

Institute of Tropical Forestry: --- The First Fifty Years



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United States
Department of
Agriculture

Forest Service

International
Institute of
Tropical Forestry

General
Technical Report
ITF-GTR-7
April 1999



A vertical illustration on the left side of the page, featuring stylized tropical plants. At the top, there are palm fronds. Below them are large, broad leaves with prominent veins, some showing serrated edges. The style is graphic and somewhat abstract, using various shades of gray and white.

Authors

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A horizontal illustration at the bottom of the page, continuing the tropical theme. It shows more stylized leaves and plant structures, similar to the ones in the left margin, rendered in a light gray tone.



Institute of Tropical Forestry: The First Fifty Years

**Ariel E. Lugo and
Louise Mastrantonio**

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Forest Service
International Institute of Tropical Forestry
Río Piedras, Puerto Rico 00928
April 1999

*Sierra palm forest, Luquillo
Experimental Forest, in about 1931.*



*Scientist Martin Chudnoff in
subtropical wet forest,
Luquillo Experimental
Forest, in about 1975. The
large tree is tabonuco, for
which the forest type is
named; it contains some
175 tree species and
generally grows below
2,000 feet.*



Abstract

Lugo, Ariel E.; Mastrantonio, Louise. 1999.

Institute of Tropical Forestry: The first fifty years. Gen. Tech. Rep. IITF-GTR-7. Río Piedras, PR: U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry. 55 p.

The first fifty years (1939-1989) of the Tropical Forestry Experiment Station, which has evolved into the International Institute of Tropical Forestry, are reviewed—through pictures, narrative, summaries of

accomplishments, and a selected bibliography. Plans and projections for the future are also discussed. Appendices describe the people of the Institute in the past and up to the 50th anniversary, and contain the texts of two speeches given at the celebration, one by USDA Forest Service Chief F. Dale Robertson and the other by Congressman Bruce F. Vento.

Keywords: Tropical forestry, Institute of Tropical Forestry, tropical forestry management, tropical forestry rehabilitation, tropical forestry research, Luquillo Experimental Forest.



*The International Institute
of Tropical Forestry, Río
Piedras, Puerto Rico.*

Contents

Foreword	v
Preface	vi
Introduction	1
The Institute	7
Early research	7
Education and cooperative extension	12
Legacy of the Luquillo Experimental Forest	13
Tropical Forests	19
Forest destruction	19
Multiple benefits	19
Turning the tide	19
New Directions	23
Epilogue	25
Acknowledgments	25
Appendix 1.	
The People of the Institute of Tropical Forestry	27
Staff and cooperators	27
Awards	31
Cooperators	33
Appendix 2. Selected Bibliography	35

Appendix 3.	
The Luquillo Forest Reserve: A Proclamation by the President of the United States	38

Appendix 4.	
The Challenge in Tropical Forestry, Chief F. Dale Robertson	39

Appendix 5.	
Tropical Forestry Research: Turning Vision into Reality, Congressman Bruce F. Vento	45

Appendix 6.	
Title IV. International Forestry Cooperation Act of 1990	50

Appendix 7.	
Energy Release by Chlorophyll, L.R. Holdridge	53

Photo pages

Wood for many uses	2-3
Charcoaling	4-5
Early research	8-9
Forests for people	14-15
Road building	16-17
Plantation forestry	20-21

Foreword

Since early in its history, the Forest Service has contributed significantly to tropical forestry. In 1922, for example, Raphael Zon—one of the pioneers in Forest Service Research—published the first global forest assessment, including the first quantitative estimate of the area of tropical forest (Zon and Sparhawk 1922). In 1928, the McSweeney-McNary Forest Research Act authorized establishment of a Forest Experiment Station in the “tropical possessions of the United States in the West Indies.” That authorization led to the establishment of the Tropical Forest Experiment Station in Río Piedras, Puerto Rico, in 1939, with an annual budget of \$25,000 (Wadsworth 1995). This brief history was prepared for the 50th anniversary of that Experiment Station, which evolved in 1989 into the Institute of Tropical Forestry. Delayed, first by Hurricane Hugo in 1989 and later by the Institute’s reorganization as the International Institute of Tropical Forestry, this publication summarizes—through pictures and narrative—the achievements of Forest Service Research in Puerto Rico.

Today, the Institute is about to celebrate 60 years of research activity in this beautiful tropical island. The expanded International Institute is now responsible for programs in State and Private Forestry, International Programs, and Research and Development. The Institute also manages the Caribbean Operations Cluster, which provides administrative services to all Forest Service programs in Puerto Rico, including the Caribbean National Forest, our only tropical forest in the National Forest System. I am pleased to present this tribute to the tropical forestry pioneers who helped establish this Institute as one of the research flagships of the Forest Service. The history of accomplishments in its first 50 years serves as an inspiration to the dedicated employees of the International

Institute of Tropical Forestry that today face different, but equally important, challenges in achieving our mission—**Caring for the Land and Serving People**—in a tropical and international context.

Mike Dombeck

Mike Dombeck
Chief

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Zon, R.; Sparhawk, W.N. 1923. *Forest resources of the world*. Two volumes. New York: McGraw-Hill Book Co., Inc. 997 p.



Mike Dombeck

Preface

A week-long celebration in Puerto Rico in May 1989 marked the 50th anniversary of the Institute of Tropical Forestry. The Institute was established in 1939 by the Forest Service as the Tropical Forest Experiment Station. The celebration included a scientific symposium, field trips to the nearby Luquillo Experimental Forest, poster exhibits, a display of historical documents at the Commonwealth archives, a special postage-stamp commemorative cancellation by the U.S. Postal Service, and a photographic exhibit showing highlights of the Institute's first 50 years. Many of the photographs are included in this publication.



Ariel E. Lugo

More than 200 people attended the celebration, among them U.S. Department of Agriculture Forest Service Chief F. Dale Robertson and Leslie Holdridge, the first scientist to work at the Institute, who honored the anniversary by contributing an article included in this publication as appendix 7. These two honored guests were joined by representatives of all tropical continents and participants from the Puerto Rico Department of Natural Resources, the Agricultural Experiment Station, the World Bank, the U.S. Agency for International Development, the United Nations Food and Agriculture Organization, the International Union of Forestry Research Organizations, the University of Puerto Rico, and other universities.

The size of the celebration says much about the Institute, its accomplishments, and the continuing need for forestry and forestry research in the Tropics. Little was known about tropical forestry when the Institute first opened in 1939. Knowledge about which trees to plant and how to plant them for best results was limited, and no evidence had yet suggested that tropical tree plantations could be successful. Yet

research at the Institute flourished and soon increased understanding of the Caribbean's natural forests and of the opportunities and limitations of commercial forestry in the Tropics.

Much of what has been accomplished during 50 years of research at the Institute has been basic, fundamental forestry: the process of identifying species, conducting inventories, selecting species for reforestation, and developing silvicultural practices for tropical timber trees. The Institute faces many new challenges as it looks to the future; tropical forestry is at a crossroads. Along with concern about our forests and their economic, social, and environmental benefits, global anxiety about population growth, atmospheric pollution, global warming, and tropical deforestation and their effects on global climate is increasing. These problems are among the many that the Institute and its scientists are poised to tackle in the coming years.

People are always asking, "What is the Institute of Tropical Forestry?" and "What does it do?" This publication answers these questions. It also summarizes the first 50 years of the Institute's accomplishments and outlines the future course of technical information in the Tropics.

If you have questions or want additional information, please call or write us here at the International Institute of Tropical Forestry. You may also visit our web page at <http://www.fs.fed.us/global/iitf/welcome.html>

A handwritten signature in dark ink, appearing to read 'Ariel E. Lugo'.

Ariel E. Lugo, Director



*Luquillo Experimental
Forest in the 1950s,
showing intensive use of
the land for agriculture all
the way to the Forest
boundary.*

Primary forest of the central Luquillo Experimental Forest. Palm forest is in the foreground; lower montane wet forest (the palo colorado type), in the distance, is the principal habitat of the Puerto Rican parrot.

Inset: The Puerto Rican parrot. Despite intensive conservation efforts, only a few of these beautiful green birds, native to Puerto Rico and a few of its offshore islands, are left in the wild.



This time is crucial. The period between now and the time all of us go to the grave is crucial in making a difference in tropical forestry. It deserves our best effort.

F. Dale Robertson, Chief
U.S. Department of Agriculture,
Forest Service
(appendix 4, this volume)

Introduction

In his address at the 50th-anniversary celebration of the Institute of Tropical Forestry, U.S. Department of Agriculture, Forest Service Chief Dale Robertson spoke eloquently about the challenge of tropical forestry. The world's population is projected to double from 5 billion to 10 billion people by the year 2025. Much of this growth is expected to be concentrated in the Tropics—a region where roughly 60 percent of the world's people currently live.

People generate pressure on natural resources, and people tend to worry and be motivated more by the present than the future, especially when it comes to meeting their basic needs for food, shelter, and protection. Robertson continued

It's hard to think much about the future when your stomach is empty, your skin is cold, and you are struggling for survival. People are motivated to improve their standard of living by converting the value of the forest to something more immediately tangible . . . half the people of the world depend on wood for 90 percent of their energy needs . . . It takes a lot

of economic power to sustain good conservation policies. Until you take care of people's basic subsistence needs and provide enough economic flexibility for people to have options and choices, conservation is likely to end up in second, third, or even fourth place.

Therein lies the challenge. Complete preservation of tropical forests is not a solution. Certainly, tropical forest reserves need to be set aside for watershed protection, wildlife habitat, and scenic enjoyment. But most of the region's forest lands will have to be managed for multiple uses: for wood production, special forest products, agroforestry, and amenity values.

Most tropical forests require basic, wise, multiple-use management—a task that requires a lot of science and technology and skillful management—working day-to-day, hand-in-hand with tropical people.

Robertson called for an aggressive tropical strategy that will apply existing research, guide research's path over the next 50 years, and gain the cooperation of all countries and international organizations concerned with managing tropical forests. He vowed to increase the Forest Service's role in Puerto Rico by using the Institute of Tropical Forestry and the Caribbean National Forest (also known as the Luquillo Experimental Forest) as a focal point for research, to demonstrate tropical forest management, and as a training center for tropical foresters. He envisions the Institute of Tropical Forestry and the Caribbean National Forest as available to cooperators from around the world to come and study tropical forestry, and to use the experience gained in Puerto Rico to greatly accelerate applying scientific management to the world's tropical forests.

**Wood for
many uses:**

*Top: Women carrying
fuelwood from the
Cambalache Experimental
Forest (now the
Cambalache State Forest),
in about 1945.*

*Bottom: Forest Ranger
Pedro Aguilar checking
broomsticks made from
small trees growing in
thickets on hilltops,
Guajataca State Forest, in
about 1945.*





Top left: Twisting strands of majagua (Hibiscus tiliacaceus) bark into rope, in about 1948.

Top right: Fuelwood cut to the proper size for bakeries, Toro Negro Division, Caribbean National Forest (now the Toro Negro State Forest), in about 1945; this practice continued until the 1960s.



Bottom: Whip-sawing lumber by hand in the Luquillo Experimental Forest, in about 1943. Trees were felled across the slope, bucked into logs, and rolled onto a frame for sawing.

Charcoaling:

Top: Fuelwood split from upper trunks and branches of saw timber trees was extracted from the upper areas of the Luquillo Experimental Forest, converted to charcoal by burning, hauled to market, and sold for cooking fires.

Bottom: Producing charcoal from the wood of trees removed to improve forest growth.





Left: Forest ecologist Leslie R. Holdridge examines an eroded slope caused by grazing in the Susúa State Forest, about 1935.

Top: Bringing charcoal to the road to be transferred to a truck for shipment to the city, Toro Negro Division, Caribbean National Forest, in about 1945.

Bottom: Truck loaded with charcoal ready for market, Toro Negro Division, Caribbean National Forest.

*Headquarters building
of the Tropical Forest
Experiment Station,
completed in 1942; it is
now the International
Institute of Tropical
Forestry.*



Forestry had been attempted in Puerto Rico for some 80 years prior to the establishment of the Institute of Tropical Forestry. During that time, the forest area had continued to decline and the success of reforestation efforts had been unpredictable.

Frank H. Wadsworth
Research forester and former director
Institute of Tropical Forestry

The Institute

At the time of Christopher Columbus's arrival in 1493, dense forests covered Puerto Rico. The island supported a rich diversity of forest types, each adapted to specific environmental conditions. Beginning with the earliest European occupation, however, these forests were decimated. Their lush vegetation was cut for fuel and lumber, and to make way for growing communities. By the time the Spanish Crown established the first forest reserves in 1876, considerable damage had already been done. Eventually, 90 percent of the island's forests had been cut. Watersheds were damaged and abandoned, and agricultural land supported only inferior timber species.

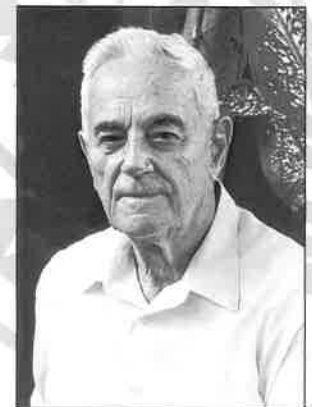
The Institute was established, in part, to respond to these growing concerns about forest destruction and watershed protection. Reforestation of cutover areas had been attempted since the mid-1800s, with only limited success. The failure of a 324-hectare plantation in the late 1930s served as a catalyst for more research on how to grow tropical tree species.

The Institute itself was authorized by the McSweeney-McNary Forest Research Act of 1928, but the facility was not formally established as the Tropical Forest Experiment Station until 1939. Its name was changed to the Institute of Tropical Forestry in 1961. On the campus of the University of Puerto Rico in the San Juan suburb of Río Piedras, the Institute is one of 11 Forest Service research units of the Southern Forest Experiment Station. Its two-hectare compound includes a headquarters building, laboratories, a library, an arboretum, a nursery, a seed-storage facility and wood shop, and a solar kiln.

Early research

In the early years, the Institute's research was dominated by reforestation and timber management—information needed before cutover forest lands could be restored. The year that the Institute was established, roughly 10,000 hectares of timber had been planted in Puerto Rico—most of which had failed. One early research task was to evaluate the success of these plantations and assess their potential for producing timber. These assessments were published for Federal lands in 1948, for State lands in 1950, and for private lands in 1958.

Species trials, which had been in progress informally since 1921, were also a major part of the Institute's early research program. More than 450 tree species, including more than 100 that were native to Puerto Rico, were planted and tested to determine their suitability for reforesting cutover areas in both Puerto Rico and the Virgin Islands. Before 1960, however, only three species were judged sufficiently important to justify spacing and thinning trials.



Frank H. Wadsworth

Early research:

Top left: Research forester José Marrero observing natural regeneration of yagrumo hembra in an abandoned farm near the Caribbean National Forest.

Top right: Forest Ranger José Reyes Mateo in a recently cutover tabonuco-type forest (Caribbean National Forest), showing well-formed trees left for the future.

Bottom: Loading bare-root planting stock of mahogany for reforestation in the Toro Negro Forest, 1940.





Top left: Technician Ernesto Goytia (off center, holding fenceposts) showing farmers a cold-soaking process for applying preservatives to fenceposts, in the central mountains, in about 1965.



Top right: Wood technologist Franklin R. Longwood, with seasoned posts ready for preservative treatment.



Bottom left: Ranger patrols the boundaries of the Caribbean National Forest, in about 1942.



Bottom right: Monitoring station for watershed studies at Bisley, in the Luquillo Experimental Forest, in about 1988.

Early tobacco production contributed to erosion, as on these steep slopes above Carnillas Lake; this reservoir was heavily sedimented in the 1950s.





In 1943, long-term growth plots were established on the Caribbean National Forest. Later, similar plots were set up on most of the State Forests and areas of the Virgin Islands. These plots, used to measure the relative growth rates of different tree species, were in forests undisturbed by people as well as in forests recovering from human disturbance. Many of these research plots are still being used.

As plantation research progressed, the need for companion studies of wood utilization became apparent. Such studies were conducted from 1952 to 1972. The machining properties of 50 local tree species were studied and analyzed. Roundwood uses were explored, beginning with the service life of native

woods as fenceposts, and techniques were developed for wood drying and seasoning.

Although much of the early research was timber related, other needs soon became apparent. Watersheds were studied, and methods for combining forestry with agriculture were explored. The plots originally established to evaluate species for timber production became useful for long-term ecological studies.

Forestry and watersheds were not the only subjects studied. Frank H. Wadsworth, Director of the Institute from 1956 to 1978, first recognized the plight of the Puerto Rican parrot, a green species native only to Puerto Rico and two of its offshore islands. Wadsworth's studies led to listing the parrot as an endangered species and to a recovery program engineered by the Forest Service, the U.S. Fish and Wildlife Service, and the Puerto Rico Department of Natural Resources. At the recovery program's lowest point, only 12 parrots survived; in 1989 their numbers had increased to more than 100.

In 1956, in recognition of the growing importance of tropical forestry research, the entire Caribbean National Forest was designated as the Luquillo Experimental Forest. A diversity of elevations, climates, and vegetation makes this 11,332-hectare forest an ideal research site. It includes representative samples of Puerto Rico's four major forest types: tabonuco, palo colorado, sierra palm, and elfin. It is near Río Piedras and metropolitan San Juan, which makes travel fairly convenient for forest managers, scientists, and visiting professionals.

Other forest types, including mangrove, are available for study in the State Forest system's 13 units. The 50-hectare Estate Thomas Experimental Forest in the Virgin Islands and the Caribbean National Forest's two Research Natural Areas also provide opportunities for field research.

Forest ecologist Leslie R. Holdridge examines an eroded slope caused by grazing in the Susúa State Forest in about 1935.

*Top: Scientist John Francis
in the experimental nursery
at the Institute of Tropical
Forestry, 1989.*

*Bottom: The Institute library
in 1975. Information
specialist JoAnne Feheley
answers the library
telephone.*



Education and cooperative extension

From its inception, the Institute has played an important role in forestry extension. The close association between research and land management has led to the prompt transfer of new research information to the field in Puerto Rico and throughout the Caribbean. The Institute's technical journal, Caribbean Forester, was published from 1939 to 1953. It brought the latest technical information to forestry professionals throughout the Caribbean and Latin America. Over the years, the Institute's research has led to more than 700 technical papers and numerous short courses and seminars.

The Institute's library, one of the best tropical forestry collections in the world, provides Institute staff, university staff, visiting scientists, forestry professionals, and many of the hundreds of students who visit the Institute each year with an excellent reference facility.

As the Institute's work has gradually become known, it has been deluged with requests for consultation on forestry problems from all over the world. Institute scientists have served as consultants for the United States and the United Nations's Food and Agriculture Organization. They have made study tours to Africa, Asia, and all the countries of tropical America and have attended four World Forestry Congresses and most sessions of the Latin American Forestry Commission. An increasing number of visits by foreign students led to creating the first of the Institute's 16 tropical forestry short courses in 1953. The course, in turn, has led to graduate teaching and research-planning assignments for Institute scientists in Argentina, Chile, Perú, Paraguay, Brazil, Venezuela, Costa Rica, and Jamaica. Many visiting scientists have stayed long enough to conduct research projects of their own.

Forest plantations in Puerto Rico have had a significant role in reforestation. Altogether, about 11,200 hectares have been planted by public agencies and 27,000 hectares by private interests.

Richard A. Birdsey and Peter L. Weaver (1982)

The Legacy of the Luquillo Experimental Forest

In Puerto Rico, the forest land management functions of the Forest Service have always been closely tied to research. In an effort to speed the application of new technical information, the administration of the Caribbean National Forest and the Insular Forest Service was combined with research in 1943. Though the Insular Forest Service was turned over to the government of Puerto Rico in 1953 and the Caribbean National Forest was separated from the Institute's research program in 1973, a strong link had been firmly formed between Institute researchers and the managers of the Forest.

Through the activities of both the Institute of Tropical Forestry and the Luquillo Experimental Forest, the Forest Service has been a pioneer in applying sound land management principles in tropical America. In the Luquillo Forest, efforts have been made to control trespass (particularly subsistence farming), conduct timber sales, and build roads and trails to improve access and ease of forest use. On-site demonstrations of superb forestry practices have been a positive influence for good land management in the Carib-



bean, illustrating what can be done to reforest degraded timberlands. Between 1931 and 1956, the acreage of the Luquillo Experimental Forest more than doubled—from 5,018 to more than 11,332 hectares; it is now the largest forest reserve in Puerto Rico. Some of these additional lands were consolidated from surrounding farmlands, many of which had been abandoned after crop failure, and most of the blatant trespass on Federal forest lands has been eliminated.

Road building improved access to the Caribbean National Forest and its developing recreation areas.

***Forests for
people:***

*People gathering at La Coca
Falls along the Caribbean
National Forest highway in
about 1970.*





Baño de Oro swimming pool in the La Mina Recreation Area of the Caribbean National Forest in about 1938.

Inset: Forest supervisor Larry Hill describing the forest along the La Mina River Trail, Caribbean National Forest, in about 1970.

Road building:

*Civilian Conservation Corps
workers line up at Catalina
administrative site on
payday.*

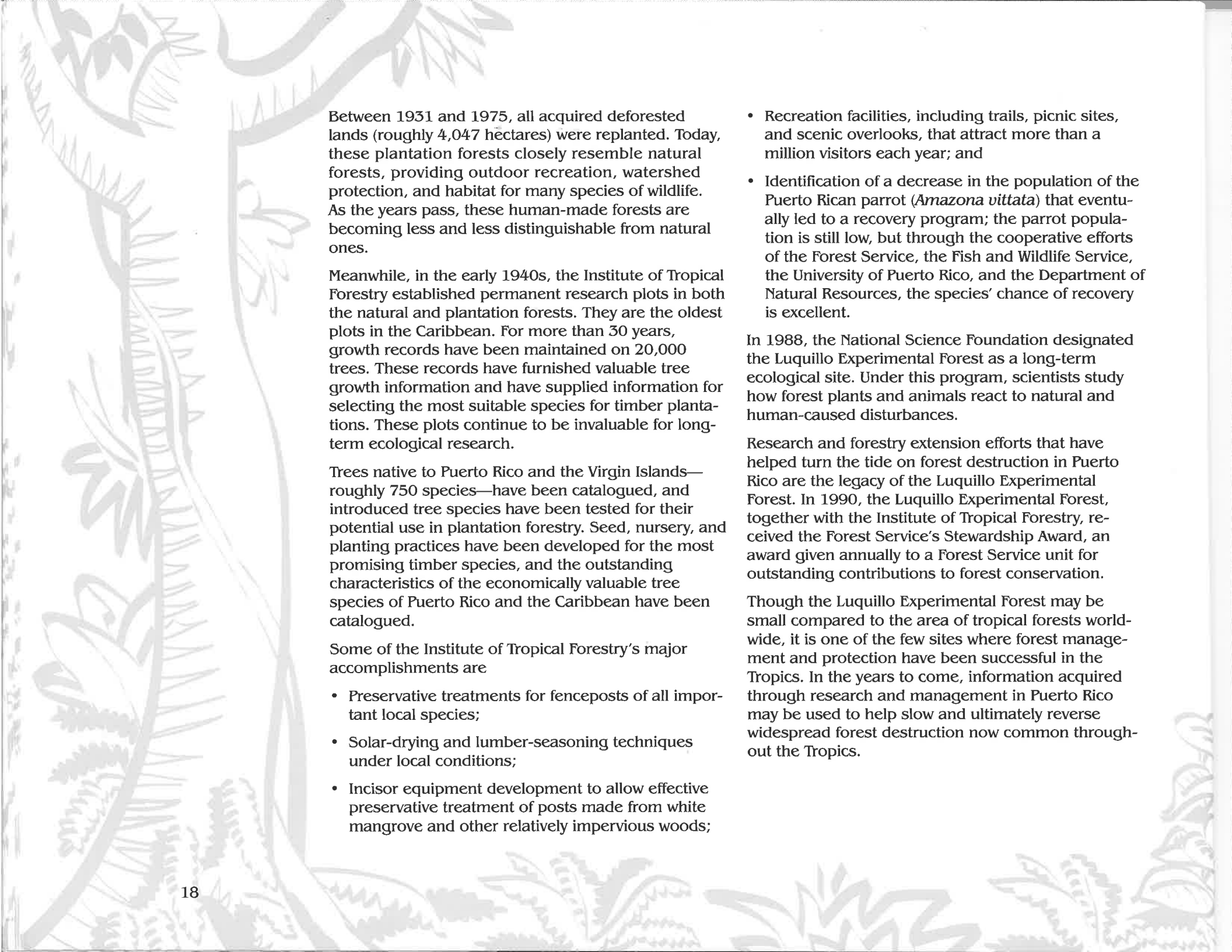




Top: Building the principal road (now PR-191) into the Caribbean National Forest, 1929-1937.



Bottom: Civilian Conservation Corpsmen carry a supervisor with a broken ankle to a medical facility, Caribbean National Forest, in about 1937.



Between 1931 and 1975, all acquired deforested lands (roughly 4,047 hectares) were replanted. Today, these plantation forests closely resemble natural forests, providing outdoor recreation, watershed protection, and habitat for many species of wildlife. As the years pass, these human-made forests are becoming less and less distinguishable from natural ones.

Meanwhile, in the early 1940s, the Institute of Tropical Forestry established permanent research plots in both the natural and plantation forests. They are the oldest plots in the Caribbean. For more than 30 years, growth records have been maintained on 20,000 trees. These records have furnished valuable tree growth information and have supplied information for selecting the most suitable species for timber plantations. These plots continue to be invaluable for long-term ecological research.

Trees native to Puerto Rico and the Virgin Islands—roughly 750 species—have been catalogued, and introduced tree species have been tested for their potential use in plantation forestry. Seed, nursery, and planting practices have been developed for the most promising timber species, and the outstanding characteristics of the economically valuable tree species of Puerto Rico and the Caribbean have been catalogued.

Some of the Institute of Tropical Forestry's major accomplishments are

- Preservative treatments for fenceposts of all important local species;
- Solar-drying and lumber-seasoning techniques under local conditions;
- Incisor equipment development to allow effective preservative treatment of posts made from white mangrove and other relatively impervious woods;

- Recreation facilities, including trails, picnic sites, and scenic overlooks, that attract more than a million visitors each year; and
- Identification of a decrease in the population of the Puerto Rican parrot (*Amazona vittata*) that eventually led to a recovery program; the parrot population is still low, but through the cooperative efforts of the Forest Service, the Fish and Wildlife Service, the University of Puerto Rico, and the Department of Natural Resources, the species' chance of recovery is excellent.

In 1988, the National Science Foundation designated the Luquillo Experimental Forest as a long-term ecological site. Under this program, scientists study how forest plants and animals react to natural and human-caused disturbances.

Research and forestry extension efforts that have helped turn the tide on forest destruction in Puerto Rico are the legacy of the Luquillo Experimental Forest. In 1990, the Luquillo Experimental Forest, together with the Institute of Tropical Forestry, received the Forest Service's Stewardship Award, an award given annually to a Forest Service unit for outstanding contributions to forest conservation.

Though the Luquillo Experimental Forest may be small compared to the area of tropical forests worldwide, it is one of the few sites where forest management and protection have been successful in the Tropics. In the years to come, information acquired through research and management in Puerto Rico may be used to help slow and ultimately reverse widespread forest destruction now common throughout the Tropics.

... [W]e are approaching a worldwide environmental crisis ... Near the top of everyone's list of pending environmental disasters is tropical deforestation. The loss of 27 million acres of tropical forests each year is a cause of the worst problems facing the world today.

Congressman Bruce F. Vento, Chair
Subcommittee on National Parks and
Public Lands, Committee on Interior
and Insular Affairs, U.S. House of Representatives
(appendix 5, this volume)

Tropical Forests

Although half the world's forests are in the Tropics, only 40 percent of all tropical forest lands are still covered by mature forests. In recent years, the accelerated cutting and burning of tropical forests has become a major conservation issue worldwide. Although most remaining tropical forests are in Central and South America, Africa, and the Southeast Asia-Pacific region, everyone on the planet clearly has a stake in their protection.

Forest destruction

Tropical forests are being cut at a rate of almost 11 million hectares a year. The United Nations Food and Agriculture Organization has estimated that tropical rain forests will decrease by almost 16 million hectares between 1975 and 2000. The best commercial

forests in Malaysia and the Philippines are already gone; cutting is reportedly on the rise in Indonesia and Brazil. The principal cause of this rapid deforestation is a system of slash-and-burn agriculture, an age-old practice in which rural people cut and burn the trees, plant and harvest the crops, and then, in a few years when the soil fertility has been depleted, move on to another area.

Multiple benefits

Tropical forests are magnificent ecosystems containing many resources: valuable hardwoods, an almost untapped storehouse of medicinal plants, and a variety of species of wildlife. Tropical forests create their own climate over large areas; the water in rain forests recycles in a pattern of endless transpiration and downpour that nourishes life in the forest and influences the climate for miles around.

Turning the tide

Many of the world's forests were cut centuries ago, at almost the same rate as the growth of human population. Though forestry in the Tropics is about 100 years old, only recently has concern about deforestation brought efforts to slow this destruction and improve forestry practices.

Tropical forests remain in only a few places—generally in remote areas unsuitable for human activities. Although tools are available to stop the destruction of these precious forests, deforestation cannot be slowed until alternatives can be found to slash-and-burn agriculture. Solutions can be found only by using the best available forest technology and the latest forest research results in conjunction with the help and cooperation of many people.

Plantation forestry:

Top inset: Stock of big-leaf mahogany ready for planting. Trees were bagged to improve planting success; the bags were removed, but the ball of earth was preserved around the roots.

Middle: La Catalina Forest Nursery in about 1950; the nursery—operated cooperatively by the Forest Service and the State government—produced trees to be planted in the National Forest and distributed to farmers.

Bottom inset: A member of the Youth Conservation Corps planting on an eroded hillside in about 1985.





Top: A 12-year-old plantation of West Indies mahogany, a valuable furniture wood, on Mona Island.



Bottom left: Silviculturally treated natural forest in the Luquillo Experimental Forest in about 1985. Bryan Clark, then Associate Deputy Chief of Research, Washington Office, views a large mahogany tree.



Bottom right: Experimental thinning in a 20-year-old teak stand in the Río Abajo State Forest.

*A 15-year-old big-leaf
mahogany plantation,
overdue for thinning, in Río
Abajo State Forest, in about
1952.*



What we're going to be doing new in the next 50 years is expand the focus of research to global and regional spatial scales—to long-term time scales—and synthesize information through modeling and other techniques; in short, multidisciplinary teams of scientists with new technology.

Ariel E. Lugo, Director
International Institute of Tropical Forestry



New Directions

Many factors point to the need for change in the direction of tropical forestry research. Modern societies are far more complex than they were when the Institute was established in 1939. Urban populations recognize the value of tropical forests for purposes other than supplying wood. Although tropical forests' value as watersheds and as places to enjoy and study nature and wildlife have been known for many years, tropical forests are only now being recognized for their potential role in ameliorating air pollution and regulating the global climate. The increasing scarcity of tropical forests makes those that remain critically important as tools for educating the public on this rapidly disappearing environment and for illustrating human dependence on natural resources.

Nowhere are forestry's challenges greater than in the Tropics. Not only must forest managers protect the diversity and integrity of natural ecosystems, but they must consider the economic value of these same forests to local people. In the Tropics—perhaps more so than anywhere else in the world—people live in close association with the forest. Rural people often depend on these forests for their very survival. Forest management plans must therefore take into account rural people's physical and economic needs without losing the diversity of natural ecosystems. This challenge calls for new practices and policies.

In recent years, the Institute helped in developing forestry research and management programs in several tropical regions: Africa, South and Central America, and the Far East. In the decades ahead, cooperative research will be increased throughout tropical America.

*Chemist Mary Jeane
Sánchez determining
nutrient concentrations in
soil samples in the Institute
laboratory in about 1989.*



Brazil was recently selected from all the countries of Latin America for a special research focus. According to Institute Director Ariel Lugo, many factors make Brazil a desirable location for tropical forestry research. "Brazil is just sizzling," Lugo once said. "We spent three weeks with Brazilian scientists; they are enthusiastic at all levels. You turn on the television there, and even the politicians are talking about the Amazon. It is a very vigorous dialogue. I am very excited to be working with the researchers in Brazil."

Lugo envisions the Institute's scientists on long-term details to Brazil. The Institute is hiring additional people especially for this work—a biometrician, an economist, an atmospheric scientist, and a hydrologist, as well as foresters and wildlife biologists. Projects will be set up in various parts of Brazil—with one or two scientists teamed with a local person. "We'll just let those projects develop and see what works," Lugo said. "Eventually we'll probably settle down in one specific locality, but the country is so large and complex, it would be a mistake to go to just one place."

The Institute's 10-year research program begun in 1989 has several goals: to understand the processes and functions of tropical forests; to relate forest productivity and biodiversity to the needs of people and to economic values (market and nonmarket); and to develop techniques to rehabilitate forest lands damaged by human or natural disturbances. The new research program continues some old studies and puts increased emphasis on forest ecology, watershed protection, ecosystem management, and providing

information for planning and conducting forestry programs in tropical America. The program includes

- Developing forest management practices that do not jeopardize water quality;
- Identifying sites suitable for commercial forestry and developing genotypes and silvicultural practices to ensure successful tree plantations;
- Documenting and stimulating forest growth in silviculturally treated disturbed forests;
- Identifying habitat requirements and habitat improvements for the endangered and migratory wildlife; and
- Providing fundamental resource information for planning, leading, and carrying out forestry programs in tropical and subtropical America.

Several major cooperative studies are also underway, including long-term ecological research funded by the National Science Foundation, soil biology and fertility research in cooperation with the International Union of Biological Societies, global carbon-cycle research funded by the U.S. Department of Energy, and pine growth research in the Caribbean and Central America funded by the U.S. Agency for International Development.

Epilogue

The 50th anniversary celebration in May 1989 was followed by two events that changed both the focus of the research program and the organizational structure of the Institute. On November 18, 1989, Hurricane Hugo struck the Luquillo Mountains; it was the first category 4 hurricane to pass over the Experimental Forest since 1932. It caused significant effects on the experimental forest's vegetation and gave Institute scientists and collaborators the opportunity to study how rain forests respond to hurricanes. Today, nine years after Hugo, the research program at the Institute is fully reoriented towards the issue of how tropical forests respond to disturbances.

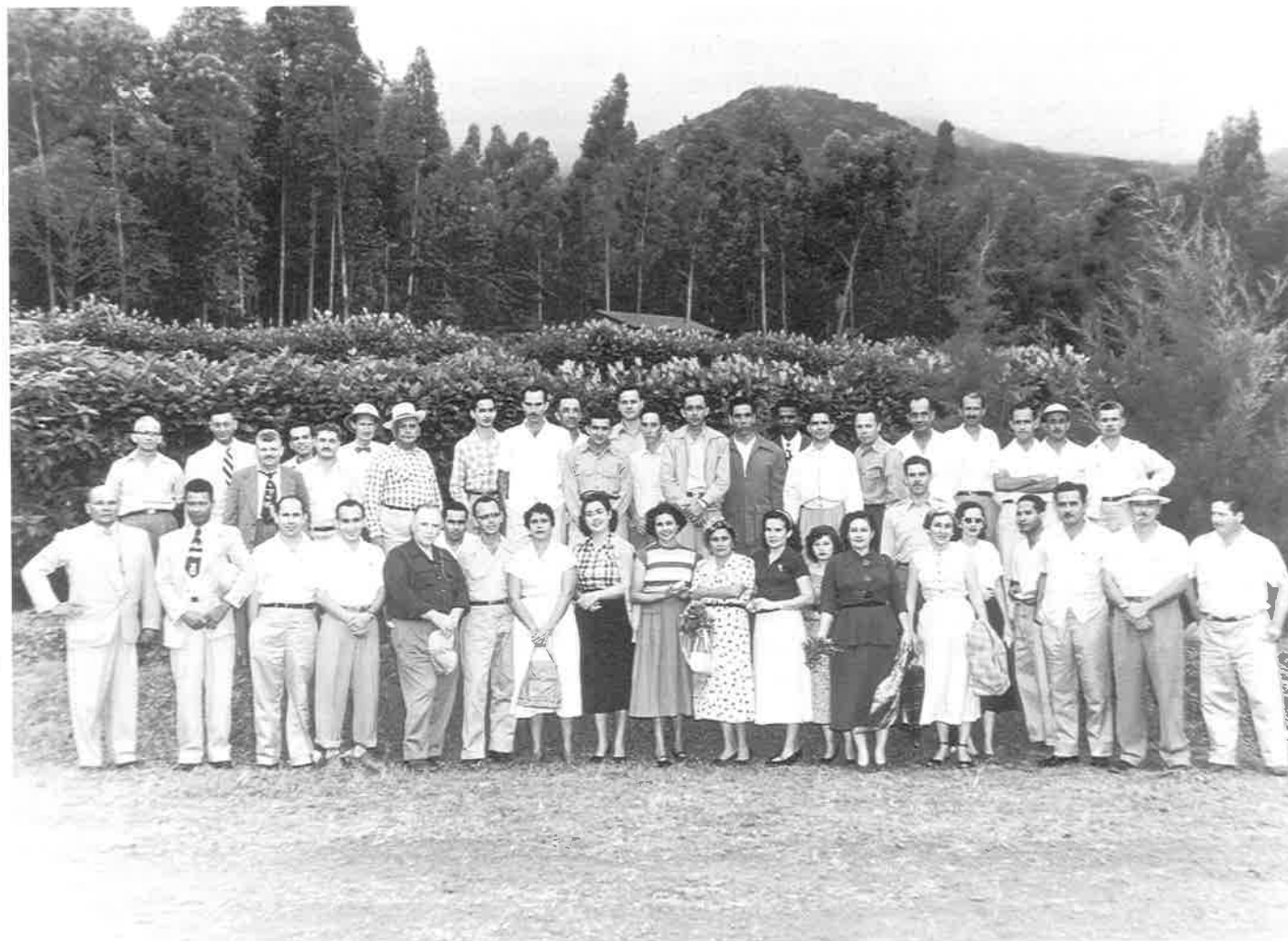
The other event was administrative. In 1992, the mission of the Institute was expanded to include the International Forestry and State and Private Forestry programs. In addition, administrative support for Forest Service programs in Puerto Rico was delegated to the new International Institute of Tropical Forestry. The Director of the Institute became the official voice of the Forest Service in Puerto Rico, supervised by the Chief's Office in Washington, DC. The Institute became analogous to a Forest Service region, with program overview assigned to the Washington Office. Unlike a region, the International Institute of Tropical Forestry became a multifunctional unit with representation of all Forest Service programs under a single management team.

Today, the Institute has about 100 employees, a 6-million-dollar budget supplemented by about 2 million dollars in grants and agreements, and program responsibility that extends from Puerto Rico to the U.S. Virgin Islands, the Caribbean, and Latin America. More than 30 countries have formal agreements with the Institute, as do some 50 additional organizations—including universities, conservation groups, and Federal and State government agencies. A new library has been built, the analytical laboratory greatly improved, and the computing capacity multiplied. Institute scientists and technicians are applying new research technologies to tropical forestry programs. These new technologies include global positioning systems, geographic information systems, modeling, gas chromatography, and remote sensing.

Acknowledgments

We appreciate the assistance of Gisel Reyes, International Institute of Tropical Forestry; Cindy Miner, Tami Lowry, and Martha Brookes, Pacific Northwest Research Station; and John C. Ivie of Ivie Design, Portland, OR, in getting this document into print.

Staff of the Institute of Tropical Forestry and the State Forest Service are pictured in about 1950 at La Catalina Forest Nursery in the Caribbean National Forest: Henry B. Bosworth, fifth from the left in the front row, served as Director of both organizations.



Appendix I.

The People of the Institute of Tropical Forestry

Staff and Cooperators

Forestry research includes many highly specialized disciplines—such as silviculture, genetics, wildlife biology, chemistry, ecology, hydrology, and engineering. The members of the scientific staff are supported by technicians, librarians, and clerical personnel. Temporary employees and students in stay-in-school programs, high school, and college complete the staff.

Many Institute scientists are authorities in their fields. Through scientific publications, they have contributed to the growing body of technical information about forestry in tropical America. Of the many scientists who have worked at the Institute, a few stand out because of their significant contributions to tropical forestry.

Leslie R. Holdridge

The Institute's first scientist was Leslie R. Holdridge. A plant ecologist, he worked for the Caribbean National Forest from 1931 to 1939, when he moved to the newly established Tropical Forest Experiment Station. He left the Station in 1941 and subsequently worked for private corporations in Haiti and Guatemala, taught forest ecology at the International American Institute of Agricultural Sciences in Costa Rica, and founded the Tropical Science Center in San Jose, Costa Rica. His accomplishments include establishing

the Institute's herbarium, developing a classification system for tropical life zones that has since been widely used, and publishing two books on the trees of Puerto Rico.

Frank H. Wadsworth

Frank H. Wadsworth began his work at the Institute in 1942, serving as a scientist from that time to the present and as Director from 1956 to 1978. His contributions to the field of tropical silviculture, in addition to forestry teaching and extension work, have been primarily in analyzing plantation performance and tree growth in natural forests. He was the first person to detect the decreasing number of Puerto Rican parrots and to push for a recovery program.

Wadsworth is credited with pioneering watershed research. Ariel Lugo recalls: "Frank started measuring streamflow. . .40 years ago. . . and discovered that he was measuring more waterflow coming out of the forest than had been brought in as rainfall. Frank, being a dedicated Forest Service employee, dutifully wrote a memo to the Washington Office saying, 'Look, these are my results.' And the hydrologist in Washington took one look at Frank's memo and told Frank, 'Stop at once. Don't waste your time. That is not your specialty. Continue with the trees.' But what Frank had discovered, 20 years before anyone else, is that the cloud forest was intercepting water directly from the clouds. It turns out that this water contributes 10 percent of the total forest streamflow—water that never reaches the ground to be recorded as rainfall."

Wadsworth is also the author, with Elbert L. Little, Jr., of two books on the trees of Puerto Rico. These monumental works describe in detail more than 700 species of trees found in the region.

*Staff of the Institute of
Tropical Forestry in July
1990. The arrow indicates
current Director Ariel E.
Lugo.*



Martin Chudnoff

Martin Chudnoff, a wood technologist, worked at the Institute from 1964 to 1973. He pioneered wood utilization research in the Tropics and published several articles on preservative treatments for tropical woods, service life and treatment of fenceposts and poles, solar-drying techniques, and wood utilization.

Charles Briscoe

Charles Briscoe, a forest management specialist, worked at the Institute from 1959 to 1972. He pioneered research on the silviculture and regeneration of species for afforestation. His work contributed greatly to the successful establishment of forest plantations in Puerto Rico. Briscoe also conducted basic research on the stand structure and yield of natural stands of tabonuco and other species, and he studied the relation between tree growth and the local climate.

Ariel E. Lugo

Ariel E. Lugo came to the Institute in the early 1960s as a technician working on a large rain forest irradiation experiment. After completing his education, he taught at the University of Florida and worked for the Council of Environmental Quality in Washington, DC. In 1979, he returned to the Institute as Project Leader and then Director. An ecologist, he has published more than 300 scientific and technical papers, dealing mainly with interpreting tropical forest phenomena, including nutrient cycling and carbon balance. He has also been instrumental in bringing to the Institute a broad cooperative research program supported by grants and contributions from many outside institutions.

Directors through the Institute's history

Ariel E. Lugo (1979-present)

Frank H. Wadsworth (1956-1978)

I.P. Murray (1953-1955)

Henry B. Bosworth (1951-1953)

Arthur T. Upson (1943-1951)

Arthur Bevan (1939-1943)

Scientists and professionals at the time of ITF's 50th anniversary

Salvador Alemañy, research biologist

Wayne J. Arendt, wildlife biologist

John K. Francis, Jr., research forester

Andrew J.R. Gillespie, mathematical statistician

Edwin López, chemist

Sandra Molina, botanist

John A. Parrotta, research forester

Mary Jeane Sánchez, chemist

Frederick N. Scatena, hydrologist

Frank H. Wadsworth, research forester

Robert Walker, research biologist

Peter L. Weaver, research forester

Joseph M. Wunderle, Jr., research wildlife biologist

Irving T. Haig, Leslie R. Holdridge, and Arthur Bevan at Forest Service headquarters in about 1940. Haig was Director of Forest Service Research in Washington, DC; Holdridge was a scientist and Bevan the first Director of the Tropical Forest Experiment Station, later the ITF, now the International Institute of Tropical Forestry.



Other staff

Carlos Domínguez, biological technician

Ivette Figueroa, secretary

Victoria N. Gillam, administrative officer

Aixa Mojica, clerk (stay-in-school program)

Jorge Morales, library technician

Yolanda Padilla, clerk (stay-in-school program)

Evelyn Pagán, editorial clerk

Olga Ramos, biological technician

Gisel Reyes, information specialist

Carlos Rivera, forestry technician

María Rivera, biological aid

Noel Rivera, computer clerk

Alberto Rodríguez, biological technician

Carlos Rodríguez, ecologist (student trainee)

Mildred Román, editorial assistant

Miriam Salgado, biological technician

Griselle Sánchez, clerk typist

Felipe Torres, forestry technician

Guadalupe Torres, support services specialist

Awards

Over the years, the Institute of Tropical Forestry has received many awards.

To the research unit

Chief's Stewardship Award, U.S. Department of Agriculture, Forest Service, 1990

Global 500 Award, United Nations Environment Programme, 1989

Unit Civil Rights Award, U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, 1988

To staff members

Frank H. Wadsworth

Caribbean Conservation Association Award, 1989

Superior Service Award, U.S. Department of Agriculture, Forest Service, 1989, 1985, 1964

Gulf Oil Conservation Award, 1985

Distinguished Service Award, University of Michigan, School of Natural Resources Alumni Society, 1983

Special Award of Merit, U.S. Environmental Protection Agency, 1980

Pioneer Award for Conservation, Puerto Rico Environmental Quality Board, 1980

Meritorious Services Award, U.S. Department of Agriculture, Forest Service, 1979

Bernhard Eduard Fernow International Forestry Award, 1973

*Ariel E. Lugo and his
students from the College
of Natural Sciences,
University of Puerto Rico,
taking a break one week
after Hurricane Hugo
devastated the forest in
September 1989.*



Ariel E. Lugo

Distinguished Scientist Award, 1990

Distinguished Service Award, U.S. Department of Agriculture, 1988

Alberto Rodríguez

Technician Public Service Award, U.S. Department of Agriculture; Southern Forest Experiment Station, U.S. Department of Agriculture, Forest Service, 1988

Cooperators

Much of the scientific work of the Institute has been possible because of close ties with other organizations. The University of Puerto Rico has played an especially important role. For more than 50 years, the Institute has been on the university campus. Faculty members share such facilities as the library, laboratories, and field experimental areas, and they cooperate with Institute scientists on research projects.

The government of Puerto Rico has provided forest lands including, for many years, exclusive use of the Cambalache State Forest. Other major cooperators include the U.S. Fish and Wildlife Service, the Virgin Islands Government, the Mayagüez Tropical Agriculture Research Station, and several mainland universities. The Institute has had joint projects with the following cooperators:

International organizations

Caribbean Natural Areas Research Institute

Centro Agronómico Tecnológico de Investigación y Enseñanza

International Society of Tropical Foresters

International Tropical Timber Organization

International Union for Conservation of Nature and Natural Resources

International Union of Biological Sciences

International Union of Forestry Research Organizations

United Nations Educational, Scientific, and Cultural Organization/Man and the Biosphere Program

United Nations Food and Agriculture Organization

Other governments

Antigua and Barbuda

Argentina

Dominica

Dominican Republic

Ecuador

Grenada

Guadeloupe

Jamaica

Mexico

Montserrat

St. Kitts and Nevis

St. Lucia

St. Vincent and the Grenadines

U.S. Virgin Islands

Venezuela

U.S. governmental agencies

Agency for International Development

Department of State

Fish and Wildlife Service

Geological Survey

National Aeronautics and Space Administration

National Park Service

National Science Foundation

Peace Corps

State governmental agency

Department of Natural Resources

Universities

Center for Energy and Environmental Research,
Michigan State University

State College of New York

University of Colorado

University of Illinois

University of Missouri

University of Puerto Rico

University of Tennessee

Yale University

Other organizations

Institute for Ecosystems Studies

Oak Ridge National Laboratory

Science Teachers Association

Society of American Foresters

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For a complete list of publications, see the Institute's "Annual Letter 1983-84" and subsequent annual lists.

Appendix 3. The Luquillo Forest Reserve:

A Proclamation by the President of the United States

Whereas, it is provided by section one of the Act of Congress, approved July first, nineteen hundred and two, entitled, "An Act Authorizing the President to reserve public lands and buildings in the island of Porto Rico for public uses, and granting other public lands and buildings to the government of Porto Rico, and for other purposes," That the President be, and he is hereby, authorized to make, within one year after the approval of this Act, such reservation of public lands and buildings belonging to the United States in the island of Porto Rico, for military, naval, light-house, marine-hospital, post-offices, custom-houses, United States courts, and other public purposes, as he may deem necessary:

And whereas, the public lands in the island of Porto Rico, within the limits hereinafter described, are in part covered with timber, and it appears that the public good would be promoted by setting apart and reserving said lands as a public reservation;

Now, therefore, I, Theodore Roosevelt, President of the United States, by virtue of the power in me vested by section one of the aforesaid Act of Congress, do hereby make known and proclaim that there is hereby reserved and set apart as a Public Forest Reservation all those certain tracts, pieces of parcels of public lands, not heretofore appropriated or reserved, lying and being situate in the island of Porto Rico, and

within the boundaries particularly described as follows, to wit:

Beginning at the point where the parallel of eighteen (18) degrees and twenty-two (22) minutes, north latitude, intersects the meridian of sixty-five (65) degrees and fifty-five (55) minutes, west longitude; thence due east along said parallel to its intersection with the meridian of sixty-five (65) degrees and forty-five (45) minutes, west longitude; thence due south along said meridian to its intersection with the parallel of eighteen (18) degrees and fourteen (14) minutes, north latitude; thence due west along said parallel to its intersection with the meridian of sixty-five (65) degrees and fifty-five (55) minutes, west longitude; thence due north along said meridian to its intersection with the parallel of eighteen (18) degrees and twenty-two (22) minutes, north latitude, the place of beginning.

Warning is hereby expressly given to all persons not to occupy or use the lands reserved by this proclamation.

The reservation hereby established shall be known as The Luquillo Forest Reserve.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the City of Washington this seventeenth day of January, in the year of our Lord one thousand, nine hundred and three, and of the Independence of the United States the one hundred and twenty-seventh.

THEODORE ROOSEVELT

The President

John Hay

Secretary of State

Appendix 4. The Challenge in Tropical Forestry

F. Dale Robertson

**Chief, U.S. Department of Agriculture,
Forest Service**

**Speech presented at the Golden
Jubilee Celebration of the Institute of
Tropical Forestry**

Río Piedras, Puerto Rico

May 25, 1989

Did you know that within the lifetime of many of us in this room today the population of the world is likely to double from 5 billion to 10 billion people? That is the latest updated projection by the United Nation's Population Fund, which made headlines in the "Washington Post" last week. The headline reads, "World population may hit 10 billion by year 2025." That growth will be concentrated in the Tropics, where 60 percent of the people in the world live now.

I don't know about you, but I'm optimistic that I'll still be around in 2025 when we will be celebrating the 86th anniversary of the Institute of Tropical Forestry. And, I suspect that I will look back on this meeting in 1989 and think about what we discussed and concluded. How well did we grasp the complexity and the monumental challenge that we face in tropical forestry management? Were we shortsighted or far-sighted?

I would hazard a guess that we will look back and say, "Our thinking fell short of the mark." The "strategic fit" of our proposed research program over the monumental size of the problem wasn't very good. I say that because I believe this new population projection of 10 billion people, or a doubling of our population in 35 years rather than the 110 years based on the old projection, puts us in a different ball game. That's not evolutionary change as we've experienced to date; it's massive population explosion beyond the previous experience of mankind. It's people who generate the pressure on the natural resource base. Think about the kind of devastation and environmental damage being done in the world today to support 5 billion people, and then double it—a sobering thought!

This is especially a problem for research when you think about trying to connect the results of a slow, deliberate research process with a very rapidly changing situation.

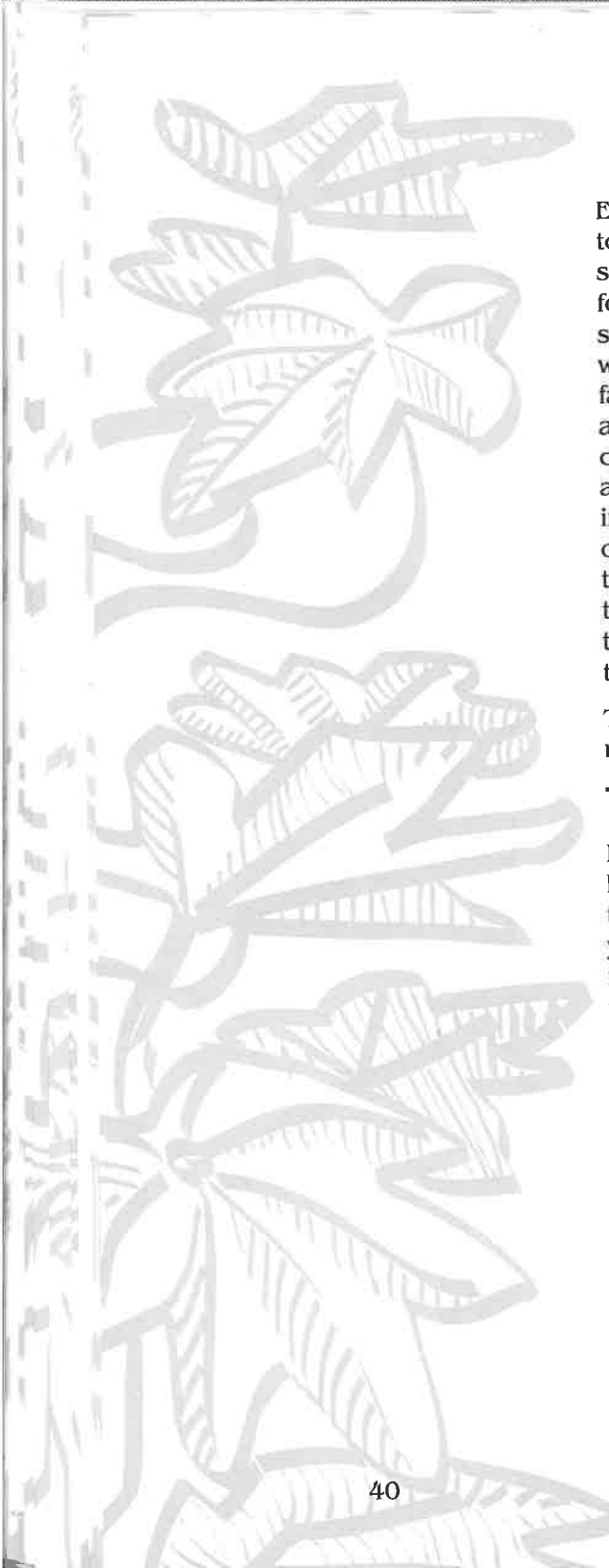
I have this mental image of trying to change a tire while it's spinning at 90 miles per hour. How do you ever get a hold on the situation so that it can be managed? It seems to me that it's going to take a lot of new science and technology; even then, the job is less than half done.

Mark Twain once told a story about a man who asked what could be done about the threat of German submarines. He replied, "Just boil the ocean." When asked how to go about boiling the ocean, the man replied, "Look, it's difficult enough for me to come up with the solution. It's up to you to figure out how to get the job done."

That's kind of the way it is with research. It's difficult enough to come up with the scientific answers, but it's even more difficult, especially in tropical forestry, to figure out how to get research applied widely throughout the world.



F. Dale Robertson



Even in the United States, it's common to have a 10- to 15-year lag time between development of new scientific findings and their widespread application in forest management. In the developing countries, I suspect the lag time is much longer. For example, I was in Honduras a few weeks ago and visited a model farm. One purpose of the farm was to demonstrate and convince local farmers to do contour plowing and quit plowing up and down the hill. Contour plowing is a 100-year-old concept just now being implemented in the mountains of Honduras. So, just assuming optimistically that one-half of this 35 years will be taken up implementing new research results, we're talking about having the scientific basis for supporting twice as many people in the Tropics over the next 15 to 20 years.

That's not very long in the world of research! There's no time to waste!

The People

Let's take a look at the people side of things—5 billion now, headed for 10 billion in 35 years. One thing that hasn't changed much over thousands of years is "basic human nature." People tend to worry more and be motivated more by the present rather than the future, especially when it comes to meeting their basic needs for food, shelter, and protection.

It's hard to think much about the future when your stomach is empty, your skin is cold, and you are struggling for survival. People are motivated to improve their standard of living by converting the value of the forest to something more immediately tangible. For example, there is a poor person's energy crisis—half of the people in the world depend on wood for 90 percent of their energy needs. There are places in Africa where a person must spend many hours to

gather enough wood for one cooked meal, and where the infant mortality rate is increased because people don't have enough wood to sterilize liquids and food.

The conflict between agriculture and forestry will intensify as twice as many people try to get enough food to eat. That's pretty basic stuff; yet, that's what we're dealing with in tropical forestry—the real human side of the problem.

Basic Law or Simple Truth

It takes a lot of economic power to sustain good conservation policies. Until you get people's basic subsistence needs taken care of and provide enough economic flexibility for people to have options or choices, conservation is likely to end up in second, third, or even fourth place. If economics aren't right, other issues like conservation have a hard time breaking through to get priority attention.

I think we North Americans sometimes forget the tremendous amount of economic power we have, which permits us to devote so much time, energy, and resources to conservation and environmental matters. It's hard for us to understand and sympathize with the human misery and poverty of many tropical people who really don't have many choices of doing anything other than what they are doing. So, I think we should remember the old Indian prayer: "Judge me not until you have walked a mile in my moccasins."

There is tremendous pressure on tropical people to deplete their forest resources to meet their short-term basic needs. I suspect they will continue doing the same thing until they have a better option. I suspect, if we were in their shoes, we would pretty much be doing the same thing. In fact, the United States did destroy its eastern and southern forests in the name of progress, building a nation, and generating the wealth of economic power that we have today.

So, I don't think we have much choice but to put at the front end of our thinking that "forests are for people." The forests have to be managed to meet the needs of people, future generations as well as present.

Forests are for people, and we can't factor that out of the equation as we talk about tropical forestry this week.

The Environmental Side

Now, let's look at the environmental side, which is no better than the human side, with tropical deforestation occurring at the rate of 28 million acres a year, and without much thought given to the future forest. We're losing precious valuable resources—soil, fish and wildlife species, biological diversity, habitat for migratory birds that overwinter in Latin America—you know that story!

The bottom line is that we are losing much of the future productivity of the land, which can only be partially restored with tremendous future investments. And that will be needed to support 10 billion people in 35 years.

Trees are the lungs of the planet and, as I understand it, the Tropics are no longer a big "carbon sink" as they historically have been. The "greenhouse effect" and concern over global warming have done more to bring tropical deforestation to the attention of the rest of the world than anything else. They brought the issue to the attention of those people who have the economic power—those who can afford to worry about such things. They've been well publicized in the press, and we're even having world conferences on the global warming issue.

The weather pattern has also cooperated in a major way to help get this issue imprinted in the minds of

people. I believe we've had three or four of the hottest years in recorded history in the 1980s. In the United States, we've had two consecutive years of drought, with last year being one of the worst we've ever had.

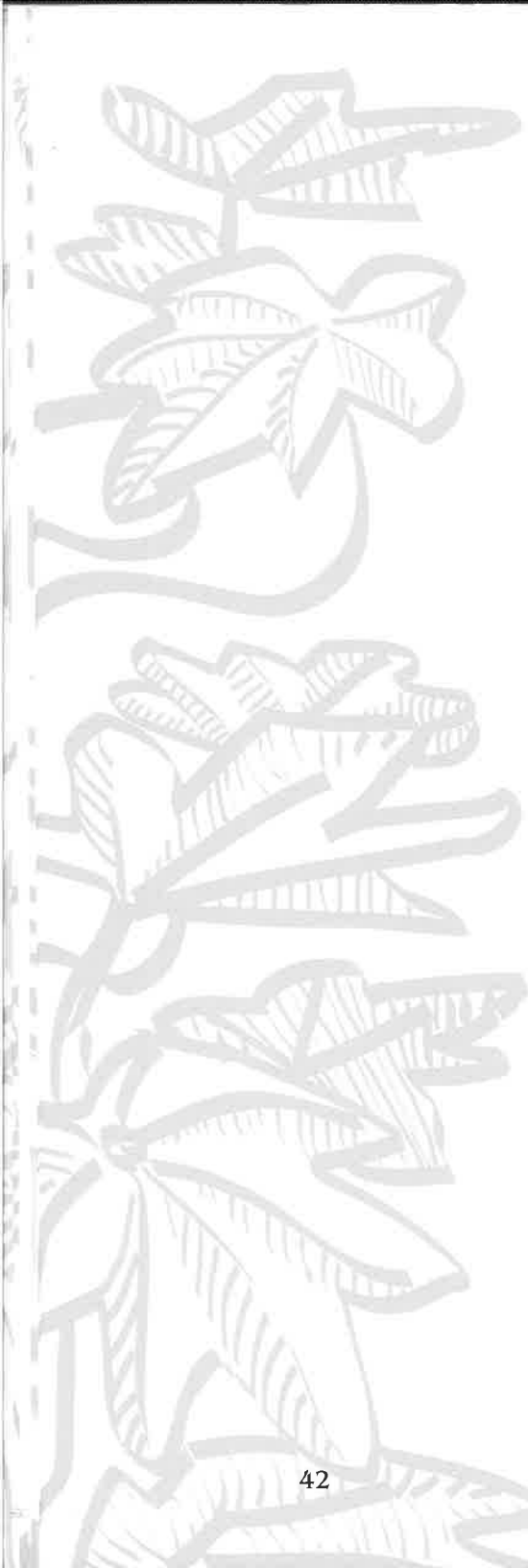
Figuring out to what extent, if any, that tropical deforestation has changed this weather pattern can occupy the scientists for years. But, right or wrong, what is important is that the public's mind, helped along by the press, has already concluded that it is a major contributing factor. People are beginning to see how they might be directly affected by not only industrial pollution, but also by tropical deforestation.

The tropical deforestation problem has gotten the attention of people around the world as never before. And they include people who have the economic power and can afford to worry about such things. For example, in the United States, a lot of members of Congress are talking about tropical deforestation, visiting Latin America to see it first hand, and even introducing bills in Congress to help solve the problem.

So, as they have with a lot of other issues in our past, the scientists and professionals worry about something for years, trying to get the attention of the people, policymakers, and politicians. Then, when it catches on or a crisis hits, the political system makes a giant leap over the scientists and politicians to become the leading advocates for doing something about it.

Our human nature is to say that we've been trying to tell you that for years—but that would be a strategic error on our part!

Even if the political rhetoric isn't quite right scientifically, it's an essential step that issues like tropical deforestation have to go through in the world of politics to get on the front burner and bring along the



rest of the world. We, the scientific and professional community, have to be smart enough to figure out how to capitalize on this public attention to advance the cause of scientific research and extension work to get the science and technology applied in the Tropics, working cooperatively with tropical countries.

The only way we're going to be successful is to integrate the human side with the environmental side so that it makes sense to the tropical people and includes their involvement every step of the way.

We can't push one-sided solutions. For example, preservation is an easy, quick solution to the environmental problem. But it doesn't deal very well with the human side. For most of the land, it takes basic, wise, multiple-use management of the tropical forest. This, in turn, takes a lot of science and technology, along with skillful management working day to day, hand in hand with tropical people. We will simply have to worry about the needs of those 5 to 6 billion people living in the Tropics in the year 2025. Those people are an integral part of the tropical forestry situation, and they can't be ignored in any viable solution.

So, we in the natural resources field must fit our technical expertise into the much broader social, economic, political setting in dealing with the tropical forestry situation. To do that, we at least need a conceptual grasp of how social, economic, environmental, biological, cultural, and political factors all fit together to create the tropical forest management problem that we're trying to help solve.

There's a lot of momentum for the way things are with so many forces, like the population explosion, propelling the past into the future with great speed. It will take extraordinary effort and steadfastness in our commitment to get tropical forest management on a course of sustainable development.

Institute of Tropical Forestry—The Past 50 years

Fortunately, through the hard work of people at the Institute of Tropical Forestry, and our many cooperators, especially the University of Puerto Rico and the Commonwealth of Puerto Rico, we know a lot about forestry management, as we saw yesterday on our field trip. We have a good, solid, 50-year research base to build upon.

Moreover, if we could just get what we already know applied throughout the Tropics, we would be a long way down the road toward supporting that 10 billion people in 35 years. Frank Wadsworth will talk about those accomplishments next on the program. They are substantial and much greater than people outside the scientific community recognize.

The Agenda for Research Over the Next 50 Years

I think this is an important meeting to not only celebrate the golden anniversary of the Institute of Tropical Forestry but to size up where we are in tropical forestry research and help develop an aggressive strategy to guide research over the next 50 years. But, in my mind, the next 15 to 20 years are crucial because of the lag time in getting research results implemented. We'll have the scientific basis for tropical forestry management done over the next 15 to 20 years to support 10 billion people in 35 years, but we must allow time for implementation.

So, in view of that, it's hard in my mind to figure out how we could overdo the strategy in relation to the size of the job, its critical nature, and time available to do it.

Cooperation

The size of the tropical research management job is really bigger than all of us put together. It's obvious that all countries and international organizations have to work together in close cooperation with the tropical people. So, we have a big management and coordination job among all of us to make sure we use our scarce resources and talents effectively.

There's no silver bullet in this business. It's just hard work, and we have to keep at it, keep at it with determination and commitment to keep pushing out the boundaries of our knowledge, keep spreading that knowledge into the heads of people who need it and can use it to make a difference, and keep coordinating and influencing the other "circles"—social, economic, political—because no group, even us foresters, can do the whole job. We need a coordinated approach.

I think the Tropical Forestry Action Plan of the Food and Agriculture Organization of the United Nations is really an important process and document to help coordinate our joint efforts. But we need to make sure that the lack of knowledge about technical forestry is not one of the more limiting factors holding back progress.

I think the U.S. Forest Service can and should do more to bring our expertise and experience to bear on the management of tropical forests. The Congress has already held hearings on how the Forest Service could provide technical assistance to tropical countries, and Jim Bradley will talk about that tomorrow. We have some members of Congress, like Bruce Vento, who understand tropical forestry and are anxious to do their part in passing new legislation giving the Forest

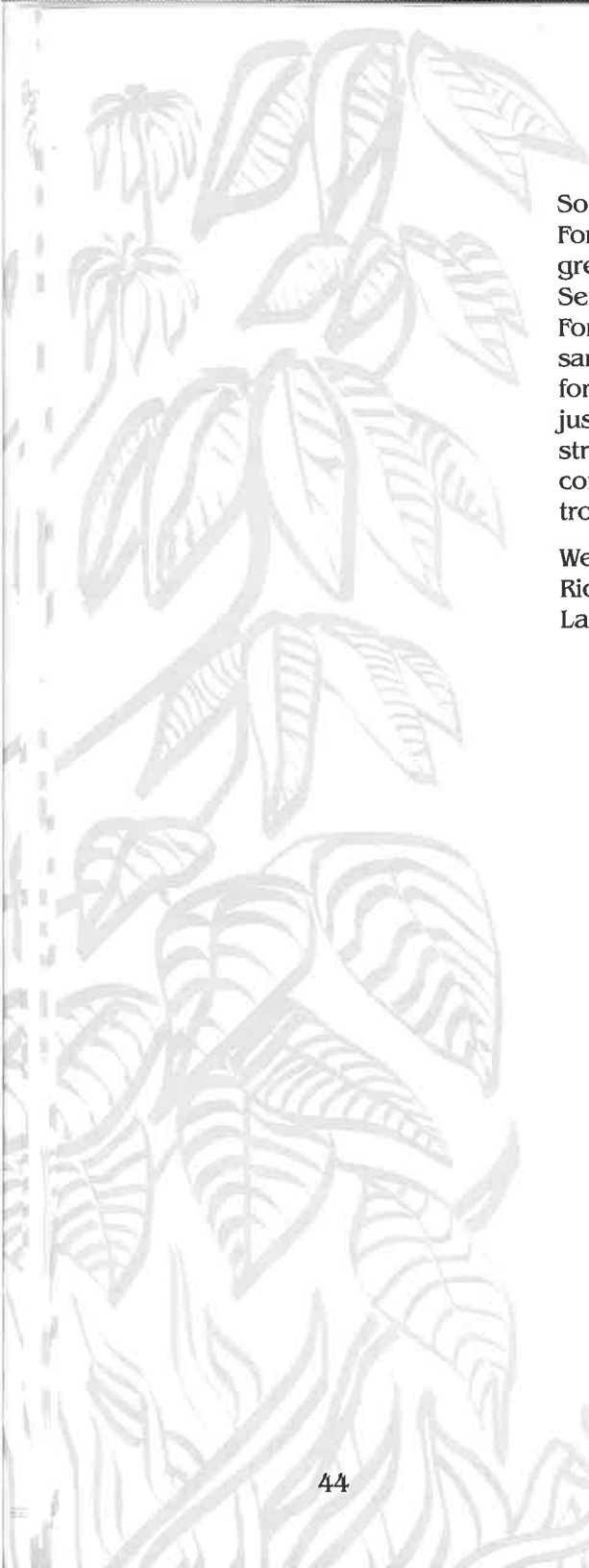
Service additional authority. Congressman Vento's bill will be very helpful in clarifying our authorities and responsibilities, and give added emphasis to international forestry.

The Forest Service intends to step up its efforts here in Puerto Rico in using the Institute of Tropical Forestry and the Caribbean National Forest as a focal point for research, demonstrations of tropical forestry management, and as a training center for tropical foresters. I believe our program here in Puerto Rico, in cooperation with our partners—the Commonwealth of Puerto Rico, the University of Puerto Rico—could become a "world-class resource" with 50 years of experience in tropical forestry already and building rapidly on that foundation.

I envision the Institute of Tropical Forestry and the Caribbean National Forest being available to cooperators around the world to come study tropical forestry, and use the experience gained in Puerto Rico to greatly accelerate the application of scientific management of tropical forests around the world.

Fifty years of experience is too valuable a resource to waste. The Forest Service is going to do all it can to get the most out of it!

Although Puerto Rico is a focal point for the Forest Service in tropical forestry, we envision using the Institute of Pacific Islands Forestry in Hawaii in much the same way. We also have the Forest Products Laboratory in Madison, Wisconsin, which is a world-class research lab in wood utilization.



So, this 50-year anniversary of the Institute of Tropical Forestry is coming along at just the right time. It was great foresight on the part of some early Forest Service pioneers to establish the Institute of Tropical Forestry so that we could celebrate its golden anniversary just at the time tropical forestry is coming to the forefront as a worldwide, high priority issue. It came just at the time to help the Forest Service sort out our strengths and weaknesses and what we can do best to contribute and complement the worldwide effort in tropical forestry.

We intend to build upon our strengths here in Puerto Rico, in the Pacific Islands, and at the Forest Products Lab. Also, we have a large cadre of former Peace

Corps volunteers in the Forest Service with many years of experience who want to get involved in international forestry again.

I would like to close with a quote from Rene Dubos: "Trends are not our destiny. While we can't escape the past, neither can we avoid inventing the future."

It is up to us to do our part in cooperating with tropical people to create "a winning future" for tropical forestry. I'm optimistic that by working together as global neighbors we can do that. Just remember, it's the period between now and the time all of us go to the grave that is crucial in making a difference in tropical forestry. It deserves our best effort!



Appendix 5.

Tropical Forestry

Research: Turning Vision

Into Reality

Congressman Bruce F. Vento

**Chairman of the Subcommittee on
National Parks and Public Lands**

**Committee on Interior and
Insular Affairs**

U.S. House of Representatives

Speech presented at the Golden Anniversary Symposium of the Institute of Tropical Forestry (USDA Forest Service) on May 26, 1989, in San Juan, Puerto Rico

I am disappointed that I cannot be here to speak with you in person. Controversial wilderness and wild and scenic river legislation require me to be on the Los Padres National Forest in California instead. Nevertheless, I will attempt to be at two places at the same time and have my staff share with you what I would liked to have said to you myself. Although I cannot be with you in person, I am with you in spirit because the plight of the world's tropical forests is an issue that is always near to my heart.¹

Fortunately, I have had the pleasure, just this year of visiting the Institute of Tropical Forestry and the Caribbean National Forest. Last January, I led our subcommittee on a field visit to the Institute and the forest to look for solutions to the global tropical forest

crisis. We observed Forest Service research projects on the ground, or maybe I should say, on the mud. I will remember Congressman Fuster and me sliding and slogging through the mud ankle-deep as we struggled to reach the top of El Toro Peak. Undeterred by a little mud, rain, and mountains, we agreed the end justified our efforts. We did learn about the research efforts here and were impressed by the quality of the research, the special qualities of the forest, and the academic achievements of the Forest Service in Puerto Rico.

As a result of this visit, I know from personal experience that the Institute of Tropical Forestry has good reason to feel proud on this golden anniversary of its founding. Let me extend my congratulations and the thanks of the U.S. Congress to all the Forest Service employees who work for the Institute and especially to Dr. Ariel Lugo, its Director, and Dr. Frank Wadsworth, its Director Emeritus. We commend the Institute and all those associated with it for 50 years of service to the world's tropical forests.

The audience here today is as distinguished as the Institute. It is a privilege to speak to tropical forest researchers and students not only from all over the United States, but from around the world as well. To me, you are environmental heroes. The world desperately needs you and your good work. At no other time in history has so much depended on the research of the tropical forester. It is clear that we are approaching a worldwide environmental crisis. Global warming, atmospheric change, ozone depletion, loss of biological diversity, acid rain, hazardous wastes, ocean pollution, and oil spills are growing problems that are gradually overwhelming the health of our planet. Near the top of everyone's list of pending environmental disasters is tropical deforestation. The loss of 27 million acres of tropical forests each year is a cause of some of the worst problems facing the world today, problems such

¹ Note: The Congressman's speech was presented by staff member Jim Bradley.



as the extinction of species, changes in climate and atmosphere, lost opportunities for new foods and medicines, poverty, and even, as Dr. Wadsworth can so eloquently explain, political instability. The crisis is so alarming that already in this session of Congress seven bills have been introduced dealing with tropical forests. Many more will soon follow.

The world must look to you in this room for solutions to this crisis. Government cannot slow or reverse tropical deforestation without your help. Without more and better research, politicians like me cannot formulate the necessary policies and laws needed to save tropical forests. We lack knowledge on topics such as the interrelations between forests and the atmosphere, the importance of biodiversity to our future well-being, and the potential products to be found in forests that would benefit all of humankind. This ignorance has crippled government's ability to act. We look to you to find the answers we need that will enable us to do our job.

One of the most important examples of the need for research is our inability to derive enough economic benefit from maintaining and using tropical forests as forests. The underlying cause behind the deforestation crisis is that many people in tropical countries see little economic gain from leaving tropical forests intact. In their view, much more wealth comes from cutting and burning the forests and from converting them to other uses. To me, the simple right of wild plants and animals to share the planet with us is reason enough to preserve tropical ecosystems. I feel that our species has a moral obligation not to wantonly eliminate other species. I don't need economic arguments to convince me on the need to save tropical forests.

But I have plenty to eat and live a comfortable lifestyle. What would happen to my environmental sensitivity if I lived in poverty and felt hunger? We

cannot solve the crisis unless we have compassion and understanding for people as well as this extraordinary ecosystem. Through research, we seek solutions for forests, managed and used as forests, to benefit local people economically and serve their many needs. We are surely aware of the shining examples of creative, nondestructive uses of forests that make income. The rubber tappers of Brazil come to mind, and I've learned that, in Peru, oil seeds are being harvested as a substitute for kerosene. Most of these types of activities are not being applied on a wide scale, however. I suspect that there are many more economic uses waiting to be discovered or implemented. I hope that those in attendance today will be the catalyst—the force—that will make this hope a reality. As you do, there will be many in Congress anxious to put your findings to practical use.

The theme of this symposium is the celebration of 50 years of accomplishment at the Institute of Tropical Forestry and the contemplation of what the next 50 years should bring. Since, by now, we are all familiar with what the Institute has already done, let's try to focus on the Institute's future. I have a view as to what this future might be. My view is that the Forest Service will live up to its global responsibility as the world's premier forest research organization by developing a much more aggressive tropical forestry program. My view is that the Institute will likely launch new projects clearly focused at slowing and reversing tropical deforestation. I know it cannot act without support of its leadership in Washington. Good intentions by themselves are not enough. We all must act. I was pleased to learn that Chief Robertson attended part of this symposium, and I hope that he returned to Washington convinced that the Caribbean National Forest should be a special flagship of the National Forest System, not a leaky scow in some forgotten backwater.

Where I feel the most concern about the gulf between vision and reality is at the Tropical Forestry Institute itself. As the world's tropical forest crisis has worsened, it would seem only logical that the Institute's programs to help solve the crisis would be strengthened. But logic does not always prevail in the administration's environmental policies and in the annual Federal budget process, and, tragically, through no fault of its own, the Institute has shrunk while the crisis has grown. During the past 10 years, the Institute has lost funding, scientists, and projects while the world has lost 254 million acres of tropical forests.

It is time for Congress to act to end this shocking state of affairs. Congress needs to make the vision of what Forest Service research can and should be a reality on the ground. I have taken specific steps to accomplish this, and I would like to share them with you.

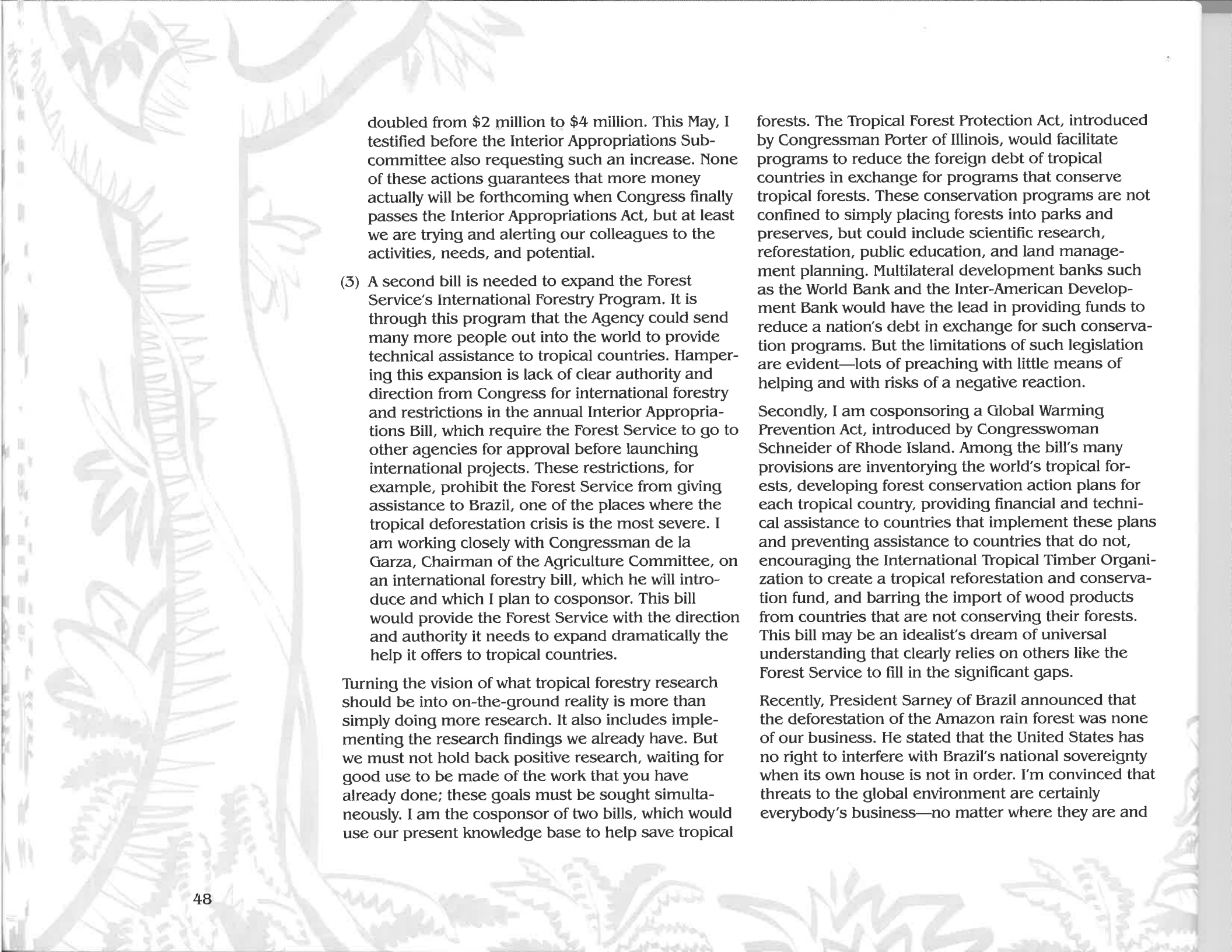
- (1) I have introduced the Tropical Forestry Initiative Act, a bill to bring new life to the Forest Service's tropical forestry research program. It has bipartisan support. Joining me as cosponsors are Congressmen Volkmer, Chairman of the Agriculture Subcommittee on Forests, Family Farms and Energy; Congressman Fuster, Resident Commissioner from Puerto Rico; and Congressman Lagomarino, the ranking minority member of our subcommittee. I'm planning a hearing on the proposal in Washington, June 13.

My bill would strengthen the Forest Service's tropical research program in the following ways:

- (a) It would give the Forest Service a Congressional mandate to conduct research that focuses on methods to slow or reverse tropical deforestation. No such mandate exists today.
- (b) It would establish a line item in the Forest Service's budget for tropical forestry research. Because today there is no line item, it is

difficult for Congress to earmark extra money for this program or even to determine how much money the program already has.

- (c) It would give the Institute of Tropical Forestry a Congressional mandate to expand its current program to include research on recreation and tourism; alternative economic uses of tropical forests that sustain them as forests, including the development of new products; and the effects of tropical deforestation on biodiversity and global climate change. With a mandate from Congress, the Institute would compete better in the budget process and would receive more support from the Forest Service.
 - (d) The bill would direct the Institute to share its findings with other countries and to assist researchers and natural resource managers throughout the tropical world.
 - (e) It would direct the Forest Service to manage the Caribbean National Forest as a model of tropical forest management with an international outreach program and with the necessary training and educational facilities to fulfill this role.
- (2) Giving the Institute and Forest Service Congressional mandates must be accompanied by increases in funding. I am working to provide these increases in fiscal year 1990. Last February, I held a hearing on the Forest Service budget which highlighted the funding needs for tropical forestry research. Dr. Wadsworth presented moving testimony at that hearing. In March, the 10 interior committees, of which my subcommittee is part, unanimously approved our report to the budget committee recommending that the Forest Service's tropical forestry research budget be



doubled from \$2 million to \$4 million. This May, I testified before the Interior Appropriations Subcommittee also requesting such an increase. None of these actions guarantees that more money actually will be forthcoming when Congress finally passes the Interior Appropriations Act, but at least we are trying and alerting our colleagues to the activities, needs, and potential.

- (3) A second bill is needed to expand the Forest Service's International Forestry Program. It is through this program that the Agency could send many more people out into the world to provide technical assistance to tropical countries. Hampering this expansion is lack of clear authority and direction from Congress for international forestry and restrictions in the annual Interior Appropriations Bill, which require the Forest Service to go to other agencies for approval before launching international projects. These restrictions, for example, prohibit the Forest Service from giving assistance to Brazil, one of the places where the tropical deforestation crisis is the most severe. I am working closely with Congressman de la Garza, Chairman of the Agriculture Committee, on an international forestry bill, which he will introduce and which I plan to cosponsor. This bill would provide the Forest Service with the direction and authority it needs to expand dramatically the help it offers to tropical countries.

Turning the vision of what tropical forestry research should be into on-the-ground reality is more than simply doing more research. It also includes implementing the research findings we already have. But we must not hold back positive research, waiting for good use to be made of the work that you have already done; these goals must be sought simultaneously. I am the cosponsor of two bills, which would use our present knowledge base to help save tropical

forests. The Tropical Forest Protection Act, introduced by Congressman Porter of Illinois, would facilitate programs to reduce the foreign debt of tropical countries in exchange for programs that conserve tropical forests. These conservation programs are not confined to simply placing forests into parks and preserves, but could include scientific research, reforestation, public education, and land management planning. Multilateral development banks such as the World Bank and the Inter-American Development Bank would have the lead in providing funds to reduce a nation's debt in exchange for such conservation programs. But the limitations of such legislation are evident—lots of preaching with little means of helping and with risks of a negative reaction.

Secondly, I am cosponsoring a Global Warming Prevention Act, introduced by Congresswoman Schneider of Rhode Island. Among the bill's many provisions are inventorying the world's tropical forests, developing forest conservation action plans for each tropical country, providing financial and technical assistance to countries that implement these plans and preventing assistance to countries that do not, encouraging the International Tropical Timber Organization to create a tropical reforestation and conservation fund, and barring the import of wood products from countries that are not conserving their forests. This bill may be an idealist's dream of universal understanding that clearly relies on others like the Forest Service to fill in the significant gaps.

Recently, President Sarney of Brazil announced that the deforestation of the Amazon rain forest was none of our business. He stated that the United States has no right to interfere with Brazil's national sovereignty when its own house is not in order. I'm convinced that threats to the global environment are certainly everybody's business—no matter where they are and

that the world needs the United States to provide leadership in solving global environmental crises. If we don't, who will?

But the Brazilian president does have a valid point. How can the United States lead when our own house is clearly not in order? A tangible example of our own poor housekeeping is the one-third of our Nation's lands in Federal ownership. For the past 10 years, we have allowed a million square miles to collect dust in the attic of our national priorities. The percentage of the Federal budget devoted to natural resources and the environment has declined from 2 percent in 1980 to 1.3 percent in 1989. President Bush's proposed budget for 1990 recommends a further decline to 1 percent, half of what it was 10 years ago. An essential element of any American program to slow tropical deforestation has to be putting our own house in order. Our Federal lands, starting right here with the Caribbean National Forest, must become shining examples of quality management that demonstrate our sincerity instead of exposing our hypocrisy. Unfortunately, the state of our Federal lands today presents an example that is somewhat tarnished.

As Chairman of the Subcommittee on National Parks and Public Lands, which has jurisdiction over most of these Federal lands, I am committed to bringing them down from the attic, dusting them off, and polishing them up. There is a lot of work to be done. One of the most urgent tasks is solving the crisis in our own temperate rain forests. It makes little sense to launch new policies to save tropical rain forests in other countries while we cling to old policies that are destroying temperate rain forests of our own. We must find a solution that maintains enough of the unique old-growth ecosystem of Alaska and the Pacific Northwest to protect America's biodiversity, but which also does not unduly disrupt local economies. As with the tropical forest crisis, government must look to

research foresters to help solve the temperate forest crisis. Our subcommittee will be holding an oversight hearing on the old-growth issue in the near future, and will hear testimony from the research community. Hopefully, the hearing will be a first step towards creating new policies for our temperate rain forests.

We are about to begin a new decade, and I predict that the 1990s will bring about a revolution in the way the world views natural resources and the environment. As the health of the world's environment deteriorates, the nineties will force people everywhere to realize that there is a global crisis, that the protection of the world's resources is a global responsibility that transcends national boundaries, and that all of humankind had better act quickly and in concert to save the environmental quality of this planet. I predict that the nineties will be the decade of the global environment and, let's hope, of global environmental action. Let's hope that, as conditions worsen, the world's resolve to act will strengthen. Let's hope that the degradation of the Earth's environment will awaken us from the environmental apathy of the eighties into a decade of environmental activism in the nineties.

If and when this happens, the world will surely turn to you, the tropical forester, to help extricate it from the mess. To many of us, the crisis is already here and we already recognize just how urgently we need your help. There is missionary work enough for us all. Although there are few doorstep conversions, there are plenty of opportunities to plant seeds, especially now that the "greenhouse effect" is receiving national attention. Nourished, these seeds can grow into a sound conservation policy that serves all the peoples of the world today, and especially, tomorrow.

Appendix 6.

Title VI—International Forestry Cooperation Act of 1990

SEC. 601. SHORT TITLE.

This title may be cited as the "International Forestry Cooperation Act of 1990."

SEC. 602. FORESTRY AND RELATED NATURAL RESOURCES ASSISTANCE.

- (a) **FOCUS OF ACTIVITIES.**—To achieve the maximum impact from activities undertaken under the authority of this title, the Secretary shall focus such activities on the key countries which could have a substantial impact on emissions of greenhouse gases related to global warming.
- (b) **AUTHORITY FOR INTERNATIONAL FORESTRY ACTIVITIES.**—In support of forestry and related natural resource activities outside of the United States and its territories and possessions, the Secretary of Agriculture (hereinafter referred to in this title as the Secretary) may—
- (1) provide assistance that promotes sustainable development and global environment stability, including assistance for—
 - (A) conservation and sustainable management of forest land;
 - (B) forest plantation technology and tree improvement;
 - (C) rehabilitation of cutover lands, eroded watersheds, and areas damaged by wildfire and other natural disaster;
 - (D) prevention and control of insects, diseases, and other damaging agents;
 - (E) preparedness planning, training, and operational assistance to combat natural disasters;
 - (F) more complete utilization of forest products leading to resource conservation;
 - (G) range protection and enhancement; and
 - (H) wildlife and fisheries protection and improvement;
- (2) share technical, managerial, extension, and administrative skills related to public and private natural resource administration;
- (3) provide education and training opportunities to promote the transfer and utilization of scientific information and technologies;
- (4) engage in scientific exchange and cooperative research with foreign governmental, educational, technical, and research institutions; and
- (5) cooperate with domestic and international organizations that further international programs for the management and protection of forests, rangelands, wildlife and fisheries, and related natural resource activities.
- (c) **ELIGIBLE COUNTRIES.**—The Secretary shall undertake the activities described in subsection (b), in countries that receive assistance from the Agency for International Development only at the request, or with the concurrence, of the Administrator of the Agency for International Development.

SEC. 603. TROPICAL FORESTRY ASSESSMENT AND ASSISTANCE.

In support of the Tropical Forestry Action Plan and to specifically address tropical deforestation and degradation, the Secretary may—

- (1) support and actively participate in global and regional meetings that seek to reform such a Plan;
- (2) together with the United States Agency for International Development, and other Federal Agencies, provide technical assistance to tropical countries for the formulation of national forestry sector development strategies; and
- (3) cooperate with tropical countries on research, training, and technical programs aimed at implementing national forestry sector development strategies.

SEC. 604. INSTITUTE OF TROPICAL FORESTRY.

- (a) **EXPANSION.**—The Secretary shall expand the capabilities of and construct additional facilities at the Caribbean National Forest and Institute of Tropical Forestry in Puerto Rico, as the Secretary determines necessary to support the purpose of this title, and as funds are appropriated for such expansion and construction.
- (b) **TROPICAL FORESTRY PLANS.**—Not later than 1 year after the date of enactment of this Act, the Secretary shall prepare and submit to the Committee on Agriculture, Nutrition, and Forestry of the Senate, the Committee on Agriculture of the House of Representatives, and to the Committees on Appropriations of the Senate and House of Representatives, a tropical forestry plan for expansion and construction of additional facilities under subsection (a). Such plan shall include provisions for—

- (1) the construction or acquisition of a major center for education, interpretation, and appreciation of the benefits and methods of the intelligent management of tropical forests;
- (2) the acquisition or construction of facilities for housing and classroom instruction near the Caribbean National Forest/Luquillo Experimental Forest; and
- (3) the acquisition or construction of facilities for the study and recovery of endangered tropical wildlife, fish, and plant species.

SEC. 609. ADMINISTRATIVE PROVISIONS.

- (a) **COORDINATION OF ACTIVITIES.**—The Secretary shall coordinate all activities outside of the United States under this title with other Federal officials, departments, agencies, and international organizations, as the President may require.
- (b) **ASSISTANCE.**—The Secretary may provide assistance, as determined appropriate by the Secretary to carry out this title, including technical and financial assistance, equipment, and facilities without reimbursement.

SEC. 610. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated such sums as may be necessary to carry out this title.

SEC. 607. CONFORMING AMENDMENTS.

- (a) **FOREST AND RANGELAND RENEWABLE RESOURCES RESEARCH ACT.**—The Forest and Rangeland Renewable Resources Research Act of 1978 (16 USC. 1641 et seq.) is amended—
 - (1) in section 2 (16 USC. 1641)—
 - (A) by inserting “(1)” after “(a)”;
 - (B) by adding at the end of subsection (a) the following new paragraph:

"(2) Congress further finds that the forest and rangeland renewable resources of the world are threatened by deforestation due to conversion to agriculture of lands better suited to other uses, over-grazing, over-harvesting, and other causes that pose a direct adverse threat to the people, the global environment, and the world economy"; and

(C) by adding at the end thereof the following new subsection:

"(c) It is the purpose of this Act to authorize the Secretary to expand research activities to encompass international forestry and natural resource issues on a global scale"; and

(2) in the first section 4(c) (16 USC. 1643)c, by inserting "international," before "Federal."

(b) **COOPERATIVE FORESTRY ASSISTANCE ACT.**—The Cooperative Forestry Assistance Act of 1978 (16 USC. et seq.) is amended—

(1) in section 2(a)—

(A) by striking "and" at the end of paragraph (16);

(B) by striking the period at the end of paragraph (17) and inserting "; and"; and

(C) by adding at the end thereof the following paragraph:

"(18) the same forest resource supply, protection and management issues that exist in the United States are also present on an international scale, and the forest and rangeland renewable resources of the world are threatened by deforestation due to conversion better suited to other purposes, over-grazing, over-harvesting,

and other causes which pose a direct adverse threat to people, the global environment, and the world economy."

(2) in section 2(b), by inserting "in the United States, and forest lands in foreign countries," after "non-Federal forest lands," the first place it appears in paragraph 10; and

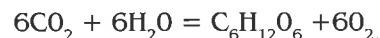
(3) in section 12, by adding at the end thereof the following new subsection:

"(h) In addition to the authority provided elsewhere in this Act, the Secretary may provide assistance to other countries with respect to the activities described in paragraphs (1) through (5) of section 7(b), and paragraphs (1) through (3) section 9(b). For the purposes of providing assistance to other countries, under this subsection, the term 'non-Federal forest land' shall mean any forest land and related renewable resources in such countries. In providing the assistance authorized under this subsection, the Secretary shall coordinate with other Federal officials, departments, agencies, or international organizations, as the President may direct. The references to 'State Foresters or equivalent State officials' in this Act shall not apply to the assistance provided by the Secretary to other countries under this subsection."

Appendix 7. Energy Release By Chlorophyll

L.R. Holdridge
Tropical Science Center
San José, Costa Rica

The following simple chemical equation,

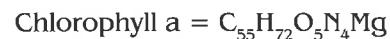


shows the separation of carbon from the carbon dioxide and its union with water to form a simple sugar. The chemical process is produced in vegetation exposed to sunlight or artificial light.

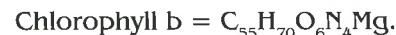
In a glass jar containing water and green algae, placed in the light, one may observe the tiny bubbles of oxygen rising towards the surface of the water. In the dark, the process would be reversed and the rising bubbles would be of carbon dioxide produced by oxidations of the simple sugar formed during the day.

The predominant green color of Earth's vegetation during the growing season is due to the green chlorophyll in the leaves of most plants or the bodies of simpler plants. Within plant cells, the molecules of chlorophyll are contained in small, rounded bodies, called chloroplasts. Under a microscope, the chloroplasts of *Spirogyra* spp. are seen streaming around inside of the cell walls. The chloroplast movement would provide varied exposure to the light source.

The molecules of chlorophyll are complex and made up of many atoms. There are two different molecules, called chlorophyll a and chlorophyll b. Their formulas are as follows:



and



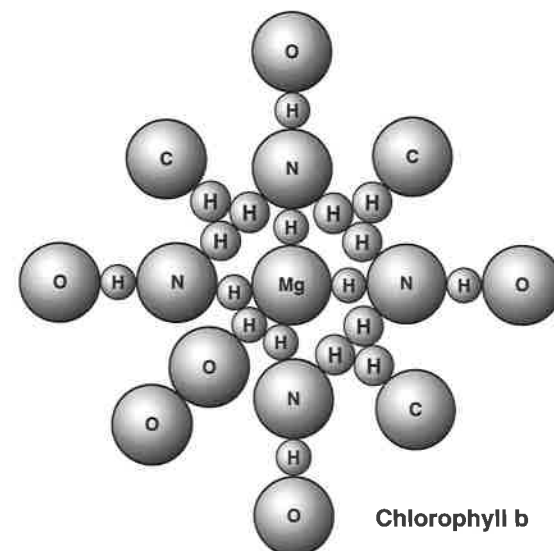
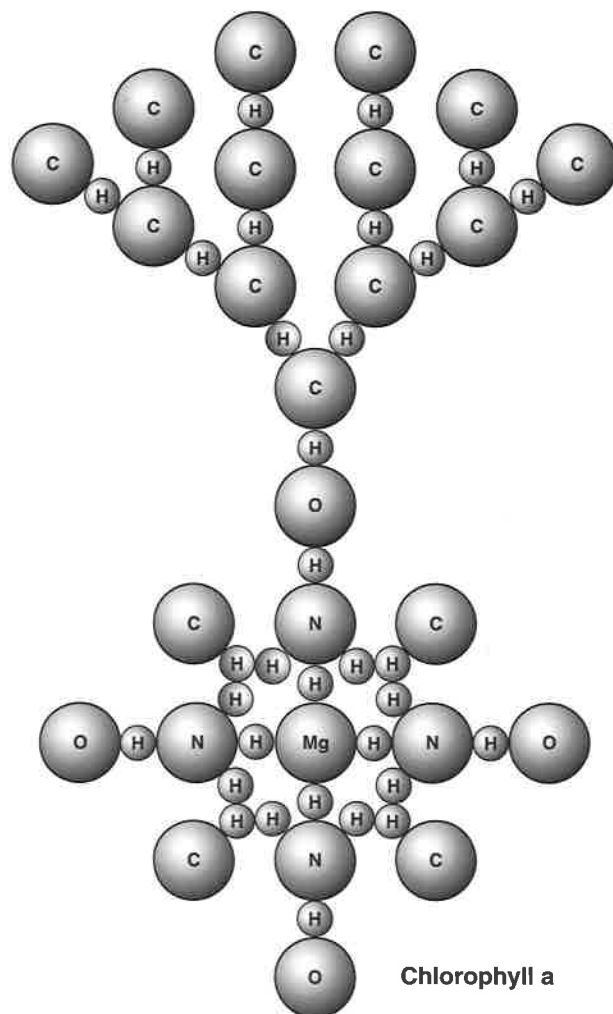
Apparently, both molecules are equally effective in their release or capture of the energy in either sunshine or other forms of light. Based on the observation that the two molecules of chlorophyll appear more different chemically than structurally, the structures of proposed molecules have been worked out and are shown in figure 1.

By imagining a carbon-hydrogen wing (fig. 2) extending outward as a projection from the central structure of chlorophyll, one should have in mind a large, essentially two-dimensional molecule of either chlorophyll a or b.

The several outer atoms of carbon in the four wings of the chlorophyll molecules are supposedly tied together by the synchronization of their outer orbit electrons. Those electrons are readily separated by the striking of visible light fotons or visitons of electrons of the hydrogen atoms, thus releasing the carbon atoms. The released carbon can then form carbon rings, which tie the water molecules together to produce simple sugar, $\text{C}_6\text{H}_{12}\text{O}_6$. The oxygen released in the breakdown of CO_2 is derived from the separation of CO_2 into carbon and oxygen.

The visible light foton or visiton, supposedly spherical, travels through space, like the fotons of other octaves, on a helicoidal path, thus having characteristics of both mass and waves. Fotons travel forwards through space at a velocity of c but at velocities much higher along the helicoidal paths. The visiton has a mass of 4.0367×10^{-33} (Holdridge 1974).

Figure 1. Molecular structure in the central portion of chlorophylls a and b.



Ultraviolet photons or “ultravisitons” can knock electrons out of metals. They have double the mass of the visiton, but because the electrons all make one orbit around the nucleus in the same length of time and because the outer orbits in metals, like nickel, should be larger than those of the simple hydrogen electron orbit, the visiton should be just as, if not more, capable of knocking electrons out of orbit.

Many may object to my hypothesis that the bonding together of atoms into molecules is the result of synchronization of their outer electron orbits to form molecules, but the evidence is very strong, as may be observed in the material in Holdridge [n.d.] and Holdridge 1986.

Literature Cited

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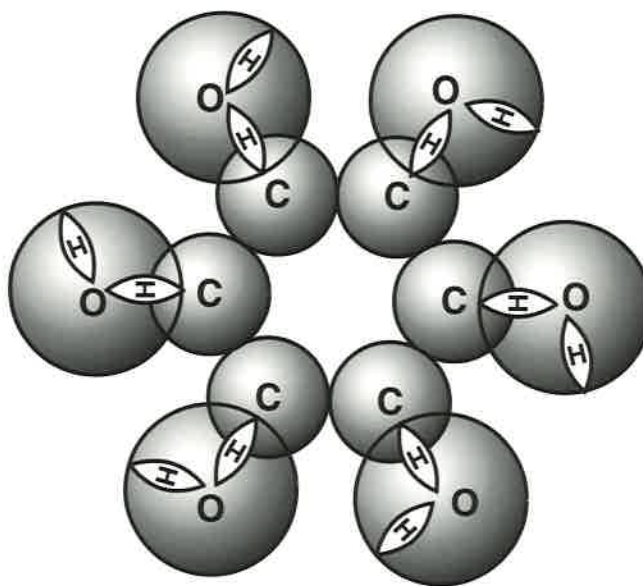
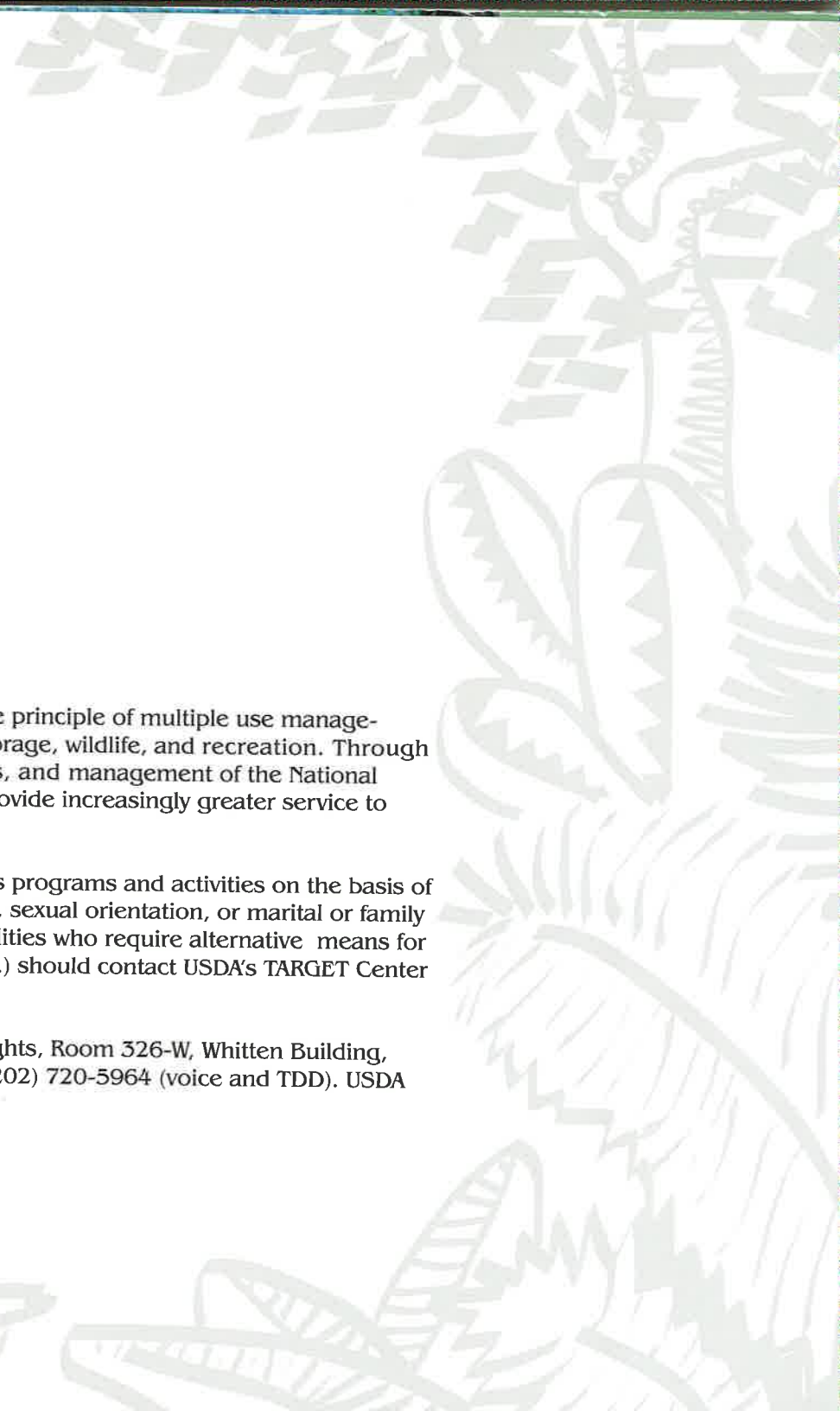


Figure 2. A carbon-hydrogen wing (one of four) extending outward as a projection from the central structure of either chlorophyll a or b.

Notes



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