources: IUCN/ITTO (1991); World Bank (1990); Poore, et al., (1989); FAO (1988); UNDP/FAO (1988); Winterbottom (1988); World Bank (1987)

management of some concession areas may be turned over to communities as is happening in Mexico, or designated a protected area, as witnessed in the Philippines, Thailand, and Guatemala. But since concessions will continue to be the major mechanism for allocating and managing forest resources, concession policies must be revamped if these forests are to be managed sustainably.

First, a long-term goal is to reform the rationale for allocating concessions. Concessions should be viewed as an agreement between government and the private sector to manage public forest areas for a variety of goods and services, including timber—not simply as contracts covering extraction alone. Under such an agreement, concessionaires would be held responsible for maintaining vital ecological services (including water regimes, soil quality, and wildlife at set levels) and ensuring that non-timber forest products aren't jeopardized. This shift in thinking will not occur unless governments and development agencies invest in innovative and experimental alternatives to traditional timber concession systems.

Timber will continue to be the forest resource that concessionaires find most attractive.

In the meantime, timber will continue to be the forest resource that concessionaires find most attractive. To a large extent, the irresistible appeal reflects economic policies and market conditions that define forest resource values largely in terms of timber. If non-timber forest resources were valued more than timber, then concessionaires would treat them better—assuming concessionaires could capture such values. As forests and non-timber resources grow more scarce, some will become more valuable—but only some, and only after they have been substantially diminished. Revising national income accounts and macro-economic policies now would reveal how large market failures are in relation to forest resources and provide a basis for reforming policies and markets to better recognize the values for a range of forest resources (Solorzano, et al., 1991; Repetto et al., 1989).

The most practical short-term step toward making concessions sustainable is to define guidelines for "best practices." Already, ITTO guidelines issued in 1990 serve as an international reference standard upon which to base national guidelines. (A useful survey of "best practices" can be found in Jonsson and Lindgren (1990) and Poore et al. (1989). Emerging tropical timber-certification programs also highlight best practices. *(See Chapter V.)* Now national (and subnational) guidelines are urgently needed to improve the sustainability of production forests everywhere and international donors should make their development and implementation key priorities. Meanwhile, no concession should be officially issued until the chosen concessionaire submits and gets approval for a forest management plan in accordance with the national guidelines.

Even with suitable guidelines, governments must do a much better job at setting sustainable limits on timber harvesting and ensuring that concessionaires comply with prescribed standards and regulations. Where allowable cut levels are uncertain (i.e., most places in the humid tropics), levels of timber harvest and rotation lengths should be set conservatively. Extraction levels should be determined in conjunction with estimates of environmental damage caused by harvesting and extraction. To raise harvest levels, or shorten rotation cycles, concessionaires should have to prove that the changes don't make forestry unsustainable. A concessionaire might, for instance, have to demonstrate that its harvest and extraction activities cause minimal damage to remaining trees, water quality, and soil conditions if it wants to be granted a higher cut.

Although governments are ultimately responsible for monitoring compliance, most forest departments don't have enough staff to do the job properly—to periodically review compliance over the concession's lifetime and to provide the basis for concession continuance, cancellation, or transferability. But since such rules and regulations will mean little as long as local institutions lack the capacity to monitor and enforce guidelines, initial investments in the forest sector should be used to establish these guidelines and the institutional capacities needed to carry them out.

Implementing guidelines and monitoring compliance will take additional resources. To cover the costs, governments must thus capture fair value for

the public resources extracted by private concessionaires. The current royalty system, which affords concessionaires huge windfall profits and invites the wasteful use of forest resources, needs to be restructured. Many economists believe that bidding systems would bring in more revenues and would be less politicized than most concession allocations are today. Alternatively, if better forest inventories informed collection systems, governments could estimate the realistic value of forest tracts and charge fees accordingly. Accurate inventories would also strengthen the government's negotiating position under a bidding system. Higher license fees for areas and *ad valorem* royalties instead of undifferentiated royalties would also help. Such reforms could, however, raise serious equity questions. In particular, how can communities and local companies compete with highly capitalized bidders?

Collecting adequate forest revenues from concessionaires, however, is not enough. In any viable fee-collection system, sufficient funds must be returned for reinvestment in forest management. This need is as much an issue of internal government administrative management and revenue allocation as it is of collecting fees high enough to reflect the true value of the forest and its management. Forest revenues deposited in general treasury accounts simply won't improve forest management, concession monitoring, and management oversight even if governments are paid a fair rent for the forest land. As a rule of thumb, forest revenues can subsidize other government activities, but sustainable forest management requirements should be covered first.

A PLACE FOR COMMUNITY-BASED MANAGEMENT SYSTEMS

The assault on tropical forests and its implications for the global environment are now prodding governments to take new approaches to managing what remains. One of the most exciting alternatives to emerge is the rebirth of community forestry. Often reluctant to share authority with local people, governments are beginning to realize that the livelihoods of rural peoples and the rational use of forests are inseparable.

Community forestry's roots predate the emergence of agricultural society. Swidden agriculture—the practice of clearing small forest glades for crops—is perhaps the oldest form still being practiced. But community forestry has diversified to encompass activities as wide-ranging as using trees to improve agricultural productivity and conserving primary forest reserves by legalizing the customary claims of local indigenous people. Exactly which form community forestry takes depends on how particular groups of rural people coexist with their forest environment. While their perceptions of the forest and its uses often center around economic need, they may also reflect cultural, spiritual, moral, or ethical values. Further, though community forestry implies collective management for common good, it works best when individuals, especially the very poor, gain through collective action (Cabarle, 1991).

Many of the most promising initiatives in natural forest management are community-based and controlled (Perl, et al., 1991; Poffenberger, 1990). The advantages of local control include better policing and husbanding of local forest resources and a more equitable distribution of benefits. Closely knit communities deeply tied to land they own tend to be committed to sustainability and to weather the vagaries of fluctuating markets and sociopolitical change with remarkable grace. Then too, programs to encourage community forestry generally cost less than government management of public lands and often work better.

Yet, community forestry is not a panacea. Not all communities are equipped politically, financially, and technically to manage extensive forest tracts. Many forests are remote from markets and services. Often, local land claims are unrecognized by governments and disregarded by outsiders. Few state forestry agencies and donors provide the short or long-term investment needed to develop local capacity. Most investors prefer highly technical and capital-intensive forest operations that yield a quick return but lie outside the reach or interest of community groups. Perhaps most important, national economic and development policies—especially in agriculture, energy, trade, and finance—are often dictated by global market forces that encourage short-term profit-taking, promoting land-use practices that endanger forests and local communities (Cabarle, 1991; Colchester, 1991).

If community forestry is to have a real impact, three interrelated issues must be addressed: land and

resource tenure; the development of organizational cohesion and management skills; and the blending of local knowledge with technical assistance to promote sustainable production (Cabarle, 1991). These factors are not unique to community forestry endeavors, but they are crucial to their success (Rodriguez, et al., 1990).

Secure tenure—to the forest as well as the trees—underpins all successful community forestry projects. Sometimes, securing tenure is the result of dramatic popular movements in which local interests converge to demand guaranteed access to critical natural resources and to organize community management schemes for controlling their use. In Bolivia, 800 Indians from five tribes marched 35 days from the city of Trinidad to the capital of La Paz in a peaceful demonstration for land and self-determination and won legal rights to ancestral land claims in the Chimanae Forest. Other, less dramatic methods can also work. Along Ecuador's northwestern coast, a farming community of African descent organized as a commune and ushered its claim to 60,000 hectares of ancestral land through government bureaucracies. The commune's reserve was declared a national patrimony site, effectively removing it from the government's designated colonization zone.

Since most forests throughout the humid tropics are state property, or "public forests," bureaucratic entanglements are a major impediment to expanding community forestry. When communities negotiate these external barriers--among them lack of tenure, and planning and policy processes with no public participation--they often confront obstacles within the community as well, including vested interests and weak institutions.

Community forestry projects face five organizational challenges to success. First is leadership. Strong and catalytic leaders are central to securing and demarcating community lands. But leaders with the gifts needed to form organizations may be horrible managers and become a liability once a group starts the day-to-day labor of building on initial achievements. Leadership must therefore evolve to meet the task at hand—or have enough sense to delegate authority to get the job done.

Second, managerial qualities become paramount once a nascent grassroots organization obtains secure tenure and enters the maze of fund-raising, project planning and administration, and market competition. The transition from "crisis" management to long-range planning is essential to the administrative, monitoring, and evaluation guidelines that governments set for securing tenure and that donors demand as a precondition for grants or loans, but it can be painful. However, examples from Quintana Roo, Mexico and Palcazu, Peru demonstrate that it is possible—and desirable.

Third, once basic administrative capacity is established, the distribution of project benefits must be seen as fair and impartial if the organization is to succeed. Murky decision-making behind closed doors eventually divides the community. The key is not ensuring that each community member receives an equal share, but that all members perceive benefits to be commensurate with individual input.

The fourth organizational challenge is to negotiate outside political or financial support while maintaining internal consensus in the face of an indifferent, if not hostile, policy environment. Once agreement on land tenure is reached, local communities and state agencies often view the same forest quite differently. Negotiations between communities and government agencies usually begin over which combinations of land uses (intact forests, annual crop production, agroforestry schemes, etc.) fulfill legal requirements once land titles have been issued.

Finally, community forestry projects will flounder without sound fiscal management. Many fail because savings are not accrued and reinvested productively. Others have oversubsidized roads, schools, medical clinics, and other social services, sapping funds for capital improvements and forest management. This misplaced generosity is common where value-added processing equipment is donated or sold to communities without adequate advance planning and generates sudden cash windfalls.

If community-based forest enterprises are to endure, they must employ techniques attuned to local ecological limitations. Careless community forestry projects can deplete the resource base as quickly as conventional timber concessions can. Fortunately, a number of innovative projects do not. In Mexico, for instance, forestry *ejidos* in Quintana Roo rely on a selective harvesting technique to promote natural regeneration, supplemented by "enrichment"

plantings of preferred native tree species that had been overexploited before the *ejidos* took charge of forestry operations. To reconstitute the forest's composition and structure, the *ejidos* have required buyers of preferred timber species to purchase lesser known species too. During the rainy season, *ejidal* members ban logging and tap resin from chicle trees, thus integrating non-timber products into their forest management scheme.

Central to successes like this one has been the ability to merge local knowledge with technical expertise. In the Yanesha project, Amuesha Indians worked with technicians from the Ministry of Agriculture and the Tropical Science Center, a Costa Rican nongovernmental organization, to design the forest-harvesting technique mentioned above. They also decided to employ draft animals to extract felled timber and minimize damage to the surrounding forest (Hartshorn, 1990). Such examples demonstrate that community forestry schemes can be beneficial to both local economies and the sustainable management of dwindling forest resources.

4. NATURAL FOREST MANAGEMENT AS A CONSERVATION TOOL: THE "USE IT OR LOSE IT" PRINCIPLE

Governments, conservation organizations, and donors need criteria for recognizing when and where natural forest management projects are an appropriate conservation tool, especially in primary forests. Such criteria could best be developed by applying the "use it or lose it" principle.[10] Simply stated, under certain conditions natural forests will soon be degraded or destroyed if these resources are not well managed and if substantial economic benefits are not derived from the standing forest. The level of intervention depends, of course, on the severity and imminence of the threat(s).

Natural forest management is frequently justified on the grounds that it will, in the end, conserve forests that might otherwise fall to competing land uses. However, natural forest management is no panacea for conserving humid tropical forests. In some places, the techniques that are its hallmarks lessen the risk that a forest area will be lost to other land uses. In others, they could increase the risk of deforestation. Knowing where these differences lie is key to assessing whether natural forest management is an appropriate forest conservation strategy. A problem here is that the ways in which natural forest management averts or enhances risk vis-à-vis deforestation is not widely understood or recognized.

Of course, there are many situations where little or no debate exists over the use of sound natural forest management practices—in previously logged forests, in secondary forests, and possibly in forest management units that are firmly and irrevocably allocated to production forestry. The controversy over natural forest management centers on its practice in primary forests and its effectiveness in protecting them from complete destruction by agricultural activities and other economic pressures.

Primary forest areas where the "use it or lose it" principle applies should include at least several of the following conditions:

- proximity to agricultural frontiers;
- high local population densities;
- high local deforestation rates;
- easy road access;
- high local immigration rates; and
- proximity to wood markets and wood-processing industries.

Primary forests considered for natural forest management projects under the "use it or lose it" principle should be part of the designated permanent production forest estate, and other examples of whatever forest type is involved should be adequately represented elsewhere in the country's protected areas network. Finally, any forest area singled out for such projects should not be a critical habitat for species listed under the CITES Convention or those listed in the IUCN Red Data Books. If these two conditions do not apply, then options to more fully protect the forest should be examined first. If this proves impractical, special provisions for conserving biodiversity in managed forest as outlined by IUCN/ITTO (1991) will be essential.

5. POLICIES FOR A PERMANENT FOREST ESTATE

Governments are usually the chief determinants of the fate of forest lands, even if they do not directly control them. Unless governments offer some guarantee that forest will remain forest, sound natural

forest management practices will be considered irrational. In practical terms, this means that governments should be firmly committed to keeping certain areas under permanent forest cover.

In most countries, such a commitment means protecting public forest lands from conversion to non-forest uses. In some countries, especially those with large and growing populations and large forest areas, some forest lands will inevitably be needed to meet basic development needs, and including extensive areas that are highly suitable for sustainable agricultural production in the permanent forest estate will prove impractical and politically impossible. Yet, in most countries the areas best suited for agriculture have already been developed, however inefficiently and inequitably they may be used. The overriding point is that once it includes certain lands in the permanent forest estate, government must be prepared to resist further losses to agricultural production, colonization, and infrastructure development. Often, demands for the conversion of forest lands will come from within the government itself, so the establishment and maintenance of a permanent forest estate must have political commitment at the highest levels.

The permanent forest estate should not be limited to public forest lands supervised or protected by government. In many areas, legally gazetted or not, forest-dependent peoples have long viewed local forests as a permanent estate. In many cases, the legal recognition and protection of their claims can be viewed as an effective way to help maintain a permanent forest estate. Moreover, governments should respect the desire of these people to keep their lands within the permanent forest estate and support their resistance to demands by outside interests for access to natural resources without the approval of local communities.

Many countries that have legally established a permanent forest estate have failed to defend it effectively. For example, the Philippines has 56 percent of its territory legally classified as public forest lands; Thailand, 40 percent. Each now has less than 20 percent of their territory under forest cover, and only a fraction of that is considered productive. This failure to protect the permanent forest estate is now showing up in lost export revenues, costly and widespread environmental degradation, and, ironically, in the loss of foreign currency to pay for wood imports. In Latin America, where many countries have relatively little forest area designated as permanent forest estate (IUCN/ITTO, 1991), forest-based enterprises have no long-term security.

Finally, where lands are slated to be turned over to the private sector for development, policies should be enacted to encourage the new owners to keep all or part of their lands in forest. Mechanisms might include changing requirements for obtaining land titles, which now usually require conversion to agricultural production or pasture; reforming tax policies to favor forest-based enterprise rather than inefficient agricultural production; or developing effective forestry-extension programs.

Whatever the legal and administrative details, a permanent forest estate is an important foundation for maintaining forests. Communities, concessionaires, and forestry agencies all need secure and long-term land tenure if they are to use forest reserves and production forests sustainably. Legal gazettement must be followed by boundary demarcation and effective oversight. Only then can the designation of a permanent forest estate provide the basis for the legal and administrative regulation of resource uses and their allocation to suitable areas.

Nels Johnson is an associate in the World Resources Institute's Center for International Development and Environment where he works on forestry and biodiversity conservation projects. Previously, he worked for the International Institute for Environment and Development in Washington, and as a forest ecologist with Oregon State University's cooperative forest research program. **Bruce Cabarle** is an associate and manager of the Latin America Forestry Program at the World Resources Institute's Center for International Development and Environment. Before joining the World Resources Institute, he worked in the Washington office of the International Institute for Environment and Development, was a forest manager with the Puerto Rico Department of Environment and Natural Resources, and a timber sale administrator with the U.S.D.A.-Forest Service in Idaho.

NOTES

1. UN Food and Agriculture Organization, "Second Interim Report on the State of Tropical Forests," presented at the 10th World Forestry Congress, Paris, September, 1991. The FAO interim report estimates that tropical deforestation (for closed and open forest) increased from 11.4 million hectares in 1980 to approximately 17 million hectares in 1990. Estimates published by the World Resources Institute (WRI, 1990) are similar.
2. *See* for example the various classification systems used by the Lanly (1982) analysis of tropical forest resources.
3. This classification system is relatively broad, and provides only limited information on the physical environment. Biological diversity is immensely more complex. There are efforts underway to consolidate landscape classifications to more accurately delineate major ecosystems, but consensus on a given system may take many years.
4. Because of the inconsistency in tropical forest definitions, we use the terms provided by primary sources when referring to specific data or citations in areas that we generally refer to as humid tropical forest. For example, the Lanly (1982) analysis does not make general distinctions between humid and dry forests in summaries of forest cover. However, the natural broadleaved closed forests category used by Lanly largely overlaps with forests that could be classified as humid tropical forests under the Holdridge system.
5. Perhaps the most notable forest peoples' movement is that of Chico Mendes Filho and the Brazilian rubber tappers (*see* Amnesty International, "Amnesty International Brazil Briefing," background paper, Washington, DC, September 1989). In March 1987, thousands of Penan, Kayan and other indigenous communities set up over 25 road blocks in Sarawak, Malaysia to stop violations of their customary rights and forest livelihoods from commercial logging operations (*see* Sahabat Alam Malaysia/World Rainforest Movement, "The Battle for Sarawak's Forest," Malaysia: Jutaprint, 1989). Under the auspices of the World Rainforest Movement, forest dependent peoples worldwide are joining together in a unified response to the tropical forest crisis through "A Forest Peoples Charter" (*see* "Towards a Forests Peoples Charter," Interim Report on Progress by Marcus Colchester, World Rainforest Movement, England, 6 September 1990).
6. Very little, if any, of this value is returned to tropical forest areas for conservation or management purposes. The lack of willingness on the part of the pharmaceutical industry to pay for forest conservation and grant intellectual property rights and just compensation to local inhabitants who possess knowledge of medicinal plants is a growing North-South debate (Reid, 1992; Rietbergen, 1991), and a major part of the disagreements over the recently completed Convention on Biological Diversity. An agreement between Merck, the world's largest pharmaceutical company, and the Costa Rica Institute for Biodiversity (INBIO) is a notable exception (*see* WRI/IUCN/UNEP, 1992). It is interesting to note that the worldwide tropical hardwood trade itself only generates about US$7 billion a year
7. For example, research shows that the Yucatan Peninsula and the Northwest Amazon Basin supported larger populations in pre-Hispanic times than today's present day societies (Gomez-Pampa and Kaus, 1990; Meggers, 1988).
8. For example, based on demographic data and trends in the Philippines, it is now estimated that nearly 20 million people live on public forest lands and are legally landless (Cruz 1986). Most of these peoples have migrated to public forest lands during the past 20–30 years, with the exception of approximately 6–8 million indigenous forest peoples (Owen Lynch, 1992).
9. This proposition may be debatable for several countries. For example, deforestation projections by Trexler and Haugen (1992) would suggest that some major forest area, including primary forest, will persist beyond the year 2,000 in Laos, Myanmar, and Vietnam.

10. The countries are: Brazil, Cameroon, Costa Rica, India, Indonesia, Myanmar, Philippines, Thailand, and Vietnam. *See* WRI (1990).
11. In part, however, this increase may be due to more accurate estimates based on satellite imagery than was available during the 1980 FAO assessment.
12. For 18 countries in the Asia/Pacific region, estimates in Collins et al. (1991) indicate that approximately 50 percent of the original extent of "closed canopy tropical moist" forest remains.
13. Even in protected areas, forests are often not secure from agricultural expansion, illegal logging, and oil and mineral development. Existing protected areas are likely to face intensified pressures in many areas without concerted efforts to manage and maintain them.
14. Some, however, maintain that the largest factors involved in the lower deforestation rates observed beginning in 1988–89 were weather conditions and worsening economic conditions in Brazil. There is some evidence to suggest that some subsidies continue to be paid, even though they are illegal.
15. *See* Repetto (1988) for a more complete treatment of the explanations.
16. Lanly (1982) defines "undisturbed productive closed broadleaved forest" as forests more than 60–80 years of age and not disturbed by logging. It is, however, possible that many of these forests may have been cleared at one time for shifting cultivation.
17. It is not possible, based on FAO published sources, to discern exactly where or in what type of forest the ten percent of deforestation caused by logging took place. However, it is unlikely that much of the logging-related deforestation took place in the other FAO forest categories—open forest, bamboo forest, and conifer forest.
18. Of course, it should be pointed out that extending the length of concession periods is, in itself, of little consequence without other concurrent changes in concession policies (e.g., increasing rent capture, enforcing cutting limits and other regulations, substantial bonds to cover rehabilitation, etc.).
19. At a recent conference, *WRI Colloquium on Sustainability in Natural Tropical Forest Management* (held in Washington, D.C. March 21–22, 1991), several experienced tropical foresters argued that natural forest management, largely defined in terms of timber production, is much too restrictive. A much broader definition should be used, and applied in practice.
20. Individuals can earn more than $3,000 during the rainy season through chicle tapping.
21. These projects include the Palcazu project in Peru, Carton de Colombia in Colombia, Plan Piloto in Quintana Roo, Mexico, and the Yapo Forest in Côte d'Ivoire. Evidence of regeneration is usually reported in terms of seedling and sapling numbers, often limited to species of timber value. Occasionally, more complete species inventories are made of regenerating seedlings and saplings. Because of the relatively limited experience of most natural forest management projects, or due to the lack of monitoring, there is often little evidence of how successful natural regeneration (following silvicultural treatment) is at producing mature trees later in the rotation period.
22. A few examples of such measures include tax incentives, credit subsidies, tariffs, quantitative restrictions on exports or imports, embargoes or outright boycotts, licensing or other customs and administrative requirements, pricing regulations and specialized treatment (such as "favored nation" status). These issues are treated extensively in Repetto and Gillis (1988).
23. This is true in the short run. However, several studies show that destructive logging practices are, indeed, less profitable, given the costs of equipment maintenance and repairs, repeated skid trail construction and entrances into the same stand, due to careless planning and haphazard implementation (*see* Jonsson and Lindgren, 1990).
24. ITTO/HIID (1988) provides an in-depth treatment of this issue.
25. Even where designated forest estates do exist, government claims to vast areas of forest lands often outstrip its institutional capacity to manage such areas (*see* Barber et al., in press for further treatment of this issue).
26. Many argue that it is unlikely that lengthening of concession periods will motivate better forest

management practices. The long term nature of private investments in forest production will still prove very risky due to the extreme political and economic uncertainty in many tropical countries.

27. *See* Cort (1991), Colchester (1990), and SAM (1989), for further treatment of these issues.
28. Case studies presented on Quintana Roo and Malaysia have demonstrated some of the problems which arise when lack of data leads to the application of an inappropriate silvicultural system (WRI, 1991).
29. Of course, the public desire to use a forest area for non-wood purposes is often contradicted by growing consumer demands for wood products.
30. Thanks go to Simon Rietbergen for the wonderfully descriptive term "use it or lose it" in connection with deciding where natural forest management is a necessity.

REFERENCES

Aidara, G. 1991. SODEFOR's Experience in Forest Management in Côte d'Ivoire and Its Relevance to West Africa. Paper presented to the Colloquium on Sustainability in Natural Tropical Forest Management, Washington, D.C. March 21–22, 1991.

Amnesty International. 1989. Amnesty International Brazil Briefing. Washington, D.C. Background paper.

Appanah, S. and G. Weinland. 1991. "Will the Management Systems for Hill Dipterocarp Forests Stand Up?" *Journal of Tropical Forest Science*. 3(2): 140–158.

Anderson, P. 1989. "The Myth of Sustainable Logging: The Case for a Ban on Tropical Timber Imports." *The Ecologist*, 19: 166–168.

Barber, C., N. Johnson, and N.A. Hafild. In press. *Obstacles to Forest Policy Reform in Indonesia and the United States*. World Resources Institute, Washington, D.C.

Barrera, C. 1986. "El Aprovechamiento de Bosques Naturales en la Region del Pacifico Colombiano." In: J. Colón (ed.) *Management of the Forests of Tropical America: Prospects and Technologies*. Proceedings of a Conference in Puerto Rico, Sept. 22–27, 1986. Institute of Tropical Forestry, Puerto Rico.

Barrera, C. 1991. Paper presented to the Colloquium on Sustainability in Natural Tropical Forest Management, Washington, D.C., March 21–22, 1991.

Barnett, T. 1989. *Commission of Inquiry into Aspects of the Timber Industry*. Final Report. Government of Papua New Guinea, Port Moresby, PNG.

Bruenig, E.F., and J. Poker. 1989. *Management of Tropical Rainforests: Utopia, or Chance of Survival?* Proceedings of an international symposium sponsored by the German Foundation for International Development (DSE), January 15–21, 1989. Nomos Verlags Gesellschaft, Baden-Baden, Germany.

Budowski, G. 1988. "Is Sustainable Harvest Possible in the Tropics?" *American Forests*, 94: 34–81.

Bundestag. 1990. *Protecting the Tropical Forests: A High Priority International Task*. Second Report of the Enquete Commission on Preventive Measures to Protect the Earth's Atmosphere to the 11th German Bundestag. German Bundestag, Bonn, Germany.

Burgess, P. 1989. Asia. In: D. Poore (ed.). *No Timber Without Trees: Sustainability in the Tropical Forest*. Earthscan Publications, London.

Buschbacher, R. 1990. "Ecological Analysis of Natural Forest Management in the Humid Tropics." In: R. Goodland (ed.) *Race to Save the Tropics*. Island Press, Washington D.C. pp. 59–79.

Cabarle, B., M. Crespi, C. Dodson, C. Luzuriaga, D. Rose, and J. Shores. 1989. An Assessment of Biological Diversity and Tropical Forests for Ecuador. Unpublished report, World Resources Institute, Washington, D.C.

Cabarle, B. 1991. "Community Forestry and the Social Ecology of Development." *Grassroots Development: Journal of the Inter-American Foundation*. 15: 3–9.

Cassells, D. 1992. "ITTO develops criteria for measuring sustainable forest management." *ITTO Tropical Forest Management Update* newsletter.

Clay, J. 1988. *Indigenous Peoples and Tropical Forests: Models of Land Use and Management from Latin America*. Cultural Survival, Cambridge, MA.

Colchester, M. 1990. Toward a Forest People's Charter: Interim Report on Progress. World Rainforest Movement, Penang, Malaysia and Chadlington, U.K.

Colchester, M. 1991. "Forest Peoples and Sustainable Forest Management." Paper presented at the WRI Colloquium on Sustainability in Natural Tropical Forest Management, March 21–22, 1992. World Resources Institute, Washington, D.C.

Collins, M.N., J. Sayer, and T.C. Whitmore. 1991. *The Conservation Atlas of Tropical Forests: Asia and Pacific*. World Conservation Monitoring Centre. MacMillan Press, London.

Cort, C. 1991. *Voices From the Margin: Nongovernmental Organization Participation in the Tropical Forestry Action Plan*. World Resources Institute, Washington D.C.

Counsell, S. 1989. *Good Wood Guide*. Friends of the Earth, London.

Cox, C. and H. Kwishthout. 1989. Ecological Trading Company: A Policy for Trading in Sustainably Produced Tropical Timber. Ecological Trading Company, Newcastle upon Tyne, U.K.

Cruz, M.C. 1986. "Population Pressure and Migration: Implications for Upland Development." University of the Philippines/Los Banos, Center for Policy and Development Studies. Working Paper Nos. 86-06 and 86-07.

DeBonis, J.N. 1986. "Harvesting Tropical Forests in Ecuador." *Journal of Forestry*. 84: 43–46.

Donovan, R. 1992. Director, Rainforest Alliance Smartwood Program, New York. Personal communication.

Dudley, N. 1991. Importing Deforestation: Should Britain Ban the Import of Tropical Hardwoods? World Wide Fund for Nature/U.K., Godalming, U.K.

EIU. 1991 Philippines Country Profile. Economic Intelligence Unit, London.

Elkins, S. 1992. City Council Staff, City of Minneapolis, MN. Personal communication. February 28, 1992.

Elliott, C. 1991. Sustainable Tropical Forest Management by 1995. A WWF Discussion Paper. WWF/International, Gland, Switzerland.

Environment and Energy Study Institute. 1991. *Task Force Report on Partnership for Sustainable Development: A New U.S. Agenda for International Development and Environmental Security*. EESI, Washington, D.C.

FAO. 1991. Second Interim Report by the Forest Resources Assessment 1990 Project, presented at the 10th World Forestry Congress, Paris, France, September, 1991. Food and Agriculture Organization, Rome.

FAO. 1988. An Interim Report on the State of the Forest Resources in the Developing Countries. U.N. Food and Agriculture Organization, Rome.

FAO. 1988. 1986 Yearbook of Forestry Products—1975–1986. U.N. Food and Agriculture Organization, Rome.

Feedback. 1990. Newsletter published by the Center for Environmental Concerns, Manila, Philippines. July–August, 1990.

Golin/Harris and Angus Reid Group. 1992. "Americans Will Back their Green Feelings with Greenbacks." *Trilogy*. May–June 1992.

Gomez-Pampa, A., and A. Kaus. 1990. "Traditional Management of Tropical Forests in Mexico." In: A.B. Anderson (ed.), *Alternatives to Deforestation: Steps Toward Sustainable Use of the Amazon Rain Forest*. Columbia University Press, New York. pp. 46–64.

Goodland, R. 1990. "Tropical Moist Deforestation: Ethics and Solutions." Draft paper prepared for the Vatican Discussions on Tropical Forests and the Conservation of Species, May 14–18, 1990, Vatican City.

Goodland, R.J.A., E.O. Asibey, J.C. Post, and M.B. Dyson. 1990. "Tropical Moist Forest Management: The Urgency of Transition to Sustainability." *Environmental Conservation*, 17:303–318.

Grainger, A. 1990. "Strategies to Control Deforestation and Associated Carbon Dioxide Emissions in the Humid Tropics." In: *Tropical Forestry Response Options to Global Climate Change*, São Paulo, Brazil, January, 1990. Conference Proceedings.

Grainger, A. 1987. "TROPFORM: A Model of Future Tropical Hardwood Supplies." In: *Proceedings of CINTAFOR Symposium on Forest Sector and Trade Models*. University of Washington, Seattle, WA. pp. 205—212.

Green Cross. 1991. Development of a Certification System for Sustainable Forestry Management Systems. Green Cross Certification Company, Oakland, CA.

Grut, M., N. Egli, and J. Gray. 1990. *Forest Revenue Systems and Concession Management Policies for West and Central African Moist Forests*. World Bank, Washington, D.C.

Hafild, N.A. 1992. Personal communication, June 10, 1992.

Halpin, L. 1990. *Indigenous Peoples and the Tropical Forestry Action Plan*. World Resources Institute, Washington, D.C.

Hamilton, L.S. 1990. *Boycotts of Tropical Timber Products Will Not Stop Deforestation*. Environment and Policy Institute, East-West Center, Honolulu, Hawaii.

Hammel, D. 1992. Personal communication, February 12, 1992.

Hartshorn, G. 1990. "Natural Forest Management by the Yanesha Forestry Cooperative in Peruvian Amazonia." In: A. Anderson (ed.) *Steps Toward*

Sustainable Use of the Amazon Rain Forest. New York: Columbia University Press. pp. 128–138.

Hartshorn, G. 1989. "Application of Gap Theory to Tropical Forest Management: Natural Regeneration on Strip Clear Cuts in the Peruvian Amazon." *Ecology* 70: 567–569.

Hartshorn, G. 1988. "Natural Regeneration of Trees on the Palcazu Demonstration Strips." Unpublished paper for the U.S. Forest Service Forest Support Program, Washington, D.C.

Hewett, J., S. Rietbergen, and D. Baldock. 1991. Target 1995: Problems and Perspectives Relating to the Import of Sustainably Produced Tropical Timber into the Netherlands. Institute for European Environmental Policy, London, U.K.

Holdridge, L.R. 1967. *Life Zone Ecology*. Tropical Science Center. San José, Costa Rica.

Hutchinson, I.D. 1988. "Points of Departure for Silviculture in Humid Tropical Forests." *Commonwealth Forest Review*, 67(3): 223–231.

Hutterer, K.L. 1988. "The Prehistory of the Asian Rain Forests." In: J.S. Denslow and C. Padoch (eds.), *People of the Tropical Rain Forest*. University of California Press, Berkeley, CA. pp. 53–62.

Institute for Sustainable Forestry. 1991. Pacific Certified Ecological Forest Products. March 19, 1991 draft program description. Institute for Sustainable Forestry, Petrolia, CA.

International Task Force on Forestry Research. 1988. A Global Research Strategy for Tropical Forestry.

ITTO. 1990. ITTO Guidelines for the Sustainable Management of Natural Tropical Forests. ITTO Technical Series 5. International Tropical Timber Organization, Yokohama, Japan

ITTO/HIID. 1988. *The Case for Multiple-Use Management of Tropical Hardwood Forests*. Harvard Institute for International Development, Cambridge, Mass.

IUCN/ITTO. 1991. Conserving Biological Diversity in Managed Forests: Africa. March 1991 draft report. World Conservation Union (IUCN), Gland, Switzerland.

IUCN/ITTO. 1991. Conserving Biological Diversity in Managed Forests: Latin America. March 1991 draft report. World Conservation Union (IUCN), Gland, Switzerland.

Jackson, J.K. 1986. A Study of Timber Transfer Pricing in Papua New Guinea. U.N. Centre on Transnational Corporations, New York.

Jensen, C., and S. Pfeifer. 1992. Assisted Natural Regeneration: A New Reforestation Approach? unpublished manuscript.

Johns, A.D. 1992. "Species Conservation in Managed Tropical Forests." In: T.C. Whitmore and J.A. Sayer (eds.) *Tropical Deforestation and Species Extinctions*. Chapman and Hall, London.

Johns, A.D. 1988. "Effects of Selective Timber Extraction on Rain Forest Structure and Composition and Some Effects For Frugivores and Folivores." *Biotropica*, 20: 31–37.

Johns, A.D. 1986. Effects of Habitat Disturbance on Rainforest Wildlife in Brazilian Amazonia. Unpublished report to the World Wildlife Fund, U.S., Washington, D.C.

Johnson, N., and P. Alfonso. 1991. The Philippines Biodiversity Survey and Action Plan. Unpublished report, World Resources Institute, Washington, D.C.

Jonkers, W.B.J. and J. Hendrison. 1987. "Prospects for Sustained-Yield Management of Tropical Rainforest in Surinam." In: *Management of the Forests of Tropical America: Prospects and Technologies*. Proceedings of a conference sponsored by USAID, USDA Forest Service, and Office of International Cooperation and Development, Puerto Rico, September 22–26, 1986. Institute of Tropical Forestry, USDA Forest Service, Puerto Rico.

Jonsson, T, and P. Lindgren. 1990. *Logging Technology for Tropical Forests—For or Against?* Forest Operations Institute, Kista, Sweden.

Katelman, S. 1992. Institute for Sustainable Forestry, Redway CA. Personal communication, February 27, 1992.

Kauffman, J.B. 1991. "Survival by Sprouting Following Fire in Tropical Forests of the Eastern Amazon." *Biotropica* 23(3): 219–224.

Keto, A.I., K. Scott, and M.F. Olsen. 1990. Sustainable Harvesting of Tropical Rainforests: A Reassessment. Rainforest Conservation Society, Brisbane, Australia.

Knoll and SCS. 1991. "Knoll Group and Green Cross Announce Guidelines for Timber Suppliers." *Business and the Environment*, Newsletter, June 14, 1992.

Lambeth, C. 1991. Presentation at the Colloquium on Sustainability in Natural Tropical Forest Management, Washington, D.C., March 21–22, 1991.

Lanly, J.P. 1990. The Status of Tropical Forests. Forest Resources Division, U.N. Food and Agriculture Organization, Rome.

Lanly, J.P. 1982. Tropical Forest Resources. FAO Forestry Paper 30. Food and Agriculture Organization of the United Nations, Rome.

Lee, H.S. 1991. Presentation at the Colloquium on Sustainability in Natural Tropical Forest Management, Washington, D.C. March 21-22, 1991.

Lintner, B. 1992. "Burmese Plunder: Rangoon Unleashes an Onslaught of Logging." *Far Eastern Economic Review*, June 4, 1992, p. 63.

Lugo, A.E. 1987. "Tropical Forest Management with Emphasis on Wood Production." In: *Ecological Development in the Humid Tropics: Guidelines for Planners*. Winrock International, Morrilton, AR. pp. 169-190.

Lynch, O. 1992. World Resources Institute, Washington, D.C. Personal communication, February 3, 1992.

Lynch, O. 1991. "Community-Based Tenurial Strategies for Promoting Forest Conservation Development in South and Southeast Asia." Unpublished paper, World Resources Institute, Washington, D.C.

Lynch, O. 1990. Whither the People? Demographic, Tenurial and Agricultural Aspects of the Tropical Forestry Action Plan. World Resources Institute, Washington, D.C.

Malingreau, J.P., G. Stevens, and L. Fellows. 1985. "Remote Sensing of Forest Fires: Kalimantan and North Borneo in 1982-1983." *Ambio* 14: 314-321.

Marn H.M. and W.B.J. Jonkers. 1982. "Logging Damage in Tropical High Forest." In: P.B. Srivastava (ed.), *Tropical Forests, Source of Energy through Optimization and Diversification*. Pertanian University, Kuala Lumpur, Malaysia. pp 27-32.

Mather, A.S. 1990. *Global Forest Resources*. Timber Press, Portland, OR.

Matthews, E. 1983. "Global Vegetation and Land Use: New High Resolution Data Bases for Climatic Studies." *Journal of Climatic and Applied Meteorology*, 22: 474-487.

Meggers, B.J. 1988. "The Prehistory of the Amazon." In: J.S. Denslow and C. Padoch (eds.), *People of the Tropical Rain Forest*. University of California Press, Berkeley, CA. pp. 53-62.

Mergen, F., and J. Vincent (eds.). 1987. *Natural Management of Tropical Moist Forests: Silvicultural and Management Prospects of Sustained Utilization*. Yale University School of Forestry and Environmental Studies, New Haven, CT.

Moad, A.S. 1989. "Sustainable Forestry in the Tropics: The Elusive Goal." Paper prepared for Rainforest Alliance Workshop on the U.S. Tropical Timber Trade: Conservation Options and Impacts. April 1989. Rainforest Alliance, New York.

Monbiot, G. 1991. "Against the Grain." *The Guardian* (London), May 3, 1991.

Myers, N. 1989. *Deforestation Rates In Tropical Forests and Their Climatic Implications*. Friends of the Earth, London.

Myers, N. 1984. *The Primary Source: Tropical Forests and Our Future*. W.W. Norton and Co., New York.

Nectoux, F. and N. Dudley. 1987. *A Hard Wood Story: Europe's Involvement in the Tropical Timber Trade*. Friends of the Earth, London.

Nectoux, F. and Y. Kuroda. 1989. *Timber from the South Seas: An Analysis of Japan's Tropical Timber Trade and its Environmental Impact*. World Wildlife Fund International, Gland, Switzerland.

Paisal, S. 1989. "Getting Lumbered." *Far Eastern Economic Review*, February 2, 1989, p.9.

Pearce, F. 1992. "Timber Trade Stripped of its Green Veneer." *New Scientist* 134: p.4.

Perl, M., M. Kiernan, D. McCaffery, R. Buschbacher, and G. Batmanian. 1991. Views from the Forest: Natural Forest Management Initiatives in Latin America. Tropical Forest Program, World Wide Fund for Nature/U.S., Washington, D.C.

Poffenberger, M. 1990. *Keepers of the Forest: Land Management Alternatives in Southeast Asia*. Kumarian Press, West Hartford, CT.

Poore, D., P. Burgess, J. Palmer, S. Rietbergen, and T. Synnott. 1989. *No Timber Without Trees: Sustainability in the Tropical Forest*. Earthscan Publications, London.

Rainforest Alliance. 1991. Smartwood Certification Program. February 1991 program description. Rainforest Alliance, New York.

Rainforest Alliance. 1989. Statement on Tropical Timber Boycotts. Rainforest Alliance, New York.

RAN. 1991. Tropical Timber and the Death of the Rainforests. Factsheet 20b. Rainforest Action Network, San Francisco, CA.

Reid, W.V. 1992. "How Many Species Will There Be?" In: T. Whitmore and J. Sayer (eds.), *Tropical Deforestation and Species Extinctions*. Chapman and Hall, London, U.K.

Reid, W.V., and K. Miller. 1989. *Keeping Options Alive*. World Resources Institute, Washington, D.C.

Repetto, R. 1988. *The Forest for the Trees? Government Policies and the Misuse of Forest Resources*. World Resources Institute, Washington, D.C.

Repetto, R. and M. Gillis. 1988. *Public Policies and the Misuse of Forest Resources*. Cambridge University Press, Cambridge, U.K.

Repetto, R., W. Magrath, M. Wells, C. Beer, and F. Rossini. 1989. *Wasting Assets: Natural Resources in the National Income Accounts*. World Resources Institute, Washington, D.C.

Republic of Ecuador. 1990. Plan de Accion Forestal para el Ecuador. Ministry of Agriculture and Livestock, Quito, Ecuador.

Republic of Peru. 1987. *National Forestry Action Plan: 1988–2000*. Ministry of Agriculture, Lima, Peru.

Richards, D.C. 1992. Personal communication, February 12, 1992.

Richards, J.F. and R.P. Tucker. 1988. *World Deforestation in the Twentieth Century*. Duke University Press, Durham, N.C.

Rietbergen, S. 1991. Forest Program, International Institute for Environment and Development, London. Personal communication, March 16, 1991.

Rodriguez, S. and B. Cabarle. 1990. Revisando Cuentas: Una Evaluacion del Plan de Accion Forestal en Centroamerica. CCAD and World Resources Institute, Washington, D.C.

Rodriguez, S., A. Vargas, S. Dedina, and D. Standfield. 1990. Communal Management of Forest Resources in Latin America. Draft report prepared for FAO Forestry Department. Land Tenure Center, University of Wisconsin-Madison.

Roselle, M., and T. Katelman. 1989. Tropical Hardwoods: A Report on the US Role in the International Tropical Hardwood Trade and the Non-Timber Economic Alternatives. Rainforest Action Network, San Francisco, CA.

SAM. 1989. *The Battle for Sarawak's Forests*. Sahabat Alam Malaysia and World Rainforest Movement, Penang, Malaysia.

Salati, E. and P. Vose. 1983. "Depletion of Tropical Rain Forests." *Ambio*, 12: 47–56.

Santos, V. 1991. Presentation at the Colloquium on Sustainability in Natural Tropical Forest Management, Washington, D.C. March 21–22, 1991.

Savage, J.M. 1987. Introduction. In: *Ecological Development in the Humid Tropics: Guidelines for Planners*. Winrock International, Morrilton, AR. pp. 3–11.

Schmidt, R. 1987. "Tropical Rain Forest Management: A Status Report." *Unasylva*, 39: 2–17.

Shariff, A., M. Zakaria, M.G. Hasan, and R. Ahmad. 1990. "Nutrient Dynamics of Tekam Forest Reserve, Peninsular Malaysia, Under Different Logging Phases." *Journal of Tropical Forest Science*, 2: 71–80.

Smithsonian. 1990. Tropical Forestry Workshop: Consensus Statement on Commercial Forestry Sustained Yield Management and Tropical Forests. Workshop cosponsored by the Smithsonian Institution and the International Hardwood Products Association; October, 1989, Washington, D.C.

Snook, L. 1991. Presentation at the Colloquium on Sustainability in Natural Tropical Forest Management, Washington, D.C. March 21–22, 1991.

Solorzano, R., R. de Camino, R. Woodward, J. Tosi, V. Watson, A. Vasquez, C. Villalobos, J. Jimenez, R. Repetto, and W. Cruz. 1991. *Accounts Overdue: Natural Resource Depreciation in Costa Rica*. Tropical Science Center, San José, and World Resources Institute, Washington, D.C.

Sullivan, K. 1992. Personal communication, February, 18, 1992.

Tang, H.T. 1987. "Problems and Strategies for Regenerating Dipterocarp Forests in Malaysia." In: F. Mergen and J. Vincent (eds.). *Natural Management of Tropical Moist Forests: Silviculture and Management Prospects of Sustained Utilization*. Yale School of Forestry and Environmental Studies., New Haven, CT.

Tang, H.T. 1991. Presentation at the Colloquium on Sustainability in Natural Tropical Forest Management, Washington, D.C. March 21–22, 1991.

Tho, Y.P. 1991. "Tropical Moist Forests: Facts and Issues." In: *Technical Workshop to Explore Options for Global Forestry Management*, Bangkok, 1991. Conference Proceedings. Published by the International Institute for Environment and Development, London, U.K.

TFF. 1991a. TFF News: A Monthly Publication of the Tropical Forest Foundation. September, 1991. Tropical Forest Foundation, Alexandria, VA.

TFF. 1991b. Should You Boycott Tropical Woods? October, 1991. Tropical Forest Foundation, Alexandria, VA.

Trexler, M., and C. Haugen. In press. *Weighing the Tropical Forestry Alternatives to Slow Global Warming*. World Resources Institute, Washington, D.C.

Uhl, C. and I. Viera. 1989. "Ecological Impacts of Selective Logging in the Brazilian Amazon: A Case Study from the Paragominas Region of the State of Para." *Biotropica*. 21 (2): 98–106.

Uhl, C., R. Buschbacher, K. Clark, B. Kauffman, D. Nepstad, and S. Subler. 1990. "Studies of Ecosystem Response to Natural and Anthropogenic Disturbances Provide Guidelines for Designing Sustainable Land-Use Systems in Amazonia." In: A. Anderson (ed.) *Alternatives to Deforestation: Steps Toward Sustainable Use of the Amazon Rain Forest*. New York: Columbia University Press.

Uhl, C. and B. Kauffman. 1990. "Deforestation Effects on Fire Susceptibility and the Potential Response of Tree Species to Fire in the Rainforest of the Eastern Amazon." *Ecology*. 71: 437–449.

UNDP/FAO. 1988. TFAP Joint Interagency Planning and Review Mission for the Forestry Sector: Cameroon Mission Report, Vol. 3. Main Report. United Nations Development Program, New York.

Ussach, I. 1992. Director, Rainforest Alliance Smartwood Program. Personal communication, February 12, 1992.

Vanclay, J. 1991. "Tropical Rainforest Logging in North Queensland: Was it Sustainable?" Paper presented to the Colloquium on Sustainability in Natural Tropical Forest Management, Washington, D.C. March 21–22, 1991.

Verissimo, A., P. Barreto, R. Tarifa, and C. Uhl. 1992. "Mahogany Extraction in the Eastern Amazon: A Case Study." Paper presented at Tropical Forest Foundation Mahogany Workshop, February 3–4, 1992, Washington, D.C.

Wadsworth, F. 1983. "Production of Usable Wood From Tropical Forests." In: F.B. Foley (ed.) *Tropical Rain Forest Ecosystems: Structure and Function*. Elsevier Scientific Publishing Company, Amsterdam. pp. 279–288.

Wadsworth, F. 1987. "A Time For Secondary Forestry in Tropical America." In: *Management of the Forests of Tropical America: Prospects and Technologies*. U.S. Forest Service, Washington, D.C. p. 189–198.

Westoby, J. 1987. *The Purpose of Forests: Follies of Development*. Basil Blackwell, Oxford, U.K.

Wilson, N. 1989. The Impact of Logging in Tropical Forests. Report prepared for the Wilderness Society (Australia).

Winterbottom, R. 1990. *Taking Stock: The Tropical Forest Action Plan after Five Years*. World Resources Institute, Washington, D.C.

Winterbottom, R. 1988. Zaire Forest Policy Review. Summary Report. Department of Land Affairs, Environment and Nature Conservation, Government of Zaire, Kinshasha, and International Institute for Environment and Development, Washington, D.C.

Winterbottom, R. 1987. Le Territoire Forestiere Camerounais: Les ressources, Les intervenants, Les politiques d'utilisation. International Institute for Environment and Development, Washington, D.C.

World Bank. 1990. Papua New Guinea: The Forestry Sector: A Tropical Forest Action Plan. World Bank, Washington, D.C.

World Bank. 1987. Ghana Forestry Sector Review. World Bank, Washington, D.C.

World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press. New York.

Worldwatch. 1991. *State of the World 1991*. New York: Norton and Co.

WRI. 1992. *World Resources 1992-93: A Guide to the Global Environment*. Oxford University Press, New York.

WRI. 1991. *Summary Report on the Colloquium on Sustainability in Natural Tropical Forest Management*. WRI. Washington, D.C.

WRI. 1990. *World Resources 1990–91: A Guide to the Global Environment*. Oxford University Press, New York.

WRI. 1985. *Tropical Forests: A Call for Action*. Report of an International Task Force, Washington, D.C.

WRI, IIED. 1988. *World Resources 1988-89*. Basic Books, New York.

WRI, IUCN, UNEP. 1992. *Global Biodiversity Strategy: Guidelines for Action to Save, Study, and Use*

the Earth's Biotic Wealth Sustainably and Equitably. World Resources Institute. Washington, D.C.

WWF. 1991. Forest Stewardship Standards. December 10, 1991 draft. World Wide Fund for Nature/ U.K., Godalming, Surrey, U.K.

WWF. 1989. Tropical Forest Conservation. Position Paper No. 3. WWF International. Gland, Switzerland.

Wyatt-Smith, J. 1987. The Management of Tropical Moist Forest for the Sustained Production of Timber: Some Issues. IUCN/IIED Tropical Forest Policy Paper 4. IUCN, Gland, Switzerland.

World Resources Institute

1709 New York Avenue, N.W.
Washington, D.C. 20006, U.S.A.

The World Resources Institute (WRI) is a policy research center created in late 1982 to help governments, international organizations, and private business address a fundamental question: How can societies meet basic human needs and nurture economic growth without undermining the natural resources and environmental integrity on which life, economic vitality, and international security depend?

Two dominant concerns influence WRI's choice of projects and other activities:

The destructive effects of poor resource management on economic development and the alleviation of poverty in developing countries; and

The new generation of globally important environmental and resource problems that threaten the economic and environmental interests of the United States and other industrial countries and that have not been addressed with authority in their laws.

The Institute's current areas of policy research include tropical forests, biological diversity, sustainable agriculture, energy, climate change, atmospheric pollution, economic incentives for sustainable development, and resource and environmental information.

WRI's research is aimed at providing accurate information about global resources and population, identifying emerging issues, and developing politically and economically workable proposals.

In developing countries, WRI provides field services and technical program support for governments and non-governmental organizations trying to manage natural resources sustainably.

WRI's work is carried out by an interdisciplinary staff of scientists and experts augmented by a network of formal advisors, collaborators, and cooperating institutions in 50 countries.

WRI is funded by private foundations, United Nations and governmental agencies, corporations, and concerned individuals.