FOREST BIODIVERSITY IN LATIN AMERICA: REVERSING THE LOSSES?

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DALLMEIER, F. & DEVLIN, F.A. 1992. Forest biodiversity in Latin America: reversing the losses? Throughout Latin America's forested regions, a number of factors are causing reduction and degradation of habitat and the elimination of species. One of the world's richest storehouses of biodiversity is under severe stress. Innovative research projects and initiatives for sustainable forestry hold promise for habitats and biodiversity. In particular, reliable research provides the information necessary for sound conservation measures and sustainable use strategies. Ultimately, however, the peoples of Latin America must change their basic attitudes and beliefs about the value of the forest if biodiversity is to be preserved. Also, mechanisms need to be in place which enable them to value the forest.

Key words: Biodiversity - forest - Latin America - conservation - land management - deforestation - restoration - habitat - forestry

DALLMEIER, F. & DEVLIN, F.A. 1992. Biodiversiti hutan di Amerika Latin: mengurangkan kehilangan? Disegenap kawasan hutan Amerika Latin, beberapa faktor telah menyebabkan pengurangan dan pendegradan habitat dan pemusnahan spesies. Salah satu gudang biodiversiti dunia kini sedang menghadapi tekanan hebat. Projek-projek penyelidikan yang inovatif dan inisiatif-inisiatif untuk perhutanan secara berkekalan memberi harapan kepada habitat dan biodiversiti. Paling penting, penyelidikan yang jujur akan dapat menyediakan maklumat yang diperlukan bagi mengadakan langkah-langkah pemeliharaan dan strategi penggunaan secara berkekalan. Namun demikian, penduduk Amerika Latin harus mengubah sikap dan tanggapan mereka terhadap nilai hutan sekiranya biodiversiti ini hendak dipelihara. Selain dari itu, beberapa mekanisma perlu diadakan untuk membolehkan mereka menghargai hutan.

Introduction

Today, many of the world's richly diverse forest ecosystems are endangered. The problem can be attributed to commercial development, soil erosion, excessive logging, and other methods of human exploitation. The challenge is to find a workable solution that strikes a balance between human needs and the important goal of preserving and maintaining nature's integrity.

Latin American forest resources are especially threatened. Because of their immense biological value, they deserve our close attention.

The highest levels of forest-related biodiversity in Latin America are found primarily in the foothills along the eastern slope of the Andes, the tropical rainforest of the Amazon. The complex structure and composition of the rainforest combine with vertebrate and invertebrate species to maintain a dynamic system. Millions of organisms, particularly invertebrates associated with a great abundance of microhabitats, make their home in the rainforest (Erwin 1988). In certain pockets of the Amazon, species diversity is extraordinarily high. "Hot spots" can contain between 180 and 350 species of trees per *ha*, while the more common range is from 40 to 100 species (Gentry 1990, Dallmeier *et al.* 1991a,b,c,d, 1992a,b). Although less diverse than the Amazon rainforest, the dry forest of the wider Caribbean area, the western coast of Central America to Mexico, and the temperate forests of Chile and Argentina also represent unique, threatened ecosystems.

Tropical forest systems must contain large enough habitats to support viable populations of species that are necessary to maintain the integrity of the forest. For example, peccaries, agouties and pacas are the most important species for seed dispersal of many tree species, including the palm (*Schelea princeps*), in the rainforest of Bolivia. Over-hunting of these species may drastically change forest composition and diversity over time.

Factors contributing to forest destruction and degradation are not uniform throughout the region, and some forests are at greater risk. In tropical Latin America most human populations reside in the dry and moist zones and these forests suffer the impacts of settlement (Tosi & Voertman 1964,Tosi 1980). The dry forests of the wider Caribbean are virtually extinct today because they were valued more for their agricultural, cattle ranching, and wood products potential than as intact natural systems (Janzen 1988). Mangroves in the Caribbean islands are in jeopardy from agricultural,industrial and tourist development along coastal areas. Run-offs from farms and wastes from facilities such as oil refineries, sewage treatment plants, and sugar mills degrade water quality and threaten the health of the mangroves. High levels of toxics and nutrients in the water put fish and invertebrate populations at risk (Botero & Marshall 1992).

Based on the average yearly rate (0.6 %) of tropical deforestation in Latin American (Sharma 1992, World Resources Institute 1992), one-quarter of the species diversity in the region may be extinct before the middle of the next century (Raven 1988, Wilson & Peters 1988, Reid & Miller 1989, McNeely *et al.* 1990, World Resources Institute 1992). Wilson (1992) estimates that the number of species lost every year in the tropical forest is 27,000, based on the rule of thumb stating that when an area is reduced to one-tenth of its original size, the number of species eventually drops to one half. This dramatic loss is not solely related to the timber industry; shifting cultivation and grazing usually follow new road construction and industrial logging.

Such unfortunate estimates are partly a reflection of the fact that sustainable forestry is not being achieved in Latin America. Instead, legislation often requires that plantations of exotic pines and eucalyptus be planted in cleared areas. The removal and conversion of the primeval forest indicates that the forests themselves are not properly valued; they are simply cleared to make way for other economic uses.

In light of current policies, a number of questions come to mind. For example, how resilient are the forests? Can they naturally adapt to overcome pollution that does not recognize human-imposed boundaries? When is it appropriate to intervene, and to what extent? How much tropical, temperate, or dry forest can be preserved and for how long?

We cannot answer these and other questions without a comprehensive understanding of the nature and diversity of the tropical forest. This necessarily entails a number of repeated inventories executed over time - costly and difficult work. In addition, many developing countries lack the highly skilled personnel needed to identify precisely the elements of forest diversity. Even highly developed nations do not always commit adequate human and financial resources to the study of forest biodiversity. Given these constraints, it is important to agree on sites, specific forestry issues, and methods required to analyze and define the status of forest ecosystems in Latin America (Dallmeier 1992b).

Biodiversity baseline profiles - describing critical biodiversity issues, the areas that require special conservation, and alternative management approaches - have only recently been made available for several Latin American countries (USAID Ecuador 1989). The next step is to identify natural and human induced environmental changes that will help to detect further alterations in biodiversity, compare natural changes to those induced by humans, and generate conservation and management strategies.

This paper provides details and discussion of the condition of forest biodiversity in Latin America. It begins with a status report on biodiversity and major threats to maintaining this resource. Next, the paper examines research projects and sustainable forest management activities which may help preserve biodiversity. We end with conclusions based on the information presented.

Status of forest biodiversity

Latin America is a huge region, containing 32 countries and 17 % of the world's population. Most of the region shares a history of Iberian colonialism and other cultural similarities. It is characterized by economies based on local farming, large-scale agriculture (including cattle ranching), and fishing. Brazil, Chile and Mexico are industrial giants, when compared to the tiny countries of Central America.

A variety of ecosystems are found in Latin America - from tropical, subtropical, and temperate to paramo at the higher elevations in the Andes. These physical characteristics have helped create a richness of species, including the showpiece of diversity in the vast Amazon rainforest.

Due to the size and complexity of the region and for purposes of comparison, we have divided the region into four subregions - the Caribbean, Central America and Mexico, Tropical South America, and Subtropical South America (Figure 1).

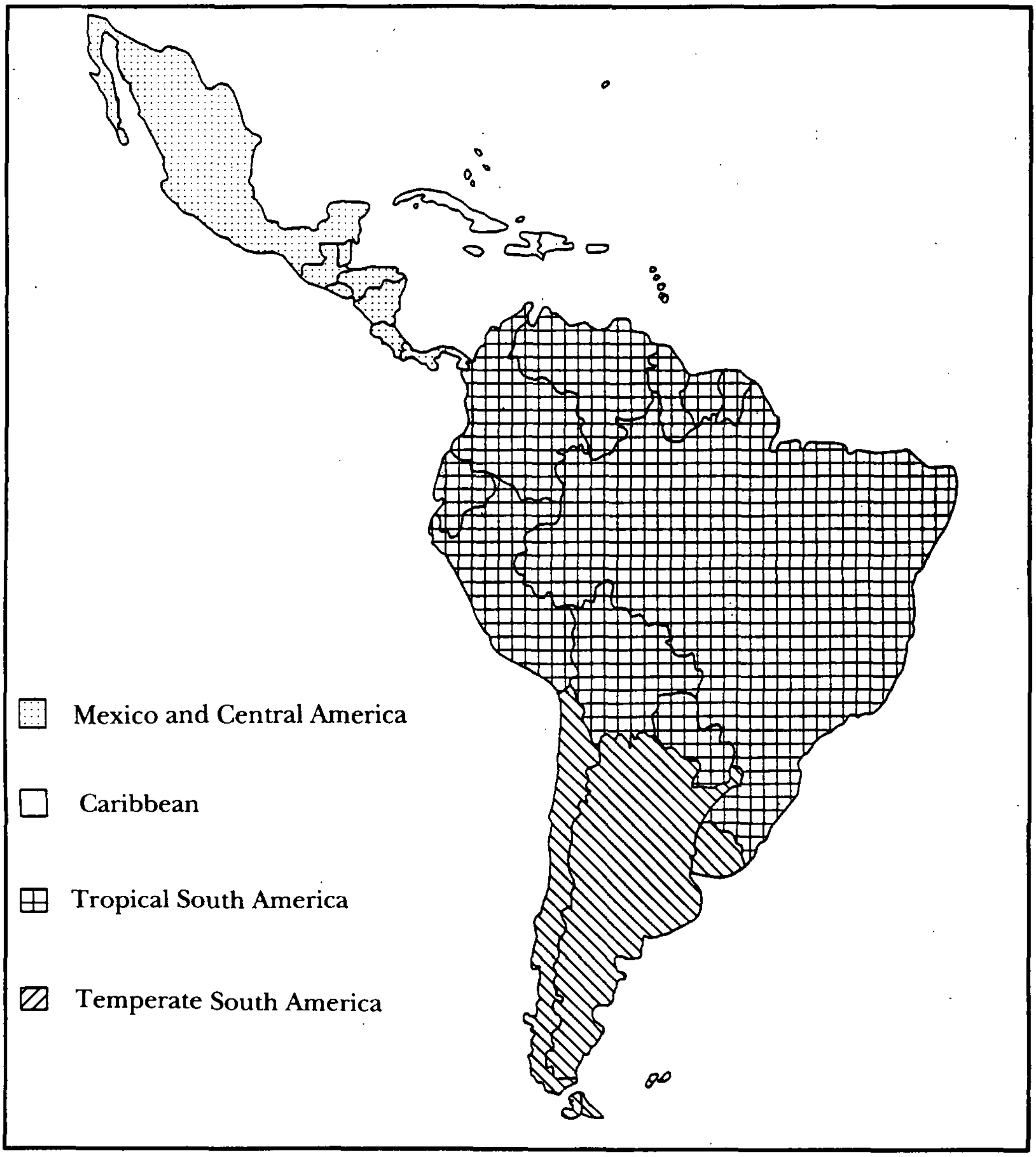


Figure 1. Subregions of Latin America

Latin America's tropics cover 35% of the world's tropical zone, representing nearly one-quarter of the earth's forested areas (Figure 2) and about half of all tropical forest resources. In 1990, approximately 50% of the land area of Latin America was still forested, dominated by the 400,000-*ha* tropical rainforest of the Amazon Basin in Brazil, Bolivia, Colombia, Ecuador, Peru, and Venezuela. To date, 78% of the tropical rainforest zone is forested (Table 1). Moist deciduous forest occupies 34% of the land in the region. The montane area (mainly in the Andes) covers around one-fifth of the land area, but only 27% of it is forested. Deforestation for all forest types in the region totaled 8.3 million *ha* between 1981 and 1990.

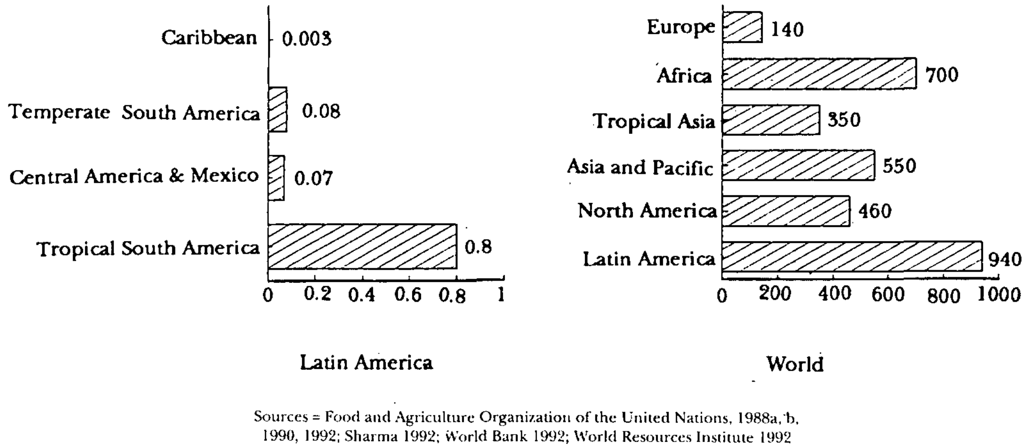


Figure 2. Latin America's tropical forest in relation to the world's forest area (million *ha*)

Appraisals of forest resources in Latin America are conducted by the Food and Agriculture Organization (FAO) in two phases: FAO first gathers survey information and then monitors forest changes using remote sensing techniques that include several layers of information on vegetation types, ecological zones, population distribution, and other relevant factors. The discussion below is based primarily on the latest FAO data on land area, population, forest cover, and changes in forest cover. Overall results are presented in Table 2 by subregion and country.

The Caribbean

The islands of the Caribbean occupy the smallest area of Latin America. Many of them such as Hispaniola, are heavily populated in relation to their size (Figure 3). Dry and very dry forests have suffered greatly from deforestation, having been nearly eradicated from the smaller islands. The highest population densities and population growth occur in the remaining fragments of this most threatened forest type, but settlement has also taken a toll elsewhere. During the 300 *y* following European exploration of the Caribbean, the dry forest was transformed (Lugo 1988). Human populations then moved to the hill and montane forest, which today represents the second most impacted ecological zone in the Caribbean. At present rates of deforestation, the remaining unprotected forests of the Caribbean subregion will be totally destroyed within the next 50 to 60 *y* (Table 11). With them will go hundreds of organisms that depend on the forest.

Table 1. State of tropical forests of Latin America by ecological zone

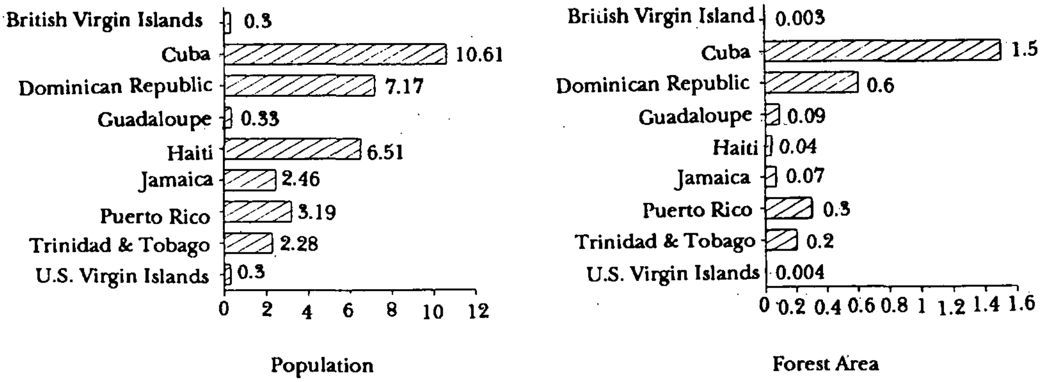
Ecological zones	Land area ('000 *ha*)	Land area % of Total	Forest area ('000 *ha*)	Forest area % of Land area	Forest area % of Total area	Annual deforestation (1981-90) ('000 *ha*)	Annual deforestation (1981-90) %	Population Total ('000 inh.)	Population Density (1990) inh./km^2	Population Growth 1981-90 % per *y*
Montane forest	345,200	21	94,400	27	11	1,200	1.1	161,400	47	2.4
Tropical rain forest	511,700	31	401,400	78	48	2,500	0.6	52,900	10	2-3
Moist deciduous forest	653,700	39	285,300	44	34	4,100	1.3	153,000	23	2.6
Dry deciduous forest	129,600	8	54,300	42	6	400	0.8	39,600	31	1.9
Very dry forest	14,500	1	2,100	14	N/A	N/A	N/A	6,400	44	2.7
Desert	21,000	1	2,400	11	N/A	100	2.0	5,200	25	3.5
TOTAL	1,675,700	101	839,900	216	99	8,300	5.8	418,500	180	15.4

N/A = Not available; Source = Food and Agriculture Organization of the United Nations 1992

Table 2. Land area, population, forest per capital forest area and annual deforestation rate in Latin America

Countries	Land Area ('000 *ha*)	Total population (millions) 1990	Forest per capita (*ha*) 1989	Total forest area ('000 *ha*) 1980-85	Annual deforestation rate of total forest area % 1981-90
CARIBBEAN					
British V.I.	15	.01	0.02	3	N/A
Cuba	10,982	10.61	0.14	1,455	0.1
Dominican Rep.	4,838	7.17	0.09	629	0.6
Guadeloupe	176	.33	0.29	94	N/A
Haiti	2,756	6.51	0.01	48	3.8
Jamaica	1,083	2.46	0.03	67	3.0
Puerto Rico	886	3.19	0.09	284	N/A
Trinidad and Tobago	513	1.28	0.18	224	N/A
U.S. Virgin Is.	N/A	.12	0.03	4	N/A
Total	21,249	31.68	0.79	2,808	
CENTRAL AMERICA AND MEXICO					
Belize	2,280	.19	7.61	1,446	N/A
Costa Rica	5,106	3.02	0.60	1,798	3.6
El Salvador	2,072	5.25	0.03	141	3.2
Guatemala	10,843	9.20	0.49	4,542	2.0
Honduras	11,189	5.14	0.78	3,997	2.3
Mexico	190,869	88.60	0.55	48,350	1.3
Nicaragua	11,875	3.87	1.16	4,496	2.7
Panama	7,599	2.42	1.72	4,165	0.9
Total	241,833	117.69	12.94	68,935	
TROPICAL SOUTH AMERICA					
Bolivia	108,439	7.31	9.13	66,760	0.2
Brazil	845,651	150.37	3.42	514,480	0.5
Colombia	103,870	32.98	1.58	51,700	1.7
Ecuador	27,684	10.59	1.39	14,730	2.3
French Guiana	8,915	.07	111.90	7,833	N/A
Guyana	19,685	.80	23.37	18,695	0.0
Paraguay	39,730	4.28	4.61	19,710	1.1
Peru	128,000	21.55	3.28	70,640	0.4
Suriname	15,600	0.42	35.71	15,000	0.0
Venezuela	88,205	19.74	1.72	33,870	0.7
Total	1,385,779	248.11	196.11	813,418	
TEMPERATE SOUTH AMERICA					
Argentina	273,669	32.32	1.91	61,600	N/A
Chile	74,880	13.17	1.29	16,918	0.7
Uruguay	17,481	3.09	0.24	750	N/A
Total	366,930	48.58	3.44	79,268	

N/A = Not applicable or not available; Sources = Food and Agriculture Organization of the United Nations 1988a,b, 1990, 1992; Sharma 1992; World Bank (1992); World Resources Institute (1992)



Sources = Food and Agriculture Organization of the United Nations, 1988a, b, 1990, 1992; Sharma 1992; World Bank 1992; World Resources Institute 1992

Figure 3. Human population (millions) and forested area (million *ha*) in the Caribbean subregion

Cuba is the largest island in the Caribbean and contains the lar rainforest. Over the past 15 *y*, several protected areas were created to prese: iodiversity (MAB 1986). However, hard economic times are causing local comn ies to clear more forests for firewood and agriculture. Deforestation is expec.... .o increase substantially in the coming years.

The greatest annual rates of deforestation in the Caribbean are occurring in Haiti and Jamaica (Table 3). Haiti's deforestation rate is the highest in all of Latin America, a consequence of the economic and political situation in that country. Hispaniola, Dominican Republic and Haiti contain the highest density of human populations in the Caribbean. In Haiti and Dominican Republic, the forest is a source of charcoal and firewood, and expanding populations are putting increasing pressure on these forest resources.

Reforestation is practically nonexistent in the Caribbean subregion, although some plantations occur, the largest being in Cuba (Table 4). On smaller islands, a significant portion of the forest has been lost to urban and industrial development, while on larger islands, such as Cuba and Hispaniola, croplands and permanent pastures occupy a large part of the area once covered by native forest (Table 5).

Logging is a significant forest activity in the Caribbean (Table 6). In Cuba, Haiti and Jamaica the value of the timber sector increased considerably over the past 30 *y* (Table 8), while in Dominican Republic the gross value of the timber sector decreased from US$ 28 to US$ 26 million. The remaining Caribbean countries do not cut wood for commercial purposes on a large scale; the main use is for fuel (Table 9).

Table 3. Average annual deforestation rates in Latin America and the Caribbean, 1980s

	Average annual deforestation ('000 *ha*)			
			Total Forest	
Countries	Closed Forest	Open Forest	Area	% of Total
CARIBBEAN				
British V.I.	N/A	N/A	3	N/A
Cuba	2	N/A	2	0.1
Dominican Republic	4	N/A	4	0.6
Guadeloupe	N/A	N/A	94	N/A
Haiti	2	N/A	2	3.8
Jamaica	2	N/A	2	3.0
Puerto Rico	N/A	N/A	284	N/A
Trinidad and Tobago	N/A	N/A	224	N/A
U.S. Virgin Islands	2	N/A	2	
Total	10	N/A	617	
MEXICO AND CENTRAL AMERICA				
Belize	9	N/A	N/A	N/A
Costa Rica	N/A	N/A	65	3.6
El Salvador	5	N/A	5	3.2
Guatemala	90	N/A	90	2.0
Honduras	90	N/A	90	2.3
Mexico	595	20	615	1.3
Nicaragua	121	N/A	121	2.7
Panama	36	N/A	36	0.9
Total	946	20	1,022	
TROPICAL SOUTH AMERICA				
Bolivia	87	30	117	0.2
Brazil	1,360	1,050	2,530	0.5
Colombia	820	70	890	1.7
Ecuador	340	N/A	340	2.3
French Guiana	N/A	N/A	7,833	N/A
Guyana	2	1	3	0.0
Paraguay	190	22	212	1.1
Peru	270	N/A	270	0.4
Suriname	3	N/A	3	0.0
Venezuela	125	120	245	0.7
Total	3,197	1,293	12,440	
TEMPERATE SOUTH AMERICA				
Argentina	N/A	N/A	N/A	N/A
Chile	N/A	N/A	50	0.7
Uruguay	N/A	N/A	N/A	N/A
Total	N/A	N/A	50	

N/A = Not applicable or not available; Sources = Food and Agriculture Organization of the United Nations 1988a, b, 1990, 1992; Sharma 1992; World Bank 1992; World Resources Institute 1992

Table 4. Reforestation and plantation rates in Latin America and the Caribbean

Countries	Reforestation Average Annual Rate 1980's ('000 *ha*)	Established Plantation Area by 1980: Total ('000 *ha*)	Established Plantation Area by 1980: Non-industrial Plantations (as % of Total)
CARIBBEAN			
British V.I.	N/A	N/A	N/A
Cuba	11	157	0
Dominican Republic	1	6	100
Guadeloupe	N/A	N/A	N/A
Haiti	0	1	100
Jamaica	1	12	0
Puerto Rico	N/A	N/A	N/A
Trinidad and Tobago	N/A	N/A	N/A
U.S. Virgin Islands	N/A	N/A	
Total	13	176	
MEXICO AND CENTRAL AMERICA			
Belize	0	3	0
Costa Rica	0	2	0
El Salvador	0	1	N/A
Guatemala	8	15	N/A
Honduras	0	N/A	N/A
Mexico	22	159	55
Nicaragua	1	1	0
Panama	0	3	0
Total	31	184	
TROPICAL SOUTH AMERICA			
Bolivia	1	26	77
Brazil	449	3,855	49
Colombia	8	95	0
Ecuador	5	43	N/A
French Guiana	N/A	N/A	N/A
Guyana	0	1	0
Paraguay	1	3	33
Peru	6	84	61
Suriname	0	8	0
Venezuela	19	125	0
Total	489	4,240	
TEMPERATE SOUTH AMERICA			
Argentina	40	600	0
Chile	74	817	5
Uruguay	5	140	57
Total	119	1,557	

N/A = Not available or not applicable; Sources = Food and Agriculture Organization of the United Nations 1988a, b, 1990, 1992; Sharma 1992; World Bank 1992; World Resources Institute 1992

Table 5. Forest changes and land use patterns in Latin America and the Caribbean (1975-87)

Countries	Land area (millions *ha*)	Forest & woodland: % of Land area	Forest & woodland: % Change	Cropland: % of Land area	Cropland: % Change	Permanent pasture: % of Land area	Permanent pasture: % Change	Other land: % of Land area	Other land: % Change
CARIBBEAN									
British V. I.	.01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cuba	11.0	25	13.2	30	5.9	25	3.0	21	-20.3
Dominican Republic	5.0	13	-3.1	30	13.2	43	0.0	13	-18.9
Guadeloupe	.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Haiti	3.0	2	-16.1	33	4.4	18	-7.6	47	1.0
Jamaica	1.0	17	-5.0	25	2.2	18	-8.6	40	5.6
Puerto Rico	.89	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Trinidad and Tobago	.51	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U.S. Virgin Islands	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MEXICO AND CENTRAL AMERICA									
Belize	2	44	0.0	2	2.2	2	2.3	51	-2.0
Costa Rica	5	32	-22.9	10	6.1	45	34.1	13	-16.4
Salvador	2	5	-35.4	35	8.9	29	0.0	30	-1.0
Guatemala	11	38	-16.4	17	10.2	13	7.9	33	17.4
Honduras	11	32	-18.5	16	5.9	23	8.3	30	18.5
Mexico	191	23	-11.9	13	3.0	39	0.0	25	12.6
Nicaragua	12	32	-22.6	11	3.1	44	11.8	13	50.0
Panama	8	53	-7.0	8	4.5	17	8.3	23	11.3

(continued)

Table 5. (Continued)

TROPICAL SOUTH AMERICA									
Bolivia	108	51	-1.3	3	3.0	25	-1.2	21	4.5
Brazil	846	66	-4.2	9	22.7	20	6.4	5	0.3
Colombia	104	50	-5.5	5	3.2	38	7.3	7	1.5
Equador	28	44	-19.6	9	1.4	18	61.5	29	14.9
French Guiana	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Guyana	20	83	-7.7	3	21.3	6	17.0	8	223.2
Paraguay	40	42	-20.4	5	71.2	48	26.0	5	-25.2
Peru	128	54	-3.5	3	12.8	21	0.0	22	8.1
Suriname	16	92	-0.3	0	49.2	0	22.9	7	2.1
Venezuela	88	36	-8.5	4	6.0	20	3.4	40	6.3
TEMPERATE SOUTH AMERICA									
Argentina	274	22	-1.1	13	3.2	52	-0.7	13	1.6
Chile	75	12	0.0	7	4.0	16	1.7	65	0.8
Uruguay	17	4	7.6	8	0.0	77	-0.6	10	2.3

N/A = Not available or not applicable; Sources = Food and Agriculture Organization of the United Nations; 1988a, b, 1990, 1992;Sharma 1992; World Bank 1992; World Resources Institute 1992

Table 6. Status of unmanaged and managed forests in Latin America and the Caribbean

			Closed broad-leaved Forests		Coniferous forests	
			unmanaged			
Countries	Total (000 *ha*)	Primary (% of total)	Logged (% of total)	Managed (% of total)	Unmanaged (% of total)	Managed (% of total)
CARIBBEAN						
British V.I.	N/A	N/A	N/A	N/A	N/A	N/A
Cuba	995	0	80	0	0	20
Dominican Republic	573	35	34	0	31	0
Guadeloupe	N/A	N/A	N/A	N/A	N/A	N/A
Haiti	25	0	56	0	44	0
Jamaica	45	91	9	0	0	0
Puerto Rico	N/A	N/A	N/A	N/A	N/A	N/A
Trinidad and Tobago	N/A	N/A	N/A	N/A	N/A	N/A
U.S. Virgin Islands	N/A	N/A	N/A	N/A	N/A	N/A
MEXICO AND CENTRAL AMERICA						
Belize	891	0	90	0	10	0
Costa Rica	1,100	30	70	0	0	0
El Salvador	20	0	0	0	100	0
Guatemala	3,012	40	40	0	20	0
Honduras	3,038	10	39	0	49	2
Mexico	24,300	51	1	0	48	0
Nicaragua	3,976	88	4	0	2	6
Panama	2,943	72	28	0	0	0
TROPICAL SOUTH AMERICA						
Bolivia	29,850	59	41	0	0	0
Brazil	300,910	96	4	0	0	0
Colombia	39,500	98	2	0	0	0
Ecuador	10,915	99	1	0	0	0
French Guiana	N/A	N/A	N/A	N/A	N/A	N/A
Guyana	13,465	90	10	0	0	0
Paraguay	3,040	18	82	0	0	0
Peru	43,500	86	14	0	0	0
Suriname	12,495	97	3	0	0	0
Venezuela	19,210	40	60	0	0	0
TEMPERATE SOUTH AMERICA						
Argentina	1,200	0	0	0	100	0
Chile	6,705	0	100	0	0	0
Uruguay	70	0	100	0	0	0

N/A = Not available or not applicable; Sources = Food and Agriculture Organization of the United Nations 1988a, b, 1990, 1992; Sharma 1992; The World Bank World Resources Institute 1992

Several initiatives are in place to protect forests in the Caribbean (Table 7). A new government system in Dominican Republic attempts to preserve substantial amounts of the existing forest. In Puerto Rico, most of the existing moist forest and some dry forest are under protection. In addition, economic changes on that island have promoted industrial development. Subsequent abandonment of much of the agricultural lands has allowed a secondary generation of forest. Efforts in Jamaica since 1990 are aimed at preserving some of the island's remaining forest.

Table 7. Forest protected areas in Latin America and the Caribbean

		National protected systems		Protected forests	
				Total forest	
Countries	Number	Area ('000 *ha*)	% of land area	Area ('000 *ha*)	% of total forest
CARIBBEAN					
British V.I.	N/A	N/A	N/A	N/A	N/A
Cuba	29	714	6.4	N/A	N/A
Dominican Republic	14	152	11.4	N/A	N/A
Guadeloupe	N/A	N/A	N/A	N/A	N/A
Haiti	2	8	0.3	N/A	N/A
Jamaica	N/A	N/A	0.0	2	3.0
Puerto Rico	4	N/A	N/A	N/A	N/A
Trinidad and Tobago	N/A	N/A	N/A	N/A	N/A
U. S. Virgin Islands	2	N/A	N/A	N/A	N/A
MEXICO AND CENTRAL AMERICA					
Belize	8	74	3.2	5	0.3
Costa Rica	28	606	11.9	320	17.8
El Salvador	9	116	1.3	N/A	N/A
Guatemala	9	88	0.8	62	1.4
Honduras	34	709	6.3	N/A	N/A
Mexico	61	9,420	4.9	360	0.7
Nicaragua	6	43	0.4	N/A	N/A
Panama	16	1,326	17.4	N/A	N/A
TROPICAL SOUTH AMERICA					
Bolivia	23	6,774	6.2	N/A	N/A
Brazil	162	20,525	2.4	5,460	1.1
Colombia	42	9,302	9.0	2,430	4.7
Ecuador	14	10,686	38.6	350	2.4
French Guiana	N/A	N/A	N/A	N/A	N/A
Guyana	1	12	0.1	12	0.1
Paraguay	12	1,186	3.0	1,300	6.6
Peru	24	5,518	4.3	850	1.2
Suriname	14	763	4.7	580	3.9
Venezuela	74	20,265	23.0	4,500	13.3
TEMPERATE SOUTH AMERICA					
Argentina	113	12,639	4.6	2,594	5.8
Chile	65	13,650	18.2	845	11.2
Uruguay	8	32	0.2	N/A	N/A

N/A = Not available or not applicable; Sources = Food and Agriculture Organization of the United Nations, 1988a, b, 1990, 1992; Sharma 1992; World Bank 1992 ; World Resources Institute 1992

Species of small mammals, ground nesting birds, reptiles and amphibians of the Caribbean forest were eradicated soon after the introduction of the rat, domestic cat, and mongoose in many of the islands. Donkeys, horses and pigs also rapidly altered forest composition, structures and diversity. Only the more competitive endemic species survived. Parrots are diminishing because logging has created a lack of nesting cavities; populations of several endemic species of parrots have been added to the list of endangered and threatened species (Pasquier 1981). Intercontinental migratory birds, which winter in the forests of the Caribbean or spend relatively short periods of time there, are becoming more susceptible to predators and starvation because dry forests have been destroyed. Some rare species of snakes are now found only on very small islands where remnants of dry forest exist. Collection is also a threat and has considerably reduced the populations of rare and endemic species of forest orchids.

Mexico and Central America

Mexico is the third largest country in Latin America. Its human population is second only to that of Brazil (Figure 4),and it has the fifth largest forested area in the entire region (Table 2). Combined, the seven small, heavily populated countries of Central America have a total forest cover similar in size to that of Peru. The highest annual deforestation rates in the subregion are occurring in Costa Rica and El Salvador (Table 3). Belize has relatively low deforestation rates, probably because of its lower population density. The amounts of forest remaining in Guatemala, Honduras, and Nicaragua are comparable to each other, as are deforestation rates in those countries. Panama's annual deforestation rate is the lowest in the subregion.

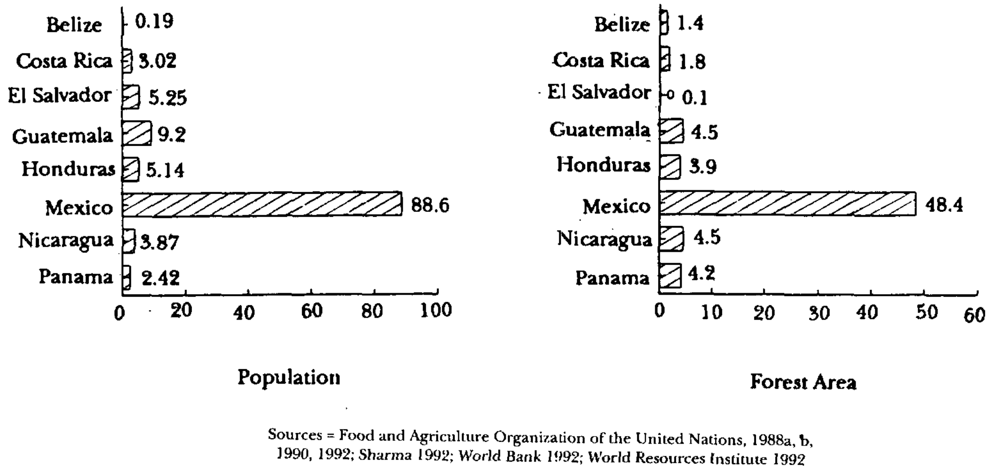


Figure 4. Human population (millions) and forested area (million *ha*) in the Mexico and Central America subregion

The pattern of forest degradation in Mexico and Central America is similar to that described for the Caribbean. Dry and very dry forests were the first to vanish after human colonization, and hill and montane forests are the next most threatened habitats. Wars have also played an important role in the intensive deforestation of Central America, with a particular devastating impact on El Salvador, Nicaragua, and Guatemala, disrupting economies hard pressed by debt and thus encouraging governments to exploit their natural resources (Vaughan 1988). Wars have displaced populations, and as people escape aggression, they put pressure on the forests in other areas. The tropical forest of eastern Honduras felt the impacts of refugees fleeing from Nicaragua and El Salvador (Utting 1991). Military tactics themselves are directly responsible for damage to the forests. Defoliating chemicals have been reported in Guatemala, and ten percent of the coniferous trees in Honduras were removed during military maneuvers (Vaughan 1988). Armies in Guatemala and El Salvador have used scorched earth tactics (Utting 1991).

Mexico is the only country in the subregion where any notable reforestation is in progress, averaging 22,000 *ha* annually, or about three to four percent of the area logged each year (Table 4). But for the most part, Mexico's forests and woodlands are being transformed to grasslands, urban and industrial uses, and, on a smaller scale, croplands (Table 5). Similar trends exist in Costa Rica and Nicaragua. Turning forest into croplands is the leading cause of deforestation in El Salvador, followed by urban and industrial development and the creation of permanent pasture. Most of the forested areas of Guatemala have been converted to urban, industrial and other uses, although some forest losses are caused by the creation of permanent pastures and croplands, a pattern that also holds true for Honduras and Panama.

In Mexico and Central America, there is no tradition of management strategies which maintain original forest. The tendency is to convert to commercially valuable tree species (Table 6). Large-scale logging is the most profitable industry in many of these countries. Throughout the subregion, except in Belize, the gross value of the timber sector increased significantly over the last 30 *y*. A small increase in the percent of fuel wood consumption was also observed between 1980 and 1988 (Table 9), as well as a rise in the percent of wood used for industrial purposes in Honduras and Nicaragua. Processed wood exports increased between 1980 and 1988 in Belize, Guatemala, Mexico, and Nicaragua (Table 10), but decreased in the remaining countries. There was no change in Panama. Imports of processed wood products grew in Belize, El Salvador and Mexico; fell off in Costa Rica, Guatemala, Nicaragua and Panama; and remained the same in Honduras. Fewer imports probably indicate a tendency to use locally processed wood sold at lower prices.

The subregion contains 171 protected areas (World Resources Institute 1992); however, only Costa Rica has dedicated a significant proportion of its total land area, 11.9 %, to forest protection (Table 7). This represents the largest ratio of protected area in the Latin American countries.

At present rates of deforestation, the last Central American tropical forest and much of its species diversity will be confined to protected areas within the next

30 to 40 *y* (Table 11). The isthmus' forest diversity will be reduced by 60 to 70% and many more species will become extinct later on as populations fall below minimum viable size. Mexican and Central American forests constitute important winter migration habitat for North American birds. Forest degradation is affecting these species and will ultimately impact their composition and abundance.

Table 8. Value of the timber sector in Latin America and the Caribbean

	Gross value (millions US$ 1961	% Gross value of GDP 1961	Gross value (millions US$ 1989	% Gross value of GDP 1989
Countries	Timber sector total	Timber sector total	Timber sector total	Timber sector total
CARIBBEAN				
British V.I.	N/A	N/A	N/A	N/A
Cuba	78	1.2	211	0.9
Dominican Republic	28	1.3	26	0.3
Guadeloupe	N/A	N/A	N/A	N/A
Haiti	84	10.0	136	9.8
Jamaica	N/A	N/A	14	0.4
Puerto Rico	N/A	N/A	N/A	N/A
Trinidad and Tobago	N/A	N/A	N/A	N/A
U.S. Virgin Islands	N/A	N/A	N/A	N/A
MEXICO AND CENTRAL AMERICA				
Belize	11	0.3	7	0.1
Costa Rica	92	5.9	208	3.5
El Salvador	57	3.7	126	3.7
Guatemala	106	3.8	207	2.5
Honduras	156	16.9	219	7.1
Mexico	559	1.0	2,614	1.2
Nicaragua	65	5.5	123	4.9
Panama	49	4.6	61	1.7
TROPICAL SOUTH AMERICA				
Bolivia	22	1.1	53	1.1
Brazil	3,989	6.4	12,110	4.1
Colombia	473	3.8	816	1.8
Ecuador	134	4.2	518	3.5
French Guiana	N/A	N/A	N/A	N/A
Guyana	17	4.4	14	3.5
Paraguay	73	5.6	363	6.2
Peru	155	1.7	415	2.1
Suriname	22	0.6	20	0.2
Venezuela	63	0.2	336	0.5
TEMPERATE SOUTH AMERICA				
Argentina	595	0.7	993	0.7
Chile	370	2.5	1,621	4.6
Uruguay	63	0.9	123	1.2

N/A = Not available or not applicable; Sources = Food and Agriculture Organization of the United Nations 1988a, b, 1990, 1992; Sharma 1992; World Bank 1992; World Resources Institute 1992

Table 9. Consumption of industrial and fuel wood in Latin America and the Caribbean

Countries	Fuel wood as a % of total 1980	Fuel wood as a % of total 1988	Industrial roundwood as a % of total 1980	Industrial roundwood as a % of total 1988	Growth Rate (%) 1980-88: Total round-wood	Growth Rate (%) 1980-88: Wood-fuels	Growth Rate (%) 1980-88: Indus-trial round-wood
CARIBBEAN							
British V.I.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cuba	84	82	16	18	-0.1	-0.6	2.7
Dominican Republic	93	95	7	5	0.8	1.0	-3.2
Guadeloupe	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Haiti	95	96	5	4	1.8	1.8	0.0
Jamaica	13	6	87	94	25.0	8.1	27.5
Puerto Rico	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Trinidad and Tobago	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U.S. Virgin Islands	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MEXICO AND CENTRAL AMERICA							
Belize	61	70	39	30	N/A	N/A	N/A
Costa Rica	64	71	36	29	1.7	2.8	-0.6
El Salvador	97	98	3	2	1.1	1.3	-5.0
Guatemala	97	99	3	2	2.7	2.9	-6.8
Honduras	78	85	22	16	2.6	3.5	-1.3
Mexico	66	67	34	33	2.4	2.4	2.3
Nicaragua	72	77	28	23	2.5	3.4	-0.1
Panama	83	83	17	17	0.1	0.1	-0.1
TROPICAL SOUTH AMERICA							
Bolivia	70	90	30	11	0.1	2.8	-11.7
Brazil	71	73	29	27	1.9	2.2	1.1
Colombia	81	85	19	15	1.6	2.2	-1.4
Ecuador	73	68	27	32	3.0	1.9	5.7
French Guiana	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Guyana	6	9	94	91	1.3	5.5	0.9
Paraguay	64	63	36	37	3.5	2.8	4.6
Peru	76	87	24	13	1.3	2.6	-4.5
Suriname	7	10	93	90	-3.9	-2.6	-4.0
Venezuela	43	49	57	51	1.7	3.1	0.4
TEMPERATE SOUTH AMERICA							
Argentina	61	40	39	60	1.7	-3.3	6.7
Chile	44	51	56	49	1.0	1.7	0.4
Uruguay	88	92	12	8	1.9	2.3	-1.4

N/A = Not available or not applicable ; Sources Food and Agriculture Organization of the United Nations 1988a, b, 1990, 1992; Sharma 1992; World Bank 1992; World Resources Institute 1992

Table 10. Exports and imports of processed wood in Latin America and the Caribbean

	Processed wood ('000 m^3) 1980		Processed wood ('000 m^3) 1988	
Countries	Exports	Imports	Exports	Imports
CARIBBEAN				
British V.I.	N/A	N/A	N/A	N/A
Cuba	0	612	0	585
Dominican Republic	0	115	0	39
Guadeloupe	N/A	N/A	N/A	N/A
Haiti	0	11	0	1
Jamaica	0	40	0	115
Puerto Rico	N/A	N/A	N/A	N/A
Trinidad and Tobago	N/A	N/A	N/A	N/A
U.S. Virgin Islands	N/A	N/A	N/A	N/A
MEXICO AND CENTRAL AMERICA				
Belize	5	3	6	6
Costa Rica	26	3	22	2
El Salvador	0	8	0	12
Guatemala	28	6	29	1
Honduras	273	3	174	3
Mexico	24	609	40	748
Nicaragua	10	1	12	0
Panama	1	16	1	3
TROPICAL SOUTH AMERICA				
Bolivia	95	0	58	0
Brazil	1,133	549	1,314	139
Colombia	13	25	15	11
Ecuador	78	0	39	0
French Guiana	N/A	N/A	N/A	N/A
Guyana	14	2	9	2
Paraguay	372	0	148	0
Peru	23	18	3	2
Suriname	42	0	7	0
Venezuela	0	337	0	73
TEMPERATE SOUTH AMERICA				
Argentina	23	689	31	310
Chile	1,331	0	967	0
Uruguay	0	0	0	20

N/A = Not available or not applicable; Sources = Food and Agriculture Organization of the United Nations 1988a, b, 1990, 1992; Sharma 1992; World Bank 1992; World Resources Institute 1992

Table 11. Predicted tropical forest area loss in Latin America and the Caribbean, based on present deforestation rates and population trends

Countries	Forest ('000 *ha*) 1985	Loss of 25% forest area	Loss of 50% forest area	Loss of 75% forest area	Loss of 100% forest area
CARIBBEAN					
British V.I.	3	1990	2000	2010	2020
Cuba	1,455	2135	2195	2225	2260
Dominican Republic	629	2025	2065	2110	2155
Guadeloupe	94	1995	2000	2010	2020
Haiti	48	1995	2000	2005	2015
Jamaica	67	1995	2000	2010	2020
Puerto Rico	284	2025	2065	2110	2155
Trinidad and Tobago	224	1995	2005	2010	2020
U.S. Virgin Islands	4	1995	2005	2010	2020
MEXICO AND CENTRAL AMERICA					
Belize	1,446	1995	2000	2005	2015
Costa Rica	1,798	1995	2000	2005	2015
El Salvador	141	1995	2000	2010	2015
Guatemala	4,542	1995	2010	2020	2025
Honduras	3,997	1995	2005	2015	2020
Mexico	48,350	2005	2020	2030	2040
Nicaragua	4,496	1995	2005	2010	2020
Panama	4,165	2010	2045	2060	2080
TROPICAL SOUTH AMERICA					
Bolivia	66,760	2050	2080	2095	2110
Brazil	514,480	2035	2110	2165	2185
Colombia	51,700	2000	2015	2025	2035
Ecuador	14,730	1995	2010	2015	2025
French Guiana	7,833	1995	2005	2005	2015
Guyana	18,695	1995	2000	2010	2020
Paraguay	19,710	2010	2030	2045	2060
Peru	70,640	2035	2060	2075	2095
Suriname	15,000	1995	2000	2010	2020
Venezuela	33,870	2015	2035	2050	2060
TEMPERATE SOUTH AMERICA					
Argentina	61,600	1995	2005	2010	2020
Chile	16,918	2020	2045	2050	2060
Uruguay	750	1995	2000	2010	2020

Tropical South America

Tropical South America is the largest geographical area in Latin America. It contains the basin of the Amazon River and more uninterrupted rainforest than any other area in the world. This immense forested enclave lies mainly in Brazil, but it includes parts of Bolivia, Colombia, Ecuador, Peru, Venezuela and the Guianas. Close to 40 % of all forest in the subregion is in Brazil, with other significant forested areas in Peru, Bolivia, Colombia and Venezuela (Table 2). Brazil also contains

35 % of the subregion's population (Figure 5). The highest deforestation rates are reported for Ecuador, Brazil and Paraguay, while the lowest rates correspond to the least populated countries of Bolivia, French Guiana, Guyana and Suriname.

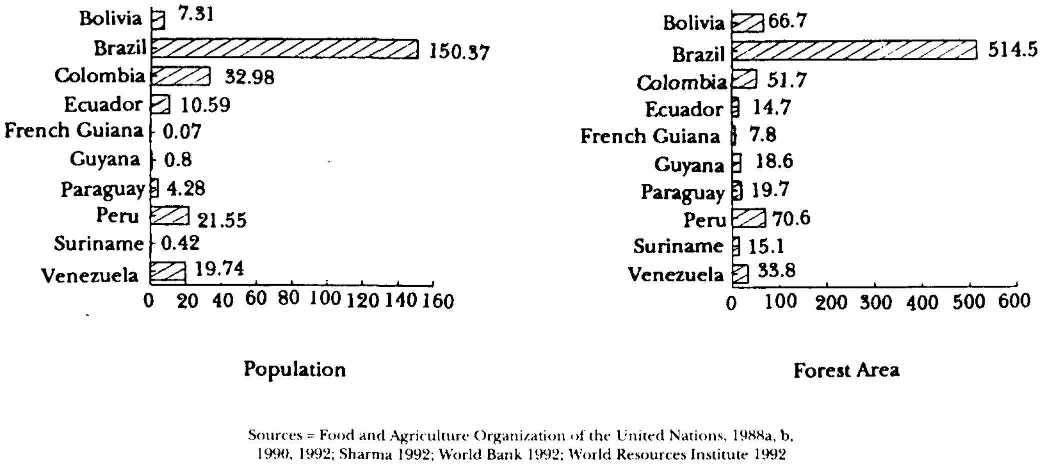


Figure 5. Human population (millions) and forested area (million *ha*) in the tropical South America subregion

In Bolivia, Brazil, Colombia and Paraguay, most of the degraded forest has been converted to permanent pasture. Urbanization and industrial development account for some deforestation as, to a lesser degree, does cultivation (Table 5). In Ecuador, Guyana, Peru and Venezuela, the primary uses of deforested land are urban and industrial, followed by creation of permanent pastures. Conversion to croplands occurs in limited areas. In Suriname, forests are generally cleared for urban and industrial development.

Destroying forests for coca has had major impacts in Peru, Bolivia and Colombia and, less extensively, in Ecuador and Brazil. By 1989, coca plantations in Peru had increased to 200,000 *ha*, and coca growers were blamed for 10 % of Peruvian deforestation (World Resources Institute 1992). Since most coca cultivation takes place on the steep slopes of the Andes, it is not sustainable. Growers continually move as soil wears out and to escape detection. Coca farming in the Andes is located in some of the most biologically diverse areas of the continent, and even national parks in Peru and Colombia have been used to grow coca.

Experts warn that the corruptive power of drug money and related violence pose a threat to fragile Latin American democracies and hamper the ability of local governments to deal with tropical deforestation and the loss of biodiversity. But the incentives for cultivation are great. A coca grower in the foothills of the Bolivian and Peruvian Andes can make between 18 and 20 times as much money per *ha* than by growing corn, tea, or other crops (World Resources Institute 1990).

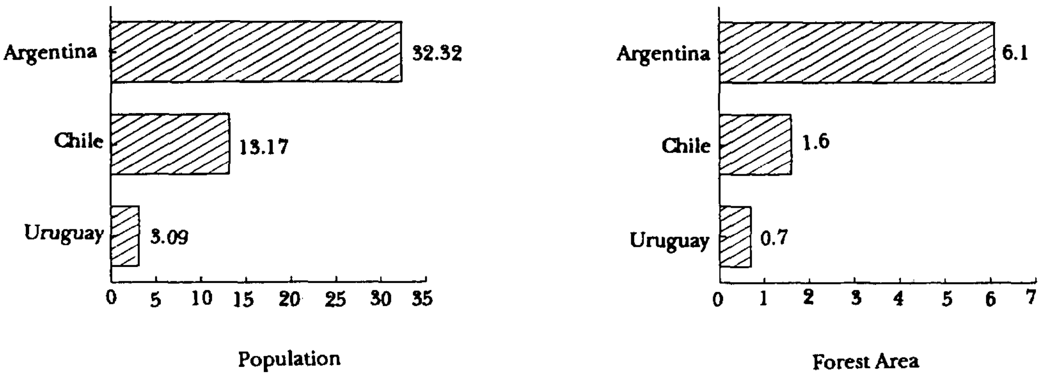
The countries in Tropical South America have experimented with reforestation and plantations to a larger degree than the Caribbean and Central American countries. However, introduced species are mainly used. Brazil, Venezuela, Colombia and Peru have established large-scale industrial plantations of exotics for paper production, internal wood consumption, and reclamation of some deforested areas. Logging is the main forest activity in the subregion (Table 6). Paraguay and Venezuela have cut down more than 50 % of their original forests. Forest protection there is very limited. Only Venezuela has preserved more than 10 % of its forest (Table 7). All other countries (except Paraguay at nearly 7 %) have less than 5 % of their forest land under some type of legal protection.

The gross value of the timber sector in the subregion has increased considerably in the last 30 *y*, led by Brazil with an increase of four times the gross value in 1961 (Table 8). The consumption of fuel wood also increased from 1980 to 1988 in all countries but Ecuador and Paraguay, where a small decrease was reported (Table 9). An inverse pattern was observed for the same countries in the consumption of wood for industry, with only Ecuador and Paraguay increasing their industrial wood production. Exports and imports of processed wood play an important role in Tropical South America (Table 10). Between 1980 and 1988, Colombia was the only country that slightly increased its wood exports. Imports were considerably reduced for all the countries but Guyana. The changes are the result of national economic policies that set prices of in-country wood products below those of imports (World Bank 1992).

Table 11 indicates when the forests in Tropical South America will probably disappear. Again, loss of forest-dependent species will occur. Illegal and legal traffic and commercialization of many species of birds, monkeys, and other wildlife are common throughout the area. Indicator species, such as the golden lion tamarind, have disappeared from most of the Brazilian Atlantic forest. Expensive efforts are underway to reintroduce some of the lost populations in the subregion.

Temperate South America

Argentina, Chile and Uruguay are grouped in the Temperate South American Subregion. They cover 23 million square *ha* with a population of 48.6 million people (Figure 6). This subregion contains the only temperate forest of South America with unique endemic species. In Chile, nearly all of the 50 tree species are found nowhere else but in that country and portions of Argentina.



Sources = Food and Agriculture Organization of the United Nations, 1988a, b, 1990, 1992; Sharma 1992; World Bank 1992; World Resources Institute 1992

Figure 6. Human population (millions) and forested area (million *ha*) in the temperate South America subregion

There is intense pressure to convert the suoregion's forests to plantations and use the trees for wood chips to export to Japan, and, on a smaller scale, for fuel wood. These factors have considerably reduced biodiversity. More than 20 species of trees and several species of mammals and birds have gone extinct (Jelvez *et al.* 1990, INFOR-CORFO 1991, Fuentes & Hoffman 1992). A continuation of present trends means that most of the temperate forest in South America will be converted to exotic timber production in less than 30 *y* (Table 11). The native temperate forest - dominated by southern beeches, several other broad leafed species, and some conifers - will look much different.

As shown in Table 1, Argentina and Chile contain much of the existing forested area. Uruguay has only a small fraction. Chile has the most aggressive reforestation policy planting 74,000 $ha\ y^{-1}$ (Table 4). In fact, Chile's conversion of native forest since 1974 has created the largest radiata pine holdings in the world (Jelvez *et al.* 1990), resulting in a lucrative export industry that rose in value from US$ 39.1 million in 1973, to US$ 855 million in 1990 (INFOR-CORFO 1991). Still, Chile's forests are primarily converted to urban and industrial uses, permanent pasture, or cropland. In Argentina and Uruguay, most deforested land becomes permanent pasture. A lesser amount is used for urban and industrial development and crops.

Chile legally protects a little more than 10 % of its forests, while Argentina protects close to 6 % (Table 7: data is not available for Uruguay). The gross value of the timber sector in Chile increased 4.4 % between 1961 and 1989, and doubled in Argentina and Uruguay (Table 8). Between 1980 and 1988, the use of fuel wood increased in Chile and Uruguay, but decreased in Argentina (Table 9). During that period, the consumption of wood for industry increased in Argentina and decreased in Chile and Uruguay. Exports of processed wood increased in Argentina, decreased in Chile, and were not practiced by Uruguay (Table 10). Imports of processed wood decreased in Argentina and began in Uruguay in 1988. Chile does not import wood products.

Major threats to forest biodiversity

Much deforestation in Latin America results from human attitudes toward the forests and the pattern of economic development that stems from these attitudes. Forests and forest services are quite simply undervalued. Naturally diverse forest ecosystems are viewed as nothing more than hectares of trees to be cut down to make way for use of the land. Government policies in the region consistently promote forest clearance through laws, regulations, and lack of incentives for forest protection. Furthermore, the poor state of knowledge concerning the limitations of natural processes has allowed development to proceed unchecked by consideration for environmental constraints. The result has frequently been conversion of forest lands for inappropriate and unsustainable uses. The discussion below provides added details about the major threats to forest biodiversity in Latin America.

Agriculture

Agricultural development has had an enormous impact on the rate of deforestation in Latin America. As large-scale farming continues to expand, displaced and landless peasants are driven into the forest in search of a livelihood. Much of the output from farming is exported. Utting (1991) notes that forests in Central America were replaced primarily with beef pastures and coffee and cotton plantations as world markets for these products were successfully developed.

The agro-export model is characterized by an uneven distribution of resources. Land is increasingly being accumulated by commercial farmers, and peasant producers are being displaced. Much of the population consequently exists "on the margin", practicing shifting agriculture in the forest.

Agricultural projects, including ranching, are spreading with little regard for the fundamental fragility or lack of productivity of a given area. World Resources Institute (1990) reports that in Central America and the Caribbean, the principal type of rangeland is cattle pasture derived from tropical forests. In Mexico's southern states, humid and subhumid tropical forests are being converted to pastures; in central Mexico's subhumid areas, about 5.5 million *ha* of pasture have been created. But initial productivity has proved to be short lived (World Resources Institute 1990) and, instead of ensuring that the land is being used on a sustainable basis, ranchers and farmers move on to clear more forest.

Steep slopes and areas of high rainfall are often cleared for agriculture, resulting in erosion and soil loss (Vaughan 1988). Such problems are particularly acute on the eastern slopes of the Andes. The conversion of coastal lands for agriculture and urban development is destroying mangrove habitat. Much of the farming is unsuccessful because of the expense of controlling soil salinity. The land is often abandoned after deforestation, but by then changes to soil chemistry and hydrologic systems make it impossible for the forests to recover. Fifty percent of Costa Rica's coastal mangroves disappeared by 1979, largely because of agriculture (Bossi & Cintron 1990).

Associated with agricultural development are the threats posed by the migration of human populations. New projects introduce workers to an area and threaten nearby forests with the pressures of human exploitation. Banana plantations in Costa Rica are bringing workers to the land surrounding a national park (Perfecto personal communication). In Panama, Honduras, and Venezuela, banana cultivation encourages settlements in forest areas that were previously sparsely populated.

Many government policies supply financial incentives to clear forests for agriculture. In Brazil, Chile, Costa Rica and Ecuador, loans can be obtained for cultivation of crops and tree plantations but not for management of the natural forest (USAID-Ecuador 1989, USAID 1992). Government efforts to promote investment in the Brazilian Amazon resulted in subsidized clearance of forests to establish cattle ranches that were not even profitable. Government tax credits and rural credit loans allowed investors to realize returns about 2.5 times more than the initial investment, although the ranch operated at a loss. The scheme ate up forests and put a drain on the government's treasury (Repetto 1988).

Land tenure regulations, which require a farmer to clear the land in order to gain tenure, are a further disincentive to forest preservation. In Ecuador, for example, 80% of a farm must be in production; managing a natural forest is not considered a productive use (USAID-Ecuador 1989).

Land ownership

Colonization of forested land and its accompanying pattern of shifting agriculture rise primarily from inequitable distribution of land. World Resources Institute (1990) has concluded, "No other region in the world exhibits such concentration of land ownership in a tiny segment of the population." In Ecuador, 50% of the land used for agriculture is in the hands of 2% of the landowners (USAID-Ecuador 1989); in Brazil two percent of the landowners own 60% of the land (World Resources Institute 1990); in Guatemala, 2.8 % of the people own 80% of agricultural land. As large-scale farming becomes increasingly mechanized and more small-scale farmers and thousands of farm workers are displaced, the forests provide hope. In Rondonia, Brazil, more than a quarter of all settlers in 1988 were farmers displaced by the great increase in mechanized soybean farming.

The need for land also threatens dry forests because farmers, with little or no land of their own, use dry forests and scrublands as open range for goats (World Resources Institute 1990).

It is clear that settlers must have access to productive agricultural land if they are to be kept from practicing farming on unsuitable forest soils. But in

Brazil, Peru, Ecuador, Chile, Bolivia and other countries, land reform efforts have thus far met with little success (World Resources Institute 1992, USAID Ecuador 1989). Governments of Amazon forest countries have resorted to encouraging settlement in the Amazon to delay the need for the politically exacting task of land reform and the redistribution of wealth. In 1989, despite the demonstrated problems of settlement in the Brazilian Amazon, Peru passed a law to promote development in its portion of the Amazon (World Resources Institute 1990).

Growing debts and populations

The forces driving deforestation in Latin America are further magnified by two critical factors: the huge debt burden and the steadily expanding population. During the 1980's Latin American debt increased from US$ 197 to US$ 422 billion (World Resources Institute 1992). All countries in the region at least doubled the amount of their debt in a 10-y period. The Haitian and Nicaraguan debts each quadrupled.

Debt burdens have a devastating effect. In attempts to spur economic development, concurrent with servicing debts, Latin American governments are promoting policies that result in short term gain at the expense of sustainable development. USAID Ecuador (1989) reports that Ecuador was forced to "mine" its natural resources, aggressively selling concessions for oil exploration (even in natural parks) at a time when oil prices were down. The economic crisis also undermines conservation efforts by reducing the funds available for environmental protection, policing of parks, environmental education, and natural resource management.

Population expansion in the region continues at a high rate, putting a further strain on tight government budgets and acting to exacerbate deforestation. Existing distributions of productive agricultural land coupled with the lack of sustainable-use policies indicate that the clearing of forest land will increase as populations grow. Furthermore, the poor in the region depend on wood for fuel. Studies estimate that 72% of Central American households use wood for this purpose, and in El Salvador, fuel wood collection is now the leading cause of deforestation and forest degradation (Utting 1991).

Additional threats from development

Other development projects such as mining, logging, dams, and road construction, remove or degrade forest habitat. The US$3.5 billion Grande Carajas Programme in Brazil is using trees to provide charcoal for its smelters (World Resources Institute 1990). Logging may pose more of a threat in the future. As they exhaust Asian forests, timber companies are turning their attention to South American forests (World Resources Institute 1989). Changes in technology are also enhancing the utility of Latin American forests. Timber is increasingly being used for products such as particleboard, and clear cutting is becoming more commercially attractive. Planning for such enterprises rarely considers environmental consequences.

Road construction is a major component of most development activities, and provides another source of deforestation. Roads also make forest land more accessible to colonization by peasants, ranchers and farmers. Brazil is seeking funding from Japan to complete a road from the Amazon to Lima and open up markets for Amazonian products in Pacific rim countries (World Resources Institute 1990). In the Alto Madidi area of Bolivia, the drive for oil exploration means road construction is likely (Conservation International 1991). In Ecuador, two road construction projects threaten the tropical forest of Esmereldas Province through subsequent colonization and logging (Conservation International 1992).

Loss of indigenous cultures

The impacts on forests described above have all stemmed from recent human interference. However, forest biodiversity is also threatened by the loss of indigenous human activity that has adapted to the forest environment over thousands of years. Gomez-Pompa and Kaus (1992) state that many tree species now dominant in the mature vegetation of tropical forests were planted or nurtured by traditional tribal societies. The Amazon, while not a natural center of annual crops, is an important producer of perennial vegetation. Rubber, cacao, pineapple and cassava all originate there. Amazonian Indians have cared for and developed many of these species, especially the fruit trees. But the ways of the Indians are being lost, and peasants of Indian descent, who inherited and still tend the crops, are leaving the forest. Once neglected, the crops die out in competition with other forest plants, and an important source of crop genetic diversity becomes endangered (Clement 1991).

The picture painted thus far is not optimistic, but there are steps being taken to slow the pace of deforestation. Some Latin Americans are recognizing the need to place value on forests and their services. The Amazon nations, for example, have signed the Amazon Pact, declaring the importance of genetic and biotic conservation and establishing a special commission to carry out research and assess environmental impacts on indigenous cultures (Schneider 1991).

Some governments are providing incentives for forest conservation. Brazil recently legalized extractive reserves, guaranteeing residents the right to harvest nontimber products and defending such areas from clear-cutting (Harrill 1991). The Costa Rican Land Reform Agency is working to establish forest management and conservation as activities that qualify farmers to hold title to the land (USAID 1992).

Debt-for-nature swaps also provide mechanisms for forest preservation, although, to date, the amount of land preserved and the amount of debt set aside are very small. The first debt-for-nature swap helped to create the Beni reserve in the Amazon rainforest of Bolivia (Dogse & von Droste 1990). In 1991, the Brazilian government exchanged US$100 million of debt for environmental projects (World Resources Institute 1992).

Regional biodiversity research initiatives

A great deal of research is underway in Latin America holding promise for maintaining forest biodiversity and ecosystems. Several biodiversity projects in the region are described below.

Biodiversity inventories

Large scale surveys and inventories: Costa Rica's National Biodiversitv Institute (INBio). The Costa Rican National Biodiversity Institute, or INBio (Instituto Nacional de Biodiversidad), was established in 1988 (Janzen 1990, 1991) as a private, non-profit, public service association administered by the National Biodiversity Inventory, the National Biodiversity Data Base, and the Public Biodiversity Information Service. INBio works to bring about a better understanding of Costa Rica's biodiversity resource and to support non-destructive uses. The organization maintains a library, herbarium, and insect, mammal, and bird collections. Education is provided through course work and internships in censusing, organizing, interpreting, and distributing biodiversity data. This specialized training ranges from basic information on species to database and literature management. Trainees produce field guides and lectures and provide data to users.

Two primary components of INBio's work are the arthropod inventory and phytochemical prospecting. A pool of 100 to 200 parataxonomists are cooperating with INBio to identify and document 95 % of the country's biodiversity - close to a million species of flora and fauna - over the next 10*y*.

Merck & Co., Inc., the largest pharmaceutical company in the world, was INBio's first customer, providing US$ 1 million dollars for research as well as royalties on the sale of any product ultimately developed by Merck. Both Merck and INBio expect to use synthesized materials derived from forest plants and animals, rather than destroying forest resources.

Biological Diversity in Latin America Project. The Biological Diversity in Latin America Project (BIOLAT) supports research on biodiversity through descriptions of new species and studies of the origin and maintenance of species richness. In addition to basic research, BIOLAT holds workshops that creatively address scientific collections. The programme's products include published summaries of flora and fauna; checklists and keys to groups of geographic subunits, especially for BIOLAT sites; the results of long-term inventories of selected species at BIOLAT sites; and data from systematic studies, such as continuously updated descriptions of new species. The Programme is operating principally in the Andean crescent of South America, on areas rich in species and habitat types.

Monitoring and ecological research

Rapid Ecological Assessment: The Nature Conservancy. Rapid Ecological Assessments (REA) enable the gathering and application of biological and ecological information so that appropriate conservation decisions can be made in a timely fashion (Sobrevila & Bath 1992). The Nature Conservancy uses REA methods by integrating data obtained from satellite images, aerial photographs, and on-site verification in a process called stratified sampling. The final product is a series of maps and reports that describes vegetation, fauna, human activities, and land-use patterns in great detail. This information combined with data obtained by teams conducting field work, is a valuable tool for identifying and monitoring protected areas and devising appropriate management strategies. The Nature Conservancy applies REA in a number of countries, including Paraguay, Jamaica and Brazil.

Remote sensing. As part of an initiative to measure changes in forests around the world, the Woods Hole Research Center has created a map of South America using satellite imagery. The map, compiled from satellite data at a resolution of one kilometer, separates vegetation into several forests types. It is updated regularly as new data is received. Because the map indicates changes in forest distribution, it can be used to draw attention and research efforts to areas that are facing the greatest threats (Harrill 1991).

Similar efforts on a smaller scale are conducted locally. In Peru, the decline of traditional crops is being analyzed using satellite remote sensing and geographic information systems (Morain 1988). These methods allow for more efficient use in collecting critical germplasm and for *in situ* conservation of many tropical species.

Network of Intensive Monitoring on Forest Plots: Smithsonian Institution/ MAB Biological Diversity Programme. The Smithsonian Institution/Man and the Biosphere Biological Diversity Programme (SI/MAB) has developed, tested, and refined procedures for establishing and monitoring forest plots at field sites in Bolivia, Peru, Puerto Rico, the U.S. Virgin Islands, and Great Smokey Mountains National Park in Tennessee, USA (Dallmeier 1992a, SI/MAB Biodiversity News 1991, 1992). The SI/MAB Programme also documents inventories and monitors plant diversity in tropical forests, providing long-term data on the growth, mortality, regeneration and dynamics of forest trees. Researchers are currently creating an information base for research and education that will contribute to the conservation and management of biosphere reserves and other protected areas throughout the world. To date, the SI/MAB Programme has generated several tropical forest data sets containing more than 54,000 independent observations of its research sites that can be used to describe and understand the dynamics of the forest.

On-going Tropical Ecology Research. The Smithsonian Tropical Research Institute of Panama established the Center for Tropical Forest Science in 1990, in cooperation with Harvard and Princeton Universities. The Center's activities are pantropical in nature, stemming from the long-term tropical research tradition of the Smithsonian in Barro Colorado Island of Panama, the most studied tract of forest in the world.

The Organization for Tropical Studies, an international consortium of universities and research institutions, operates a research and teaching facility at La Selva in the lowland tropical rainforest of Costa Rica (Clark 1990). La Selva is one of the most active research sites for tropical biology research.

The Cocha-Cashu Biological Station is located in the lowland sector of Manu National Park in southeastern Peru (Terborgh 1990). Tropical forest ecology research in this unique Amazon rainforest has been conducted since 1969 under the leadership of Dr. John Terborgh of Duke University. Cocha Cashu is one of the few research sites in the neotropics that offers an undisturbed ecosystem with a complete complement of predators and prey.

The study site for the Minimum Critical Size of Ecosystems Project is located in the central Amazonian Forest of Manaus, Brazil (Lovejoy & Bierregaard 1990). This joint project of the Smithsonian Institution, World Wildlife Fund-US, Instituto Nacional de Pesquisas da Amazonia, and the Institute Brasileiro de Desenvolvimento Florestal, studies a large number of taxa. It focuses on how scale and rates of species loss relate to subsequent species composition and habitat fragmentation.

The Luquillo Experimental Forest in the Luquillo Mountains of Puerto Rico is managed by the U.S. Forest Service. The forest includes four life zones. A significant number of research activities have been conducted in Luquillo since 1939, coordinated by the Institute of Tropical Forestry.

Assessing Biodiversity

Rapid Assessment Programme: Conservation International. Conservation International has assembled a multidisciplinary team of experienced field biologists to explore remote tropical ecosystem areas. This specialized group, called the Rapid Assessment Programme team, is capable of quickly gathering information about the distribution and abundance of plant and animal species. Information resulting from the field trips can be rapidly integrated to produce assessments of conservation priorities.

Genetic. Research is underway in the Amazon rainforest of Venezuela to locate species of rubber trees that can be used for genetic improvement of the commercial varieties (Aymardc personal communication).In Brazil, researchers are developing a germplasm sampling strategy for several palm species (Coradin 1985), and management practices have already been improved for biomass production of native stands of Babassu palms (Balick 1988). In Costa Rica, work focuses on maintaining the genetic diversity of several threatened, multi-purpose species through vegetative propagation (Dvorak 1988). In Honduras, techniques are being developed for production of native palms in high densities (Tabora 1989). In Peru, studies on alternative management methods are being conducted through seed dispersal in the tropical forest (Gorchov 1987).

Economic Value. The Institute of Economic Botany at the New York Botanical Gardens is endeavoring to locate and study plants that can provide new sources of food, renewable energy and medicines. Research has been conducted on the camu-camu, a small fruit from the Peruvian Amazon, which has a very high concentration of Vitamin C. Investigations by Boom (personal communication) have found that Indians utilize up to 80% of the tree species in their forests, suggesting a potentially high value in intact forests.

Conservation International is searching for multiple uses of forest products to encourage tropical forest conservation. And in Peru, studies center on traditional Peruvian remedies derived from the forest (Leon-Barua 1986) to gain information for improving the treatment of diarrhea and to decrease parasites. Researchers also focus on wound healing materials from the tree Sangre de Drago (Vaisberg 1989).

Coordinating Knowledge. The International Union for Conservation of Nature and the World Conservation Monitoring Centre compile and distribute information concerning issues of biodiversity and conservation around the world, including countries in Latin America.

The Nature Conservancy is establishing a hemisphere wide network of Conservation Data Centers, each of which will maintain inventories of the most significant biological and ecological features of the country or region in which it is located. The primary goals of the programme are to help identify high-priority conservation areas and assist in development and management planning. The inventories are computerized and can be updated. The centers use the same methodology and software so that information can be readily exchanged and thus used to help address regional and multi-national conservation problems.

The objective of the Agency for International Development's Biodiversity Profiles is to compile information on the status of the environment and biodiversity in individual countries. The compiled data provide the basis for the design and implementation of USAID's in-country renewable natural resource and related activities.

Sustainable forestry

Sustainable management of primary and second-growth forests and tree plantations can play a vital role in preserving biodiversity in Latin America. Sustainable forestry employs silvicultural and harvesting practices that increase the amount and value of products removed from the forest while maintaining the capacity of the forest to regenerate naturally and maintain basic ecological functions. Intensively managed tree plantations, on the other hand, serve to deflect pressure on the intact forests by providing a supply of timber. Similarly beneficial are animal domestication projects that help to reduce hunting pressure on wild, forest populations.

Successful sustainable management strategies depend on an understanding of a forest's regenerative capacity; thus, management techniques will differ with forest type. But knowledge alone will not ensure success. The economic, political, and social environment must be receptive. Government policies must promote, not hinder, sustainable management; forest products must be economically viable; and local people must be allowed to participate in, and benefit from, the forest management project.

In Latin America, government policies that deter farmers from practicing sustainable forestry must be reversed. Secure tenancy or title to land should be allowed based on sustainable management practices, not on forest clearance. Loans should be made available for forest management, not merely for crops and ranching (USAID 1992).

For forests to be managed in an economically sustainable fashion, forest products must have value and be marketable. For example, the value of the forest can increase through the processing of timber into products such as furniture or carvings. USAID (1992) cautions, however, that processing facilities for value-added products must be appropriate to the size of the managed forest to avoid unsustainable exploitation of the available resources. And it is not wise for localities to become dependent on only a few forest-based commodities because of the economic vulnerability should slumps in the market occur. Such a dependence also downplays the value of the total forest. It is thus essential to understand the full range of benefits that accrue from management of intact forests. Research in this area is being undertaken on extractive reserves in Acre, Brazil, by the Woods Hole Research Center (Harrill 1991). If forest management is to be economically feasible, markets must also be available for forest products. Also, consumers in developed countries can encourage management by paying a premium for tropical wood which comes from managed forest (Perl *et al.* 1991).

Sustainable forestry in Latin America is still rare. Projects that do exist are often in isolated localities with little opportunity to exchange information and techniques. A 1989 workshop sponsored by World Wildlife Fund brought together representatives from sustainable timber production projects - government-run operations, corporate forest industries, local cooperatives. In response to a recommendation made by the participants, World Wildlife Fund is exploring ways to establish a natural forest management network to coordinate the exchange of information and technical assistance (Perl *et al.* 1991). Brief descriptions of some regional initiatives follow.

<u>Mexico's Plan Piloto Forestal, Yucatan Peninsula</u>. This project, initiated in 1983, is located in a subtropical moist forest characterized by disturbances such as hurricanes and fire that favor the regeneration of mahogany and cedrela (Negreros 1992, Perl *et al.* 1991). The management plan has replaced logging by concessionaires with logging under the management of local Mayan communities (organized as land cooperatives, or Ejidos) that participate directly in decision-making and administration of the project. Sixteen Ejidos oversee 360,000 *ha* of land, approximately 150,000 *ha* of which are protected. The Ejidos area is divided into blocks that are logged on 25-*y* rotations. Within each block, five units are established and cut on a 5-*y* cycle. Each unit regenerates naturally over the 25-*y* rotation. The Ejidos have begun processing the timber, adding value to the logs and increasing the range of species that can be marketed. The non-timber products, honey and chicle, are also harvested. Chicle can be extracted from a tree every three to five years and this activity can be performed during the rainy season when logging is not possible.

The population of the Ejidos provides a permanent work force for the project. Technical advisors are now training workers in forestry, wood processing, business, and administration skills. According to Perl *et al.* (1991), project personnel attribute the high level of interest in the project to the fact that a significant amount of local income is provided. Commitment to the project is demonstrated by the

Ejidos' plan to continue investing some of the proceeds from the sale of timber in harvesting and processing equipment.

Portico (Tecnoforest del Norte S.A.), Atlantic zone of Costa Rica. The Portico project was established in 1987 by Portico, a private firm, to manage 12,000 *ha* of tropical wet forest for "caobilla" timber (*Carara guianensis*), a species related to mahogany. Management techniques include selection cutting on a 15-*y* cycle. Mature trees are felled in an initial cut; seed trees and saplings are left for future cuts. While Portico concentrates on caobilla, it also harvests other species for sale as raw logs. Felling and skidding practices are designed to minimize environmental damage from skid trails and increase the amount of usable wood. Thus far, natural regeneration is occurring and caobilla seedlings continue to dominate (Perl *et al.* 1991).

Portico adds value to caobilla timber by manufacturing high quality doors for the upper end of the export market. Perl *et al.* (1991) report that sufficient value is added to the raw material to cover forest management costs through high level technology in wood processing. Provision also seems to have been made for local farmers. Although Portico obtained its forest land from farmers and land owners, it generally purchased only portions of farms. Farmers are therefore able to continue working their land while also providing the labour force for Portico.

Ministry of Agriculture and Rural Affairs/Inter American Development Bank, Forest Management Programme, Project for Protection of Ethnic Groups and Renewable Natural Resources (MACA/BID), Bolivia. A major goal of this project is to promote the rational use of forest lands once they are opened by roads to settlement and conversion to agriculture (Perl *et al.* 1991). The project was initiated in 1989 and is operated by the Bolivian government in collaboration with a unit of the national university. Located in the Bosque Experimental Elias Meneses of the Universidad Gabriel Rene Moreno, Santa Cruz, the project is within the area of influence of the new Yapacani-Chimore highway.

Of the 55,000 *ha* of tropical wet forest that have been set aside for the project, 35,000 *ha* are designed for timber production. Other parts of the forest will be used as a reserve for the preservation of flora and fauna. A private logging company will extract and process timber under a management plan drawn up and supervised by project personnel. Although the project area is uninhabited, nearby forest has been settled. The project hopes to develop forest management techniques that can be used by the landholders and loggers in the settled areas.

Costa Rica, San Isidro Demonstration Project. According to USAID (1992), the objective of the San Isidro project is to demonstrate that the diverse trees of the secondary forest, which can be used for fuel and furniture, are of greater value than any crops produced on the poor soils of the forest after its conversion to agriculture. At the same time, managed use of the secondary forest should reduce pressure to clear primary forest. The 35-*y*-old, second-growth forest at San Isidro is managed for timber and firewood. Practices intended to lessen the impacts of harvesting include controlled logging, enhancement of selected tree species, directional felling, and the use of oxen to haul the timber (USAID 1992).

The Man Kote Manqroves, St. Lucia. The Man Kote mangroves near Vieux Fort on St. Lucia have been over-harvested for charcoal. A project developed by ENCAMP (East Caribbean Natural Area Management Programme), the government of St. Lucia, and local groups involved nearby communities in developing a solution. Essentially, the project reduces pressure on the remaining mangrove forest by supplying local people with a fuel wood plantation (USAID 1992). Secondary school children surveyed the charcoal producers and found them well aware of the harvesting problem. However, difficult access to other areas had led the producers to exploit the Man Kote mangroves. Idle government land close at hand was put to use as a fuel wood plantation, supplying raw material for the producer and decreasing the threat to the mangroves (Bossi & Cintron 1990).

Non-timber products

Iguana Management Project, Smithsonian Tropical Research Institute and the Pro Iguana Verde Foundation, Panama. Although iguanas serve as a source of protein in every country in which they are found, they are now over-hunted. The objective of the Iguana Management Project in Panama seeks to determine whether iguana can be restored to their native forest habitat, thus providing peasants with a source of protein and an incentive for the protection of the forest.

Dagna Werner, who directs the project, has outlined some of the conditions necessary for viable management. Present low numbers of wild iguanas and the biological characteristics of the animal (highly variable hatching success, high hatching mortality) will necessitate captive breeding to ensure a population sufficient for management in the forest. Werner calculated that iguana production could be economically feasible if the managed population were sustained by captive reproduction and supplied with food, half of which could come at no cost from excess farm products. Werner notes, however, that land distribution in Panama may create a disincentive to iguana management: 30% of campesinos are employed by large landowners and do not have exclusive rights to the land or products of management (Werner 1991).

The Taqua Initiative, Esmereldas Provinces , Ecuador. This project, designed by Conservation International, attempts to meet local people's needs while demonstrating that conservation and sustainable use of the forest have greater economic potential than destructive uses. Tagua is an ivory-like nut from the tagua palm and can be carved into ornamental objects such as buttons. Once the nut is harvested by local people, Conservation International ensures a market by linking the artists with the manufacturers of buttons, jewelry, and carvings. By 1992, nearly 144 clothing companies were participating in the project. According to Conservation International, the area shows the signs of the project's success. Warehouses are full of tagua nuts, groves of tagua palm are flourishing, and, to date US$ 75,000 has been generated for the province of Esmereldas (Conservation International 1992,Onderdonk personal communication)

Kuna Indians, Panama. The Kuna Indians have established a homeland (CONAMA) in Panama with government assistance. They have lobbied for legal land rights and have developed a reserve and a management plan for sustainable use involving ecotourism, the use of medicinal plants and controlled hunting. The reserve is the basis for much of the Kunas' economic activity, supplying a variety of jobs and serving as a successful example for other Latin American Indians (Vaughan 1988).

Domestication of pacas. Smythe (1991) has endeavored to produce rapid domestication of pacas by rearing young animals under conditions intended to imprint social behavior. If successful, this project will help provide a new source of protein and thus aid in reducing hunting pressure on wild populations.

Until the Smythe experiment, the aggressive and social temperament of pacas impeded domestication efforts, but project personnel have made progress. Young pacas were removed from their mothers, handled daily, and kept together at night. Social behavior was enforced by housing the pacas in cages with no retreat except a pond for immersion. The treatment has produced an adult paca that is more socially tolerant than a wild paca. Although the initial experiment was labour intensive, successive generations of pacas have been allowed to learn from their parents. Results suggest that the changed behavior of the parents will be adopted by their offspring. The third generation of animals has been born and remains relatively easy to handle. Selective breeding for faster growing pacas and continued domestication so that expensive cages are not needed will make paca raising more economical.

Conclusions

A root cause of deforestation in Latin America is the attitude of nonindigenous residents and governments toward forests. While their wood is converted for a number of uses, the forests themselves are generally viewed as impediments to economic development. This perspective is the basis of government policies that promote forest clearance. Lack of environmental information has allowed exploitation to proceed unchecked by concerns for inappropriate and unsustainable uses.

The question of sustainability is important in relation to forest ecosystems. Sustainability emphasizes maintenance of the forest structure and biodiversity. It should not be, but often is, confused with sustainable timber yield, a management strategy that promotes wood fiber production over time for economic gain. In practice, the two concepts are usually incompatible. With few exceptions, large-scale commercial timber projects are conducted without taking actions to maintain the biological and ecological diversity of tropical forests.

Latin American governments have failed to take into account the importance of forest biodiversity because of intense pressure to adhere to steady timber yields. This out-moded forest management regime is adhered to most aggressively in socioeconomic climates dominated by poverty, runaway population growth, lack of access to farm land and debt burdens that encourage intensive exploitation of resources for short-term profits.

The strong demand in Japan, United State and Europe for tropical wood from developing countries has to be reduced. At the same time, new alternatives must be created. Any plan to protect forest biodiversity, even in the most remote areas, must blend conservation with the necessity of meeting the needs of local people to achieve sustainable economic livelihoods in harmony with their surroundings. Regional research and development centers should provide the critical scientific force to maintain national and regional biodiversity conservation in a way that allows sustainable use.

Moving toward sustainable management principles in the forests of Latin America will require the following:

- Innovative, efficient, no-waste technologies. Such "closed loops" include recycling, less destructive agricultural practices, and longer lasting products that require simpler and less packaging.
- A framework and a time-table for change based on economic criteria. Impose taxes on environmentally destructive technologies and provide tax breaks and economic incentives for environmentally sound technologies. Provide international assistance and debt relief for poor nations in combination with family planning, education programmes for women (including forestry), and forest protection strategies.
- Population stabilization through improvements in the standard of living, status and education of women, and aggressive family planning programmes to reduce birth rates.
- Re-education of industrialized countries to reduce excessive consumption and lower the toll on the environment. Encourage "green" life styles that decrease reliance on products obtained from the destruction of forests. In crease investment in environmentally sound public transportation and transportation technologies, such as electric and gas efficient vehicles.
- Strong national and international political support for environmentally sound forest management.
- Innovative land use policies for forest management and a restructuring of national institutions to implement the new policies. In conjunction with local peoples, encourage sustainable agricultural practices and land tenure rights to reduce forest destruction.
- Physical, biological and economic inventories of forests in each country in Latin America. Promote long-term biodiversity monitoring programmes.
- Large-scale in-country training programmes for forest managers at all levels.

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