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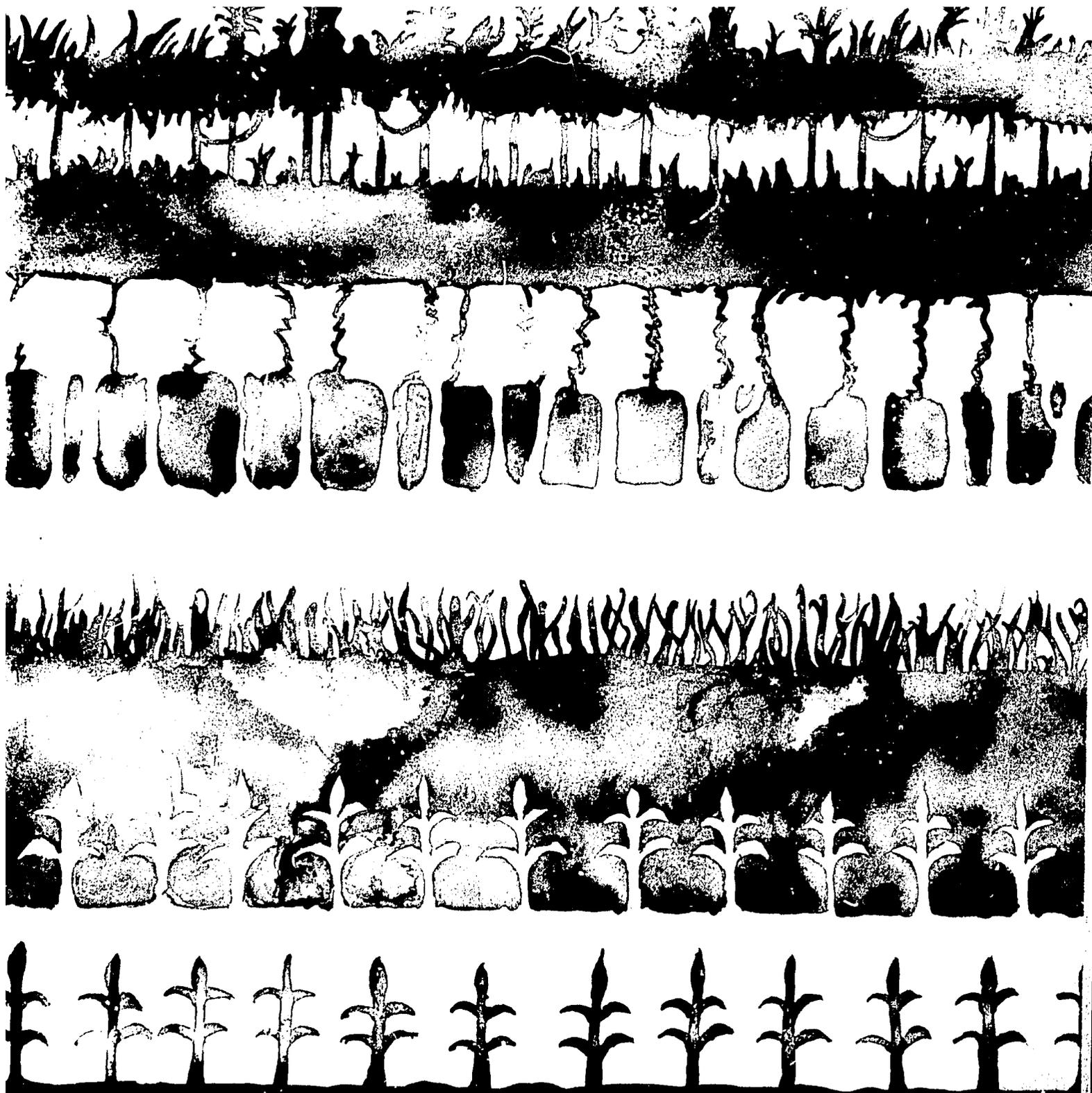
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The World's Tropical Forests:

A Policy, Strategy, and Program for the United States



Report to the President
by a U.S. Interagency Task Force
on Tropical Forests

**The World's
Tropical Forests:**

**A Policy, Strategy,
and Program for
the United States**

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The World's Tropical Forests: A Policy, Strategy, and Program for the United States

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EXECUTIVE SUMMARY

In his Environmental Message of August 2, 1979, President Carter cited the work of a recently established United States Interagency Task Force on Tropical Forests to develop a U.S. policy, strategy, and program for tropical forests, and requested that its findings and conclusions be reported to him. This is the Task Force's response to that charge.

The point of departure for this effort was a United States Strategy Conference on Tropical Deforestation, held June 12-14, 1978, in Washington, D.C., which concluded:

The world is being confronted by an extremely serious problem with immediate and long-range socioeconomic and ecological consequences as the result of the accelerating loss of forest and vegetative cover in the humid and semi-arid lands within or near the tropical latitudes. Further, the community of nations must quickly launch an accelerated and coordinated attack on the problem if these greatly undervalued and probably irreplaceable resources are to be protected from virtual destruction by the early part of the next century.

The Task Force analysis confirms that the world's tropical forests are indeed in jeopardy, and that serious social, economic, and environmental costs are being incurred—particularly by rural populations in tropical developing countries. The analysis further indicates that the United States has a vital stake in sound stewardship of its own limited tropical forest resources and in helping other nations to protect and sustain theirs. Most important, the Task Force firmly believes that U.S. efforts, meshed efficiently with those of other nations and international organizations, can make a difference.

Several important perspectives emerged during the course of the study:

- Industrial (non-fuel) wood production accounts for

one-fifth of the total volume of wood removed from tropical forests. Of this total, only one-fourth—about 6 percent of total tropical wood removals—is exported by tropical countries. Wood harvesting for in-country use and large-scale conversion of forest land to other uses, mainly agriculture, are by far the principal sources of tropical forest loss.

- Although U.S. imports of tropical hardwood and hardwood products are substantial in terms of value (averaging \$430 million annually from 1974 to 1978), in terms of volume they amount to only 1 to 2 percent of the total softwoods and hardwoods, or about 3 percent of total hardwoods, used in this country.
- Forest removal is not to be condemned per se. Legitimate, compelling social and economic reasons justify some tree removal and forest land conversion. The call in this report for improved "tropical forest management" should not be perceived as an effort to remove all forest resources from further development and utilization. On the contrary, the need is to expand both the short-term and long-term economic and social benefits obtainable from tropical forests. This includes their management as a renewable timber resource under the principle of sustained yield, and also the protection and maintenance of other values (e.g., ecological, recreational, scientific, and educational) that will be increasingly important to future generations.
- The future of tropical forests will be determined largely by seemingly unrelated "non-forestry" decisions by governments on rural development, food production, energy, land-use policies, and population growth. Efforts must be intensified to address these fundamental influences as they affect tropical forests, while concurrently providing a new policy focus and program priority for tropical forests.

Part I. The Forest Resource: Basis for Concern

Forty-two percent of all tropical lands is forested, constituting 1.9 billion hectares with significant woody vegetation (Chapter 1-A). Of this, some 0.8 billion hectares is "open" forest (woodland and semiarid shrubland such as the African Sahel), and 1.1 billion hectares is "closed" (a continuous forest canopy such as the Amazon rain forest). Africa has about 64 percent of all tropical open forest, while more than 50 percent of the closed forest is in South and Central America and 30 percent is in Asia/Australia/Oceania.

U.S. tropical forests—representing less than 1 percent of the world's total—are mainly in southern Florida, Texas, Hawaii, Puerto Rico, the Virgin Islands, Guam, and American Samoa.

Pressures and Losses: The tropical forests—the world's richest ecosystem and source of sustenance for millions of people (Chapter 1-B)—are disappearing at an alarming rate due to intense pressures by populations seeking food, energy, wood, and shelter.

Ten to 20 million hectares of closed tropical forest (1 to 2 percent) are cleared each year (Chapter 2-A). In the wake of this loss come secondary problems that undercut social and economic development throughout the Tropics, reduce the availability of raw materials and other forest products, and threaten to eliminate thousands of unique habitats and wildlife species. Solutions for preventing further losses and degradation are difficult to implement under the social, institutional, financial, and policy constraints found in many tropical forest areas.

Principal direct causes of tropical forest losses are their conversion and use for agriculture, fuelwood gathering, and poorly managed commercial logging (Chapter 2-B). On a worldwide scale, the ever-expanding quest for food supplies is the principal contributor, involving shifting agriculture, clearing of closed forests for pasture, and heavy grazing pressures in the open forests of semiarid regions. Behind these pressures, however, are fundamental problems of increasing population, inequalities in land tenure, lack of advancement in agricultural technology, and absence of employment opportunities outside the forest sector.

The consequences of uncontrolled tropical forest losses are myriad and serious (Chapter 2-C). They include rising prices and wood shortages in tropical countries, as

well as a diversity of ecological problems. Floods of unprecedented severity, with large life and property losses, have been reported recently by Asian nations, and attributed largely to the loss of vegetation on upland watersheds. Lakes, reservoirs, and irrigation systems are adversely affected by siltation. In the semiarid regions of Africa and Asia, where up to 90 percent of the population depend on woody vegetation for fuel, fuelwood supplies are receding far from human settlements. Fuelwood prices, wood collection time, and the suffering from doing with less continue to increase. With no other substitutes available, people are burning dung and crop residues which previously were used to maintain soil fertility. The process of "desertification," triggered by vegetative cover removal and overgrazing in semiarid regions, now threatens the productive capacity of the resource base over large areas of the Tropics.

Consequences of forest loss also include the extinction of indigenous plant and animal species which is occurring at a rate never before experienced. According to a forthcoming National Academy of Sciences report, fully one-third of all tropical organisms—almost a million species—may become extinct by the end of the century as a result of deforestation. As an additional source of concern, recent investigations of the carbon cycle have suggested that continuing tropical forest losses on the current scale may contribute to destabilization of the Earth's climate in the 21st century.

U.S. Influences: The United States affects tropical forests both positively and negatively through a variety of public and private sector policies and practices (Chapter 2-D). Major influences include: (1) U.S. consumer demand for wood and beef, the latter associated with conversion of forested land to pasture, particularly in Central and South America; (2) U.S. tariff policies and quotas on wood and meat imports; (3) domestic environmental policies that restrict cutting of temperate forests, regulate international trade in endangered plant species, and require environmental assessments of certain types of U.S. overseas activities that might impact tropical forests; (4) U.S. development assistance projects in tropical countries which may modify, restore, or protect forests; (5) commercial forestry activities, with some 30 U.S. firms currently involved, mostly in Southeast Asia; and (6) private investment in cattle ranching operations in other countries.

Part II. International Framework: Mechanisms for Action

The problems of tropical forest loss, compounded by complex socioeconomic conditions and short-term needs, are difficult to address successfully on a global scale (Chapter 3-A). By the year 2000, tropical country populations are expected to grow from the current level of 2 billion people to some 3 billion; permanent cultivation in the Tropics will expand by 1 million km²; and fuelwood demand—which currently constitutes over 80 percent of the total wood harvest in tropical countries—will at least keep pace with the anticipated 50 percent increase in population growth. Soaring prices for fossil fuels and imported wood products, as well as lucrative overseas markets for native tropical woods, will undoubtedly create strong pressures for developing countries to increase indigenous forest resource exploitation.

At some time, however, the secondary ecological and economic problems associated with forest losses (e.g., flooding, erosion, and siltation; firewood deficiencies; and soaring wood prices) will so seriously affect national economies and social well-being that the need for remedial actions will be compelling. In some countries this time has arrived, as evidenced by the recent growth in reforestation investments, tree-cutting bans, and protection of forests in their natural state.

Managerial and technological deficiencies in many tropical countries are major constraints on improved forest management. Another principal factor is inadequate investment by the international community in the tropical forest sector, at least partly due to high program costs. The Food and Agriculture Organization (FAO) estimates, for example, that the investment required to replace wood currently being cut for industrial purposes and fuelwood worldwide would total about \$3.3 billion per year.

Despite this rather discouraging outlook, governments and international development agencies are beginning to appreciate the linkage between forests and economic development, and both tropical timber producing countries and consuming nations perceive a common interest in the protection, conservation, and management of tropical forest resources (Chapter 3-B). This perception is, in turn, reflected in new programs and investments. Many rural development projects, for example, are now being designed and implemented to protect the previously neglected forest resource, and donors are expanding their forest research, training, and technical advisory activities.

While modern technology will not, by itself, solve the complex problem of tropical forest loss, it can provide a stimulus and the tools to attack them. The Task Force be-

lieves that promising technological opportunities exist in a range of critical fields which include land-use assessment, silviculture, more efficient forest resource utilization, and forest removal alternatives (Chapter 4). In addition to the greater availability of technological capabilities, a broadening array of national, regional, and international organizations exists, with growing interests and programs in tropical forest management (Chapter 5). However, a well-coordinated and efficient international program will require: (1) expansion of the linkages among national and international institutions through better information exchange; (2) an increase in joint planning and programming; and (3) above all, a strengthening of forest-related institutional capabilities within the tropical developing countries.

U.S. technical and financial support in this field is in increasing demand, and many public and private institutions are already expanding their tropical forest-related activities. This interest, talent, and investment provides a nucleus around which a larger, more coherent, and focused U.S. tropical forest program can be built. The Forest Service of the U.S. Department of Agriculture, the U.S. Department of the Interior, the Peace Corps, the National Science Foundation (NSF), and the U.S. Agency for International Development (AID) are among the Federal Agencies preparing new policies and programs in this area. A university consortium on tropical forests has recently been established; a large nongovernmental Working Group on Tropical Forests, with participation of environmental groups and universities, was created last year; and the Society of American Foresters has reactivated the International Society of Tropical Foresters.

Several key constraints must be overcome if the United States is to play a more significant international role. This Nation has few well-qualified, internationally recognized experts on tropical forests, and inadequate language capabilities hinder placement of U.S. nationals in international forestry organizations. In addition, U.S. institutions and agencies often do not encourage or reward staff participation in international programs, and this country has not been as aggressive as others in pursuing positions for its experts in international organizations or in providing appropriate training and career opportunities in Federal programs. Nonetheless, U.S. expertise is recognized and in demand in fields that include watershed, range, and wildlife management; commercial forestry; fire control; resource inventory and mapping; land-use planning; environmental monitoring; information collection, processing, and dissemination; and ecology.

Part III. The U.S. Role: Response to Need

Why should the United States be concerned about tropical forests when it exercises sovereignty over less than 1 percent of the world's total resource? The answer involves a combination of political, humanitarian, economic, developmental, environmental, educational, and scientific considerations—each with proponents within diverse U.S. public and private sectors (Chapter 6):

- U.S. commitments to world peace, economic and social stability, and the maintenance of the Earth's basic life-support system all require concern about the productivity of the natural resource base, including forests.
- The United States is party to international agreements which call for sound resource management and environmental protection.
- Economic and social progress in less developed countries, a basic U.S. foreign policy goal, is influenced by the integrity and use of indigenous forest resources.
- The influence of tropical forests on global physical, biological, and geochemical processes—including the stability of world climate—is poorly understood.
- One-third of the U.S. export market is with non-oil-producing developing countries, and their purchasing power is affected by the health of their natural resource base.
- U.S. economic growth is aided by a sustained supply of wood and other tropical forest products at reasonable prices.
- Closed tropical forests contain large numbers of uninvestigated plant and animal species, many of which may have important uses as food or medicinal or industrial products.
- The United States shares with tropical countries hundreds of animal species including migratory birds, mammals, insects, and turtles whose survival depends, to varying degrees, on tropical forests.
- Unique tropical flora and fauna provide outstanding scientific and educational opportunities.
- U.S. assistance to the international community for improved forest management is in increasing demand.

U.S. economic interests are related principally to the export of our products and investments abroad, and to the importation of tropical wood, food, medicinal plants, and related products. The developing countries represent the fastest growing export market for the United States. Further, the United States earned more than \$16 billion from direct investments in the developing world in 1978 alone.

Obviously, this Nation has a vital economic stake in the general health and welfare of these countries.

In 1978, U.S. hardwood imports worldwide amounted to \$682 million, with tropical countries (principally in Southeast Asia) supplying 82 percent of the total. Imports of tropical wood (logs, lumber, plywood, and veneer) averaged \$430 million annually from 1974 to 1978, with plywood constituting 78 percent of the total. As previously noted, however, although the dollar value of these imports is high, on a volume basis they account for only 1 to 2 percent of all hardwoods and softwoods used in this country.

Tropical countries also export to the United States such food commodities as sugar, bananas, and pineapples—collectively valued at hundreds of millions of dollars annually—which are often dependent on water supplies from forested uplands. In addition, tropical forests are principal sources of U.S. imports of (1) medicinal plants, valued at approximately \$25 million annually; (2) primates used in medical research; and (3) natural products such as rubber, licorice, Brazil nuts, and gum arabic. Further, important chemical clues are obtained from tropical forest species with pharmaceutical properties that provide a basis for laboratory synthesis of similar chemicals.

In sum, although the U.S. share of the world's tropical forests is small, our overall stake in their sustained productivity is substantial.

A U.S. Policy on Tropical Forests

A general statement of U.S. policy on tropical forests, setting forth the Nation's aspirations and commitment to improved worldwide management of this vital resource, will have important symbolic and practical values.

The following, therefore, is recommended by the Task Force as a general policy statement to guide and direct future program responses (Chapter 7):

IT IS THE POLICY OF THE UNITED STATES TO:

1. Recognize the importance and vulnerability of tropical forests in the conduct of this Nation's domestic and international affairs.
2. Pursue, in concert with other nations, policies and programs to sustain the integrity and benefits of tropical forests, as part of a broader effort to protect and maintain basic life-support systems.
3. Collaborate internationally, working through both bilateral and multilateral channels, to increase the social and economic benefits obtained from tropical forests, while concurrently protecting environmental values.
4. Support other nations' efforts to improve their standards of

living in a manner that will reduce destructive pressures on the forest resources on which they depend.

5. Encourage an international investment climate for private and public capital which stimulates and rewards sound management practices and efficient forest resource use.
6. Contribute to the international effort to designate and maintain representative tropical forest areas, such as biosphere and ecological reserves, national parks, wildlife refuges, natural areas, and multiple-use forests.
7. Seek to protect and manage U.S. tropical forests in an exemplary fashion.
8. Conduct a strong domestic research and development program designed to help the international community maintain, protect, and manage tropical forests—and share the results widely.
9. Expand training and educational programs in U.S. public and private institutions to increase the pool of U.S. expertise on tropical forests and to provide expanded opportunities for participation by specialists and students from other countries.
10. Encourage and assist U.S. public and private institutions to pursue their overseas programs and activities in a manner that promotes good stewardship of host countries' forest resources.
11. Promote a strong partnership between U.S. public and private sectors in support of this policy.

U.S. Goals

The United States cannot establish goals for other countries. However, it is possible to identify a number of important goals, consistent with the policy statement proposed above, that are likely to be in harmony with those that most other countries would develop (based on recent international meetings, reports, and consultations). The Task Force therefore addressed these questions: What conditions (i.e., goals) should the United States and the rest of the international community strive for within the next 5 years (by 1985)? Over the subsequent 10 years (by 1995)? And by the year 2000 and beyond?

The following are among the principal goals recommended by the Task Force (Chapter 8):

Short-Term Goals (1–5 Years)

- Policy commitments by all countries and international organizations to pursue sound, long-term forest management practices and programs.
- Initiation of an internationally coordinated action program on tropical forest research, monitoring, training, education, and information exchange.
- Doubling of the worldwide rate of reforestation and afforestation.
- Launching of an international program to introduce low-cost energy and alternative food production systems into rural areas.

Medium-Term Goals (6–15 Years)

- Significant reduction in the rate of forest losses, with any continuing losses the result of deliberate, informed decisions by governments and local communities.

- Programs in virtually all countries to preserve an study representative and unique forests and ecosystems, and to protect indigenous cultures.
- Increased commercial wood production, with expansion provided increasingly from forest plantations, including village woodlots, and from natural forest managed for multiple use.
- Sufficient understanding of the forest-climate relationship to establish whether and how tropical deforestation and reforestation affect global and regional climate.

Long-Term Goals (2000 and Beyond)

- A stabilized global situation, in which a broad mix of forest ecosystems and values are maintained and reforestation rates offset cutting and conversion.
- Success by the international community in providing food, shelter, energy, and employment for poor people, in slowing population growth, and otherwise addressing the root causes of pressures on forest resources.

U.S. Strategy and Program

A U.S. strategy and program for achieving the desired goals must recognize that ultimate responsibility for making changes lies within those countries possessing tropical forest resources. Further, U.S. motives and credibility are subject to challenge and skepticism because of: (1) the relative level of U.S. economic well-being; (2) the pressures placed on the world's tropical forests by U.S. consumer demand; and (3) the policies and practices of U.S. public and private institutions. And U.S. international involvement and initiatives in the tropical forest area will be limited by personnel and funding constraints.

Nonetheless, the United States can, and should, do much more than at present. Drawing on its concern, interests, scientific and technological capabilities, and its influence in international organizations, the United States can provide greater leadership and effectiveness through better coordination and selective expansion of the activities it undertakes domestically and internationally.

To provide coherence and direction for an expanded U.S. effort, the Task Force proposes in this report a series of specific strategies, including recommendations on immediate next steps and lead agency responsibilities. The strategies are designed to promote expanded worldwide awareness; achieve better use of multilateral and bilateral institutions and programs; mobilize and implement an internationally coordinated action program on tropical forests; accelerate the acquisition and application of management information and technologies; attack the root causes of deforestation; create an international investment climate in which commercial forestry is rewarded; and assure that the United States is in a position to "lead by example" (Chapter 9–A).

In addition, the Task Force has set forth a broad program planning framework to guide U.S. public and private investments. The program's components include international cooperation; bilateral development assistance; re-

search and demonstration; training and education; resource monitoring and assessment; information and data exchange; and Federal and non-Federal collaboration (Chapter 9-B).

It is recommended that the standing U.S. Interagency Task Force on Tropical Forests, cochaired by the U.S. Departments of State and Agriculture, assume the central responsibility for oversight, review, and coordination of the U.S. policy, strategy, and program (Chapter 9-C). Specific functions would include insuring that short-term studies called for in the report are carried out; arranging for periodic evaluations of individual program components (especially the bilateral assistance, research, training, and

information components); and synthesizing a comprehensive U.S. Government program and budget on tropical forests based upon individual Agency submissions.

The Task Force further recommends that Federal Agencies pursue appropriate modifications in their statutory authorities, staffing, and funding levels in response to the proposed strategy and program framework. Funding recommendations are not offered in this report. However, additional investment clearly will be needed to implement an expanded U.S. effort. Specific details must await Agency responses to the general strategy and program framework proposals, evaluated in relation to activities already underway and planned.

INTRODUCTION

President Carter, in his Environmental Message of August 2, 1979, highlighted the accelerating loss of the world's tropical forests as one of the most pressing global environmental problems confronting the international community. In calling for greater efforts by the United States to address this situation, he cited the ongoing work of a U.S. Interagency Task Force to prepare a comprehensive U.S. policy, strategy, and program on tropical forests, and requested that its report be submitted to him, along with specific recommendations. This report is the response by the Task Force* to the President's charge.

The concept of a specialized policy and strategy on tropical forests emerged from a U.S. Strategy Conference on Tropical Deforestation held June 12-14, 1978, in Washington, D.C., cosponsored by the U.S. Department of State and the U.S. Agency for International Development (AID) (See list of references, p. 51: U.S. Dept. of State, 1978). The principal conclusion of the Conference was that:

The world is being confronted by an extremely serious problem with immediate and long-range socio-economic and ecological consequences as the result of the accelerating loss of forest and vegetative cover in the humid and semiarid lands within or near the tropical latitudes. Further, the community of nations must quickly launch an accelerated and coordinated attack on the problem if these greatly undervalued and probably irreplaceable resources are to be protected from virtual destruction by the early part of the next century.

Noting the absence of a clear national commitment and policy guidance on which to base an expanded effort by the United States, the Conference recommended that:

A comprehensive United States policy and strategy on tropical forestry should be jointly developed by the Department of State, AID, the Department of Agriculture, the Department of the Interior, Peace Corps, National Science Foundation, the Council on Environmental Quality, and other appropriate public and private institutions. It should identify priority programs and activities for United States bilateral and multilateral support; outline fields in which the United States has special competence; define the types of potentially destructive actions which should be avoided or modified in tropical forest ecosystems; address the matter of responsibilities of United States firms, agencies, and institutions

operating abroad; and enunciate research, development, and training needs. The policy and strategy should be developed in consultation with other nations and appropriate international organizations to insure that it complements the experience and activities of others.

A second recommendation of the Conference called for creation, within the U.S. Government, of an Interagency Task Force on Tropical Forests to provide a focal point for policy and program planning, review, and coordination. At its initial meeting in October 1978, the new Task Force agreed that its first priority should be to propose a U.S. policy and strategy.

The Task Force's analyses and conclusions, presented herein, support the views of other recent studies carried out within the United States and abroad that the world's tropical forests are in trouble; that serious social, economic, and environmental costs are being incurred through the accelerating loss of forest cover; that the United States has a vital stake in improved stewardship of its own limited tropical forest resources and in helping other nations protect and sustain theirs; and that U.S. actions, meshed efficiently with those of other nations and international organizations, can make a difference.

This report is, therefore, intended to achieve three principal objectives:

- Focus greater public attention on the increasing loss of the world's tropical forests and on the associated social, economic, and environmental costs.
- Promote and guide an expanded dialogue within and between the U.S. public and private sectors about the nature and significance of the problem, and especially about the responsibilities and future activities of each sector related to improved tropical forest management and protection.
- Recommend policy for an expanded U.S. effort on tropical forest management—along with specific goals, a strategy, and a program framework—to assist both Federal and non-Federal institutions with the design, justification, and implementation of their future activities in this sector.

Part I of the report presents the basis for concern about tropical forest loss. It describes the character and importance of this resource and the causes and consequences of forest cover loss.

Part II addresses two basic questions: What are the prospects for mounting an effective internationally coordinated attack on the problem of deforestation? And, is an increased U.S. policy commitment and resource invest-

* See inside back cover for list of members of the U.S. Interagency Task Force, plus participants on the ad hoc Working Group established to prepare this report.

ment in this area desirable and can it make a difference? This section of the report assesses the global trends that will likely affect the forest resources in the future, as well as the technological institutional capabilities on which a new intensive effort in this field must be based.

Part III articulates why the United States is interested in tropical forests, and presents the Task Force's views on an appropriate U.S. response to international needs and opportunities. A recommended general statement of U.S. policy is set forth along with recommendations on specific goals, strategies, and short-term actions that should be pursued. Also presented is a broad program-planning framework to help provide direction and coordination for future U.S. activities on tropical forest management.

In presenting its report, the Task Force wishes to emphasize the following perspectives and considerations:

- This report is viewed as only a first step toward implementing a coherent, effective U.S. response to the need for improved tropical forest management. Momentum must be maintained by early followup to the efforts now set in motion. The dialogue initiated among government agencies, private industry, universities, and professional organizations during development of the report should be continued and expanded. Additional information on the nature of the deforestation problem and on the adequacy of the international institutional and technological response capabilities should be obtained. And the program framework outlined in the report will need to be fleshed with specific new program and resource commitments by both U.S. public and private institutions.
- The nature and extent of U.S. interests in tropical forests—as detailed in Chapter 6—provide a strong rationale for expanded U.S. involvement in this area, despite the limited extent of our own tropical forests. Most important is the fact that many other nations and a variety of international bodies are expressing similar concerns about the problem and are seeking U.S. assistance. The Task Force does not suggest that the United States should, or can, act unilaterally or attempt to assume sole leadership internationally. Rather, the call is for the United States to do considerably more than it is at present, in a better focused and more coordinated fashion, and within the framework of a larger international effort which the U.S. program should support.

- Although this report discusses principal forest loss causes—including specific U.S. influences—the discussion should not be construed as “fixing the blame.” Legitimate and compelling reasons point out why much of the forest loss occurs. Nonetheless, better use can be made of the tropical forest resource through greater awareness and better management. The report, therefore, points positively toward the future, and recommends a U.S. policy and program that will encourage new commitments and better stewardship on the part of all nations, institutions, and individuals who are now involved or who might play a future role.
- The future of the world's tropical forests will be determined largely by decisions outside the scope of forestry per se—decisions on, for example, population growth and migration, rural development, food production, and national land-use policy. Such decisions influence the number of people who want or need to use the forests, the purposes of such uses, and the degree of commitment to long-term resource management. This report, however, focuses on the tropical forests themselves, and directly associated social, economic, developmental, and environmental conditions and policies. Such emphasis does not imply that attention to tropical forests should detract from efforts in other development sectors. Rather, it is a matter of attempting to redress the lack of priority the resource currently receives in most countries by giving it greater recognition and attention.

Numerous individuals throughout the world contributed information and time to this report. Especially valuable support was rendered by the Nongovernmental Tropical Forest Working Group established with the assistance of the Natural Resources Defense Council, Inc., and by a broad range of U.S. industrial firms, individually and also collectively through the coordinating efforts of the National Forest Products Association. In addition, review comments were provided by a broad spectrum of the university community and by U.S. professional organizations. The Task Force obtained views of other governments and international organizations by circulating an early draft of the report through U.S. overseas Embassies and Missions, and also by reviewing the results of a variety of recent international and regional meetings on forestry. Comments from all sources were carefully considered.

To the many who contributed, the U.S. Interagency Task Force on Tropical Forests extends its deep appreciation.

**Part I:
The Forest Resource:
Basis for Concern**



The world's tropical forests comprise vast, important ecosystems that are being lost and disturbed because of human attempts to obtain food, shelter, energy, and economic reward. As plant cover is reduced, social, economic, and ecological problems left in its wake pose great risks to millions of people in tropical areas. Moreover, opportunities to extract greater economic and social benefits from tropical forest resources are being forfeited because of inadequate knowledge and unwise management practices. To address the problems of tropical forests, the nature and character of this resource, its value to mankind, and the diverse stresses it is under must be understood.

Tropical Forests: Character and Importance

A. Location and Diversity

"Tropical forests" are broadly defined in this report to include all forests and shrublands within the geographic Tropics and in generally frost-free areas outside the geographic Tropics (Fig. 1). The geographic tropical zone covers the equatorial belt from the Tropic of Cancer in the Northern Hemisphere to the Tropic of Capricorn in the Southern Hemisphere, and includes about 30 percent of the Earth's land surface, or 4.6 billion hectares.

Of the total land area of the Tropics, some 42 percent—constituting 1.9 billion hectares—contains significant forest cover. This is comprised of 1.1 billion hectares of "closed" tropical forest (in which the forest canopy is generally continuous, as in the wet, dense rain forests and mangrove forests); and 0.8 billion hectares of "open" forest (in which the canopy is not continuous, as in woodlands and desert shrublands).

Nearly all tropical forests are found in three broad regions: South and Central America (with 42 percent of the total forest cover), Africa (37 percent), and Asia/Australia/Oceania (21 percent). More than 50 percent of closed tropical forests are found in South and Central America, and 30 percent are in Asia/Australia/Oceania (Fig. 2). Africa has about 64 percent of all tropical open forests. Particularly noteworthy is the fact that most of the closed tropical forests are concentrated in a relatively few countries (some 70 percent found in about 12 nations).

Tropical forests in the United States and its protectorates and commonwealths represent barely one-half of 1 percent of the world's total. These forests are located principally in Puerto Rico, the Virgin Islands, Hawaii, and the Pacific Territorial Islands of Guam and American Samoa. In addition, about 162,000 hectares—mostly palms and mangroves—are found in the extreme southern tips of Texas and Florida.

About one-quarter of the seven main Hawaiian Islands is covered with assorted wet and dry tropical and subtropical forests. Nearly all of Hawaii's forests are under some type of regulated management—usually for control of water yield. About 344,000 hectares are owned by the State, 141,700 hectares are privately owned, and 80,400 hectares are in Hawaiian National Parks. At least 7,700 hectares of the latter are designated as wilderness. Comparatively few forest types make up the natural forests of Hawaii, although considerable planting of introduced species—particularly *eucalyptus*—is underway.

True tropical forests are found in Puerto Rico, an island that originally was totally forested. As much as one-third of the island was covered by rain forest containing as many as 500 tree species. About 370,000 hectares of tropical and subtropical dry and wet forests now remain. Of this, only 6,000 hectares endure as virgin old growth, found nearly exclusively within the 13,800-hectare Caribbean National Forest administered by the U.S. Department of Agriculture's Forest Service. The remainder is comprised of cutover remnant stands, forest regrowth on abandoned agricultural lands, and coastal margins of saltwater mangrove swamps. Twenty-five thousand hectares of this, including about 1,300 hectares of planted tropical hardwoods, are administered by the Puerto Rico Department of Natural Resources. The Virgin

Islands National Park, on the island of St. John, contains about 3,800 hectares of mostly dry tropical forests.

For the purposes of this report, tropical forests can be divided into three major types: (a) thorn woodland/very dry forest; (b) dry/moist forest, and (c) wet/rain forests (See list of references, p. 51, Holdridge, 1967).

Thorn woodland/very dry forests receive from 25 cm to 100 cm of rain annually, and the seasonal availability of moisture associated with long dry seasons is the most serious factor limiting plant growth. These arid forests are generally open, have few species, and consist mainly of small trees and shrubs. Examples include Africa's miombo woodlands and woodland savannas, Brazil's caatinga forests, and forests of the central Peruvian Andes. Human settlement has in the past been relatively transient because of continuous or strongly seasonal water and food scarcities (Tosi and Voertman, 1964). Where water supplies can be developed, particularly for irrigation, permanent settlements are possible. They depend heavily on sustained water availability, however.

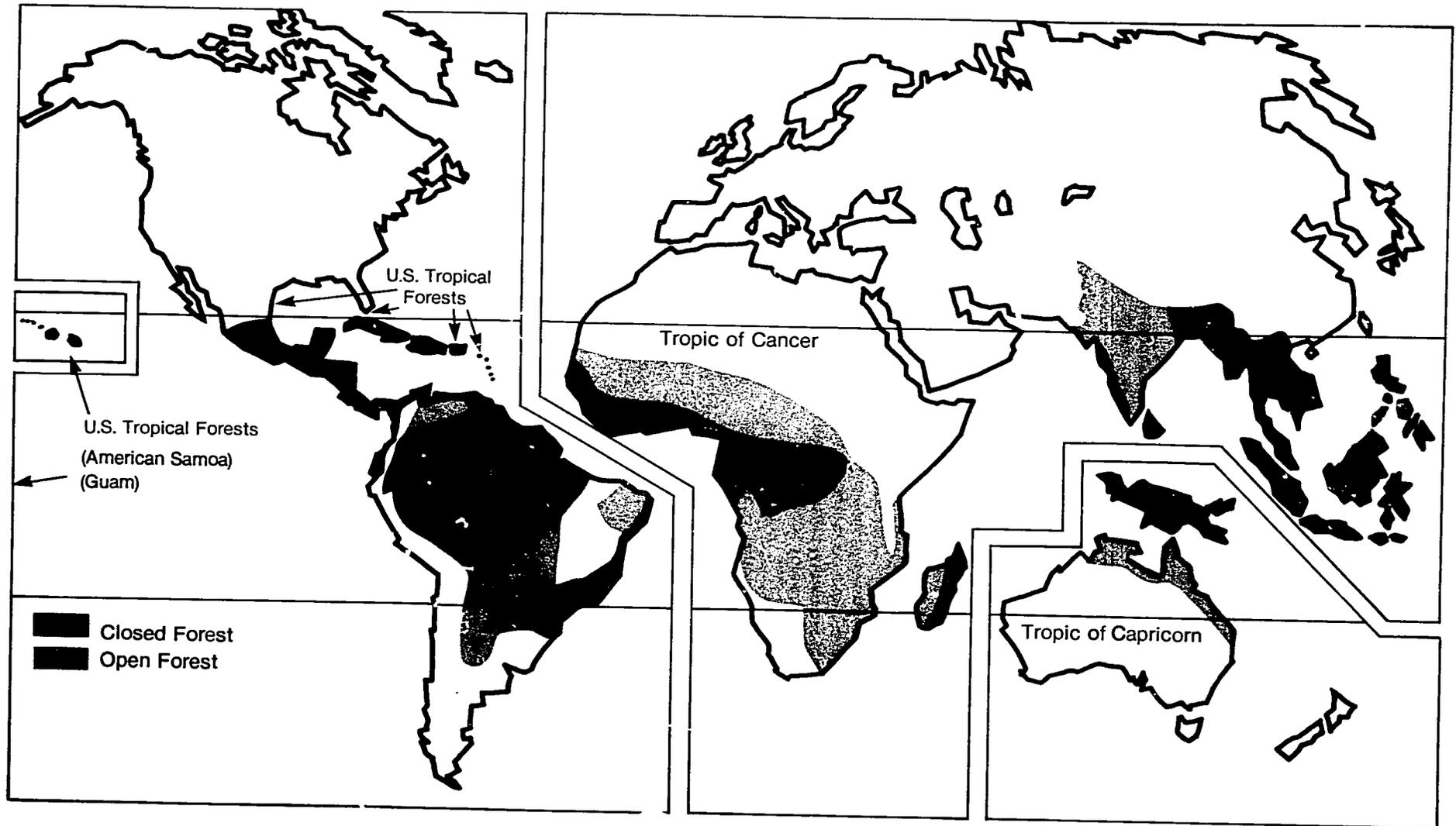
The *dry/moist forests* receive from 100 cm to 400 cm of rainfall annually. These forests are closed and may contain both deciduous and evergreen tree species. Examples include Asia's monsoon forests, the Brazilian campos cerrados, and much of the Amazon and Congo forests. Tree species diversity is high and some forests contain valuable commercial timber such as teak and mahogany.

Dry/moist forest areas historically have been subjected to more intensive human use than other forests in the Tropics (Phillips, 1959). In nonmountainous areas, where erosion is less severe, the soils of these forests often can sustain intensive permanent agriculture. Consequently, permanent settlements have flourished and the forests have been extensively cleared. Fuel supplies are generally less of a problem here than in the arid zones due to higher volumes of wood in the forests and more rapid regrowth. And it is in this type of environment that tropical forest plantations have proved most successful.

The *wet/rain forest areas* receive heavy rainfall, exceeding 400 cm annually. They are characterized, therefore, by water excess rather than deficiency. The rates of vegetation growth, nutrient recycling, and recovery following disturbances all reach their maxima here (Lugo *et al.*, 1973). Examples include the forests of Kalimantan in Indonesia, the Pacific coasts of Colombia, the Caribbean coast of Costa Rica, the Thailand-Burmese border, and the eastern slope of the Andes in Ecuador and Peru. Although the soils are commonly nutrient depleted, the diversity of plant and animal species under undisturbed conditions reaches the highest levels on Earth (Lugo *et al.*, 1973). Indonesia's lowland rain forests contain more than 3,000 tree species, the Malay Peninsula has more than 2,500 species, and all seed plants in New Guinea and Malaysia rain forests are estimated to exceed 20,000 species (Curry-Lindahl, 1972). In comparison, the North American temperate zone's closed forests have fewer than 400 tree species.

The wet/rain forest areas have in many ways been the least suitable for human settlement in the Tropics (Tosi and Voertman, 1964). Because the heavy rainfall exacerbates soil nutrient depletion, soils are often nutrient poor. When soils are exposed by removal of forest cover, they are prone to deterioration and rapid

Figure 1: World Map Showing Distribution of Tropical Forests



Adapted from:

1. FAO. State of Knowledge of Resource Potential.
PO: PAP/DST/71/3.4.

2. Udvardy, M.D.F. 1975. World Biogeographical Provinces (Map).

3. Odum, E.P. 1971. Fundamentals of Ecology.
W. B. Saunders Co.

Figure 2: Areal Extent of Closed and Open Tropical Forests in the Mid-1970's

by Geographic Region and Country

Hectares in Millions

600

Total 590

Total 230

Total 300

Other Nations
158

Burma
30

Other
40

Total 60

Total 210

Total 524

0

Closed

Open

Latin America

Closed

Open

Asia & Australia

Closed

Open

Africa

Note: Graphs depict approximate extent of forest cover based on best estimates.

Sources: Persson, 1974; UNESCO/UNEP/FAO, 1978; Myers, private communications, 1980.

erosion—particularly in the extensive mountain areas. Pests and human and domestic animal disease are serious and widespread. Human use of most of these forests was limited until recently to hunting, firewood and fruit gathering, and shifting cultivation—all low-intensity land uses. Correspondingly, few settlements are found here. But increasing populations have placed great demands on these fragile ecosystems and created complex management problems.

Tropical forests are far more diverse and complex than temperate forest ecosystems. The conservation, protection, and management of tropical forests can be successful only when this diversity and complexity is fully considered. Consideration must also be given to the equally diverse social, cultural, economic, and political milieu which exist in many tropical countries. Therefore, government policies and programs must avoid treating tropical regions uniformly and the application of techniques developed in temperate regions directly to the tropical forests must be attempted only after careful study.

B. Forest Values

Forest environments are vital to human existence in the Tropics. They provide food, fiber, fodder, fuel, building materials, and medicines. Forests also provide habitat for wildlife, as well as for indigenous human populations, and they perform important protective functions by regulating waterflow and helping to minimize soil erosion. Consequently, nearly all tropical peoples live or depend on lands that are or were recently forested. In addition, since tropical forests provide commodities important in international trade and regulate or influence critical environmental processes that occur on regional and possibly global scales, people far removed from tropical forest ecosystems are affected by this resource's existence and integrity.

An enduring use of forests by tropical communities is as a wood source. One-third of the wood removed from the world's forests for human use comes from the Tropics, more than 1 billion m³ per year (FAO, 1979b). Some 80 percent of tropical wood is used for fuel, mainly to meet household cooking needs of a large majority of most tropical country populations (Eckholm, 1975). In the absence of energy substitutes, fuelwood consumption in the Tropics is, at a minimum, keeping pace with population growth (FAO, 1979b). And the use of wood for other purposes within the Tropics currently is increasing at a rate of about 3 percent per capita per year. Taken together, this level of consumption clearly suggests a growing dependency by tropical countries on their indigenous forest resources.

Food supplies that sustain nearly 2 billion people who live in the Tropics are produced on soils that generally owe both their existence and productive qualities to former forests. Tropical forests accelerate soil formation, retard erosion and silting, regulate streamflow, create favorable soil structure, and store nutrients useful for food crop production. The area of such soils currently under continuous or periodic agricultural use in the Tropics is about equal to that of the entire United States and Canada combined (FAO, 1977). The soils on one-sixth of this area, however, require periodic restoration of their productivity by allowing a fallow stage for forest regeneration (World Bank, 1978).

Reliable freshwater supplies in the Tropics, whether from rivers or wells, depend in most instances on forested lands. By stabilizing soils, maximizing their receptivity to rainwater, and retaining available minerals, tropical forests help regulate both the quantity and quality of usable water. The production of paddy rice and other irrigated crops in the Tropics is especially dependent on forest-regulated water supplies (Curry-Lindahl, 1972). In-

creasing dependency of the Tropics on usable water for food production is evident in the 2.3 percent annual expansion of irrigated agriculture during the past 10 years (FAO, 1978a).

The use of tropical forests for outdoor recreation is still in its early stages. Examples include the Tijuca Forest on the outskirts of Rio de Janeiro and the Caribbean National Forest near San Juan, Puerto Rico. The latter receives nearly one million recreational visits annually, largely from a local population of about 3.2 million.

Tropical forests contain the greatest diversity of life on Earth—probably more than 3 million species of plants and animals. In addition, thousands of migratory species seasonally inhabit these forests. This diversity is the source of an increasing number of valuable products, for both local and worldwide use.

Colonists and indigenous human populations in many tropical areas depend on wild animals for protein. And both aquatic and terrestrial animals are dependent on healthy forest ecosystems. In some Amazonian tributaries, for example, many important food fishes depend on fruit that has fallen from floodplain trees as their major source of nourishment (Gottsberger, 1978). The integrity of forested watersheds is also critical to the functioning of downstream estuaries, mangrove swamps, and near-shore coral reefs, the principal nursery areas for many commercially important fish and shellfish.

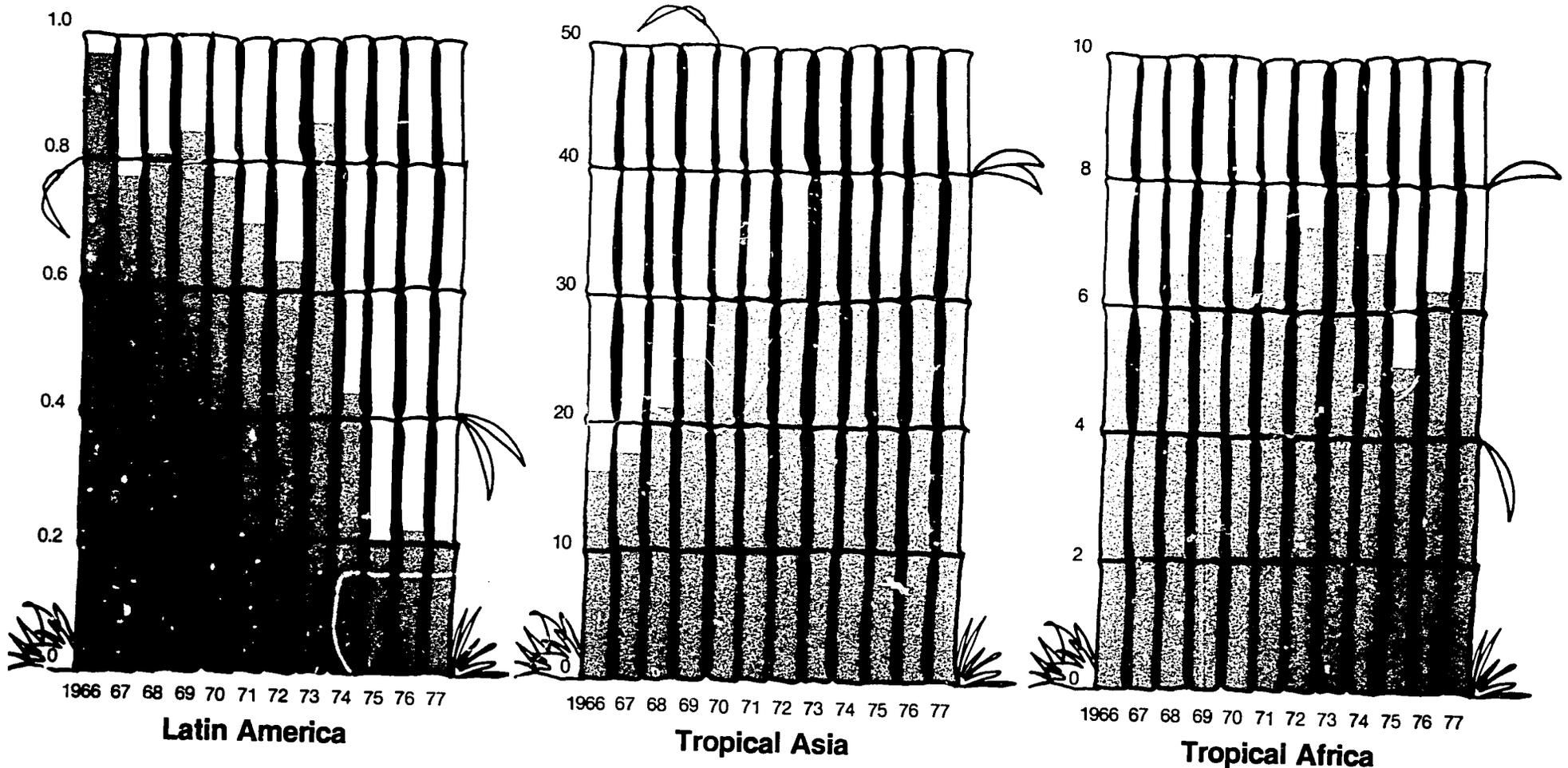
Besides supplying products used locally, forests provide many tropical countries with significant income from exported products. Although less than 6 percent by volume of the wood currently removed from tropical forests is exported, the aggregate value is about \$4.7 billion annually (FAO, 1979b).

Currently, more than 70 percent of tropical wood exports is from Asia and the Pacific and the rest are primarily from Africa (Fig. 3). The chief products are sawlogs and veneer logs, shipped mostly from Southeast Asia to Japan, Taiwan, and South Korea for processing or from Africa to Europe; and sawn wood shipped from Southeast Asia to various temperate zone countries, from Africa to Europe, and from Brazil to North America (FAO, 1979b). Wood exports from the Tropics have been increasing by 7.1 percent in volume and by 17 percent in value annually for the past 10 years. Striking regional variations with respect to tropical wood exports are evidenced in Figure 3, most noteworthy being the downward trend in exports from Latin America from an already small base. During the 1970s, the volume of wood products processed in the Tropics before shipment (sawn wood and wood panels, as opposed to logs) increased from 14 percent to 19 percent, and the total value increased from 33 percent to 43 percent, indicating growth of wood processing industries and related employment within the Tropics.

The economic potential of tropical forests is illustrated by estimates that Brazil's hardwood stocks in the Amazon are worth over U.S. \$1 trillion at current prices on international commercial markets (UN Environment Programme, 1980).

Other products derived directly or indirectly from tropical forests contribute significantly to export trade. Their aggregate value is unknown, but a wide variety, including latexes, gums, essential oils, medicines, nuts, and ornamentals, is included. Prospects for an expanding demand for such products are favorable. The U.S. National Academy of Sciences (NAS) has screened 400 under-exploited tropical plants and identified 36 with special economic promise (NAS, 1975). The search for new drug plants is also continuing. To these values must be added certain exported agricultural products, most of which are, in one way or another, dependent on forest-generated soils and water or the clearing of forests for cropland. The aggregate value of exported agricultural products is now about \$36 billion per year, appar-

**Figure 3: Exports of Tropical Woods, 1966-1977,
By Geographic Region
In Millions of Cubic Meters**



Interpretation:

Vertical axes of histograms indicate millions of cubic meters of wood exported. Exports of plywood, lumber, etc., are converted to roundwood equivalents.

Note the very different scales used on the vertical axes of the histograms.

Note downward trend of Latin American exports over period, in contrast to relatively stable situation in Africa and the rapid increase and recent leveling off of Asian exports.

(Source: FAO, 1979b.)

ently the largest single source of outside revenue for tropical developing countries from products generated locally (FAO, 1977b).

On a worldwide scale, tropical forests have unequalled scientific and educational value. The complexity of tropical forests has for years attracted scientists and students in search of answers to basic questions about life processes. No other region on Earth offers so much material for study. The interactions among the components of tropical forests, and particularly the behavior of observable animal life such as mammals, birds, and insects, constitute assets of great scientific and educational value. As investigations enrich knowledge of these relationships and the findings are interpreted for laymen, visits to tropical forests by the

general public are expected to increase greatly. Improved standards of living in developing countries also will expand this resource use.

Tropical forest influences on weather and climate are not yet fully understood. They may include, however, in addition to local effects, contributions to the stability of global climate second only to the oceans. Dense tropical forest cover intercepts the solar energy so abundant in low latitudes and regulates its reflection from the Earth's surface. Forests also help control ground temperature and atmospheric humidity, and on a global scale may significantly affect the atmosphere's carbon dioxide level. Extensively forested areas, such as the Amazon, may, through transpiration, be an important rain source for the region.

Deforestation: Loss of Forest Cover

Historically, societies have been developed and nourished by the opening up and utilization of forests and related resources. The use of these resources to serve human needs will and must continue. The challenge, however, is to use them more prudently and efficiently on a long-term basis.

The amount of permanent forest cover being lost is difficult to measure precisely. Historical records are poor, our ability to monitor deforestation is limited, and changes in cover occur rapidly. Estimates indicate, however, that closed tropical forests have already been reduced by human activities by more than 40 percent. And the best available projections indicate that, unless governments individually and collectively take action, by the end of the first quarter of the next century the world's closed tropical forests will be nothing but scattered remnants, excluding sections of the Amazon Basin and central Africa.

A. Rates of Loss

Closed forest cover in the Tropics is decreasing by 10 to 20 million hectares a year according to the best available estimates. This decline means that of the 1.15 billion hectares of closed forest in the world today, 1 to 2 percent is being cleared each year.

The most optimistic estimate of annual loss is 7.3 million hectares (Lanly and Clement, 1979). The most frequently cited estimate is 12 million hectares a year (Saouma, 1978). Reports on deforestation in specific countries suggest a current rate of as much as 20 million hectares or higher (Barney, 1978). What remains unclear is whether the forest loss rate is increasing, or whether it is decreasing gradually as the forest readily available for removal shrinks and improved management practices are introduced. Therefore, forest loss rate projections are best given in terms of worst-case and best-case scenarios (Fig. 4).

In the worst-case scenario, the closed forest area is projected to decline by one-half, to about 580 million hectares, by the year 2000—only 20 years away—assuming that forest loss in 1979 is 20 million hectares, and that the rate of tropical forest conversion will thereafter increase at the expected population growth rate. In this case, most tropical countries will have little economically accessible forest remaining at century's end. Millions of people will be without wood for fuel, shelter, or fiber. Watersheds of the major agricultural areas will be largely denuded, and reservoirs needed for flood control, irrigation, and hydropower will rapidly fill with silt. Hundreds of thousands of plant and animal species will vanish, and much of the potential for remedying agricultural, ecological, and medical problems will vanish with them. Although this case is possible, most analysts think it unlikely within the next 20 years.

The best-case scenario also is plausible, but equally unlikely to happen, unless the conditions causing rapid deforestation change substantially. If the current deforestation rate is only 10 million hectares, and if all forestry plans and goals of tropical countries are fully successful over the next 20 years, then the deforestation rate may drop to less than 5 million hectares a year by 2000. Under these assumptions, the projections indicate that wood will still be abundant in some countries of Africa, South America, and Southeast Asia. The total per capita volume of

wood growing in the closed tropical forests will have been reduced to about 50 cubic meters (compared with 94 cubic meters now), but wood for fuel and construction will still be available for people living near the remaining forests and for relatively wealthy people elsewhere. Whether wood will be available for subsistence farmers away from the forests' edges and for the urban poor depends on whether plantations of fast-growing trees can be established in the next few years. Wood exports from Southeast Asia will be cut sharply, but will be partially replaced in world markets by wood from central Africa and South America.

Because most closed tropical forests have not been inventoried accurately even once, little sequential data is available to indicate rates of change in tropical forest cover. A good picture is beginning to emerge from an increasing number of country studies, and it is cause for alarm. Thailand has lost one-fourth of its forest cover in 10 years (Boonyabhas and Klankamsorn, 1976); the Ivory Coast had its forested area diminished by over one-third in only 8 years (Persson, 1977); the Philippines in just 5 years had about one-seventh of its forests cleared (Lachowski *et al.*, 1978); and Costa Rica lost one-third of its forest cover in about 10 years (Cannon *et al.*, 1978). These figures refer to absolute losses in areas covered by closed forests. In addition, the commercial and biological quality of large areas within the remaining forests is being degraded.

No comparable estimates are available on the rates at which open forests in the Tropics are being denuded. The total area given for this vegetation type—810 million hectares—is at best a rough estimate. The process of converting open forests is more subtle than that in closed forests, and thus is seldom accurately measured. Destruction of the trees in open forests is believed to be a causal factor in desertification, a process that is claiming an estimated 5 million hectares worldwide each year according to the UN Environment Programme (UNEP).

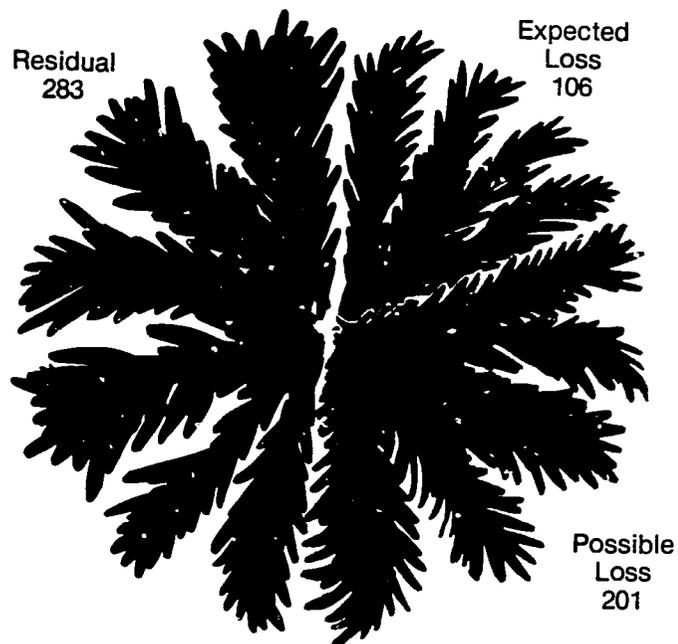
The very high deforestation rates cited from the few available studies cannot be extrapolated to the entire tropical forest resource. These studies, however, indicate some alarming national and regional problems, and even the best-case projection is cause for concern. As FAO Director General Edouard Saouma told the World Forestry Congress in 1978, the rate of deforestation "is unacceptable, not so much as a percentage of forest total, but because of where and why it is happening" (Eckholm, 1979).

B. Causes of Loss

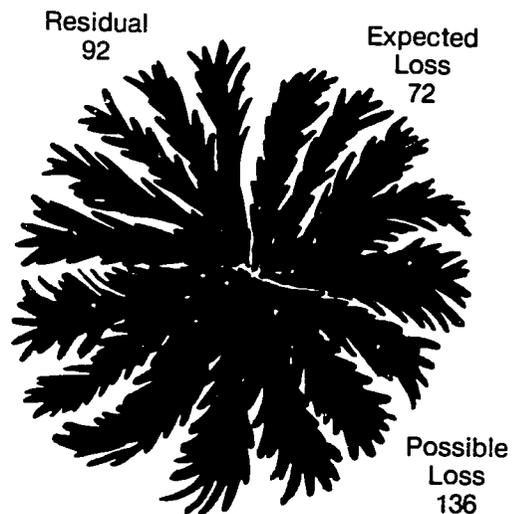
The principal direct causes of tropical forest loss are: (1) conversion and use for agriculture, (2) fuelwood gathering, and (3) poorly managed industrial logging. But behind these direct causes are more fundamental problems—rapidly increasing population, great inequalities in land tenure, absence of advancement in agricultural technology, and lack of employment opportunities on proven agricultural land or outside the agricultural sector. With changing world conditions and rapid forest loss, the quantitative importance of the various causes of deforestation may be shifting, but the conversion and use of tropical forests to support agriculture is still considered the major contributor.

Figure 4: Projected Loss of *Closed* Tropical Forests by the Year 2000 — Best and Worst Case Scenarios

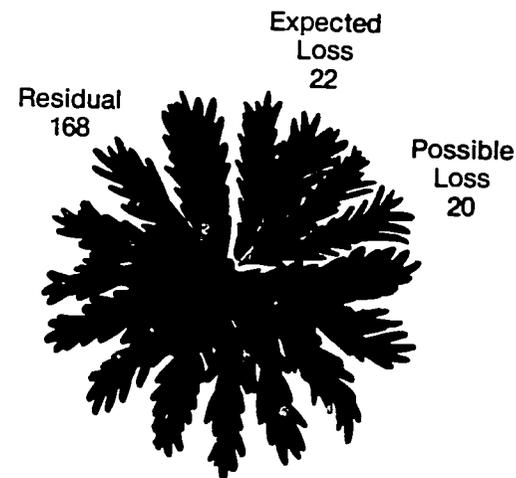
Millions of Hectares



Latin America
Total Present Forested Area:
590 Total



Asia & Australia
Total Present Forested Area:
300 Total



Africa
Total Present Forested Area:
210 Total

Interpretation:

“Expected Loss”: Forest expected to disappear by 2000 under best case assumptions.

“Possible Loss”: Additional forest loss by 2000 under worst case assumptions.

“Residual”: Forest remaining in 2000 if worst case scenario is realized.

Conversion and Use for Agriculture: The clearing of forests is not necessarily undesirable. For example, where soils are fertile and slopes are manageable, the best use of the land may well be for growing crops. Clearing of some forests in tropical regions may be a necessary step in social and economic development, as it was in parts of Europe and eastern North America.

In the temperate regions, agricultural production has been raised in recent decades mainly through more intensive use of already cleared cropland rather than by clearing forested areas. Further, industrialization and economic development have absorbed excess labor from rural areas. In much of the Tropics, however, agriculture continues to spread extensively, often onto marginal soils and sloping uplands that cannot support permanent cropping or grazing. Indeed, most agricultural replacement systems have proved less productive and more unstable than expected, and their overall economic and social benefits have fallen short of hopes and expectations.

Any generalization terming agriculture as a cause of deforestation is bound to be an oversimplification. Subsequent discussions are predicated on recognition of this limitation.

Typically, rapid and widespread deforestation occurs where newly constructed roads lead into formerly inaccessible areas. The clearing of land thus made accessible usually is done by landless people who must concentrate their main efforts on the current season's crops. As a result, little labor or capital may be left for investment in land maintenance necessary for sustained agriculture. These people must work whatever accessible site is not claimed by someone else. They have no alternative investment for their labor, and while they may be well aware of the poverty and impermanence of the soils they use, they have no choice. Often these people are illegal squatters living in remote areas who seldom get agricultural advice or aid from government sources. On other occasions, they are colonists who are encouraged by their governments to settle in forested areas. Furthermore, new agricultural techniques that might prolong land use are often unfamiliar or risky, and they have no desire or margin to assume extra risks.

To get to the fundamental causes of deforestation, why otherwise unemployed people are seeking cropland must be understood. In many countries, the traditional agricultural lands simply cannot absorb the rapidly growing population. Intensified production, which might increase both yields and employment opportunities on land already cleared, often depends on the availability of technical assistance and inputs, such as irrigation water, fertilizer, and credit, that are beyond the reach of most farmers. In some areas, land ownership systems keep productive agricultural land from absorbing as many workers as it profitably could; in others, farm workers are displaced by modernization that substitutes capital for labor, by reservoir construction, or by other nonagricultural land uses. With urban labor already in surplus, many displaced people must move to the forests. Others who move in are refugees from war or political oppression.

Official resettlement programs, designed to relieve population pressure or to increase export crop production, commonly are undertaken on insufficient budgets and with too little time or resources for land capability classification, careful planning of appropriate farming systems, or adequate support of the settlers. As a result, many "planned" settlements fail and the people move on to even poorer sites—with no planning at all.

Shifting agriculture is often blamed for much tropical forest loss. "Slash and burn" farmers generally work upland soils that cannot maintain fertility with continuous cropping and that can support crops for only a few seasons before they must be left fallow. During fallow, a secondary forest usually regenerates on the site, and plant nutrients are brought up from the subsoil by deep-rooted trees. The system is ecologically sound if the fallow period is long enough and the cleared area relatively small. In many places, however, the fallow period is too short to restore the site's fertility.

The most common reason for inadequate fallow is population pressure. Demographic data on people who practice shifting cultivation or agriculture are scanty. However, estimates suggest that about 250 million people are supported by this practice worldwide, and the area covered is 3.6 billion hectares, including land in fallow. Shifting agriculture is practiced on about one-fifth of tropical moist forests (Sommer, 1976).

The effect of population pressure is compounded in many places by social, economic, and political factors. Extremely complex land-tenure systems sometimes deter farmers from migrating to less populated regions. In other circumstances, farmers may be encouraged by their governments to shift permanently for reasons of political security. Where governments are unable to provide the techniques, training, and equipment needed to farm sloping, infertile soils without fallowing, the land becomes degraded and eventually is abandoned. The farmer then clears more forested land for cultivation. In Central and South America, lands abandoned by shifting farmers are increasingly assumed by cattle ranchers.

In other circumstances, displaced lowland farmers move onto upland sites, but lack the knowledge that traditional upland farmers apply to sustain agricultural production.

Shifting cultivation is not the only agricultural practice that leads to deforestation. The processing of agricultural products, such as grain drying, food processing, tobacco curing, and rubber preparation, requires large amounts of fuelwood.

Fire contributes significantly to deforestation in the Tropics. It is not only a widespread problem, but reportedly is accelerating rapidly (Batchelder, 1967). In most instances it is caused by humans. Fire is a primary tool of primitive and shifting agriculture to dispose of felled trees, and is also used to "renew" pastures and to prevent invasion of shrubs and trees. In terms of forest destruction, fires are of greatest significance in the dry forest areas, having converted millions of hectares into derived savannas where chronic burning makes reinvasion of trees virtually impossible. Except as employed by humans in certain cases, fire is not an important cause of destruction of rain forests which are generally not readily flammable.

Large-scale cattle ranching also is exacting a significant toll from tropical forests, particularly in the more humid Tropics. In some cases, the change to grazing use is not sustainable, but the international demand for beef is strong enough and the price high enough so that it has become extremely profitable to convert the forest to pasture—even on poor soils that deteriorate rapidly and must be abandoned after a few years. Although data on the acreage converted from tropical forest to permanent or temporary pasture are not available on a worldwide or even regional basis, the large increase in beef exports from forested tropical countries, particularly in Central and South America, suggests the scope of the changes in land use.

Livestock can also be a significant factor in semiarid regions where the animals are an important source of meat, milk, hides, bone, and dung fertilizer for the local people. The animals graze in woodlands and, in so doing, consume vegetation and disturb and compact the soil. Sometimes trees are also lopped to provide fodder for livestock. Where grazing pressures are high, disturbance to the forest and soil resource can be significant and enduring, yet the local people may have limited or no alternatives to meet their basic needs.

Fuelwood Gathering: Cutting wood for fuel is another important cause of deforestation, and in some places is the major cause. More than 1 billion cubic meters of wood are harvested each year in the Tropics, and the rate is increasing. How much of this wood is dead wood, how much is cut in closed forests, how much is from open forests, and how much is from brush are not known. At least four-fifths of all the wood annually harvested in

tropical countries (some 825 million cubic meters) is used for firewood and charcoal, the rest for building materials and export.

In Thailand, for example, charcoal production is an integral part of the process of clearing forests for agriculture; settlers support themselves during the first seasons by producing and selling charcoal from the trees they clear. In Haiti, charcoal and firewood production has been a big business, but has also triggered serious ecological degradation.

Demand for firewood and charcoal is often said to have only local impacts because the products are more expensive to transport than other fuels. But reports from Kenya indicate that open forest lands have been denuded to supply charcoal for people in the Horn of Africa and along the Persian Gulf, and surveys of coastal shipping in the Gulf of Siam indicate a large international trade in charcoal from Thailand's coastal mangrove forests.

Industrial Logging: Industrial wood (i.e., wood for construction materials, fiber, and manufactured products) accounts for one-fifth of the total volume removed from tropical forests. Of this fraction, one-fourth, only about 6 percent, is exported each year. Relationships between deforestation and the removal of industrial wood are complex and poorly understood. Most tropical logging is highly selective as to species and tree size. The use of heavy equipment for timber extraction can, however, cause substantial secondary loss. For example, estimates show that during logging operations in the dipterocarp rain forests in Malaysia, 10 percent of the trees over 0.1 meter in diameter were harvested, 55 percent were severely damaged or destroyed during the operation, and 35 percent were undamaged. The immediate result of logging operations is thus more likely to be a degraded forest than a conversion to nonforest. But the roads and clearings made by the loggers are commonly used by farmers who complete the process of deforestation. Industrial logging often depletes or destroys resources valuable to people living in or near the forest, with most or all of the benefits going to distant companies, governments, or foreign consumers.

New logging and wood use techniques, including whole-tree harvesting and on-site chipping, are making clearcutting—the removal of all trees—more common in the Tropics. On some clearcut sites, the forest will not regenerate naturally (Gomez-Pompa *et al.*, 1972). Thus, the new techniques may lead to greater resource loss if the sites are not replanted immediately with appropriate species. Replanting after industrial logging, even after clearcutting, is uncommon, however. In Indonesia, for example, logging is widespread, but only one of the international companies with large concessions (a U.S.-based firm) is experimenting with replanting, and this on a modest scale.

Reasons for the lack of tropical reforestation are a complex array of economic, political, cultural, and environmental factors that vary from place to place. Some partners in multinational logging firms are unwilling to invest profits in efforts that will have no immediate payoff. Insecure tenure is a major constraint on reforestation investments, both for large companies and small farmers, and this is often more a political than an economic issue. Concessionaires commonly are unable to protect reforested areas from people seeking land to cultivate. Site-specific cultural factors may inhibit tree planting, as in Papua New Guinea, where local people object to tree planting by timber companies because planting, unlike cutting, implies permanent ownership of the land. Depredations by domesticated, feral, and wild animals cause some reforestation efforts to fail.

C. Consequences of Loss

Permanently maintained forest values accrue over the long term. They include environmental values that are difficult to quantify as well as the more easily defined benefits from sustained production of wood and other forest products. The values of land converted from forest, on the other hand, accrue primarily

in the short term and are often easier to quantify. Because the science of economics has no method for adequately comparing trade-offs of this sort, and because population pressures and the resulting need for increased food production are seen to be of paramount importance, planners and politicians are often inclined to opt for or to accept intensive, short-term exploitation of the forest resource and conversion of forest land to other uses, particularly agriculture.

Where forests can be converted to permanently productive cropland or pasture, conversion may well make sense. However, where deforestation will result in disruption of the hydrology of a watershed that supports important agricultural production, or where irreplaceable ecological values may be lost, as in areas with a high diversity of unique species, the trade-offs have obvious, unfavorable features. Likewise, the choice may not be clear when intensive timely harvesting offers an immediate and substantial source of foreign exchange, but which will also deplete the resource in a relatively short period of time. Furthermore, the cumulative effects of forest clearing may have important local and national economic consequences that are difficult to establish. Substantial literature on the social and economic gains possible through exploitation of forest resources is available, but information on the costs of unsound forest management or inadequate forest preservation is exceedingly sparse.

One clear negative impact of forest depletion is a rising dependence on imported forest products—a trend already apparent in many tropical countries. Domestically, the high prices and (in some cases) outright shortages of wood impose severe social burdens, particularly on lower income groups, and hamper national economic development. In many tropical countries, high wood prices and wood scarcity are raising construction costs and undermining efforts to provide adequate housing. In extreme cases, wood scarcity is also impeding the development of railroad and electric power systems by forcing the use of steel and concrete for railroad sleepers and power transmission poles. In much of the Tropics, soaring prices for fuelwood and charcoal are creating a major strain on low-income people.

The fate of deforested lands in the Tropics, after they are abandoned by farmers or ranchers or when the loggers move on, has been documented in a few places but in general is not well understood. Some analysts believe that certain tropical forests are not a renewable resource (Gomez-Pompa *et al.*, 1972). On cleared land, the torrential rain of the wet Tropics causes soil erosion while high surface temperatures tend to inhibit seed germination and seedling establishment. In deforested areas where soils cannot retain nutrients or where fertility has been seriously degraded, grasses and noxious weeds may become the permanent cover. This condition is reportedly found on 16 million hectares in Indonesia alone. Some of these grasslands can possibly be reclaimed with legumes, but the economics of such restoration have yet to be tested on a large scale. In many areas, however, secondary forests of considerable value may regenerate naturally. Optimists expect secondary forests to be the predominant fate of abandoned sites; pessimists expect deforestation to be permanent in large areas.

Upland slope deforestation and overgrazing in other areas are often responsible for increased erosion, flooding, and other watershed problems. Rainfall in the Tropics usually has high erosive power. Forest cover helps diffuse this energy, however, permitting water to infiltrate the soil and recharge groundwater basins. The infiltration on a forested site can be an order of magnitude greater than if the same site is used for poorly managed crops or is covered with grass (Roose, 1977).

Forest clearing and reduction on upland slopes is generally blamed for increases in flood severity that have been experienced in South and Southeast Asia in recent years. In addition, accelerated erosion caused by deforestation has intensified siltation of

the Panama Canal's system of reservoirs while accelerated runoff has diminished water storage in the watershed. In 1977, the Canal was closed to large vessels because of low water during a drought, a situation which some experts believe may occur with increasing frequency unless watershed forest cover is restored. Further, deforestation is considered responsible for accelerated siltation of Indonesia's irrigation canals, which are being cleaned at great expense but remain vulnerable to rapid refilling.

Natural regeneration of open forests in semiarid regions is highly uncertain, particularly in areas that have been heavily cut. Dry forests in the Mediterranean Basin (e.g., Greece, southern Italy, and Spain) that were cut before the Christian era have not regenerated. Today, wood shortages are so severe in some semiarid regions, including the Sahel and much of East Africa and India, that poor people must forego even one hot meal per day. Families must spend long hours searching for firewood—time that could otherwise be invested in agricultural production (Eckholm, 1979). In more humid areas where mountain slopes have been deforested, such as Haiti and Nepal, firewood shortages also are severe. As firewood becomes scarce, people gradually shift to burning animal dung and crop residues that would otherwise be used to maintain soil fertility. If the cow dung burned for fuel in Asia, Africa, and the Near East were instead used as fertilizer, grain production could increase by 20 million tons a year (Arnold, 1978).

Consequences of large-scale tropical deforestation include changes in local climate. Once the forest canopy is removed, surface temperatures become more extreme, hotter by day and colder by night. Where widespread deforestation occurs, regional rainfall patterns also may be affected, although this possible effect is another of the many poorly understood features of deforestation.

Recently, scientists have become concerned that tropical deforestation might also affect climate on a global scale by increasing carbon dioxide (CO₂) levels in the Earth's atmosphere. One analysis suggests that CO₂ released by the clearing and burning of wood from dense tropical forests may be roughly equivalent to CO₂ contributions from fossil fuel combustion (Woodwell, 1978a and 1978b). Other studies, however, conclude that this greatly overstates the contribution of deforestation at this time (Broecker *et al.*, 1979). The atmosphere's CO₂ level is known to be increasing, and a significant portion of the world's carbon is locked in the wood of the tropical forests. Some carbon stored in the forest soils is also released as the land is converted to cropland, pastureland, or barren wasteland. Concern emanates from the hypothesis that a rising atmospheric CO₂ level will cause a general warming of the Earth due to a "greenhouse effect," with disruptions of the world's agricultural productivity in the 21st century. While much conjecture and uncertainty surround the possible contribution of tropical forest loss in this regard, the magnitude of global risks involved requires a rapid acceleration of research to determine the actual situation.

Ecologically diverse tropical forests comprise rich reservoirs of plant and animal species, many of which may be critically important to pest and disease resistance in agricultural crops. The forests contain the diminishing gene pools of parent species, from which many agricultural crops now grown as monocultures were originally bred, and which therefore may be needed in the future for breeding or synthesis if the monocultures are devastated by new diseases or other catastrophes. Other tropical species may have important potentials as pharmaceuticals. Most, however, have not been examined by scientists, although the utility of some is known to indigenous forest people.

A forthcoming report by the Committee on Research Priorities in Tropical Biology of NAS concludes that the projected clearing and degradation of tropical forests threaten to cause plant and animal extinction on a scale unprecedented in history. Fully one-third of tropical organisms—some one million

species—may be extinct by the end of the century and another million may disappear during the next century. Although this potential loss is one of the most difficult to evaluate in terms of social and economic implications, in the long run it could be one of the most alarming consequences of unchecked tropical deforestation. Although growing efforts around the world protect these values through the establishment of parks and reserves, they presently amount to only about 2 percent of tropical forests. According to many experts, 10-20 percent of tropical forest ecosystems should be brought under some type of protected status if a broad spectrum of wildlife species and genetic resources is to be preserved (UN Environment Programme, 1980).

D. U.S. Influences on Forest Loss

The United States, by virtue of a variety of public and private sector policies, programs, and practices, contributes to the loss of the world's tropical forests. Although the magnitude of this influence is difficult to determine precisely, it clearly is significant—as evidenced by U.S. demand for wood and agricultural products, and the level of U.S.-provided development assistance to tropical countries. Effective implementation of the strategy and program proposed in this report will require a detailed examination of U.S. influences on tropical forest loss so that appropriate adjustments can be made.

U.S. Consumer Demand: Decisions in the marketplace by U.S. consumers, particularly with respect to the demand for wood products and beef, have an important effect on tropical forests.

In 1977, the value of U.S. tropical wood and wood product imports totaled \$512 million. This amount represents more than 12 percent of the total tropical wood exports of \$4.1 billion from both harvesting countries and wood products processing countries, primarily South Korea, Taiwan, and Japan. Wood from Southeast Asia (Indonesia, Philippines, and Malaysia) accounts for more than 90 percent, by value, of U.S. tropical wood imports.

Demand for beef by the United States and other developed nations also contributes to tropical forest loss. In this instance the geographical areas most affected are Central America and the Amazon Basin. In 1979, the United States imported an estimated 10 percent of the beef it consumed. Central America provided about 20 percent of U.S. beef imports, while Australia and New Zealand contributed about 70 percent. U.S. imports of Latin American beef have risen consistently over the last 12 years as U.S. production has failed to keep pace with growing domestic demand. Twenty years ago, only three countries exported beef to the United States and the total was less than 2,000 tons. In 1978, six of the seven Central American nations exported beef to the United States (which usually takes 85 to 90 percent of their total beef exports), and the quantity exceeded 100,000 tons.

Is the U.S. demand for beef being met by widespread conversion of forests into pasture, particularly in Central America, as recent reports in the international press allege? Previously ranchers moved mainly into areas converted, used, and then abandoned by slash-and-burn agriculturalists. The concern now is that increased competition for land between farmers and ranchers apparently is causing ranchers to remove forest cover for rangeland use. The magnitude of such conversion is not known; nor does inadequate information indicate what percentage of U.S. beef imports comes from pastures newly created from forests, in contrast to that derived from cattle raising on traditional pastureland and on the forest periphery. Nonetheless, the demand for beef by the United States and other nations is clearly creating pressures to convert forests to pastures in many parts of Central and South America.

Government Policies: The U.S. Government's economic and environmental policies also play a role in forest practices. Tariff policy for tropical wood product imports is an example. U.S. tariffs currently vary from duty free to 20 percent of the

product's cost. Generally, the less processed products are duty free, and the greater the processing the higher the duty. Logs and lumber are imported free of charge, whereas veneer and plywood are charged a duty. Most plywood is imported at full duty levels of 10 to 20 percent, because several key plywood items are exempted from the benefits of the Generalized System of Preferences that apply to many imports from developing tropical countries. The trend has been toward lower duties for tropical wood products, however, with the Multilateral Trade Negotiations leading to substantially reduced U.S. import duties.

U.S. beef imports are regulated by the Meat Import Act of 1964 (Public Law 88-482), which calls for the establishment of flexible quotas depending on U.S. domestic production. Beef imported from Central and South American countries, Mexico, the Caribbean, New Zealand, Australia, and Canada is regulated by "Voluntary Restraint Agreements," with specific allocations established for each country. The 1979 quota level for these countries collectively was 1,570 million pounds. Tariffs also apply to imported beef, with the current rate of 2¢ per pound as the result of Multilateral Trade Negotiations (down from 3¢, effective January 1980).

Lower tariffs on wood products and beef presumably encourage further development of these industries abroad and could, in the absence of appropriate resource management strategies, result in greater forest loss. On the other hand, lower tariffs are usually desired by exporting countries' governments as aids to economic growth.

U.S. domestic environmental laws and policies restrict commercial cutting of timber in U.S. National Forests and prohibit it in certain parks, wilderness areas, and wildlife refuges. Such restrictions in the United States and other Temperate Zone countries may add to pressures for cutting forests in the Tropics.

Other domestic environmental legislation appears to have opposite effects. For example, the United States recently has determined the Guatemalan fir to be a "threatened species" under terms of the Endangered Species Act of 1973, because of its imminent disappearance from Guatemalan forests. The species had already been listed by Guatemala for protection under both the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (1941) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973). The U.S. list of endangered and threatened wildlife and plants is a major global list backed by detailed comprehensive legislation. Therefore, placement of the Guatemalan fir and other species under the U.S. Act would increase international awareness and attention to the plight of these species and their habitats. And it could lead to increased analysis of national and international projects that may affect other endangered and threatened species.

Some experts propose that greater use be made of such existing national and international mechanisms to help protect threatened tropical plant species. Most existing instruments, however, apply only to species involved in international commerce.

U.S. international environmental policies also should have a

positive influence on conservation of the world's tropical forests. In this regard, requirements that AID must carry out environmental assessments of its overseas activities in the preproject stage and examine environmentally sound alternatives should assist host governments in deciding how to protect and sustain their forest resource.

Government Programs: U.S. development assistance efforts directly influence the conditions of the world's tropical forests. Through its bilateral efforts and support for multilateral programs, the United States assists tropical countries in carrying out a variety of economically and socially important projects that may modify or even destroy tropical forest cover. Such projects include construction of settlements, rural roads, airports, and dams; government-sponsored resettlement programs; and agricultural and rangeland expansion that converts forest land. On the other hand, through programs which include family planning, intensive agriculture, land-use planning, integrated rural development, alternative energy sources, and forest management, U.S. development assistance Agencies support activities that should result in reduced pressures on tropical forests.

The programs of the Overseas Private Investment Corporation (OPIC), which promote and insure U.S. private investments overseas (including wood mills, farming operations, and meat packing plants), also bear on tropical forest uses. In addition, the Export-Import Bank finances the import of goods by forest-related industries in developed and developing countries.

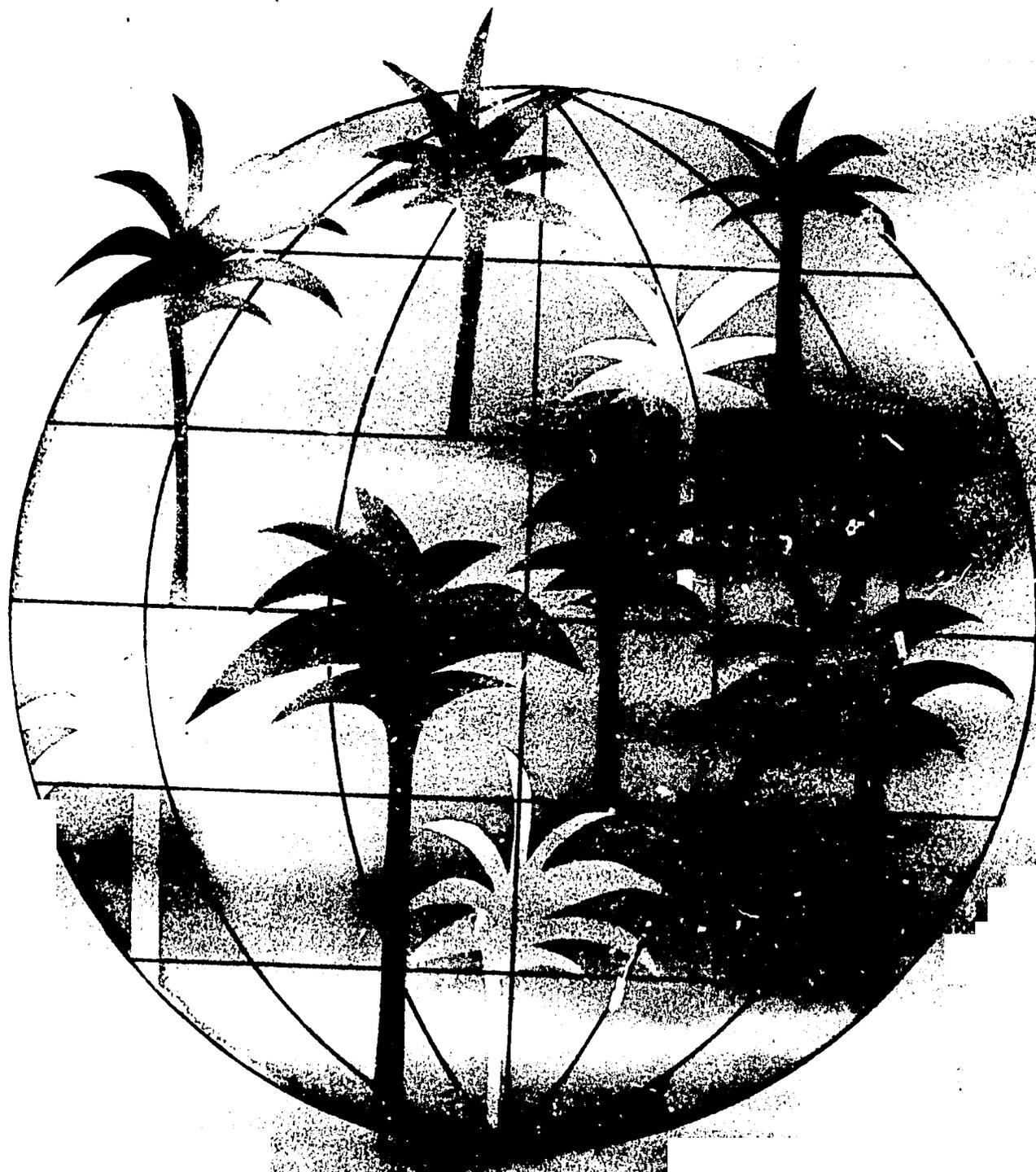
Private Sector Activities: The extent and nature of the U.S. private sector's influence on tropical forests is difficult to determine. Filling this information gap deserves high priority.

About 30 U.S. firms are involved in commercial forest product activities in tropical countries, with most of the major operations in Southeast Asia. Their collective effort seems to be relatively small compared to commercial enterprises of other nations (e.g., Japan, European countries, and host nations).

U.S. investment in tropical wood product firms through joint ventures and under licensing agreements is also estimated to be relatively minor. Integrated production and utilization of wood for paper and other products on a sustained basis, however, form an important activity of some U.S. corporations, particularly in Latin America. These ventures provide a supply of otherwise scarce capital for major, long-term investments in plantations and processing facilities for the manufacture of fiber products, such as pulp and paper. They do not necessarily produce for the U.S. market, and they may play an important role in increasing economic growth and employment opportunities within the Tropics.

Most primary producers of exported Latin American beef seem to be Latin American nationals. But, hundreds of U.S. citizens have interests in or ownership of cattle ranches in Latin America, and the number of large U.S. companies involved in cattle ranching in Latin American countries with tropical forests is growing. Moreover, scores of U.S. meat companies and brokerage firms trade in imported beef. Firms from Italy, West Germany, Switzerland, Austria, and Japan, among others—along with host country governments, individuals, and companies—are also involved in the cattle industry in Latin America.

**Part II:
International Framework:
Mechanisms for Action**



In view of the magnitude and complexity of the tropical forest loss problem, a legitimate question arises as to whether the international community can realistically hope to be successful in coping with it. Even if the problem can be successfully attacked, a second issue involves the ability of the United States to contribute to and influence in a meaningful fashion a collaborative international effort. This concern arises in part from the fact that the United States is a relative newcomer in the management of tropical forest resources compared to the longstanding involvement of, for example, many European countries.

This section establishes the rationale for new U.S. policy and program initiatives in tropical forest management by assessing: (1) the global outlook over the next several decades with respect to pressures on forest resources and prospects for effective international action; (2) the technological state-of-the-art for managing the forests and associated values; and (3) the framework of existing national and international organizations into which a comprehensive U.S. program must be integrated. Throughout the discussions, opportunities for U.S. involvement and leadership are identified.

Global Outlook

A. Pressures on Forest Resources

Projected population growth rates, forest conversion, and wood consumption offer little solace to those concerned with the well-being of tropical forests. Assuming an anticipated annual growth rate of 2.4 percent, tropical country populations will increase from the current 2 billion to about 3 billion by the year 2000. Because national economic growth is expected to lag behind population growth, millions more people will be seeking land to cultivate and graze, game to eat, and wood to burn. At its present rate, permanent cultivation in the Tropics will expand by 1 million km² by the year 2000, with a significant portion of that being at the expense of forest land. And fuelwood consumption in tropical countries is expected to at least keep pace with the projected 50 percent increase in population growth over the next 20 years, with no cost-competitive substitutes in sight.

International economic pressures to intensify exploitation of tropical country resources can be expected to grow. As oil, gas, and kerosene prices soar, local forest biomass will be an attractive substitute for fossil fuel imports. Tropical countries can also be expected to rely more on local resources to offset part of the \$3 billion they currently spend annually to import wood products.

Lucrative foreign markets for tropical timber, beef, and other food products will be an important factor. These may prove irresistible to national planners and resource managers, especially in impoverished countries. U.S. demand for tropical hardwood sawtimber, for example, is expected to increase 75 percent by the year 2000—an increase matched by those projected for Japan and industrialized European countries. In the developed nations, policies and laws restricting the cutting of domestic forests may increase dependency on tropical timber. Combined tropical timber exports by developing countries amounted to over \$4 billion in 1977, and some estimates indicate that this will quadruple by the end of the century. As traditional and well-known tropical timber species are exhausted, however, international demand for poorer quality woods that constitute the remaining growing stock may decrease.

Projections of recent and current deforestation rates indicate that, throughout much of the Tropics, the forest cover will be essentially gone by the early to middle part of the next century. This degree of forest loss probably will not happen under any but the most extreme circumstances. At some time—and this will vary from country to country—the situation probably will deteriorate to the point where the need for corrective measures will be compelling to national and local governments. Bans on tree cutting will be ordered. Certain remaining forested areas will be protected and preserved. Reforestation efforts will be expanded. Fuelwood lots and plantation forestry will be introduced. Before corrective steps are taken, however, local citizens, national governments, and the international community as a whole run the risk of incurring grave social, economic, and environmental costs.

The future of the world's tropical forests and their important associated values, therefore, depend critically on the foresight, willingness, and ability of tropical countries to control forest loss in advance of a crisis situation.

Compounding deficiencies in managerial and technological ability in many tropical nations is the lack of funds being invested

in sound forest management by the international community. An examination of estimated costs for reforestation programs provides one insight into the large future investments which will be required. The FAO has calculated that additional timber requirements associated with global industrial expansion could reach 1 billion cubic meters per year by 1994; and that an identical amount will be needed by the same year to meet world demand for firewood. The investment requirements to fill this demand for both industrial wood and fuelwood are estimated at around \$3.3 billion per year (FAO, 1978b).

The Asian Development Bank has estimated that if the deficit projected by the FAO for the Asia-Pacific region (170 million cubic meters by 1990) is to be met from within the region, the required reforestation rate is on the order of 10 million hectares annually. The cost would be from \$400 to \$800 million per annum, depending on topography, accessibility, and other factors (Asian Development Bank, 1975).

B. Prospects for Improvement

Despite seemingly implacable population and economic pressures on the forest resource that will persist well into the next century, some optimism is called for. First, tropical forest management is no longer perceived as the exclusive domain of scientists and foresters. Both governments and international development assistance agencies are now beginning to appreciate fully the link between forest cover and economic development. This is part of a broader realization that in many areas degradation of the natural resource base—soil, water, and vegetative cover—has reached the stage where the local environment's capacity to meet food, clothing, and shelter needs on a sustained basis is being questioned.

Protection and improved management of the Earth's natural resources is thus emerging as an important new dimension of economic development and development assistance planning. Leaders of both rich and poor countries increasingly address the subject when discussing international development issues. The President of the World Bank, Robert S. McNamara, highlighted the growing impact of resource degradation on the development process in his 1979 Annual Report to the Bank's Board of Governors.

This concern and awareness is being translated into action. Development planners, for example, are increasingly assessing the potential impacts of accelerated erosion from upland deforestation before proceeding with water resources projects that are vulnerable to sedimentation. They are beginning to introduce reforestation into rural development programs in an effort to reduce flood hazards; and they are establishing woodlots or seeking fuel substitutes for the firewood upon which most rural villagers depend.

The best measure of concern and commitment, however, is the increased financial investment many developing countries are now willing to make to protect and manage the forest resource, apart from the resources they traditionally have devoted to the commercial forestry sector. Both bilateral and multilateral development assistance donors are reporting an expansion of requests for loans and technical assistance. Further, the increased

willingness of developing nations to designate multiple-use forests and to protect unique tropical forest areas as national parks, biosphere and ecological reserves, and wildlife refuges is encouraging.

Brazil, for example, has recently announced a new policy to protect large expanses of its Amazon region from development, and, along with Ecuador, has designated several forested areas as national parks and reserves. Thailand, Indonesia, the Philippines, and India are among the growing number of developing countries that have begun large-scale reforestation programs; and several South and Central American nations have initiated steps to control the conversion of forests into pastureland on unsuitable soils.

International and regional development institutions, in turn, are gearing up for an expanded effort. U.N. agencies and bilateral aid donors are carrying out or planning relevant activities, including research, demonstration, and the application of any array of new technologies and methodologies. Collectively, these efforts provide the nucleus for an accelerated, integrated international attack on the deforestation problem.

In February 1980 an international meeting on tropical forests convened in Nairobi, Kenya, to review current and projected problems and assess existing and future programs. This conference sought agreement on an international division of labor and a coordinated action program involving research, monitoring, demonstration, training, education, and information exchange. It afforded the United States and other nations an opportunity to define more sharply the specific role each can play within a coordinated international program.

Although the United States historically has not been as deeply involved as many other developed nations in tropical forest resource management, its level of international participation and commitment has been increasing. This expanded involvement is due, in part, to a recent growth in the number of requests from other countries for U.S. technical and financial assistance in this area, and also due to the increase in tropical forest-related programs being proposed by regional and international bodies in which the United States participates. Furthermore, U.S. scientific and resource management institutions are taking the initiative to study and otherwise respond to a variety of tropical forest management problems and opportunities, including the possibility that large-scale deforestation may have regional or worldwide ecological or climatic implications.

The U.S. public and private sectors clearly plan to expand their involvement in tropical forest management issues. President Carter has already directed U.S. Federal Agencies to place greater emphasis on world forest issues in their budget and program planning. AID, the Forest Service of the U.S. Department of Agriculture, and Agencies of the U.S. Department of the Interior

are all in the process of developing new tropical forest policies and programs. NSF is planning to expand its support for tropical biology; the Peace Corps is programming an increase in forest-related projects within its natural resources program area; and indications are that the proposed Institute for Scientific and Technological Cooperation (ISTC) would assign high priority to research and training on tropical forestry and allied subjects.

The U.S. private sector also is demonstrating a commitment to expanding its efforts. A new Consortium of Universities for International Forestry has been formed; and the Nongovernmental Tropical Forest Working Group of the Natural Resources Defense Council, Inc., plans to continue to provide guidance to the U.S. Government and to facilitate information exchange. Private industry, through the National Forest Products Association, has agreed to make available additional information on its overseas forestry activities, and to work in other ways with the Federal Government to help achieve improved long-term management and more efficient tropical forest resource use.

The following conclusions can be drawn from this assessment of the prospects for mounting an accelerated international effort to manage tropical forests:

- The problem of tropical forest loss, driven as it is by a mix of complex socioeconomic conditions and needs, will be extremely difficult to address successfully on either a national or global scale. On the positive side, the wide range of differences which exist throughout the tropical world as to awareness, priorities, and capabilities indicates good opportunities for success—at least in some regions and countries. Regardless, the problem's magnitude and consequences are such that all nations would appear to have a stake in its solution and a responsibility for mounting or supporting new tropical forest management programs on an urgent basis.
- The international development community is beginning to respond by assigning higher priority to tropical forest management as the relationship between forest loss and economic development becomes increasingly evident. Both tropical timber-producing and -consuming nations perceive a common interest in the preservation and maintenance of forest resources. U.S. technical and financial support in this field is in demand, providing this country with a range of opportunities to play a significant, influential international role.
- U.S. public and private institutions already have begun to increase their tropical forest-related activities, thereby providing a solid nucleus of interest, talent, and investment around which a larger, more coherent, and better focused U.S. tropical forest program can be built.

Technological Capabilities

Technology, by itself, clearly will not solve the complex and multifaceted problems of tropical deforestation. Technology can, however, provide an incentive and stimulus by offering the means for attacking critical parts of the problem. A number of important techniques and methodologies already are available to those involved with tropical forest management; and other promising tools are being developed and refined. Technology, as described in this chapter, can make particular contributions in the areas of land-use planning, including forest inventory and land classification; forest management, including soil, water, and wildlife protection, and silviculture; resource conservation, including waste reduction and resource substitution; and alternatives to forest removal, including village woodlots and agroforestry.

A. Land-Use Planning

Forest Inventories: Inventory techniques can be used to define and describe the forest resource, and to assess the magnitude of tropical deforestation as well as the results of reforestation and other remedial measures. Satellite-based remote sensing, such as via U.S. LANDSAT satellites, offers a promising method for rapid, repetitive inventorying and monitoring of tropical forest cover at the regional, national, and global levels. Satellite observations are used best in combination with selective checking and interpretation from aircraft and ground-based sampling. A worldwide network of LANDSAT ground stations is being established, and existing stations already cover a large portion of the Tropics.

The FAO, with support from UNEP, recently has completed a pilot project on tropical forest inventory in West Africa (Benin, Cameroon, and Togo), using a combination of data from the ground, aerial reconnaissance, aerial photographs, and LANDSAT imagery. The results will help define more precisely the potential benefits, limitations, and costs of remote sensing applications to forest inventory in tropical areas. Because of strong U.S. capabilities for data acquisition and analysis and remote sensing, the United States can play a lead role internationally.

Land Capability Classification: Land capability classification is carried out after a forest area has been surveyed and inventoried. Resource planners and managers have long recognized the need for systematic land classification so that sound judgments can be made about optimum land use. In many cases, forest lands in the Tropics have been cleared for agriculture and grazing even when they were unsuited for these uses over the long run. Good land capability classification would help prevent such mistakes. Criteria for the classification and designation of land usually include soil types, topography, land fragility, flora, fauna, aesthetics, and certain unique features. On the basis of these criteria, an evaluation is made of the most appropriate land use. Land can then be designated for intensive agriculture, grazing, forest plantations, agroforestry, natural forests for multiple uses, mining, parks, wildlife refuges, ecological and biosphere reserves, and other uses.

Land classification methods in the past have been overly detailed, expensive, time consuming, and often based on quite sophisticated technologies. Simple, low-cost, rapid techniques—adapted to local conditions—clearly are needed.

Progress is being made. A classification developed for the

160,000-hectare Guanare River watershed in Venezuela was completed recently in two person-years at a cost of only U.S. \$23 per hectare. Data on climate, soils, geology, vegetation, water resources, and local cultural factors were analyzed to delineate land areas best suited for grazing, crops, wood production, and forest preserves. In addition, the Government of Brazil has completed a soil classification survey of its part of the Amazon Basin by using a combination of aerial photography, radar imagery, and ground reconnaissance. This survey is expected to provide land-use planners with the capability of relating future Basin uses to soil types best able to sustain various uses. The utility of land capability classifications ultimately will depend, however, on the willingness and ability of planners and managers to apply the techniques; the effectiveness of the regulatory and administrative mechanisms available to insure that the land actually is allocated and used as the classification prescribes; the availability of incentives to insure proper land use; and the acceptance and commitment of the local people.

B. Forest Management

Watershed and Soil Protection: Watershed protection is a major concern in nearly all countries. Protection is needed against slope erosion, the effects of wind on deforested or semiarid areas, stream siltation, reservoir sedimentation, and torrents in steep mountain zones. Fortunately, these are problems for which experience, knowledge, and technology exist.

Several projects in tropical countries have demonstrated that soil conservation can be combined with the growing of crops, trees, and other valuable vegetation so that land does not have to be taken out of production to be protected. The basic principles of afforestation for erosion control are well known, although much remains to be learned about the individual tree species or combinations of vegetation that will be most effective for particular situations. In some cases, afforestation may be combined with terracing or mechanical measures for erosion control.

In many semiarid and arid regions, shelterbelts and other techniques have successfully stabilized sand dunes which would otherwise encroach onto vegetated areas. Again, additional research and development are needed to determine the most suitable species for shelterbelts, and also the techniques for establishing and maintaining them under different ecological conditions. The basic concepts are sound, however, and an expanded transfer of existing information will provide significant benefits. The United States is widely recognized as a leader in watershed management and soil conservation, having probably the largest number of active domestic programs and more trained professionals than any other nation in these fields. Many U.S. universities offer specialized training in watershed management and train significant numbers of students from other countries.

Intensified Silviculture: Closed tropical forests may have, on any given hectare, as many as 100 or more tree species, only a few of which are now considered commercially valuable. The low density of desired species, therefore, has not provided much stimulus for intensified management of the total existing stand. Greater understanding now exists of the complex ecological requirements and interrelationships of these highly diverse forest types, as well as of the full range of economic values which might

be realized through proper management. In addition, an array of new techniques for managing and utilizing mixed forest stands is available. These techniques include improved guidelines for selecting crop trees; better control measures for undesirable vegetation, insects, and diseases; selective breeding of better quality tree stock; and improved reforestation methods. Other techniques include improved methods for diagnosing soil nutrient deficiencies and prescriptions for forest fertilization; standard, easy-to-use computerized models for predicting growth and yield; and improved tree harvesting techniques that protect the residual mature tree stands and enhance forest regeneration.

The potential uses of many tropical forest trees are fairly well understood as a result of long-term efforts at a number of research institutions throughout the world. The major task is to link advanced silviculture and management techniques with improved utilization in order to realize more of the economic potential of the forest resource. Mechanisms must be developed for making the management techniques more widely known, and for refining them through silvicultural experimentation and demonstration in native mixed tropical forests. Special efforts are needed to increase the economic utilization of more species.

The United States is equipped to make a major contribution internationally in this area by virtue of its experience and capabilities, much of which appear to be adaptable to the tropical environment.

Afforestation and Reforestation: Successful replanting of trees on cleared land and the use of sound silvicultural practices are principal keys to maintaining a forest resource base. The productivity of lands suffering deforestation and desertification can often be restored through reforestation and afforestation programs. However, such programs sometimes fail because they tend to ignore the root causes of the problem. Moreover, it may not be possible, or even desirable, to restore the original type of forest. In some cases it will be preferable to introduce intensive forest management using species that will give a rapid, reliable economic return. Introduced species must be matched carefully to local ecological conditions, and attention must be given to problems that may arise from the "escape" of exotic species into new environments. Replanting after logging sometimes fails because the introduced species are not suited to the soil, water, climate, or other environmental factors. Also, the need for protection and followup work after establishment of seedlings frequently is neglected in program planning.

Recently, efforts have been intensified to identify and develop appropriate species for reforestation and afforestation in the Tropics. The technology for growing and maintaining trees is being improved, and new methods are being devised for more effecting and efficient nursery operations, seed collection, seedling transport and care, and rapid, large-scale planting. By applying the proper genetic information, tree species and varieties can be matched to the site and climatic conditions of a given area, thereby facilitating rapid cover and growth.

Promising work has identified trees and other plants that are both fast growing and useful. Reforestation ventures with fast-growing trees have been carried out in India, Pakistan, Thailand, Indonesia, Malaysia, Colombia, Brazil, Ivory Coast, Nigeria, Ghana, Kenya, Malawi, P.R.C., and Fiji. Certain tree varieties (e.g., *leucaena*) tested in Indonesia, the Philippines, and Malaysia, reach 6 meters in height in 2 years, and 17 meters in 8 years. These and other fast-growing varieties can help solve problems associated with deforestation and fuelwood and charcoal shortages.

Many tree species are multipurpose, yielding combinations of food, fodder, fuelwood, and industrial wood products such as pulpwood and lumber, as well as helping to control wind and water erosion. NAS has continued to publish information helpful to decisionmakers and scientists on such subjects as under-

exploited tropical plants with promising economic potentials, fast-growing tree species, and promising fuelwood varieties (U.S. National Academy of Sciences, 1975, 1976, 1979, and items in press).

Cell tissue culture, a biological technique now under intensive research and testing in the United States and elsewhere, may provide a means of conserving and reproducing some fraction of the genetic material likely to be lost through forest clearing. Similarly, such techniques might be used to develop food crops and other commodity and medicinal plants.

Tree Plantations: The introduction of intensively managed plantations of one or more tree species offers an opportunity for relieving pressures on the mixed, natural tropical forests while simultaneously sustaining a flow of fuel and other wood products. For example, short-rotation cropping of coppic hardwood varieties, such as *eucalyptus* or *leucaena*, is being considered for production of pulpwood, fuelwood, and other forest products. Research has indicated that successful plantations in tropical areas can produce from 4 to 10 times the amount of usable wood produced by a natural forest, and may, if carefully managed, sustain even higher yields. Plantation forestry also can be labor intensive, another important element for low-employment areas of the Tropics.

On the other hand, the conversion of large-scale, biologically diversified forests to monocultures—particularly on the wrong soils—runs the risk of creating an ecosystem that is exceedingly vulnerable to disease and insect infestation. This can also trigger intensified soil deterioration and exact other ecological and social costs. Environmental problems associated with plantation monocultures can be reduced or avoided by careful planning and application of existing information about genetic variations in tree species and their individual sensitivities to site and climate.

The "Jari" project in Brazil is a highly publicized example of an extremely large-scale tree plantation project in the Tropics, although its long-term economic viability and ecological stability are yet to be demonstrated. The Weyerhaeuser Company is carrying out experimental work in a plantation establishment in Indonesia, using introduced tree species. On a worldwide basis, however, relatively little use is made of plantation forestry for commercial production in most tropical areas. As natural tree stands of commercial value disappear, plantation forestry will undoubtedly be looked to increasingly by wood producing countries and private industry to fill the demand-supply gap for wood and wood products.

C. Resource Conservation

Waste Reduction: Reducing heat losses during conversion of wood to energy, and wood loss reductions during forestry and wood-processing operations can help immeasurably to conserve and extend wood supplies. The heat loss associated with many wood- and charcoal-burning devices now in use, for example, is estimated at some 60 percent. Large losses also occur in the conversion of wood to charcoal. Both problems are receiving attention by development assistance agencies and national governments.

In addition, waste during timber harvesting is often considerable. The high-grading of only certain species, coupled with the wastage of limbs and tops which are trimmed off and left in the forests, result in inefficiency and low log yield per hectare. At the sawmills and veneer mills, additional significant losses occur. Even with straight cylindrical logs of large diameter (0.5–1.5 meters), lumber yields of only 30 percent are achieved in many sawmills.

Improved technologies to reduce wood loss during milling and other wood-processing operations are being developed, as are new methods to convert commercial logging and processing

residues into marketable wood products. Other new techniques utilize the whole tree, as well as combinations of mixed species of trees (otherwise bypassed in logging operations) for woodchips, particle board, fiber board, and paper.

Careless clearcutting, coupled with whole-tree harvesting methods, could become a major contributor to large-scale deforestation, with a more severe effect on the environment than traditional, selective logging. On the other hand, when used carefully under suitable conditions, clearcutting and all-species use techniques, coupled with replanting and sound management practices, could contribute significantly to meeting worldwide demand for wood products while reducing pressures on remaining virgin forests.

Quality wood waste can be reduced by extending the service life of "nondurable" wood (used for lumber, telephone poles, fences, stakes, etc.) through improved wood preservation. Reducing the demand for durable, high-quality woods would enable them to be reserved for other uses. Technology developed by the U.S. public and private sectors can contribute significantly to waste reduction.

Application of existing knowledge about the transport and storage of logs and lumber could reduce losses from such causes as mold, stains, insects, splitting, decay, improper drying methods, and mechanical damage due to poor handling practices. The significant toll which is often extracted is apparent when one considers that from 6 months to 2 years are sometimes required for certain logs to reach the mills. The Economic Commission for Europe has initiated work in the area of waste reduction and improved utilization of forest products, including improved energy efficiency and wood preservation, and will hold a symposium on the subject in 1982 in the Soviet Union.

Resource Extension and Substitution: As forests disappear and wood product prices rise, technological innovations to extend the resource become increasingly viable. Veneers of expensive wood laminated onto less expensive varieties is one approach to lowering costs and extending supplies of high-quality tree species. Studies have shown that heretofore neglected species can, with proper processing and marketing, gain public acceptance and thereby relieve pressure on preferred wood types. In addition, plastics or other synthetic and perhaps natural materials can be substituted for certain woods. The use of wood substitutes may, however, be constrained by resource scarcity and environmental problems associated with potential substitute materials. Resource substitution for tropical woods also could have serious detrimental effects on the poorest populations of the producing countries, in terms of reduced employment, incomes, and overall social well-being.

D. Alternatives to Forest Removal

Agroforestry: For centuries, systems combining trees and agricultural crops have been used on a limited scale by certain farmers and indigenous peoples to take advantage of symbiotic plant relationships. This "local lore," appropriately modified, now is being advanced as a new technology—agroforestry (or agrisilviculture). Agroforestry includes both the planting of trees concurrently with food crops and the rotation of trees and agricultural crops. It involves trees grown not only for wood but also for food, forage, fertilizer, soil and water management, control of wind and water erosion, and other environmental values. Agroforestry can be a means for making continuous productive use of the land without destroying its productivity. In areas formerly under shifting cultivation, it is often compatible with cultural attitudes and traditional practices of local populations. Agroforestry is particularly attractive because it offers potential for reducing the forest loss rate of two principal sources—shifting cultivation

and the opening up of forest margins for more intensive food production.

Research, demonstration, and information exchange in tropical agroforestry are being expanded or planned by a number of national, regional, and international institutions. The International Council for Research in Agroforestry (ICRAF) at Nairobi was established in 1978 to promote this technology and to expand worldwide information sharing. Among its principal interests are the proper selection of food crop-tree mixes under different rainfall, temperature, and altitude regimes; the sustained management of such systems; their social acceptability; and other constraints on their introduction and use.

Community Woodlots for Fuel: The concept of community woodlots has emerged as a response to the expanding demand for fuelwood and its diminishing supply in many parts of the world. Woodlots now are being introduced at an accelerated pace to provide fuel as well as building materials and other forest products. Most successful applications to date have been in temperate zones, particularly in the People's Republic of China, South Korea, and Gujrat State in India (Eckholm, 1979). Others, however, are found in tropical Brazil, Colombia, and Ecuador. Short-rotation cropping of fast-growing hardwoods such as *leucaena* or *eucalyptus* appears to have application in many other areas.

Usually the major impediment to successful community woodlots is not a lack of suitable forestry technologies, but rather problems of social organization. Community woodlots must be a "felt need" and have a high degree of local support—especially among poor people. Experience has shown that, without strong popular support, participation, planning, and sharing of benefits, the trees are often destroyed soon after planting. Successful community forestry programs also often require changes in the practices and attitudes of government forestry departments. Near urban areas, woodlots are likely to be commercial enterprises, guarded by their owners or employees.

Energy Alternatives: The introduction of alternative energy sources (including solar, wind, biogas, and minihydro systems) is a vital element of any comprehensive program to address fuelwood-related deforestation problems. Many efforts to develop and apply alternative energy sources are underway worldwide, although for the most part they seem to be widely scattered, uncoordinated, and generally underfunded. To the extent that breakthroughs are adopted, they will serve to reduce pressure on the tropical forest resource. For example, solar dryers for agricultural products such as grain, meat, fish, and tobacco have proven to be a cost-effective substitute for wood fuel. The 1981 UN Conference on New and Renewable Energy Resources should focus greater worldwide attention on needs and opportunities in this area, and promote expansion and improved coordination of national and international programs.

Improved Small-Scale Agriculture: Forestry is linked closely to farming in most countries. Opportunities exist throughout the tropical world to achieve increased crop production and at the same time to improve environmental conditions on denuded lands. Improved crop yields on existing cultivated lands would reduce the need to clear additional forest lands. A large international effort on agricultural production has been carried out for decades, with a recent shift toward greater emphasis on the needs of small rural farmers in developing countries. The International Agricultural Research Centers are contributing to this "new direction," and their efforts should be encouraged and supported, particularly those related specifically to the agriculture-forest interface.

Management for Nonwood Use: One method of alleviating pressures on the forests is to obtain a yield of resources from the

natural forest that exceeds the economic return from forest removal. In many regions aquatic and terrestrial animals, fruits, and nuts from the forest provide major food sources, the value of which has not been totally assessed. Economic benefits accrued from the environmental services forests provide also need to be taken into account. In addition, preserved or properly managed forests may provide commercial possibilities for recreation and tourism.

Attempts by Peru to manage selected species of aquatic and terrestrial animals in a large Amazonian forest reserve afford another example of how natural forests are being increasingly used in their natural state. With modifications, management methods currently employed for Temperate Zone fish and wildlife resources could be utilized to promote development of such animal resources in tropical forests without destruction or removal of the vegetative cover.

Institutional Capabilities

U.S. tropical forest strategies and programs must be pursued within an international institutional framework which involves the tropical countries, other countries, and a broad spectrum of international organizations. Although forest management responsibilities reside principally with the governments and institutions of those countries possessing the forest resources, the United States, other bilateral donors, and international development assistance agencies will continue to be looked to for technical assistance, training, and financial support.

This chapter provides an overview of the institutional capabilities which exist around the world. It is, however, only indicative of the array of experience, interests, and talent which the community of nations possesses. Space does not permit detailed descriptions of the institutions which are mentioned, or even citation of many others that are carrying out important, high-quality work. The Task Force also hastens to add that, despite the spectrum of talent and institutional involvement that exists, current efforts are insufficient and inadequate to significantly slow or reverse deforestation rates.

In looking to the future, the principal requirements for a coordinated, efficient international program on tropical forests include: (1) expansion of the linkages within the array of national and international institutions through better information exchange; (2) an increase in joint planning and programming; and (3) more attention to strengthening national institutional capabilities of the tropical developing countries.

A. Tropical Countries

Africa: Most African forest lands are publicly or tribally owned. Limited reserves exist for timber production, watershed management, recreation, or wildlife; some of these date back to colonial times. Many reserves are under severe pressure from cultivators, hunters, domestic cattle, and fire. Forest land management is chiefly in the governments' hands and their institutions generally are seriously understaffed.

Local forestry research in Gabon, Ghana, Ivory Coast, Kenya, Madagascar, Nigeria, Senegal, Sudan, Tanzania, Uganda, Zaire, and Zambia has produced tested silvicultural practices. Regional plantation and watershed management research has been carried out at Maguga, Kenya by the East African Agriculture and Forestry Research Organization. Research on wildlife resources management was recently accelerated in both east and west Africa. Wood properties and uses have been studied in the Ivory Coast, Madagascar, Nigeria, and Tanzania. Nigeria has a center for agroforestry as well as a Savanna Forestry Research Station in Zaria. Nigeria, Senegal, Sudan, Somalia, Upper Volta, Libya, and Algeria all have conducted successful projects in arid zone forestry or sand dune afforestation. Recently, and particularly since the 1977 UN Conference on Desertification, arid zone forestry and sand dune fixation projects have been integrated by numerous African governments into more comprehensive projects aimed at socioeconomic development.

Professional or technical education in ecology, forestry, and wildlife and watershed management are offered at universities in Cameroon, Ghana, Kenya, Liberia, Nigeria, and Tanzania. Good libraries exist at Maguga, Kenya and at the Nigerian Research Institute and the International Institute of Tropical Ag-

riculture at Ibadan. The Comité Inter-Etats de Lutte Contre La Secheresse au Sahel (CILSS) channels development assistance into ecology and forestry work in the Sahel. Professional personnel responsible for management of Africa's tropical forest lands generally are prepared technically to perform their tasks to a higher standard than is permitted by the available resources.

Asia-Australia-Oceania: Most forests of tropical Asia and Oceania are unprotected, but limited reserve areas exist in many countries. Large forest areas are affected by growing pressures from shifting cultivators.

The forest-level management in this region varies widely. Large areas are subject to uncontrolled use. By contrast, forests reserved for the public in Australia and India largely are under long-term, multiple-use management.

Forest management is often in the hands of locally trained foresters. Concern about maintaining a balance between timber production and ecological, watershed, and wildlife values appears high. Notwithstanding this, pressures for increased timber exports and shifting agriculture call for improved communications and understanding among planners, land managers, and policymakers about long-term sustained forest management.

The role of private interests in forestry is primarily that of timber harvesting and processing. However, in parts of Papua New Guinea, Indonesia, and the Philippines, large private concessionaires are also carrying out some reforestation programs.

The level of technical knowledge of forest management in this region rests on more than a century of experience and research. Early dissatisfaction with regeneration of native forests in India led to the search for new plantation techniques. Successful natural regeneration systems in Malaysia have been developed in some areas, but they are costly and not easily applicable to rough terrain. Poor management practices may be a major constraint on successful natural regeneration. The People's Republic of China devotes about 70 percent of its reforestation budget to postplanting maintenance, which has led to significant success.

Australia's experience with *eucalyptus* and pine plantations, range management, arid zone forestry, sand dune stabilization, and other types of resource management has enabled it to help with forestry assistance projects throughout the Asia-Pacific region.

Forestry research is conducted chiefly by the National Forest Services of Australia, Malaysia, India, Indonesia, Papua New Guinea, and the Philippines and includes forest botany, classification of forest types, basic ecology of native forest systems, silvicultural systems for forest regeneration, and wood technology. The main centers for professional forestry education are the universities at Dehra Dun, India; Kuala Lumpur, Malaysia; Canberra, Australia; Jogjakarta, Samarinda, and Bogor, Indonesia; Los Banos, Philippines; and Kasetsart University in Thailand. Most of these universities have good forestry libraries. A forest research institute is being established at Yezin, Burma by FAO and the UN Development Program (UNDP) under contract with the State University of New York. Capabilities already exist at the Pakistan Forest Institute in Peshawar.

Central and South America: Forest areas have been set aside in most countries of the American Tropics to conserve timber supplies or to protect watersheds, wildlife, or scenery. The

level of forest management varies widely, and although departments responsible for forestry, parks, and wildlife protection exist in nearly every country, only a few forests are well managed or protected. Large areas of cutover forest essentially lie unreforested and unproductive.

Regeneration of new timber crops is largely a non-governmental activity in tropical America. However, the local forest service commonly plays a part in species selection. Quasi-public corporations operating in Argentina, Brazil, Chile, Honduras, Colombia, and Venezuela play a key role in reforestation by providing fiscal incentives.

Botanical exploration has been in progress for decades. At least three respected centers for this work are in Brazil: the Programa do Tópico Úmido, which constitutes Projeto Flora; the Instituto Nacional de Pesquisas da Amazonia (INPA); and the Museu Paraense Emílio Goeldi Herbarium (in Belém). Research on animal life began early at the Beebe Center in Venezuela and at the Smithsonian Tropical Research Institute in Panama, both of which also conduct studies on forest structure and function. And the Threatened Plants Committee (TPC) of the International Union for the Conservation of Nature and Natural Resources (IUCN), Gland, Switzerland, has recently undertaken an inventory of threatened and endemic plant species of Central and South America.

The functioning of forests as systems, and the role of individual components of these systems, have been studied at a few centers in recent years, particularly by the U.S. Atomic Energy (now the Nuclear Regulatory Commission) in Puerto Rico; the Max Planck Institute (West Germany); INPA in Brazil; the Tropical Science Center and the Organization for Tropical Studies in Costa Rica; and the Instituto Venezolano de Investigaciones Científicas (IVIC) in Venezuela. Studies of regeneration and tree growth in native forests are being conducted by the Superintendencia da Amazonia (SUDAM) in Brazil, and the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) in Costa Rica. New university forestry programs have begun at Heredia and Cartago, Costa Rica. The Colegio Superior de Agricultura Tropical in Tabasco, Mexico is investigating sustainable agroecosystems; and the Centro de Investigación en Química Aplicada in Saltillo, Mexico is developing arid land plant byproducts with special emphasis on sustaining the yields from natural stands. Excellent forest research is being carried out in Mexico at the Graduate College of Chapingo; and the Instituto Sobre Recursos Bioticos in Xalapa conducts a broad program of research, demonstration, and application.

Although application of tropical forest management techniques is, on a regional basis, behind that in Asia, plantations of introduced tree species for timber have been established as a result of research by the Trinidad Forest Department; the Companhia Paulista de Estradas de Ferro at Rio Claro, Brazil; Celulosa Argentina in Misiones, Argentina; and by numerous other organizations. Major centers for the study of wood properties and uses are the Instituto de Pesquisas Tecnológicas of the University of São Paulo, Brazil; the Instituto Brasileiro de Desenvolvimento Florestal in Brasília; the Laboratoria Nacional de Productos Forestales (LABONAC), which now is part of the University of the Andes at Mérida, Venezuela; the Ministerio de Agricultura y Cria of Venezuela, also at Mérida; the Instituto Nacional de Investigaciones Forestales in Mexico; and CATIE and the University of Costa Rica.

Professional forestry education is offered at several universities in the larger countries of tropical America. Graduate-level education in forestry and wildland management is available at the University of the Andes in Venezuela and at CATIE in Costa Rica, and will soon start at INPA in Brazil. Subprofessional schools are numerous. CATIE, the Instituto Forestal Latinoamericano de Investigación y Capacitación in Venezuela, and INPA all have good

libraries. Many other Latin American forestry colleges are listed in a guide prepared by FAO.

B. Other Foreign Countries

Canada: The Canadian International Development Agency (CIDA) is Canada's bilateral assistance agency. The International Development Research Centre (IDRC), a public corporation created in 1970, supports research designed to adapt science and technology to the needs of developing countries. Its forestry emphasis is on the arid and semiarid regions. IDRC's current research program includes agroforestry as well as afforestation for shelterbelts, village woodlots, and fuelwood plantations in 12 African nations and tropical timber structural use and afforestation in the Andean region of Latin America. Over the past 8 years, the IDRC has invested \$1.5 to \$2 million annually in applied forestry projects in all developing regions. The Centre also is the executing agent for the International Council for Research on Agroforestry in Nairobi, and is its major financial supporter.

Federal Republic of Germany (F.R.G.): West Germany is supporting forestry projects in some 18 countries through the German Association for Technical Cooperation. It also has a volunteer program with 16 volunteers in five countries. In addition, the following F.R.G. scientific institutions are concerned with ecological research on the humid Tropics: World Forestry Institute of the Federal Research Institute for Forestry and the Timber Industry; Max Planck Institute for Limnology; and the Universities of Göttingen and Heidelberg.

France: French research services have long been active in tropical forest problems and they have a wealth of experience in Asia and Africa. The Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) is a leading supporter of tropical moist and dry forest research in Africa today. One of the most detailed ecosystem studies of plant and animal life in a tropical dry forest has been recently completed by ORSTOM at Lamto, Ivory Coast. Similar types of studies are underway in Tai Forest in the Ivory Coast and Senegal. The French forest service also has had long experience managing tropical forests, especially mangrove forests in Southeast Asia.

Japan: Japan depends heavily on timber imports from tropical regions, principally from Southeast Asia. The extent and nature of Japanese efforts on tropical forests at home and abroad was not determined for this report. However, a Japanese news report in November 1979 noted that Japan and Indonesia have agreed to conduct cooperative research on afforestation. Under the agreement, Japan will provide \$6.25 million toward the establishment of a research center at Samarinda in eastern Kalimantan (Borneo), including the cost of research on launa and other tropical timber resources. The news report stated that Indonesia provides 40 percent of Japan's tropical hardwood imports, and that successful work at the center will help reduce criticism that Japan is only interested in cutting down trees with little attention to reforestation.

Sweden: The Swedish International Development Authority (SIDA) supports tropical forest activities both bilaterally and multilaterally. It has contributed to a number of FAO projects, including the "Forestry for Local Community Development" program as well as efforts in the Sahel, and has made a trust fund contribution of \$1,880,000 to a forestry education project in the Philippines. Bilaterally, SIDA is spending \$341 million on pulp and papermill construction in Vietnam and \$12.7 million on forestry in Bangladesh.

The United Kingdom: The U.K. has long been a world leader in tropical forestry. The Commonwealth Forestry Bureau in Oxford includes an active tropical silviculture unit and is a principal authority in tropical forestry information, made available through its *Forestry Abstracts*. The Land Resources Development Centre has appraised

many tropical forest areas of the world and carried out land suitability studies. The Building Research Establishment (formerly the Forest Products Research Laboratory) at Prince Risborough is active in assessing tropical timber; and the Tropical Products Institute investigates other derivatives from tropical species. The U.K. has the greatest number of country nationals working in the forestry programs of FAO and the World Bank.

Others: The Netherlands and Belgium also have longstanding programs on tropical forestry and they carry out overseas forestry projects in Indonesia, Suriname, and other countries of special historical interest to them. Norway has been carrying out bilateral forestry projects in tropical countries for many years and is giving increased attention to social aspects as well as to reforestation. Along with Denmark, it helps support FAO training programs and workshops in tropical forestry.

C. International Organizations

The Food and Agriculture Organization (FAO) of the United Nations, located in Rome, has a major work program in forestry, coordinated by its Forestry Department. European countries, Canada, and, more recently, Third World countries, have played an important part in the FAO forestry program.

Among the 77 professionals in the Forestry Department at FAO headquarters are 65 foresters, wood technologists, biologists, or other forestry technical specialists. FAO has more than 300 persons in the field, including experts, associate experts, and consultants, working in 56 countries (or 77 countries if the projects in the planning stage are also included).

The 1978-79 FAO biennium budget for forestry was \$8,451,000 from the "Regular Programme" (i.e., essentially the headquarters-coordinated activities). Besides the funds for the Regular Programme, an estimated \$55,502,000 was allocated in 1978-79 "extrabudgetary" funds, primarily trust funds for courses, studies, workshops, and related activities. Additional funding is provided by the United Nations Development Program (UNDP) for FAO-conducted forestry field projects, totaling about \$30 million annually. About 85 percent of UNDP forestry projects are carried out by FAO.

FAO recently has given new attention to forestry's role in local rural development, fuelwood, agroforestry, and other activities related to poor people. It also continues its former work in silviculture, forest industry, statistics, and institutional development. FAO sponsors special projects on tropical forest monitoring, forestry for local community development, Sahel forestry, and forest genetics. The Forestry Department coordinates a World Forestry Congress every 6 years. In addition, FAO produces many technical publications on tropical forestry, and its library and forestry files are an important source of information.

The United Nations Environment Programme (UNEP), located in Nairobi, Kenya, serves as a coordinating body for environmental matters within the UN system. UNEP does not have professional foresters on its staff, nor does it fund operational forest management projects directly. It does, however, provide financial support for meetings, workshops, publications, consultations, expert panels, and international conferences in fields which include arid lands management, desertification, energy alternatives, and tropical forestry. UNEP is charged with followup to the Plan of Action to Combat Desertification approved by the 1977 UN Conference on Desertification. It is also responsible for convening the international meeting on tropical forests in late February 1980, in Nairobi, to begin work on an international division of labor for research, monitoring, training, and education.

The United Nations Conference on Trade and Development (UNCTAD), headquartered in Geneva, Switzerland, adopted a resolution in 1976 providing for an Integrated Program for

Commodities. The Program covers 18 mineral, metal, and agricultural products, one of which is tropical timber. Since then, five preparatory meetings on tropical timber, attended by representatives from 36 countries, have been held in Geneva. The meetings have explored methods for improving the operation of international markets for tropical timber, which would enhance the stability of producing countries' foreign exchange earnings from this commodity and insure sustained adequate future supplies. A consensus has emerged on the need for international action in four areas: (a) reforestation and forest management; (b) improved understanding of how world markets operate; (c) increased processing of wood products in producing countries; and (d) improved research and development, including increased use of lesser known species. Among the four areas, reforestation is of strongest common concern. Future meetings will explore the possibility of specific new international arrangements to undertake projects in the four areas.

The United Nations Industrial Development Organization (UNIDO), in Vienna, has responsibility for furthering industrialization in developing countries. In the forestry sector, UNIDO collaborates with FAO in projects concerning pulp and paper, wood processing, and other industrial forestry activities.

The UNESCO Man and the Biosphere Program (MAB) is an integrated, interdisciplinary, problem-focused rather than discipline-focused research approach to management problems arising from interactions between human activities and natural systems. It provides a bridge between fundamental science and technological applications. Eighty-two nations presently participate. The Program is divided into 14 project areas. Under MAB Project 1—Tropical Forests—several pilot projects in ecological training and research for management of tropical forest areas have been started: Gogol Forest, Papua New Guinea; East Kalimantan, Indonesia; Tai Forest, Ivory Coast; and San Carlos de Rio Negro, Venezuela. Under MAB Project 8, UNESCO is coordinating development of a global network of biosphere reserves. The UNESCO-MAB Program relies on individual countries to undertake activities which can contribute to each of the 14 project areas originally agreed to at the international level. One of MAB's objectives is to achieve successful integration of social sciences into practical land-use development schemes at local and national levels. Work in this area has been carried out cooperatively with the International Union of Forestry Research Organization (IUFRO), including workshops on Tropical Rainforest Ecosystems Research in Hamburg (1977) and Jakarta (1978). MAB headquarters in Paris is responsible for coordination and information exchange with respect to individual country efforts.

The UN Regional Economic Commissions—for Africa (ECA), Asia and the Pacific (ESCAP), and Latin America (ECLA)—devote a large share of their programs to inventories, development, and rational natural resource use. Emphasis is on dissemination of scientific and technical knowledge, promotion of projects for resource development, support for training of scientific and technical personnel, and provision of advisory services. Historically, however, emphasis has been largely on the water, minerals, and energy sectors, with much less attention to forest management (outside of commercial timber operations).

The UN Economic Commission for Europe (ECE) in Geneva, Switzerland appraises tropical wood markets (trade and end-use patterns) and the outlook in the ECE region, and presents this information in the ECE Timber Committee's annual review of forest products markets. Its work program includes studies in the following areas: quantification and evaluation of the environmental benefits of forests (jointly with FAO); conservation of forest resources through waste reduction and improved use of forest products; and improved energy efficiency in forest industries.

The World Bank recently has financed forestry projects, or projects with a significant tropical forestry component, in 22

countries. It has 23 forestry projects currently under preparation: 8 in western Africa, 3 in eastern Africa, 6 in southern Asia, 3 in Latin America, and 3 elsewhere. The Bank has a lending target of \$500 million for forestry projects for the 5-year period 1978-82, as compared with only \$130 million for the 10-year period 1968-77. It published a major forestry sector policy paper in 1978 which places increased emphasis on small-scale tree farming and village forestry, and calls for an improved balancing of its program by including environmental projects, rural development, and institution building along with extractive forestry.

Examples of the World Bank's approach in this area are provided by two recent projects—India Kandi catchment and Thailand Northern Agricultural Development. Protection of the catchment area and forest preservation are major objectives, but forestry investments account for only 10 percent of total project cost. Within the Bank, the formulation of such projects is a multidisciplinary process, and one which foresters alone could not be expected to handle.

The Bank has 10 forestry professionals at its headquarters in Washington, D.C.; one in New Delhi, India; and three assigned to FAO headquarters in Rome for development of cooperative projects. It also makes extensive use of consultants.

The Regional Development Banks are not highly active in forestry activities (Blake, 1978), although the Inter-American Development Bank and the Asian Development Bank recently have prepared forestry policy papers.

The Organization of American States (OAS), a regional organization for the Western Hemisphere headquartered in Washington, D.C., for many years has supported forestry and agricultural research, information exchange, and training in tropical America. The Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) in Costa Rica is an affiliate.

The Consultative Group on International Agricultural Research (CGIAR) is composed of international financing organizations, foundations, bilateral aid donors, and developing countries, and is dedicated to worldwide agricultural improvement. The Consultative Group supports a series of specialized international agricultural research institutes in the developing world, including the International Institute of Tropical Agriculture (IITA), in Ibadan, Nigeria—the leading international research center in the humid Tropics. Among the areas of IITA interest is research on mixed cropping and other agricultural techniques that could reduce the pressure to remove forest cover while providing for increased agricultural production.

The International Union for Conservation of Nature and Natural Resources (IUCN) is a leading international, nongovernmental organization in the field of conservation. Headquartered near Geneva, Switzerland, it has worldwide governmental and nongovernmental membership. Program funding, some \$7 million annually, comes from the World Wildlife Fund, UNEP, other organizations, and contributions from its membership. IUCN conducts numerous tropical forest conservation projects in all affected regions and has published a series of guidelines on ecologically sound tropical forest management. With the support of UNEP and the World Wildlife Fund and with the assistance of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and FAO, IUCN will publish a World Conservation Strategy in March 1980, with a special focus on tropical wet forests.

The World Wildlife Fund (WWF) is the largest private international conservation organization dedicated to the protection of endangered species and related habitats. WWF-International (headquarters Switzerland) has affiliated organizations in 27 countries, of which WWF-US has over 65,000 supporters. The priorities of WWF-US are in the tropical Western Hemisphere. Its current activities include supporting both basic and applied research on tropical biology; promoting establishment and support

of biological parks and reserves; providing information about endangered species and habitats to the public; and acting as liaison between government and private interests.

The International Council for Research in Agroforestry (ICRAF), created in 1978 with headquarters in Nairobi, Kenya, is an autonomous, nonprofit institution. ICRAF's objective is to improve people's lives in developing countries by promoting agroforestry and supporting research, training, and an international agroforestry information exchange.

The International Union of Forestry Research Organizations (IUFRO), with headquarters in Vienna, Austria, facilitates information exchange and cooperation in forestry research among its worldwide membership, holds international congresses every 5 years, and has one of its several scientific working groups devoted specifically to tropical forestry.

The International Society of Tropical Foresters (ISTF), after being dormant for several years, resumed activity in 1979 with the assistance of the Society of American Foresters. Headquartered in Washington, D.C., it plans to focus on information transfer among both individual foresters and tropical forest institutions on a worldwide basis.

The International Society of Tropical Ecology focuses much of its attention on forest ecology. It holds international conferences every 2 years in tropical countries and publishes a journal, *Tropical Ecology*, and a newsletter, *Wallaceana*. It is establishing regional centers for communication in Southeast Asia, the Pacific, India, English- and French-speaking Africa, Europe, North America, Spanish-speaking South America, and Brazil.

The United Nations University in Tokyo has two professionals engaged fulltime in natural resource activities. Its natural resources work program includes provisions for research, education, and information exchange on tropical forest-related issues.

D. United States

U.S. FEDERAL AGENCIES: A variety of Federal Departments, Agencies, and organizations have mandates and programs that pertain to tropical forests. The following provides an overview.

The International Development Cooperation Agency (IDCA) came into being on October 1, 1979, and has primary responsibility for formulating U.S. international development policies for the President and for serving as the principal Presidential spokesperson on those matters. IDCA insures that varied U.S. bilateral and multilateral development efforts are coordinated efficiently and effectively.

The components of IDCA include AID, OPIC, and—if approved by Congress—a new Institute for Scientific and Technological Cooperation (ISTC). IDCA's concern and responsibility is economic development, and from this perspective it shares with the U.S. Department of State the responsibility for guiding U.S. involvement in the UN system; with the Treasury Department it shares authority for U.S. participation in the multilateral development banks; and it shares with the U.S. Department of Agriculture the direction of the U.S. Food for Peace Program. IDCA has been mandated by the President and the Congress to insure that our economic relations with developing nations are taken into account in the full range of U.S. international policies, including trade, commodity arrangements, and financial matters.

In short, IDCA has a broad range of responsibilities that extends beyond U.S. bilateral assistance. The Agency is charged with leading the way in analyzing and understanding the full complexity of U.S. development relations with the Third World. As such it will strongly influence the magnitude and direction of the natural resources and forestry activities of both U.S. Government Agencies and multilateral and international development organizations.

The **U.S. Agency for International Development (AID)** has shown renewed interest in tropical forestry after a period of relative noninvolvement. In the early 1960s AID supported a variety of industrial forestry activities and provided professional training in the United States for foresters from developing countries. In the late 1960s it shifted its approach. On the basis of a new congressional mandate, it began focusing chiefly on projects related directly to food production, which had the effect of excluding forestry as an agriculture sector activity. Consequently, AID's in-house technical staff in tropical forestry, until recently, has been almost nonexistent. During the past year, the Agency has strengthened its Washington, D.C. staff, adding several persons with forestry backgrounds and training. AID is also relying on greater use of contractors and consultants for expertise in tropical forestry and tropical ecology.

In 1979, AID had forestry projects underway in tropical countries of Asia, Africa, and Latin America. These included a \$16.8 million loan to Panama to strengthen that nation's resource management institutions, increase public awareness of conservation needs, and establish prototype watershed management programs in three watersheds in the Canal Zone. The broadly conceived Panama loan agreement illustrates how U.S. bilateral cooperation can be applied to deforestation problems. Other recent AID forestry activities include reforestation projects in the Sahel region of West Africa and fuelwood plantation efforts in the Philippines, the latter associated with wood-fired "dendro-thermal" electric plants.

The proposed **Institute for Scientific and Technological Cooperation (ISTC)** is intended to provide a new mechanism for facilitating scientific and technological cooperation with developing countries. Its emphasis will be on institution building, research, and training. Tropical forestry has been identified as an area of ISTC program concentration within a broader category of natural resources and environmental planning. Its funding will likely be relatively small, and the organization will need some time to become fully operative. One of ISTC's innovative features is its proposed advisory council, with one-third of the members to be selected from developing countries.

The **Peace Corps** has about 400 Volunteers in ecology or forestry-related work, about one-half of whom had some natural resource training upon entering the Corps. Volunteers serve 2-year tours of duty. They commonly work in cooperation with specialists from bilateral or international development programs. The U.S. Department of Agriculture's Forest Service and the U.S. Department of the Interior's National Park Service have each detailed one person to Peace Corps headquarters in Washington, D.C. to help plan and coordinate forest management-related program activities.

The Peace Corps currently is studying its past successes and failures in forestry activities to assist with improved future program design and implementation. It also is in the process of developing a major new program of forestry cooperation with AID.

Three components of the **U.S. Department of Agriculture (USDA)**—the Forest Service, Science and Education Administration, and Soil Conservation Service—are all active in international natural resources work. They maintain "international offices" in Washington that carry out liaison work, arrange for visits and study tours, help organize workshops, facilitate personnel loans to AID, FAO, and other organizations, and develop cooperative intergovernmental programs in tropical ecosystems.

The **USDA Forest Service** has three field units working on research related to tropical forestry. Its Institute of Tropical Forestry, maintained by the Southern Forest Experiment Station in Rio Piedras, Puerto Rico, is staffed by six professionals. The Institute works actively on South and Central American forestry problems and is widely recognized for its expertise. It has the most complete tropical forestry library in tropical America. The Institute transfers its research on regeneration and tree growth to demonstrations on the Caribbean National Forest in Puerto Rico.

The Institute of Pacific Islands Forestry, of the **USDA's Pacific Southwest Forest and Range Experiment Station**, has a substantial research program in Hawaii and the Western Pacific. Four research units, headquartered in Honolulu, Hawaii, are working on problems in timber and watershed management, wildlife habitat, energy plantations, soils, ecosystem dynamics, and tropical forest protection. One unit is developing research and assistance programs in American Samoa, Guam, and the U.S. Trust Territories. The research is being designed for extrapolation to tropical countries of the Western Pacific and Southeast Asia.

The **USDA's Forest Products Laboratory** at Madison, Wisconsin recently carried out studies for AID on the use of underutilized tropical woods. It also has completed a worldwide inventory of forestry activities being sponsored by major donor agencies and selected forestry institutions in the Tropics.

The **USDA Science and Education Administration (SEA)** recently increased its funding for tropical and subtropical agricultural research. The research is directed at the transfer of technology on an institution-to-institution and scientist-to-scientist basis. It focuses on such areas as tropical forest legumes, citrus trees, papaya and other tropical crops, and on problems of soil erosion and soil fertility. Cooperative forestry and ecology research is carried out in several countries with funds made available and administered by SEA under U.S. Public Law (PL) 30 (i.e., funds derived from the sale of U.S. farm products abroad). In 1979, nearly \$600,000 of PL 480-financed research on tropical conservation, forestry, wildlife, park planning, and ecology was underway through the Departments of Agriculture and the Interior. Individual projects are conducted by a principal investigator who is a national of the participating country, with each effort assisted and assessed by a cooperating scientist from a U.S. Agency.

The **USDA Soil Conservation Service** recently signed a contract with AID to provide for an International Soils Program. Staffed by a small permanent crew and other consulting agricultural scientists, the program will expand significantly AID's capabilities to provide assistance to developing countries in soil classification, soil management, and land classification. Interpretation of soil surveys for forestry applications in the Tropics is a key consideration in soil management.

Both the **U.S. Department of the Interior's Fish and Wildlife Service** and **National Park Service** also maintain international offices in Washington, D.C. to carry out liaison work and develop cooperative programs.

The **Fish and Wildlife Service** has cooperative programs with several tropical countries involving the management and conservation of tropical forest ecosystems. Activities include inventories of flora and fauna; research on the taxonomy, ecology, and management of tropical forest fauna; training for biologists and natural resource managers; and development of tropical research and training centers. The Service has several scientists with extensive experience in tropical forest ecosystems.

The **National Park Service** provides instructors in park management and park planning for workshops organized and conducted by Central American, South American, and Caribbean countries. It has also been involved in short-term training of foreign nationals in the United States, multilingual dissemination of natural area management techniques through *Parks* magazine, and environmental interpretation in tropical parks.

The **U.S. Department of State** coordinates preparation of U.S. positions on tropical forestry issues and programs as they are addressed in principal international fora. It also works through its embassies to engage host country officials in discussions of the subject and to assess the attitudes, plans, and programs of other governments and international organizations. It cochaairs, with the Forest Service, the **U.S. Interagency Task Force on Tropical Forests**; coordinates the **U.S. Committee for the**

UNESCO-MAB program; and houses the United States-MAB Secretariat. The State Department cosponsored with AID the 1978 U.S. Strategy Conference on Tropical Deforestation which led to the preparation of this report.

The **National Science Foundation (NSF)** supports basic scientific research in all subject and geographic areas by members of the U.S. academic community and other research workers. In the fields of biology and anthropology, much of the basic work carried out by the United States which underlies the understanding of tropical forests and tropical forest people comes from these studies. Currently, NSF provides about \$4 million per year for studies in tropical biology, supporting most of the tropical forest ecosystem work of the United States, most of the systematic biology work, and much of the research on the biology of tropical plants and animals. NSF also supports most of the studies of man living in tropical forest environments. Since basic research provides the foundation upon which rests all the applied and management strategies, the NSF plays a key role in the proposed U.S. strategy for tropical forests.

The **Smithsonian Institution** conducts research on various aspects of the world's tropical forests through a number of its principal bureaus. Emphasis is on Central America, Amazonia, and New Guinea. Scientists of the National Museum of Natural History participate, with others, in the Smithsonian Tropical Research Institute in Panama. The National Zoological Park studies tropical forest animals, and the Office of Biological Conservation is concerned with educating the public about the global diminishment of natural resources, including tropical forests.

U.S. NON-FEDERAL ORGANIZATIONS: A broad range of non-Federal scientific, industrial, environmental, academic, and public interest organizations conduct activities relating to international tropical forest management programs and issues. The following provides an overview.

The **National Academy of Sciences (NAS)** has conducted a variety of international workshops and studies on natural resource management, including forests, through its Board on Science and Technology for International Development (BOSTID). Under a "Technology Innovations Program," BOSTID is promoting worldwide research, testing, and information exchange on neglected plant species which have economic potential, as well as on fast-growing trees and plants for reforestation and other purposes. The NAS Assembly of Life Sciences has underway a major analysis of research priorities in tropical biology, along with an evaluation of current funding and personnel resources as well as training available for tropical research. It will soon issue a comprehensive report on this study (U.S. National Academy of Sciences, in press).

The **Organization of Tropical Studies (OTS)**, a consortium of some 27 universities (mostly U.S.) pools resources, grants, faculty, and students to conduct tropical ecology research, much of it concerning forests. OTS draws on support mainly from the NSF, as well as participating universities, to conduct graduate-level courses in forest ecology within the Tropics for students from tropical and nontropical backgrounds. OTS has purchased 1,800 acres of undisturbed tropical forest in Costa Rica for a teaching and research site. As many as 1,200 graduate students, post-doctoral researchers, and university faculty have received training in tropical ecology and related fields through OTS courses.

The **Consortium of Universities for International Forestry (UNIFOR)** was established in 1978 to help provide international donors and tropical countries with U.S. technical expertise in tropical forestry. It is comprised of seven U.S. universities with forestry schools and faculty trained in the tropical forestry problems of developing countries. The Consortium consists of the Universities of Arizona, Georgia, Idaho, Michigan, and Wash-

ington; North Carolina State University; and the State University of New York at Syracuse.

The **Ford Foundation** supports research in natural resource management in many countries, including work in some on community forestry and agroforestry.

The **Rockefeller Brothers Fund** supports individual projects on wildland management and park planning in the tropical American countries.

The **Nongovernmental Tropical Forest Working Group** includes some 80 individuals representing more than 50 U.S. conservation and scientific organizations, universities, and professional associations. Established with the assistance of the Natural Resources Defense Council, Inc., the Working Group contributed five reports and a series of recommendations to assist the U.S. Interagency Task Force in preparing this report.

The **Natural Resources Defense Council, Inc.**, a 45,000-member environmental organization, has conducted studies on tropical deforestation, is engaged in public education, and is developing a network of individuals and institutions concerned about tropical forests. It provides the secretariat for the Nongovernmental Tropical Forest Working Group.

The **National Audubon Society** ranks among the oldest and largest conservation organizations in North America. It promotes the conservation of wildlife and the natural environment.

The **National Wildlife Federation**, with a membership of 3,500,000, is a conservation education organization that reaches a highly diversified audience through an array of publications and periodicals, and is active in environmental lobbying.

The **Nature Conservancy** is a nonprofit corporation dedicated to the preservation of natural areas for present and future generations.

The **Sierra Club**, an environmental action group, has conducted a variety of forestry studies in tropical America, and is engaged in public information activities through books, magazines, newsletters, filmstrips, and slide presentations.

The **Worldwatch Institute** promotes, through a publication series, an awareness of emerging global trends and issues in a broad range of areas, including natural resource management, desertification, energy, population, and tropical forest loss.

Several U.S. museums (public and private) contain some of the world's outstanding collections of tropical forest plants and animals for research and study. Botanical gardens in Miami, St. Louis, Los Angeles, and New York house excellent collections of tropical plants, conduct classification work that expands worldwide knowledge of the plant kingdom, and provide selected international advisory services.

The **Association for Tropical Biology** publishes *Biotropica*, and has a membership devoted to research on biotic phenomena of the world's Tropics, including forest species.

The **American Forestry Association** has as its objective the advancement of intelligent management and use of forest resources.

The **Forest Products Research Society** has a tropical woods section and through its journal provides an outlet for technical information relating to tropical woods.

The **Society of American Foresters** is a 21,000-member organization of professional foresters. It has an active World Forestry Committee and International Forestry Working Group, and publishes three scientific journals.

Other strong institutional capabilities exist within resource management and forestry agencies at the State level, as well as throughout the U.S. industrial sector, which can be applied to research, training, information exchange, and technical advisory services in tropical forest management. In addition, the U.S. uni-

iversity community has a broad base of experience and capabilities beyond that reflected in the two consortia cited earlier. In fact, most trained U.S. tropical ecologists are affiliated with universities and colleges scattered throughout the country.

U.S. INSTITUTIONAL CONSTRAINTS: Although the United States possesses a wide variety of public and private institutions that potentially can contribute to an expanded international program on tropical forests, several constraints must be overcome if it is to play a meaningful and direct role.

The first involves personnel limitations. Despite U.S. involvement in natural resource programs in Africa, Asia, Latin America, and elsewhere, this Nation has relatively few well-qualified, internationally recognized experts on tropical forests. Consequently, U.S. international involvement has been largely as a supplier of funds, equipment, and a few experts who work mainly under the leadership of project supervisors from other countries.

U.S. participation in UN forestry programs illustrates this point. Only two U.S. foresters, for example, are on the 77-member professional staff of the FAO Forestry Department, in addition to one journalist and one administrator (FAO, 1979a).

The United States has only a few hundred ecologists with field experience in tropical countries, and perhaps a few dozen having extensive experience (Yantko and Golley, 1977). The supply of U.S. ecologists available to deal with practical land management problems in tropical forestry and ecology is small. The shortage of U.S. forest resource economists trained to interpret long-range economic policies with either direct or indirect effects on deforestation is especially acute.

The United States does have widely recognized and sought-after skills in a number of relevant fields, including watershed management; forest products utilization; remote sensing; range, forest, and wildlife management; fire control; and forest genetics.

U.S. private industry uses tropical forest resources for the production of lumber, paper, and pulp, but to date it has not constituted a major pool of U.S. technical expertise for tropical forest management programs. Industrial foresters who have worked in the Tropics naturally have developed skills around needs of their industry in such areas as timber inventory, reforestation, plantation management, logging, and road construction. This expertise constitutes a heretofore underutilized resource that should be called upon more in the future in support of international, national, and noncommercial forest management programs.

A major factor limiting participation of U.S. forest specialists in international programs is lack of foreign language skills. Only a relatively few U.S. foresters with tropical experience can speak Spanish, and French-speaking foresters with experience in developing countries are even rarer.

The involvement of U.S. foresters abroad also has been lim-

ited by a perceived absence of long-term career opportunities. Few U.S. institutions have provisions and incentives that enable their skilled professionals to take part in international work at the peak or "pre-peak" stage of a career without potentially hindering that career. For this reason, persons wanting to work overseas are commonly those early in their careers, or those who are nearing retirement. Such individuals may not have had prior overseas experience, often lack language skills, may be beyond their technical peak, may not be trained to solve tropical problems, or in some cases may have difficulty adjusting to a new culture. Finally, many organizations, already short on staff, are reluctant to let their best personnel go abroad.

Some academic institutions consider faculty research carried out in developing countries to be less valuable than that conducted in developed countries. In some cases where State funds are involved, research not directly applicable to the State is discouraged, or at least not encouraged. Thus, young faculty may jeopardize their chances for attaining tenure by focusing mainly on tropical research, whether in forestry or some other subject area. One option is for U.S. researchers to affiliate permanently with an institution based in a tropical country, rather than to seek limited duration assignments on detail from their U.S. employers.

The various constraints just enumerated must be addressed within the framework of any new U.S. tropical forest program. Several steps, some already started, can be taken.

The involvement of U.S. universities in tropical forests must be expanded. Some schools recently have added new courses in tropical forestry and ecology designed specifically for the needs of tropical foresters. The establishment of GNIFOR should help catalyze a greater education, research, and advisory service effort throughout the U.S. university community.

Government support for university programs in tropical forestry must be expanded, and appropriate new training and employment opportunities should be made available by and within the Federal Government. The expansion of the Peace Corps program in the forestry sector will contribute to this effort. In addition, AID's International Development Intern (IDI) program provides an opportunity for specialists in forestry, natural resources, and environmental areas to apply their skills to international development work through direct involvement in AID-funded programs. The program has existed for some time, but it is only in the past year that natural resource specialists have been sought. AID now has three IDIs in natural resource fields.

Finally, the U.S. Government should attempt to place more U.S. forest management experts in prominent positions within the United Nations and other international organizations active in tropical forest work. Coupled with this is the need for the Federal Government to work with the university community and other sources of U.S. expertise to insure that individuals are not penalized for time they devote to international activities—especially when they are on short- or medium-term assignments abroad.

**Part III:
The U.S. Role:
Response to Need**



Part III sets forth the Task Force recommendations for an appropriate U.S. response to the needs and conditions described in Parts I and II. It summarizes what the Task Force considers to be this country's principal interests in tropical forests (Chapter 6), including an elaboration of U.S. economic interests that are as yet unpublished. Also proposed is a general statement of U.S. policy on tropical forests to symbolize and articulate a new national commitment and intent (Chapter 7). In Chapter 8, specific short-, medium-, and long-term goals of an expanded U.S. effort are advanced.

Part III then presents a specific tropical forest strategy and program for the United States (Chapter 9). A series of international and domestic strategy elements is identified first, each followed by specific program responses recommended for early implementation ("short-term program priorities") along with designation of lead Agencies. Finally, the components of a broad, comprehensive U.S. program framework (e.g., research and training) are elaborated, followed by a discussion of necessary supporting measures such as coordination and funding.

U.S. Stake in Tropical Forests

The United States exercises sovereignty over only a small part—roughly one-half of 1 percent—of the world's tropical forests. Why, then, should it be concerned about tropical forest management, utilization, and loss elsewhere in the world?

A variety of compelling reasons can be cited. Each has its proponents in at least one of the diverse U.S. public and private institutions and organizations with direct involvement in, or concerns about, the subject. In the aggregate, these interests represent a combination of political, humanitarian, economic, environmental, educational, and scientific considerations.

Many of the fundamental interests outlined below already are evident from discussions in earlier parts of this report. Thus, they are only summarized here. On the other hand, U.S. economic interests in tropical forests are not as evident and as yet have not been published in a coherent fashion. For this reason the latter half of the chapter addresses the following question: How dependent is the U.S. economy on wood and other products imported from the world's tropical forests?

A. Fundamental Interests: A Summary

Political Interests:

- The United States has strong commitments to world peace, economic and social stability, and maintenance of the Earth's basic life-support systems, commitments that require concern about the integrity and long-term productivity of the global natural resource base, including the tropical forest component.
- The United States is party to a broad array of international resolutions, strategies, and agreements that call upon all participating nations to promote and undertake improved management of the forest resource.
- U.S. public institutions and private firms conduct activities that directly and indirectly affect the forests of other nations and, therefore, are in positions to influence the attitudes and actions of host governments and local citizens toward the United States by their attention or inattention to sound resource management.

Humanitarian Interests:

- The United States is committed to meeting basic needs and supporting economic and social development in the less developed nations of the world which, in turn, is linked inextricably to the quality and integrity of the world's natural resource base. With increasing frequency, development programs are being affected adversely by deforestation-related problems.
- The United States and other nations have raised humanitarian concerns about indigenous populations whose cultures and very existence may be threatened by destruction of the forests.
- The United States increasingly is being requested by governments and international development organizations to provide technical assistance and financial support for forest-related activities in developing countries.

Economic Interests:

- The non-oil-exporting developing countries purchase one-third of all U.S. exports. Adverse domestic natural resource conditions could seriously affect the ability of these countries to buy U.S. goods and services.
- U.S. economic growth requires a sustained supply of wood and wood products at a reasonable price. The United States will continue to look to imports from tropical countries to help meet the demand for certain hardwood products.
- Sizeable U.S. investment in international development assistance programs can be undercut by deforestation-induced problems (i.e., intensified flooding and siltation).
- The world's closed tropical forests contain numerous little-known or undiscovered plant species, many of which are likely to have important uses as food crops, medicines, resins, and other industrial products. Many others are already used for such purposes.

Environmental Interests:

- U.S. public institutions have statutory and policy responsibilities to protect and manage wisely the environment and natural resources of our Nation, as well as those of other areas within and outside U.S. jurisdiction in which U.S.-sponsored or -assisted activities are carried out.
- The United States shares, with South and Central America and the Caribbean area, hundreds of species of migratory animals, including birds, insects, marine turtles, and mammals, whose survival depends to varying degrees on tropical forests.
- The United States is committed to helping preserve the world's flora, fauna, and vulnerable ecosystems by virtue of domestic legislation and national policies, and by being party to a large number of international conventions and agreements. Principal among these measures are the Endangered Species Act of 1973, the Convention on International Trade in Endangered Species of Wild Flora and Fauna, and the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere.
- Large-scale destruction of the Earth's rain forests runs a risk of triggering global climate change, with uncertain but potentially adverse consequences for world food production and human well-being.

Educational and Scientific Interests:

- The influence of tropical forest ecosystems on global physical, biological, and geochemical processes is poorly understood and requires long-term study.
- The unique flora and fauna of the tropical forests continue to provide outstanding scientific and educational opportunities.

U.S. interests in tropical forests correspond, in general, to those of other nations, both rich and poor. Differences in perspective among and within nations obviously exist, but these relate principally to the relative importance assigned to broad categories of interests.

The United States, for example, might assign a higher priority to the preservation of tropical forest ecosystems and less to commercial exploitation than would some other nations. But virtually all nations share an interest in environmental protection, just as the United States clearly has an interest in continued commercial development and utilization of these resources. Future efforts to improve the preservation, management, and use of the world's tropical forests, therefore, should be based on attempts by each nation to provide for the widest spectrum of its interests. Although the priority and emphasis given to each use will vary from country to country, the common goal should be to insure that the full range of interests are provided for and protected to a carefully considered degree.

B. Economic Interests: An Elaboration

The non-oil-exporting developing countries are a major—and the fastest growing—market for U.S. goods. They already buy over one-third of U.S. exports—the same share as for Europe and the Communist countries combined. The United States is also increasingly dependent on Third World countries for essential raw materials vital to our economy and security. The United States earned more than \$16 billion from direct investments in the developing world in 1978 alone. The large-scale loss of tropical forests can negatively affect the economic growth and development of these countries over the long term, and thus, U.S. interests in these vital areas.

The United States is a major consumer of tropical forest products from both Hemispheres, including those agricultural crops dependent on the hydrologic benefits of forested watersheds. Principal tropical forest products imported by the United States are wood, food, and medicines.

Wood Products: A group of primary forest products termed "tropical hardwoods" constitutes an important category of U.S. imports in terms of dollar value. U.S. imports of these products (tropical hardwood logs, lumber, plywood, and veneer) averaged \$430 million annually during 1974–78, as determined at ports in the exporting countries (U.S. Department of Commerce, Bureau of the Census, 1975–78a, 1979). By value, almost 78 percent was plywood, 16 percent lumber, 6 percent veneer, and less than 0.3 percent logs. Furniture manufactured from tropical hardwoods also is imported, but tropical forest-related statistics are not available.

In terms of volume, tropical hardwood imports in 1976 amounted to only about 1 to 2 percent of the total for softwoods and hardwoods, or about 3 percent of the total hardwoods used in this country.

Total worldwide U.S. hardwood imports for 1978 amounted to \$682 million, with the tropical countries supplying 82 percent of the total, \$146 million directly and about \$416 million indirectly (U.S. Dept. of Commerce, Bureau of the Census, 1978a). The indirect imports were items derived from tropical species but processed in other countries and then imported by the United States. Currently, about two-thirds of domestically consumed hardwood plywood is imported (U.S. Dept. of Commerce, Bureau of the Census, 1978b). U.S. hardwood plywood imports are now five times as great as they were in the 1960s, and reliance on tropical, as opposed to Temperate-Zone, hardwood plywood is increasing (U.S. Dept. of Commerce, Bureau of the Census, 1978b).

Southeast Asian countries supply the United States with the largest share of its tropical hardwood product imports (U.S. Dept. of Commerce, Bureau of the Census, 1978a). The Republic of Korea, Taiwan, and Japan import the raw tropical hardwoods—principally from Indonesia, the Philippines, and Malaysia—and then export a substantial portion to the United States and other countries in the form of semifinished and finished wood products. Direct and indirect U.S. imports from Southeast Asia amounted to 42 percent of the tropical lumber, 99 percent of the plywood, and 72 percent of the veneer imports during 1974–78

(U.S. Dept. of Commerce, Bureau of the Census, 1975–1978a, 1979). In terms of value, Southeast Asian wood, including that processed elsewhere before importation by the United States, comprised more than 90 percent of the total. U.S. imports from tropical America—primarily lumber—were mostly from Brazil, Bolivia, Colombia, Costa Rica, Ecuador, and Mexico.

Tropical hardwood products are used chiefly by the mobile home, residential home, boat building, and furniture industries, and include such products as decorative interior paneling, mouldings, doorskins and other millwork products, boat decking and fixtures, and furniture parts. Hardwood products are normally considered decorative and not essential or critical as are softwood products. Therefore, as hardwood prices increase, lower priced substitute materials may dominate the hardwood market. Top-grade tropical hardwoods, such as teak and the true mahoganies, however, will continue to find a place in the U.S. market. Preference by the U.S. consumer and prices will dictate U.S. hardwood import levels.

Food Products: Many food products exported from tropical countries to U.S. markets depend on irrigation with high-quality water from upland forests. U.S. imports of three major tropical crops—sugar, bananas, and pineapples—were valued at \$915 million, \$310 million, and \$94 million, respectively, in 1977 (U.S. Dept. of Agriculture, 1978). Other food product exports compete with forests for land. In 1977 U.S. imports of such products totaled \$4.3 billion for coffee, \$884 million for cocoa, \$820 million for beef, and \$178 million for tea (U.S. Dept. of Agriculture, 1978).

Products for Medicine: More than one-third of all pharmaceuticals were originally derived from plants. Examples include quinine from cinchona bark, emetine from impecacuanha root, digitoxin from digitalis leaves, sennosides from senna leaves for glucosides, and hormones from dioscorea leaves. Tropical countries are leading suppliers of medicinal plants. In 1974, the United States imported medicinal plants worth \$24.4 million (United Nations, 1974); and prospects for finding and using new medicinal plants from tropical forests are promising. Tropical plants also provide valuable chemical clues leading to the synthesis of drugs in laboratories.

Tropical primates are widely used for medical research; a total of 34,000 were imported into the United States in 1977. They are, however, becoming scarce in source areas because their forest habitat is being destroyed (U.S. Dept. of Health, Education, and Welfare, 1977) and because of losses that result from hunting and nonmedical collecting.

Miscellaneous Products: Tropical forests, as well as temperate forests, offer many nonmedicinal chemical substances that are important to the United States. Such substances include acetic acid, methyl alcohol, and acetone from wood distillation; wood pulping liquors used as tanning agents, adhesives, and binders; tall oil used for naval stores; glucose from wood hydrolysis used in ethanol and yeast; and cellulose polymers used in rayon and cellophane.

Plant products exported from tropical forest areas to the United States include latex of *hevea brasiliensis* (natural rubber). Natural rubber is used primarily in auto vehicle tires, particularly radials, but also is important in the manufacture of surgical gloves and related items. U.S. imports of natural rubber increased from 711,000 tons in 1973 to 803,000 tons in 1978, the latter being valued at over \$679 million (U.S. Dept. of Commerce, Bureau of the Census, 1978a).

Other tropical plant products are used in the United States by the food and beverage, perfume, cosmetic, and dyeing industries. Licorice is used in confectionery products and as a flavoring agent for tobacco; gum arabic is used in candies and soft drinks; papain is used in brewing and as a meat tenderizer; and quinine is used in the soft drink industry. Other tropical forest products such as palm hearts and Brazil nuts are sold directly as food. U.S. imports of Brazil nuts alone exceeded \$16 million in 1977 (U.S. Dept. of Agriculture, 1978).

U.S. Policy on Tropical Forests: A Recommendation

This Nation's aspirations and commitments for improved tropical forest management should be set forth in a general statement of U.S. policy. Such a policy statement would have both symbolic and pragmatic value. It would help U.S. officials proclaim U.S. interests and positions on tropical forests in international fora. And, it would encourage and assist U.S. public and

private institutions in designing and justifying new programs in this field.

The following general statement of U.S. policy is thus recommended—a statement that subsumes and directs U.S. goals, strategies, and programs proposed in Chapters 8 and 9 below.

IT IS THE POLICY OF THE UNITED STATES TO:

1. Recognize the importance and vulnerability of tropical forests in the conduct of this Nation's domestic and international affairs.
2. Pursue, in concert with other nations, policies and programs to sustain the integrity and benefits of tropical forests, as part of a broader effort to protect and maintain basic life-support systems.
3. Collaborate internationally, working through both bilateral and multilateral channels, to increase the social and economic benefits obtained from tropical forests, while concurrently protecting environmental values.
4. Support other nations' efforts to improve their standards of living in a manner that will reduce destructive pressures on the forest resources on which they depend.
5. Encourage an international investment climate for private and public capital which stimulates and rewards sound forest management practices and efficient forest resource use.
6. Contribute to the international effort to designate and maintain representative tropical forest areas, such as biosphere and ecological reserves, national parks, wildlife refuges, natural areas, and multiple-use forests.
7. Seek to protect and manage U.S. tropical forests in an exemplary fashion.
8. Conduct a strong domestic research and development program designed to help the international community maintain, protect, and manage tropical forests—and share the results widely.
9. Expand training and educational programs in U.S. public and private institutions to increase the pool of U.S. expertise on tropical forests, and to provide expanded opportunities for participation by specialists and students from other countries.
10. Encourage and assist U.S. public and private institutions to pursue their overseas programs and activities in a manner that promotes good stewardship of the host countries' forest resources.
11. Promote a strong partnership between U.S. public and private sectors in support of this policy.



Goals

An effective U.S. response to worldwide tropical forest needs and opportunities must be based on well-defined goals. The Task Force, therefore, addressed these questions: What conditions do we wish to see reached with respect to the world's tropical forests within the next 5 years (by 1985)? Over the subsequent 10 years (by 1995)? And by the year 2000 beyond?

The United States cannot set goals for other countries. It seems possible and useful, however, to set forth a series of goals to guide future U.S. efforts that would be in harmony with those most other nations might develop. Good insights are provided by the tenor of recent international discussions and reports on the subject, as the result of bilateral consultations, and by what is otherwise known about the attitudes and interests of other nations. In this regard, the goals statement should provide a useful vehicle for U.S. officials in international fora to stimulate discussion on the subject and thereby improve U.S. knowledge of the views, attitudes, and aspirations of others.

The goals evolve from three key assumptions: (1) Tropical forests have intrinsic values of such importance to mankind that some of them deserve to be maintained for present and future generations; (2) Nations will collaborate toward that end if their peoples' basic needs can concurrently be met; and (3) Immediate steps must be taken by nations, individually and collectively, if tropical forests are to remain a major viable global ecosystem in the next century.

Forests cannot be dealt with as an independent resource. Improved forest management ultimately must be addressed within a broader framework of national economic development goals designed to provide food, shelter, energy, raw materials, and manufactured goods for domestic use and export. In addition, forest management must become an integral part of rural development and regional land-use planning. Because tropical forests heretofore have been a largely neglected resource on a global scale, establishing goals specifically dedicated to them can only be rationalized. By so doing, this vital resource will command a stronger "voice at the table" when broader regional and national goals, strategies, and programs are discussed and implemented.

Short-Term Goals (1-5 Years)

By 1985, the following goals should be met through an accelerated international effort on tropical forests—one in which the United States should play a prominent role:

• *Policy commitments* by virtually all countries and international and regional organizations to adopt and pursue practices and programs that foster sound, long-term forest resource management.

• Design and initiation of an *internationally coordinated action program* for tropical forests, involving research, monitoring, training and education, information exchange, technical assistance, and management demonstration.

• Doubling of the current annual rate of *reforestation and afforestation* worldwide.

- Completion of a comprehensive *worldwide analysis* of the causes and rates of *tropical forest loss*, including socioeconomic factors, and the magnitude and trends of the impacts.
- Substantial increases in *international research and development* efforts devoted to improved forest management methodologies and technologies; ecosystem dynamics and plant and animal ecology; commercial forestry operations and efficiency; and marketable forest product uses.
- Launching of a major, internationally coordinated effort to develop and introduce alternative *low-cost energy and food production* systems into rural areas.
- Initiation of an international program to inventory, evaluate, classify, and catalog *unique forest, plant, and animal types*.
- Expansion of *national parks, wildlife refuges, ecological and biosphere reserves, and similar protected areas* by at least one-third (on a total worldwide basis), as part of the effort to maintain representative tropical forests and to preserve the greatest possible diversity of plant and animal life.

B. Medium-Term Goals (6-15 Years)

By 1995, the following goals should be achieved:

- Significant reduction in the present deforestation rate, with any large-scale land clearing the result of deliberate, enlightened decisions by governments and local communities.
- Availability, in virtually all tropical forest countries, of revised policies and laws, national planning priorities, and improved institutions and management capabilities dedicated to sound forest resource management.
- Commitment and action programs by virtually all countries for preservation and study of representative and unique forests, protection of people who inhabit the forests, and continued expansion of biosphere reserves and protected areas.
- Increased wood and wood product manufacture to meet expanding consumer demand, with expansion provided increasingly from plantation forestry, including village woodlots, and from natural forests managed for multiple use, rather than from the opening up of remaining virgin forests.
- Expanded application of sound management methods for sustained yield harvesting of plant and animal resources in tropical forest ecosystems.
- Adequate understanding of forest-carbon dioxide-climate relationships on which to assess potential consequences of additional deforestation and reforestation on global climate.

C. Long-Term Goals (2000 and Beyond)

The following goals are suggested for the turn of the century and years beyond:

- A stabilized global situation in which a broad mix of tropical

forest values exists and is maintained—including commercial forestry plantations; natural areas; and multiple-use forest areas devoted to wood and food production, biomedical products, wildlife, and other values. At this stage, total worldwide forest areas should be relatively static or expanding, as reforestation and afforestation efforts offset cutting and other losses.

- Adequate knowledge of biological and soil characteristics, ecosystem dynamics, and land-use effects on which to base sound tropical forest management in the future.
- Success by the international community in providing food, shelter, and energy for the poor, and success in slowing population growth and regulating migration and land-use patterns, to relieve and control forest resource pressures.

A Strategy and Program for the United States

In approaching the challenge of defining a U.S. strategy and program responsive to the policies and goals set forth in Chapters 7 and 8, the Task Force was guided by two objectives. Most important are (a) to identify a selected number of broad strategy elements to serve as vehicles for clustering U.S. program activities and directing them toward the desired goals; and (b) to recommend specific program activities related to each that should be carried out on an immediate, high priority basis. Second, the Task Force considered necessary the provision of a comprehensive, flexible program framework to guide and assist U.S. institutions in planning, selecting, and justifying an expansion of their tropical forestry activities over the longer term, as well as to facilitate improved integration and coordination of future activities.

The discussion and recommendations that follow emphasize responsibilities of U.S. Federal Agencies. However, an attempt has been made to construct the strategy and program framework in a manner that will also serve the interests and needs of the U.S. private sector (universities, private industry, foundations, State agencies, and professional organizations) and attract and receive its broad support. Indeed, the tropical forest "policy, strategy, and program" being recommended by the Task Force is premised on the belief that a new partnership of U.S. Government and non-Federal organizations and institutions must be forged to address the urgent task of improving tropical forest protection and management.

A. Strategy and Short-Term Program Priorities

Although the United States should intensify its efforts to assist other countries in tropical forest management, some constraints — both potential and actual — limit what the United States can and should aspire to do. The constraints include:

- Sensitivity of governments to a possible infringement by other nations on their sovereign rights over use of indigenous natural resources.
- Problems of finding a useful and accepted place and status among the array of well-established national and international institutions that have been active in tropical forest management longer than the United States.
- Difficulties in reconciling differences among countries regarding economic and environmental values, particularly regarding poor country needs to maximize the economic benefits of indigenous resources over the short term.
- The complex and sometimes unfamiliar (to U.S. experts) sociocultural beliefs, values, and behavior patterns in tropical countries that exert a strong influence on the success or failure of new practices and technologies.
- Shortage of U.S. experts who are trained in tropical ecology and tropical forestry, and who also possess adequate foreign language skills.
- Funding limitations for new U.S. program activities.

Nonetheless, the United States should be able to do much more than at present. Drawing on its awareness and concern, its scientific and technological capabilities, and its influence in international organizations, the United States can provide new direction and leadership through actions and activities it undertakes or supports domestically, bilaterally, and multilaterally.

A strategy for pursuing this opportunity must recognize that the ultimate responsibility for effecting change lies within those countries possessing the forest resource. It also must recognize that U.S. motives and credibility may be subject to challenge and skepticism because of pressures placed on the world's tropical forests by U.S. consumer demand and by various policies and practices of U.S. public and private institutions.

The following strategy elements and short-term program priorities are presented according to what the United States should do internationally, and what it should do domestically, including strengthening of U.S. institutions to support international efforts.

A lead U.S. Government institution (or institutions) is identified for each of the program responses listed under the individual strategy elements. The Task Force proposes that the designated institution(s) assume primary responsibility for implementing the program activity, including solicitation of active participation by other Federal Agencies and non-Federal institutions.

International Strategy Elements:

1. **Raise worldwide awareness of the importance of improving tropical forest resource management and utilization.** Although significant progress has been made over the past 2 to 3 years, further expansion and a deepening of interest is a prerequisite to effective action.
 - Seek out and utilize, in a coordinated, integrated fashion, a range of regional and international fora to highlight issues and build awareness and support (in particular, the UN General Assembly and the UN Economic and Social Council, including its Committee on Science and Technology and Committee on Natural Resources; the Organization for Economic Cooperation and Development (OECD); the ECE Timber Committee; other UN Regional Economic Commissions; United Nations Conference on Trade and Development (UNCTAD), FAO, United Nations Environment Programme (UNEP), and UNESCO; the Association of Southeast Asian Nations; and the Organization of American States) — U.S. Department of State, International Development Cooperation Agency (IDCA).
 - Expand the dissemination of U.S. information on the tropical forest situation and possible solutions, utilizing U.S. International Communications Agency (USICA) programs, U.S. Embassies and Missions, and channels established by non-Federal organizations — USICA, State, AID, Department of Agriculture.
 - Integrate forest management considerations systematically into consultations with other countries on development as-

assistance programs and into science and technology agreements — IDCA, State, Agriculture.

2. Pursue commitments by governments to a concept of designating, reserving, and managing portions of their total forest resource for a variety of separate uses (e.g., commercial forestry, agriculture, habitat protection, and recreation). Although forest loss is accelerating, large areas of tropical forests throughout the world remain and can be placed under sound management — some 60 percent of the historical total. Some governments are already acting to promote better use and management of the remaining resource and to protect noncommercial values.

- Assess domestically whether new regional or international agreements or conventions on tropical forest management should be pursued by the United States, and whether any existing bilateral and multilateral accords on natural resources management or environmental protection should be strengthened in this area — State.

- Support the U.S. MAB Program, within the context of the overall UNESCO strategy, particularly to help expand the international system of biosphere reserves to cover representative tropical forest ecosystems — All Agencies, U.S. MAB Program.

- Encourage and support development of methodologies, guidelines, systems, and pilot and demonstration projects for integrated land-use planning and forest management, through U.S. bilateral programs and agreements, UN Regional Economic Commissions, multilateral lending institutions, UN specialized agencies, and regional development agencies — IDCA, AID, Institute for Scientific and Technological Cooperation (ISTC), Agriculture, State.

- Build international support for, and contribute to, an accelerated worldwide effort to inventory, collect, and classify unique tropical forest flora and fauna, and to search for and exchange economically valuable crop germ plasma and other heretofore unexploited plants (working through the International Union for Conservation of Nature and Natural Resources (IUCN), FAO, UNEP, UNESCO, and World Wildlife Fund, in particular) — State, Interior, National Science Foundation (NSF), Agriculture, Smithsonian.

- Explore internationally new incentives and forms of assistance to governments committed to improved forest management but which lack the necessary institutional, managerial, or financial resources — State, IDCA.

3. Promote an international division of labor and a coordinated action program on tropical forest research, monitoring, data exchange, training and education, technical advisory services, and public awareness. Significant improvements in program efficiency and prospects for sound forest management are possible through coordinated planning by governments, international organizations, and private institutions.

- Provide strong U.S. support for the international meeting on tropical forests scheduled to be held in Nairobi, Kenya, February 25–March 1, 1980, and for regional followup meetings — State, Interagency Task Force on Tropical Forests.

- Work through international, regional, and bilateral channels, including the 1980 Kenya Conference and

followup meetings, to evaluate whether new international or regional mechanisms or centers (e.g., for research and training) are desirable and supportable — State, IDCA, AID.

- Instruct U.S. representatives to international bodies and official delegations to press for a higher priority to tropical forest activities within the programs of international and regional organizations (e.g., FAO, UNESCO, UNEP, Economic Commission for Latin America (ECLA)), and also for improved cooperation and coordination among these organizations — State, IDCA.

- Promote expanded regional cooperation within the Western Hemisphere as a special priority, because of the convergence of U.S. resource management and wildlife conservation interests with those of many South and Central American countries and Canada — State, Interior, Agriculture.

4. Encourage and support the strengthening of national institutions, policies, laws, and administrative mechanisms. Many countries lack the institutional and legal/administrative capacity necessary to implement improved forest management practices and programs. Over the long term, this may well be the single most important factor in protecting the world's forests.

- Expand U.S. technical and financial assistance for institution building in tropical developing countries, including assistance for indigenous, private forest owners and managers committed to improved management — AID, ISTC, Peace Corps, Agriculture.

- Encourage and support country assistance efforts by FAO and other international and regional organizations, particularly with respect to national policies and plans for the forest sector, legal/administrative arrangements, and economic marketing analyses — State, Agriculture, IDCA, AID.

- Urge and assist governments and international organizations to systematically undertake preproject environmental assessments designed to evaluate potential impacts on the forest and vegetative resources, and to examine alternatives — IDCA, State, Council on Environmental Quality (CEQ).

5. Improve the international information base on causes, trends, and consequences of deforestation, as well as on the status and results of reforestation and afforestation programs. Opinions differ on the roles and magnitudes of various forest loss sources, and on what remedial measures are most effective. Better information is vital for the design of well-focused, appropriate responses.

- Use the 1980 Kenya Conference to encourage a broad-based international effort to improve the information base, with FAO serving as the coordinator and central repository — State.

- Expand the U.S. information and data base, particularly to fill information gaps regarding commercial activities involving wood and beef imports, to guide short-term policy and program planning, and to serve as a U.S. contribution to the recommended international assessment effort — State, Commerce, AID.

- Urge and assist with the design and implementation of an operational monitoring and assessment system for

tropical forests within the Earthwatch Program administered by UNEP—State, AID, National Aeronautics and Space Administration (NASA), Agriculture.

- Encourage and contribute to international research on the carbon dioxide-deforestation relationship within the framework of the World Climate Program, and involving international nongovernmental bodies such as the Scientific Committee on Problems of the Environment (SCOPE)—Department of Energy, NSF, State, National Oceanic and Atmospheric Administration (NOAA), NASA.
6. *Seek to intensify efforts to address the root causes of expanding pressures on tropical forests, particularly poverty, unemployment, food and energy deficiencies, and population growth.* Although the tropical forests and associated resources deserve a greater emphasis and special focus—the purpose of this report—many keys to maintaining forests and their values for present and future generations involve effective actions taken in other sectors.
- Work multilaterally, bilaterally, and domestically to build increased support for assistance to developing countries in the areas of food production, fuel supply, forestry planning, land reform, rural employment, and family planning—State, IDCA, AID, Agriculture, Peace Corps.
 - Conduct and encourage cost-benefit studies of economic development-forest loss linkages to help clarify and articulate the values of natural forests as well as of their conversion to farmland, tree plantations, and other developmental uses—AID, ISTC, Agriculture.
 - Support efforts in developing countries to increase rural employment and income generation from natural forests to make them more competitive with alternative land uses—AID, Peace Corps.
 - Continue and strengthen U.S. support for the International Sahel Development Program, particularly the forest sector component, as an opportunity to address the economic implications of vegetation losses within the framework of a pressing socioeconomic situation—AID, Peace Corps.
7. *Promote an international climate in which improvements in commercial forestry operations are encouraged and rewarded, and can be achieved without jeopardizing output or international investment and marketing conditions.* Significant improvements in commercial forestry appear possible, in terms of increased efficiency and production, through improved management and by placing long-term output on a sustained yield basis. A stable investment climate must exist, however, and forward-looking firms must not be penalized in the marketplace for innovation and resource conservation measures.
- With U.S. industry cooperation, initiate efforts through appropriate international organizations (including the OECD, UN Economic Commission for Europe (ECE) Timber Committee, UN Conference on Trade and Development (UNCTAD), and (FAO)) to develop an international policy on the use and management of tropical forests for commercial purposes, to be adopted by most or all countries with public or private sector activities—State, Commerce.
 - Work within the new international arrangements being developed under UNCTAD auspices to promote improved forest management, industrial reforestation, research and development, and market intelligence—State, Commerce, Office of the Special Trade Representative.
 - Consult (through U.S. Embassies and Missions) with tropical countries on steps that can be taken to encourage and help private industry to carry out commercial forestry on a resource-conserving, sustained-yield basis—State, AID, Commerce.
 - Encourage and assist the international scientific community and U.S. private industry to accelerate research, demonstration, and application in plantation forestry, sustained-yield management, use of secondary species, and elimination of waste in forestry and wood manufacturing operations—ISTC, Agriculture, AID, Commerce.
8. *Accelerate, on an urgent basis, U.S. and international efforts to develop and introduce alternative technologies and methodologies that will reduce pressures on tropical forest use.* Good possibilities exist in such areas as reforestation, plantation forestry, more efficient use of tree species and wood residues, wood stove design improvements, charcoal production efficiency, and agroforestry; and these should be vigorously pursued as breakthroughs will have significant positive effects on the forest resource.
- Use the 1981 UN Conference on New and Renewable Energy Resources, including the preparatory phase, as a principal mechanism to stimulate intensified international research and development on solar and biomass substitutes for fuelwood, and to promote the planting of rural and urban woodlots—State, AID, Agriculture, Energy, ISTC.
 - Encourage and support agroforestry research, demonstration, and application—including financial support for the International Council on Research in Agroforestry (ICRAF) as a vehicle for international guidance and information exchange; provide assistance to regional centers such as CATIE in Costa Rica; and encourage increased priority by the FAO and U.S. institutions for evaluation, documentation, and promotion, where appropriate, of "local lore" as practiced by indigenous forest inhabitants—ISTC, AID, Peace Corps, NSF, Agriculture.
 - Urge the FAO and appropriate regional organizations to expand development, demonstration, and information exchange on: reforestation and afforestation techniques; plant species best suited for such purposes in various tropical areas; and rapid, low-cost methods for land-use classification and soil and resource surveys—Agriculture, AID, State.

Domestic Strategy Elements:

1. *Insure that U.S. tropical forests are managed wisely and that representative areas are preserved in a natural state.* This step is critical if the United States is to press internationally for such goals with credibility and success.

- Undertake a study of the state of U.S. tropical forests, the pressures they are under, and needs and opportunities for improved management — Agriculture, Interior.
2. **Insure compatibility between U.S. economic, development assistance, and domestic environmental policies, and U.S. programs for maintaining the world's tropical forests.** Potential for conflict exists, and an examination of the degree of compatibility and possible modifications is a prerequisite for resolving any contradictions, uncertainties, and allegations.
 - Evaluate the positive and negative influences of current and proposed U.S. economic, development assistance, and environmental policies on tropical forest ecosystems throughout the world, and consider whether any changes are desirable — Commerce, Treasury, AID, CEQ, and Office of the Special Trade Representative.
 - Seek commitments from all U.S. Government Agencies that their activities' potential impacts on tropical forests will be addressed systematically in the conduct of their international environmental assessment responsibilities, and that forest resource-conserving alternatives will be considered when significant loss is indicated — CEQ, State.
 3. **Raise the level of U.S. citizen awareness and understanding of: (a) the impact their preferences and actions as consumers have on tropical forests; (b) the nature, problems, and potentials of tropical forests and their significance to the United States; (c) the need for the United States to participate with other nations in alleviating the problems; and (d) how the individual citizen can play a role in helping achieve improved tropical forest resource management and utilization.**
 - Further quantify and verify the effects of U.S. consumer demands on tropical forests — Commerce, State.
 - Enlist the support of the U.S. Congress and the news media in focusing public attention on the significance and problems of tropical forests, including our own — Interior, Agriculture, Commerce, State, IDCA.
 - Expand the flow of Government information about U.S. tropical forest interests and activities — All Agencies.
 - Pursue expanded public sector/private sector collaboration in support of this strategy element, such as Federal cooperation in the preparation of the Tropical Forest Bulletin by the Natural Resources Defense Council and on the information distribution activities of the Organization for Tropical Studies and the Society of American Foresters (and its World Forestry Committee) — State, Commerce, Agriculture, Interior, IDCA.
 4. **Strengthen U.S. contributions toward an expanded international effort.** This strategy is predicated on the need for an expanded, better coordinated, and more sharply focused international effort.
 - Call upon individual U.S. Government Agencies, the university community, private industry, and the environmental community to develop, articulate, and implement new policies and programs for contributing to improved management and utilization of the world's tropical forests¹ within existing budgetary constraints — U.S. Interagency Task Force on Tropical Forests.
 - Assign high priority to tropical forest research, education and training, demonstration, and management within the U.S. bilateral development assistance program; and expand technical and financial assistance to countries which have serious tropical forest loss problems or wish to prevent them and which demonstrate a strong commitment to improved forest management — IDCA, AID, Peace Corps.
 5. **Strengthen U.S. Government institutional capabilities.** Although U.S. Government Agencies are beginning to respond to tropical forest needs with new programs and resource commitments, a significant redirection and possible strengthening of programs, personnel, and financial investment is required if a strong U.S. response, commensurate with the recommendations of this report, is to be mounted.
 - Analyze the tropical forest-related mandates, programs, and supporting resources (funds and personnel) of each Federal Department and specialized Agency, and modify them as required — All Government Departments and Agencies with the assistance of the U.S. Interagency Task Force on Tropical Forests.
 - Evaluate U.S. Government and university institutional capabilities for tropical forest research, demonstration, monitoring, training, and education; and recommend strengthening as appropriate, including the possibility of designating "centers of emphasis" in various areas — Agriculture, NSF, Interior, ISTC.
 - Determine how the integrated resource management approach and capabilities of the U.S. Man and the Biosphere (MAB) Program can be applied more effectively in the tropical forest area — State, Interior, Agriculture, AID.
 6. **Forge a new partnership of government, industry, academia, and the environmental community in support of the proposed "U.S. Policy, Strategy, and Program on Tropical Forests."** The fundamental goal of preserving and maintaining forests for a broad mix of uses (commercial, natural areas, and others) is widely recognized, and provides a basis for improved cooperation among various U.S. interest groups.
 - Maintain and expand the U.S. Government's dialogue with private industry representatives and others in the non-Federal community begun by preparation of this report — U.S. Interagency Task Force on Tropical Forests.
 - Obtain from industry and the environmental and university communities additional information about their international operations, activities, and interests which can serve as a base for future U.S. Government program planning and interactions with the private sector — U.S. Interagency Task Force on Tropical Forests.

¹The Task Force is pleased to note that new policies and programs specifically directed toward tropical forests already are under development by the Department of Agriculture (Forest Service), AID, Department of the Interior, NSF, and the Peace Corps.

- Promote greater participation by the U.S. private sector (foundations, industry, universities, and environmental groups) in the development of the Federal Government's plans and programs in tropical forests to make better use of private sector information, ideas, and capabilities — U.S. Interagency Task Force on Tropical Forests.

B. Principal Program Components

A number of "short-term" program activities were recommended in Chapter 9-A as immediate next steps. This section, (9-B), presents the recommended components of a comprehensive and longer term U.S. program. It does not set forth specific, detailed project recommendations or funding proposals. Rather, it is intended to serve as a broad planning and programing framework to bring together and focus existing U.S. strengths and to guide the development of new capabilities and programs into areas where critical global needs converge with ongoing U.S. institutional interests.

Priorities have not been designated among or within the various program components, partly because the need for expanded and accelerated work exists in all areas. For example, although efforts to make better use of existing knowledge and technology deserve immediate high priority attention, so too does intensified research to discover new knowledge and management techniques.

But perhaps more importantly, priorities are not assigned because the specific scope and focus of the U.S. program will largely be determined by needs and interests of cooperating tropical countries. Thus, priorities, to the degree that they can be set, should be developed in consultation with those countries. To some extent, this assertion is an oversimplification because the United States can and should, through leadership and other means, attempt to influence in a significant way the kinds of cooperative programs to be carried out. However, the Task Force suggests that a combination of opportunism and leadership may be the most effective means for achieving the goals outlined in Chapter 8.

Similarly, consideration was given by the Task Force to limiting the scope and components of a U.S. tropical forest program by selecting certain types of activities that the United States should carry out *viz-a-viz* those we would look to other countries and international bodies to undertake. Such an approach, however, would reduce opportunities for competent U.S. investigators to attract support for promising work that might fall outside a restrictive U.S. program framework. For example, although the United States clearly will look to ICRAF, FAO, CATIE, and other institutions to carry out the bulk of research, training, and demonstration in agroforestry, several U.S. investigators and institutions can also contribute significantly to the work, and should not be deterred.

Eight program components are recommended by the Task Force as building blocks for a new U.S. effort on tropical forests: (1) international cooperation; (2) bilateral development assistance; (3) research and demonstration; (4) training and education; (5) resource monitoring; (6) environmental assessment; (7) information and data exchange; and (8) involvement of the non-federal sector. These components cover a wide spectrum of activities, many of which are comparatively unrelated, but all of which fall within areas of U.S. interest and capability.

The Task Force proposes that these eight components be used as an initial framework for examining all public and private U.S. tropical forest activities, and for purposes of consultation

with tropical countries and other interested parties. One principal objective of this examination would be to determine if greater efficiency and effectiveness might be achieved through increased interaction among U.S. institutions, and also with foreign and international organizations. In addition, an evaluation should be made of the possibilities and potentials of combining smaller U.S. efforts into larger programs, and then integrating them into broader efforts at the regional and international levels.

1. INTERNATIONAL COOPERATION: To duplicate the tropical forestry work now underway elsewhere or to ignore the years of experience and knowledge accumulated by other nations, international bodies, and U.S. institutions would be wasteful. Past efforts and results must be recognized, and ongoing efforts must be strengthened and complemented by integrating new activities into existing programs through systematic coordination and collaboration among sponsoring organizations. Capital investments in industrial forestry by other donors, for example, might be complemented by U.S. support for extension work to involve local people in growing trees.

As amply demonstrated by the European countries, participation in the FAO Associate Expert Program can be an effective way to build a country's basic cadre of qualified tropical forest specialists. Not only can returning Associate Experts provide the core for a country's domestic program, but they can also serve as candidates for future positions in UN technical organizations. U.S. participation in the FAO Program could be the springboard for increased involvement in UN resource-related organizations.

The Swedish-supported FAO program "Forestry for Local Community Development" is a concrete example of how bilateral and international funds and expertise can be combined. Such arrangements are especially advantageous to countries in which tropical experience is limited, such as the United States. The United States should consider developing similar cooperative programs.

Specialized organizations, such as the International Council for Research in Agroforestry (ICRAF), offer excellent opportunities for the United States to collaborate with other donors, and to pool resources and expertise. The United States should evaluate carefully the advantages of supporting this institution and others like it, both financially and through personnel exchanges.

United States bilateral government-to-government agreements on science and technology also afford potentially useful mechanisms for engaging other nations in tropical forest research, training, demonstration, education, and management application. For example, the 1979 United States-Mexico Agreement on Arid Lands Management and Desertification Control identifies tropical forestry as one of a selected number of areas for collaboration.

The U.S. Congress has recognized the need to utilize international organizations more effectively to address worldwide natural resource management problems. For example, the Departments of Treasury and State have been requested to use their influence in the International Development Banks, in regional development banks, and with other bilateral donors to call attention to the fuelwood problem and urge its solution by those organizations (U.S. Congress, 1980).

2. BILATERAL DEVELOPMENT ASSISTANCE: Official U.S. bilateral assistance to developing tropical countries is administered through a number of U.S. Government programs. In addition, U.S. private, voluntary, and non-Government organizations commonly play roles in helping to implement U.S. Government programs, and many also are involved independently in cooperative efforts and assistance projects in tropical countries. AID, operating within the framework of the new International De-

velopment Cooperation Agency, administers by far the largest part of the official U.S. bilateral development assistance program under the U.S. Foreign Assistance Act. Other Federal Agencies, such as the Peace Corps, also are deeply involved, although their programs are smaller in scope and funding levels. However, the Peace Corps has the most direct-hire U.S. personnel working overseas in forest management and directly related activities.

Under an amendment to the basic Foreign Assistance Act, entitled the "International Development Cooperation Act of 1972," AID is authorized to "provide assistance for forestry projects which are essential to fulfill the fundamental purposes of this section. Emphasis shall be given to community woodlots, agroforestry, reforestation, protection of watershed forests, and more effective forest management."

In addition, President Carter, as a followup to his Environmental Message of August 2, 1979, directed AID to give high priority to programs which advance the following objectives:

- Preservation of key natural forest ecosystems and their rich plant and animal life complex;
- Multiple use of highly diverse tropical forests, including management of natural stands, development of ecologically sound forest plantations, and combined agriculture and forestry;
- Increased yields in family-scale tropical agriculture to relieve pressures on forest lands that are not suitable for cultivation; and
- Integrated projects for reforestation, more efficient fuelwood use, and alternative energy sources.

To be responsive to recent congressional and Presidential mandates and to the strategy and program recommended by the Interagency Task Force in this report, U.S. bilateral assistance must meet the social and human needs of each cooperating country in a manner that optimizes forest resource contributions to the development process. Conversely, improper management of this resource runs the risk of undercutting and offsetting the benefits anticipated from investments in other development assistance sectors (e.g., water projects). Assistance in forest management and related areas should involve technical, financial, and material support; and in many instances should include a combination of research, education, training, and institution-building (particularly for field extension work, administration, management, and planning). In carrying out an expanded U.S. bilateral assistance effort in the tropical forest management area, the Task Force recommends special attention to the following:

- *Meeting critical basic needs for food, fodder, fuel, water, and wood materials that are linked to tropical forest depletion.* Assistance efforts should include planting programs for fuelwood and community woodlots, intensive plantation forestry for wood production, development and application of alternative energy sources, agroforestry, watershed protection and rehabilitation, surface and groundwater development, land reform, and protection of indigenous peoples' cultures.
- *Forest resource inventory, remote sensing, and assessment aimed at providing baseline information needed to improve allocation of forest land use.* Assistance activities should support allocations based on criteria of soils, vegetation, wildlife, topography, and socioeconomic factors.
- *Watershed, rangeland, and forest management aimed at sustained use for a wide spectrum of commodity and noncommodity needs.* Assistance should focus on improved management for fuelwood, wood products, livestock, wildlife, fish, recreation, and water resources.
- *Protection and conservation of forest lands with special emphasis on long-range values.* Assistance should include

studies of ecosystem diversity and dynamics; composition and value of flora; and collaboration with countries to help designate, set aside, and manage representative areas including parks, wildlife reserves, and multiple-use forests.

3. RESEARCH AND DEMONSTRATION: Information with which to make enlightened decisions on tropical forests often is scarce or unavailable for resource planners and managers. The ecological, social, and economic effects of activities that modify or remove forest cover are not fully known. Knowledge about the cultures and needs of indigenous human societies—most important, those undergoing rapid modernization—is singularly lacking. In some localities, most plants and animals do not yet have scientific names. And their numbers; interrelationships; physical, chemical, and biological attributes; and values to society are not known.

To fill these information gaps, a worldwide expansion is needed of both short-term applied research and demonstration, and longer term, more fundamental (or basic) research. Demonstration projects can provide a bridge between research, both applied and basic, and on-the-ground extension work to actually apply the results.

The United States is a world leader in research and demonstration, with strong capabilities in both the public and private sectors. Some institutions already are focused on tropical ecosystems; others should be encouraged to become involved and then be assisted accordingly. A strengthened and expanded research and demonstration effort is thus perceived by the Task Force as an essential component of a new and coherent U.S. program on tropical forests.

The following sections describe general research needs areas which the U.S. program should address. Additional details (particularly on basic research), will be presented in a major U.S. National Academy of Sciences report "Research Priorities in Tropical Biology," soon to be released (U.S. National Academy of Sciences, in press).

With respect to *applied research*, the Task Force recommends the following as high priority needs:

- *Reforestation and afforestation.* Studies are needed to demonstrate which species in a given area are best suited for fuelwood, wood products, fodder, fertility improvement, and erosion control. Better information is needed on nursery establishment, planting methods, livestock control, and protection of plantations from insects, diseases, and fire. Research should also be carried out on species composition, spacing, and configuration of trees for shelterbelts and sand dunes.
- *Alternatives to fuelwood, such as biogas, solar energy, wind, and other wood substitutes.* Work is also needed to develop more efficient, culturally acceptable cooking stoves and heaters as well as charcoal manufacturing techniques.
- *Industrial forestry and resource conservation.* Only a few tree species are used for industrial purposes, while the lesser known or "secondary" species are ignored for lack of knowledge on how to utilize them economically. Research is thus needed to find economic uses for heretofore unutilized species and also for mixed species. In addition, investigations should be expanded to develop methods and technologies for reducing wood losses during harvesting, transporting, storing, and processing.
- *Remote sensing applications.* Basic principles are well known, but additional work must be done before remote sensing can be fully applied as a reliable tool for land and resource inventory, classification, and monitoring in tropical settings with mixed vegetation.

- *Integration of forest management into comprehensive rural development.* Answers are needed to the following: How can multiple-use management of natural forests for wood products, fuelwood, livestock, water, wildlife, and other uses contribute to rural development programs? What are ecologically and economically sound patterns of integrated forest, range, pastoral, and agricultural land use? What are effective incentives for individuals, communities, and enterprises to engage in sound forest management practices?
 - *Forest economics research.* It is known, for example, that deforestation can have major effects on reservoir siltation water and downstream supply. Concrete data are lacking, however, to support claims that erosion control through reforestation (or the prevention of the initial deforestation) is an economically justifiable part of river basin development. Some research on the economic value of wildlife management has been conducted but much remains to be done. The economics of forest plantation culture, multiple-use management of natural forests, and agroforestry are also poorly understood.
- With respect to *basic research*, the Task Force proposes that the U.S. program focus on the following:
- *Sociocultural and economic factors in tropical forest management.* Further insights are needed into how people in traditional cultures respond to development, and into the nature of sociocultural constraints on human adaptation to modern or changing conditions. Studies should include evaluation of settlement and migration patterns; social problems associated with adoption of new technologies; and the role of traditional systems of land management and food production in modern societies, including attributes of local commercial forestry operations and agroforestry production systems.
 - *Forest communities as natural systems.* This effort involves studies of organic production: cycling of nutrients and other materials; changes of environmental conditions, plants, and animals over time (succession); and responses to stress (particularly human interventions). Such knowledge is essential for management purposes because it integrates all environmental relationships and allows prediction of the effects of one part of the system on the others. The study of natural changes in representative undisturbed tropical forest types would be useful as baseline information in comparison with areas where the vegetation has been disturbed or removed. Studies should include measurements of change in soil, microclimate, mineral retention and recycling, forest composition and structure, species diversity, and overall system stability. The comparative studies of disturbed and undisturbed ecosystems being carried out under the MAB Program exemplify the type of work that is required, and these should be expanded.
 - *Rates of faunal and floral extinction from forest loss.* Additional basic research must be done to inventory and classify tropical plants and animals so that unique genetic information and values are not unknowingly lost. Key sites of special biological value should be identified and studied. In forests likely to be lost, urgent steps should be taken to collect, preserve, and study representative resident organisms.
 - *Impact of large-scale development on man and the natural environment.* Studies on the scale of river basins or subnational political areas should be conducted to characterize and evaluate the interaction between human-dominated and natural systems, including tropical forests. Such investigations will help, in particular, to establish the minimum size of tropical forest areas which can be sustained as viable, complex ecosystems.
 - *Relationships between tropical forests and climate.* In ur-

gent need of clarification is the question of whether, in fact, large scale tropical deforestation impacts significantly on global climate, and also how it might affect regional and local climate and weather. This will require expanded research on the effects of tropical forests on the global carbon dioxide cycle; and on the relationships between loss of forest cover and surface reflectivity, soil moisture and heat balances, and changes in atmospheric water balance and precipitation patterns.

4. TRAINING AND EDUCATION: The training of professionals and technicians takes on special importance in the Tropics, where trained staff is generally in short supply. Listed below are some ways in which the United States can, and should, assist tropical countries in training forestry and natural resource personnel.

The technical training of foreign nationals generally can be accomplished more cheaply, and be more relevant, at institutions in their own country or in a nearby tropical country. The training of tropical forest rangers, for example, traditionally has been done within the tropical countries; and the costs, by U.S. standards, are small. U.S. institutions should support, either financially or through the assignment of qualified instructors, national in-country training programs for forest and park rangers, nursery technicians, and similar personnel.

The United States also should support institutions in tropical regions that provide training in fields related to tropical forest management and conservation. Such support may be through financial assistance, provision of equipment, or assignments of teachers to institutions. Regional institutions which have broad endorsement and participation from countries within the region deserve particular consideration.

However, a demand for education and training remains that cannot be met by in-country, overseas programs. Training in the United States, especially in natural resource management, is in increasing demand.

U.S. public agencies and private institutions should, therefore, attempt to expand their education and training programs for personnel from tropical countries. This should include: (a) provision of first-hand experience for counterpart personnel in research projects conducted by U.S. scientists on watershed, rangeland, and forest management problems and ecology, and (b) special training programs (often short term) for developing country students and scientists on special techniques and new methods for resource planning and management. Training should emphasize areas in which U.S. expertise is directly related to conditions and needs of the Tropics.

Government Agencies and private institutions should also increase the number of university scholarships offered to students from tropical countries for study in the United States in disciplines that focus on natural resource management and protection, especially scholarships for graduate and specialized training. The disciplines should include such fields as integrated resource management, forest economics, ecology, silviculture, and behavioral sciences.

U.S. Government Agencies and non-Federal institutions also should support and encourage short-term participation by their personnel in international tropical forest programs. The Peace Corps has been the only mechanism whereby large numbers of U.S. natural resource specialists have gained any tropical or international experience, including language and cross-cultural training. This important role of the Peace Corps, providing training and experience for young U.S. professionals in tropical forest ecosystems, should be maintained and expanded. As discussed previously, U.S. participation in the FAO Associate Expert Program is also recommended.

AID is involved in forestry and forestry-related projects in many developing countries, offering opportunities for professionals to gain or apply experience. Through its International Development Intern (IDI) program, young professionals can gain international experience. This program should be expanded in the natural resources areas, including forestry.

Opportunities afforded U.S. personnel by Peace Corps, FAO Associate Experts, AID, and other overseas programs can be realized only if the value of such training and overseas work is recognized and rewarded. Credit in terms of reentry to responsible positions upon the participant's return to the United States, and in terms of professional advancement, is imperative. Lack of commitment to this need has been a historical problem which discourages U.S. personnel from taking overseas assignments. Federal Agencies, and especially U.S. universities, should review their policies on this matter.

Heretofore, the theory and practice of tropical forest management taught in U.S. institutions, as well as elsewhere in the developed world, have been based heavily on Temperate Zone examples and information. A new effort must be made to provide training programs based on knowledge of tropical forest ecosystems. Individual U.S. universities and university consortia can play an important role in this regard, and should be encouraged to translate new findings and other information on tropical forest ecosystems into modified training and education programs.

Short-term intensive courses in foreign languages would benefit technical specialists and scientists who are interested in participating in international programs. The U.S. professional forestry community is especially hampered by the lack of French-language capabilities. An acceptable language level can be achieved with 2 or 3 months of total immersion training.

5. RESOURCE MONITORING: Monitoring plays an important role in effective natural resource management. With respect to tropical forests, a need exists to inventory and assess on a repetitive basis such conditions as land-use patterns, hydrologic regimes, soil and water quality, vigor and health of vegetation, and the status and effectiveness of reforestation and afforestation efforts. Depending on the particular interest and need, monitoring may be justified at any level: local, national, regional, and global. Monitoring techniques run the gamut from ground-based soil sampling and streamflow measurement to synoptic satellite reconnaissance. Data processing and information distribution are vital elements.

Recognized as a world leader in natural resource monitoring, the United States should have a special focus on this expertise within the framework of its tropical forest program. Particular U.S. strengths which can be brought to bear include remote sensing (both conventional and satellite), soil surveying, erosion prediction, hydrometeorological monitoring, pollution observation, forest inventory, wildlife surveys, and automatic data processing. A wide variety of U.S. training and education programs sponsored by Government Agencies and universities are available. The Geological Survey of the U.S. Department of the Interior, for example, trains many professionals and technicians from other countries in the use of remote sensing for forest inventory. And AID has given high priority to training developing country officials in U.S. LANDSAT satellite applications over the past 5 years.

As with forest research, most of the work by U.S. and other experts on monitoring applications has been carried out in temperate regions. Monitoring techniques and methods need to be developed or adapted for the tropical setting. This is particularly true for satellite-based remote sensing, because monitoring environmental conditions in the dense, highly variable, moist tropical forests is quite unlike carrying out similar work in the less complex forests farther north and south.

U.S. monitoring activities, in addition, should be related closely to the growing efforts elsewhere within the international community. For example, the FAO carries out tropical forest monitoring, and UNEP's Global Environmental Monitoring Systems (GEMS) program assigns high priority to tropical forest ecosystems. Attention should also be paid to developing a closer coupling of U.S. efforts with the interests and expertise of local institutions which usually carry out the essential ground control checks and on-the-ground sampling in support of aerial or satellite-based monitoring programs. The United States might, for example, contribute satellite coverage, training, and data processing for multinational and bilateral monitoring programs of a broad, multistage, integrated nature.

6. ENVIRONMENTAL ASSESSMENT: Environmental impact assessment is a potentially useful technique for performing systematic, before-the-fact examination of likely environmental costs and benefits of proposed actions—especially for centrally controlled and managed projects. U.S. Government Agencies are now subject to formal requirements for environmental assessment of certain overseas projects. But not all Federal actions that affect tropical forests are covered by existing procedural requirements. U.S. public institutions and private organizations, other governments, international lending institutions, and regional and international bodies should all be encouraged to voluntarily perform appropriate environmental assessments of their own project activities where they are not doing so already. Existing assessment guidelines and procedures should be reviewed and modified to insure that tropical forest values and forest loss consequences are treated adequately.

Technical assistance and training in both the development and application of environmental assessment methods are being offered to developing countries by UNEP, several regional commissions and organizations, and the United States through its development assistance programs.

6. INFORMATION AND DATA EXCHANGE: A dominant theme of the Task Force's findings is the absence of the detailed information and data needed to insure that a U.S. (or international) tropical forest program is focused on widely agreed upon key problems and critical "pressure points." Major information gaps exist with respect to:

- Forest loss rates and causes on a country-by-country and global basis.
- Status of worldwide institutional capabilities and the technological state-of-the-art for tropical forest management.
- Sociocultural attitudes and preferences regarding the importance of various forest values.
- Reforestation activities of tropical countries—particularly the reasons for successes and failures, and the most suitable tree species and techniques for various ecosystems.
- Extent of overseas commercial tropical forestry operations of U.S. and foreign private industry; and industrial attitudes and practices as related to introduction of long-term resource conservation measures.
- Attitudes, degrees of commitment, and constraints at the governmental level in tropical countries, donor countries, and international organizations regarding the assignment of higher priority to improved forest management.

The "short-term program priorities" recommended in Section A of this chapter call for the United States to undertake or promote on an urgent basis the studies and analyses required to help fill these important information gaps.

The Task Force believes that much more can be done to improve tropical forest management by increased application of research results, technologies, and methodologies already in use by various nations and institutions. As pointed out earlier, it is

commonly impossible to transfer approaches directly from temperate to tropical ecosystems. But some approaches, tools, knowledge, and practices can be transferred with little modification. The problem historically has been that information on what is available, with or without adaptation, does not reach the people with the problem or need.

Therefore, the United States, as part of any new tropical forest program, should seek to foster the increased flow of information and data from its own institutions as well as throughout the international community.

U.S. Government Agencies, in particular, should expand the development of pertinent publications and reports, distribute them freely to counterpart agencies in tropical countries and international organizations, and solicit publications in return. Also, regional centers that gather and distribute tropical forest information should be supported. FAO, UNEP, UNESCO, UN Industrial Development Organization (UNIDO), and other international bodies should be encouraged to increase their information and data exchange activities. U.S. Agencies also can assist by translating more of their documents (or at least the summary sections) into major foreign languages, as well as by translating appropriate foreign publications into English for distribution to cooperating Third World and other countries. For example, much arid zone forestry information is available in French and would be used by others if it were translated into English and distributed.

The field of public information also deserves priority attention because it is important to mobilize citizen support for tropical forest programs in the United States as well as abroad. Toward this end, the Task Force recommends the increased periodic dissemination of newsletters, booklets, press releases, and other items of public information by Federal Agencies and private sector institutions. U.S. Government Agencies should also explore innovative ways to promote public interest in tropical forests. Nongovernmental organizations such as the Worldwatch Institute, Natural Resources Defense Council, Inc., and the Society of American Foresters have been carrying out especially valuable work in the public information area, and others can contribute effectively. The audiences should be viewed broadly to include the U.S. public, officials of international organizations (intergovernmental and nongovernmental), and institutions in other countries.

8. INVOLVEMENT OF THE NON-FEDERAL SECTOR: This report recommends a policy, strategy, and program for the United States—not one just for the U.S. Government. This recognizes the wealth of information, technology, and expertise that resides within the non-Federal sector. For example, most U.S. foresters experienced in tropical forestry are found in private industry and the university community. Clearly, a coherent, efficient, and effective U.S. program requires intimate involvement by the private sector.

An initial step toward a new partnership between the Federal and non-Federal sectors was taken during development of this report. Its preparation provided an opportunity for close contacts between the Interagency Task Force and representatives of the university community, private industry, and environmental and public interests groups. The need to continue and expand this productive dialogue was emphasized earlier, but is reiterated here as a specific recommendation that it should be, in effect, institutionalized.

C. Program Coordination and Support

Program Coordination: To mobilize and mount an effective new U.S. effort on tropical forests, policy planning and program implementation must be strengthened, particularly through improved coordination at the Federal level. This same conclusion

was reached at the 1978 U.S. Strategy Conference on Tropical Deforestation, and led to the establishment of the U.S. Interagency Task Force on Tropical Forests. To date, however, the Task Force has focused exclusively on developing this report.

To provide central coordination of the policy, strategies, and programs set forth in this report, the U.S. Interagency Task Force on Tropical Forests, cochaired by the Departments of State and Agriculture (Forest Service), recommends it assume the following responsibilities:

- Review the policies, plans, and programs of all U.S. Government Agencies in the tropical forest area.
- Recommend measures for improving the collective efficiency and impact of these policies, plans, and programs.
- Identify overall program gaps and weaknesses, and propose corrective measures.
- Assemble a consolidated, coherent U.S. Government tropical forest program on an annual or biannual basis to help Agencies structure and justify program and budget requests.
- Maintain close linkage and a continuing dialogue with representative non-Federal institutions to insure their participation in, and support for, the Government's activities.
- Recommend U.S. international initiatives, as well as U.S. positions on tropical forest issues and programs, that are to be discussed in international and regional fora.
- Insure that the studies and analyses called for in this report are carried out (if the overall policy and strategy are approved).

The Task Force further recommends it arrange for detailed periodic reviews and evaluations of individual components of the proposed U.S. program (especially the bilateral assistance, research, training, and information and data transfer components), to determine how each might be strengthened and possibly refocused or expanded to address evolving domestic and international needs. Such analyses should include participation by both Federal and non-Federal representatives.

Authorities and Mandates: The implementation of an effective, broad-based U.S. program will require the active participation of many Federal Agencies. In most cases, these Agencies have sufficient statutory authority to collaborate with other countries on tropical forest programs. Some Agencies, however, seem uncertain of the breadth and degree of their authorities to work overseas on such activities. And others, the U.S. Department of the Interior, for example, indicate that they are constrained from carrying out certain types of international activities that will be important for the implementation of the type of U.S. program envisioned by the Task Force. Therefore, the Task Force recommends that all Federal Agencies review and assess their mandates and authorities for contributing to the tropical forest strategy program proposed herein, and seek necessary modifications, working in cooperation with the U.S. Department of State.

Funding and Staffing: The Task Force was not able to calculate the total current U.S. investment in tropical forest programs, either public or private, because the programs are so wide ranging and because many institutions do not classify relevant activities under a "tropical forests" heading. If the proposed U.S. policy, strategy, and program framework is accepted by the U.S. Government, the development of a comprehensive project inventory will be justified. Such an inventory is, therefore, recommended as a high priority "next step" by the Task Force, with initial emphasis to be placed on U.S. Government activities.

As to funding, neither the short-term program priorities nor the broader program framework presented in this report are of a nature that budgetary requirements can be assigned at this time. While much more can be done in this area within existing budg-

etary constraints, additional funding may well be required to mount a meaningful, expanded U.S. effort dedicated to tropical forests. But details will have to await responses by the Agencies to the general strategy and program recommendations set forth by the Task Force—evaluated in relation to activities already underway and planned in this area, and other competing program priorities. Such an evaluation should be carried out by each Federal Agency. The Task Force should then review the totality of the Agencies' program proposals, recommend to the Agencies where modifications or the addition of gap-filling activities should be considered, and consolidate the final Agency decisions into a coherent, integrated U.S. Government program. The first of these

might cover the 1981–83 fiscal years time frame. Such a unified tropical forest program for the Federal Government might then be used by the Agencies to guide their allocation of budgetary resources.

Federal Agencies also should examine their staffing levels, since staffing shortages may be especially limiting—even more so than funding. Several Agencies have indicated that they already are reacting to new tropical forest concerns and interests by transferring existing staff to this area. Others, however, will have to go beyond reassigning staff and add new technical expertise.

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