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A strategy for preserving tropical forests

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SUMMARY

1 The problems of deforestation of the tropics and solutions which have been suggested are described.
2 An international programme is proposed which will preserve a sample of the remaining forests in a system of large tropical forest reserves.
3 This system will include 1000 reserves of approximately 100 000 ha each, in forty-eight tropical nations.
4 To finance this system a fund is proposed based upon an assessment schedule for those developed nations with a per caput GNP in excess of \$1500 year^{-1}.
5 Funding would exceed the cost of merely protecting each reserve. In most cases it would be sufficient to contribute to other economic needs, such as intensification of agriculture in other areas so as to ease the pressure on the remaining forests to provide new agricultural land.

INTRODUCTION

Tropical forests are assailed by a host of unrelenting and remorseless enemies. If unchecked, these forces will eliminate 50% of the world's remaining tropical forests by the end of this century. Associated with these forests, the greatest diversity of plants and animals found on earth will also become extinct, and mankind will lose, for ever, the opportunity of domesticating or harvesting these organisms for his own benefit. Many species will become extinct before their existence is recorded and their potential benefits and usefulness is assessed.

In this essay I propose a plan to preserve a sample of the world's remaining moist tropical forests through the establishment of an internationally financed system of Tropical Moist Forest Reserves. The preservation of large tracts of the world's remaining tropical moist forests would provide a proximate, albeit partial, solution to one of the most critical resource destruction problems that we will otherwise experience during the last two decades of this century. It is urgently needed because of the rapid rate at which the destruction is advancing and the irreversibility of its effects. The threatened resources cannot be replaced. No technological solutions will permit their recycling.

Forty-two percent of the tropics—some 1·9 billion ha, twice the land area of the United States—contain significant forest cover. Over 1 billion ha are closed moist forest; the remainder is relatively open, drier forest of the sort found in much of the southern parts of Africa or the Mato Grosso of Brazil. The world's remaining tropical moist forests are located in three regions: South and Central America, 42%; Asia,

Australia, Oceania, 21%; Africa, 37%. Already Latin America has lost 37%, Asia 42%, and Africa 52% of their original areas of tropical moist forest (Sommer 1976; Myers 1980). Eleven hectares of tropical forest are being cut world-wide each minute according to conservative estimates. An area of tropical forest greater than the United Kingdom or half the size of the state of California (245 000 km^2) is being lost each year (Council on Environmental Quality 1980). Not all of this cleared land is necessarily left entirely without forest. In some cases we witness a substitution of plantation or second growth depauperate forests for the original high diversity forests.

It is obvious that the tropical forests will become increasingly scarce and more valuable in years to come, because many of the developing nations which possess these forests are under heavy pressure to exploit them immediately for foreign exchange and to accommodate growing populations. It is unreasonable to expect developing nations to reverse, unaided, the conventional economics which stress immediate, short-term goals at the expense of long-term, less quantifiable benefits.

It is equally unrealistic to expect tropical nations, solely on the basis of small grants from private conservation organizations, to be effective custodians of parks and reserves called for in some of the elaborate global schemes. The great numbers of reserves enacted on paper and never supported on the ground bear grim testimony to the uselessness of conservation ethics without the concomitant financial resources to implement them.

A number of solutions have been suggested to solve or ameliorate the problems of tropical deforestation including: adoption of a new world-wide economic order; increased cooperation among nations to protect valuable resources; increasing the commodity price of timber through the formation of hardwood-exporting cartels (a solution which might turn out to be counter-productive by making it profitable to invest in the equipment necessary to extract timber from the most remote and inaccessible areas); the rental of tropical forests by developed nations; increased research and development on tropical forest resources; increased education and public awareness about tropical forests; development of alternate technologies to reduce demands for tropical forests products; and an attack on the cause of the pressures upon tropical forests including poverty, under-employment, food and energy deficiencies, and uncontrolled population growth (Myers 1979; Allen 1980; Goldsmith 1980; Nigh & Nations 1980; U.S. Interagency Task Force, 1980; IUCN 1980b).

UNESCO's World Heritage Convention (1972) establishes a system of natural and cultural sites of 'outstanding universal value' registered on a World Heritage List, and to be conserved, if necessary, with the assistance of the World Heritage Fund. It thus offers a combination of funding and an administrative framework that would promote the implementation of the Convention and ensure the quality of sites. However, in what pertains to the preservation of tropical forests the Convention has not produced a major impact. The List of World Heritage Sites in the 1982 *United Nations List of National Parks and Protected Areas* (IUCN 1982) does not include a single natural heritage site for Brazil, for example, nor for many other areas with extensive tropical forests. The World Heritage Convention appears to lack sufficient economic incentives to serve as an effective means for preserving the world's tropical forests.

Among the most promising of the various studies purporting to deal with the problems of future resources is *Global Future: Time to Act*, published in 1980 by the Council on Environmental Quality and the Department of State (U.S.A.). A series of refreshingly specific and comprehensive recommendations are made in order to counter the loss of biological diversity in certain ecosystems. Perhaps most significantly, this report recognizes the need for the richer countries 'to pay part or all of the costs of protection and management of critical areas that are unique to mankind.' However, the amount suggested of $1 billion over 10 years for establishing an international fund to assist developing nations manage reserves, is clearly insufficient to have a significant impact on the future of tropical forests.

Most of the recommendations in these studies embody admirable objectives and need to be urgently pursued. However, they are neither individually nor collectively capable of being pursued at a rate sufficient to prevent the elimination of 50% of the remaining tropical moist forest resource base by the end of this century. Nor will the nations possessing the tropical forests, for the most part fully aware of the rare and fragile resources which they possess, be able to defer the immediate economic exploitation of these resources.

INTERNATIONAL PROGRAMME

The strategy I propose requires establishment of a system of tropical moist forest reserves financed by all of the developed temperate zone nations. Payments for this system of reserves should not be regarded by the developed nations as altruistic but rather as self-serving expenditures; a vaccination now against potential future infection. In effect, we are already paying the oil-exporting nations more than the cost of finding, extracting, transporting and refining oil. Instead, we pay, and rather handsomely, into a trust for the social security of those nations when the oil runs out. It is therefore proposed that the developed nations pay now for their own future security, by investing in a trust whose aims would be to protect the diversity of life embodied in the tropical moist forests of the world.

The payments for a system of reserves must not be perceived to be an attempt on the part of the rich nations to meddle in the internal affairs of the developing countries. Participation in the programme must be voluntary and should not be viewed in any way as affecting these nations' sovereignty over their forest reserves.

According to the proposed plan, each host nation would receive an annual payment, the amount based on the area under protection, to act as custodian of reserve areas of tropical moist forests. Maintenance of the reserves would be monitored by annual inspections. If the area under protection has been reduced or there were more squatters than initially specified in the registration agreement, then the payments would be substantially reduced. Thus, there would be a direct economic incentive for rigorous protection of the reserves.

The capacities of forestry and park service institutions in many countries will be inadequate to absorb large amounts of external funds. In some cases it may prove necessary first to finance small technical assistance programmes to build up the

infrastructure of the organizations charged with the custodianship and management of the reserve system within each country.

The funding which each participating nation receives should exceed the requirements of simply developing or enriching the infrastructure of national park or forestry conservation services in the participating countries. The proposed funding should cover the intensification and diversification of agriculture in other areas so as to ease the pressure on the reserves to provide new agricultural land. Funds could also be used to develop plantation forests in other areas in order to provide employment, firewood, and other needed forest products. They should also be sufficient for public education programmes in the participating nations so as to broaden acceptance of the concept of forest preservation and to develop respect for the reserve's borders, rules, and regulations. The payments should be made without any conditions on use other than the protection of the agreed-upon area at the time of registration.

Some nations participating in the programme may lack sufficient technical personnel to prepare the necessary surveys for registering their new reserves. In these cases, a programme of 'start-up' grants should be administered, which could employ consultants to prepare surveys, mapping, inventories, legal reviews of the relevant local and environmental laws, and the preparation of new legislative packages where these are a prerequisite for participation.

Clearly, detailed surveys and inventories will not be accomplished in the relatively short term allotted for preparing the registration documents— this would normally require a long-term activity of research and analysis of each reserve (Whitmore 1980). The preparation of the application would require approximately 1 year; less for reserves where much of the requisite data already exists. Registration should be left open for approximately 5 years after the programme is initiated or until the goal of 1000 tropical moist forest reserves of approximately 100 000 ha each is established. Some reserves will be considerably larger; as in Amazonia, for example, where the Brazilian government is already establishing reserves of which some are over 1 000 000 ha. Others may be considerably smaller.

It is, of course, recognized that many of the reserve boundaries will be a compromise based upon administrative and political constraints. Clearly, boundaries that include natural barriers such as mountain ranges or rivers are usually much easier to patrol than those which abut urban areas. Since selection of the areas to be included in the international reserve programme must be left up to the individual nations, areas can be selected for which there are a minimum of conflicting development plans. The hostility frequently associated with reserve establishment as being antidevelopment can at least be partially avoided (White & Bratten 1980).

What will this plan accomplish?

A goal of 100 million ha of the world's tropical moist forests established into a system of effective and carefully monitored reserves, and financed by contributions from the developed nations may seem ambitious. Actually, this represents only about 10% of the remaining tropical moist forests. The proposed plan for a system of tropical forest

reserves will not stop the process of deforestation. What would be accomplished instead would be the establishment of a safety valve. Some diversity is preserved (Willis & Eisenmann 1979). Some options for the future are maintained. If we have erred, if 10% of the earth's remaining tropical moist forests is found to be insufficient to protect watersheds (Gentry & Lopez-Parodi 1980) or maintain climatic balance (Woodwell 1978), then at least there will be a reservoir of plants and animals adapted to life in the tropics to provide the source material with which to attempt to recolonize other areas. This process, should it prove necessary, would require vast scientific and technological developments. It is hoped that part of the revenues derived from the international reserve programme would encourage the more effective preservation of already existing parks and reserves, and thus indirectly contribute to the ultimate preservation of an area greater than the 10% of the tropical moist forests envisioned to be supported by this plan.

One criticism of the proposed scheme is that it could, by its existence, take pressure off extant national programmes, encouraging nations merely to register parks and reserves they had planned to declare anyway. This may not necessarily be bad. If any given nation is serious in its conservation commitment, and is prepared to allocate natural resources toward this end, then it would probably use the released funds to strengthen the infrastructure of extant parks, enlarge them, or establish new ones. If, as is too often the case, economic realities and/or lack of commitment only result in the establishment of new 'paper parks,' then the registration of a previously planned park in the new programme would at least ensure its protection. The revenue derived would help capitalize other immediate programmes and perhaps contribute to an ambiance in which conservation imperatives receive a greater priority and are more broadly appreciated within the nation.

There are about one thousand national parks, from the equator to the poles, listed in the *1980 United Nations List of National Parks and Equivalent Reserves* (IUCN 1980a). Unfortunately, in compiling this data, it was found that the information about the 'area of some of the parks varied by as much as 50% depending upon the source of information.' The compiler of the *1982 United Nations List of National Parks and Protected Areas*, unfortunately claims that the data available is still inadequate in order to judge the quality of management of many of the world's reserves (IUCN 1982). Parks and reserves presently make up less than 2% of the remaining tropical moist forest biome, and even that 2% is at risk.

Where will the funds come from and how much will it cost?

The strategy anticipates that the financing of the International Tropical Moist Forest Reserve System will be provided by those developed nations with per caput gross national products in excess of \$1500 year^{-1} (World Bank 1980). For purposes of this plan, a system equivalent to a progressive income tax (beginning at \$0·50 for GNP \$1500, to \$5·00 for GNP \$10 000 and above) on all nations with a GNP over \$1500, and not possessing tropical moist forests, would yield over \$3 billion annually (\$3259 000 000). This system would require support from twenty-three of the nations in

the OECD ($2613 000 000), seven nations with Centrally Planned Economies ($556 000 000), seven of the OPEC nations ($89 700 000), and six other developing or middle-income countries with GNP over 1500 dollars ($53 000 000) (Table 1). The international resource mobilization must become automatic, independent of the good will of the individual contributors, and flow through a multilateral institution such as the World Bank. This seems a great amount, yet it represents only a relatively small increase in the 1980 development assistance provided by the OECD nations. For some

Table 1. Sources of funds for the proposed international tropical forest reserve system

	Population (A) (million)	GNP/ caput (B)	Contribution/ year (C) (million)	Devel. Asst. (D) (million)	% Increase (E)
Organization for Economic Cooperation and Development					
Australia	14·2	7990	49·7	690	7
Austria	7·5	7030	26·3	174	15
Belgium	9·8	9090	44·1	714	6
Canada	23·5	9180	105·8	1151	9
Denmark	5·1	9920	23·0	448	5
Finland	4·8	6820	14·4	104	14
France	53·3	8260	213·2	3836	6
F.R. Germany	61·3	9580	275·9	3581	8
Greece	9·4	3250	14·1		
Iceland	0·2	8390	0·8		
Ireland	3·2	3470	4·8		
Italy	56·7	3850	85·1	320	27
Japan	114·9	7280	402·2	3070	13
Luxembourg	0·4	10 540	2·0		
Netherlands	13·9	8410	55·6	1547	4
New Zealand	3·2	4790	6·4	65	10
Norway	4·1	9510	18·5	491	4
Portugal	9·8	1990	4·9		
Spain	37·1	3470	55·7		
Sweden	8·3	10 210	41·5	1125	4
Switzerland	6·3	12 100	31·5	218	14
United Kingdom	55·8	5030	139·5	2453	6
United States	221·9	9590	998·6	4567	22
			Subtotal = $2613·6		
Organization of Petroleum Exporting Nations*					
Iran	35·8	2160	35·8	21	170
Iraq	12·2	1860	6·1	861	1
Kuwait	1·2	14 890	6·0	1099	1
Libya	2·7	6970	8·1	146	6
Qatar	0·2	12 740	1·0	251	1
Saudi Arabia	8·2	7690	28·7	1970	2
U. A. Emirates	0·8	14 230	4·0	207	2
			Subtotal = $89·0		

* Includes countries with a GNP in excess of $1500 per caput and excludes countries with a significant tropical moist forest habitat.

TABLE 1. (*cont.*)

	Population (A) (million)	GNP/ caput (B)	Contribution/ year (C) (million)	Devel. Asst. (D) (million)	% Increase (E)
Middle income countries					
Argentina	26·4	1910	13.2		
Hong Kong	4·6	3040	6·9		
Israel	3·7	3500	5·6		
Singapore	2·3	3290	3·5		
Uruguay	2·9	1610	1·5		
Yugoslavia	22·0	2380	22·0		
			Subtotal = $52·7		
Centrally planned economies					
Bulgaria	8·8	3320	13·2		
Czechoslovakia	15·1	4720	30·2		
German D.R.	16·7	5710	41·8		
Hungary	10·7	3450	16·1		
Poland	35·0	3670	52·5		
Romania	21·9	1750	11·0		
USSR	261·0	3700	391·5		
			Subtotal = $556·3		
			Total = $3259·0		

Data from *World Development Report*, (1980); The World Bank.

(A), (B) adapted from *World Development Report* (1980), The World Bank, Table 1 pp. 110, 111. (C) calculated on a scale of GNP.

$0–1500 = 0	$7–8000 = $3·5
$1500–2000 = $0·5	$8–9000 = $4
$2–3000 = $1	$9–10 000 = $4·5
$3–4000 = $1·5	$10+ = $5
$5–6000 = $2·5	C = A × B Scale
$6–7000 = $3	

(D) adapted from *World Development Report*, (1980) Table 16; ibid.

(E)% increase in development assistance $E = \frac{C}{D}(100)$

countries, with the proposed additional contribution, this increase would still be below the 0·7% of GNP target for development assistance proposed by the United Nations.

In addition, the planned economy nations should not continue to shirk their responsibilities to contribute to this type of programme. Whatever their contemporary perception of the contribution of the West's former colonialistic or imperialistic policies to the economics of tropical nations, the problem of deforestation will affect all nations, and all should contribute to this plan, regardless of ideology.

Adjustments are possible to even out inequalities resulting from the formula used in deriving the amounts to be contributed annually by each participating nation. For example, a scale with smaller divisions than $1000 would be more equitable for some nations with GNPs just over the minimum, and special arrangements might have to be made in the case of countries with particularly awkward foreign exchange situations.

Several industrialized countries may wish to take additional measures to protect unilaterally the relatively small amounts of tropical moist forest under their custodianship. For example, Australia has about 6000 km^2 of moist forest remaining along the east coast of Queensland; and the United States could adopt a more aggressive policy towards protecting some of the remaining forested areas in the Hawaiian islands.

There is a possibility that some nations—which are middle income as classified by the World Bank and also possess tropical moist forests, e.g. Brazil—may wish to participate in the programme both as a contributor and as a receiver of support from the International Tropical Moist Forest Reserve System. (For purposes of this model, nations possessing substantial tropical moist forests are excluded from the calculations of income. However, if Brazil and Venezuela choose to contribute, as well as register reserves, an additional $74 000 000 would be available for the programme.)

Several possibilities have been suggested for the international organization necessary to administer such a plan. International Agencies such as the Consultative Group for International Agricultural Research (CGIAR) or the International Bureau of Plant Genetic Research (IBPGR) could serve as effective models for a new international organization to be formed with the specific mission of administering a programme for the establishment, inspection, and disbursement of payments for tropical moist forest reserves.

A new institution such as the World Development Fund proposed in the study, *North–South: A Programme for Survival* would be a better choice (Brandt Commission 1980). However, the machinery is not in place and once established would be concerned with all aspects of development. Thus, it could easily fail to provide immediately the priority necessary for preserving the rapidly diminishing tropical moist forests.

Of the traditional international agencies, the World Bank appears to be the best adapted to undertake the additional responsibility for establishing and financing a large network of protected areas. The World Bank has its purpose—the provision of funds and technical assistance for facilitating economic development in its poorer member countries. It has a global reach. The additional $3 billion $year^{-1}$ would not swamp its administrative capabilities, although additional technical people would be needed, probably in a separate division devoted to giving rather than loaning money. The Bank would also be in an excellent position to provide technical advice and additional loans, where necessary, to combine with the revenues from reserve payments for other development projects in areas such as agriculture, reforestation, afforestation, restoration of eroded lands, colonization schemes, forestry training, land surveys and institution building. The Bank has already developed a philosophy towards forestry development, and it understands the role of human encroachment, principally from unplanned and poorly planned agriculture in the destruction of tropical forests (World Bank 1978).

Some of the management of the programme could be accomplished through the Bank's extant system of regional offices, many of which are located in countries with important areas of the world's remaining tropical moist forests, e.g. Cameroun,

Ghana, Ivory Coast, and Zaire in Africa; Indonesia and Thailand in Asia; and Bolivia and Colombia in South America. The Bank already conducts periodic reviews of borrower countries' economic situations and credit-worthiness. This process could be modified into an inspection procedure to ensure compliance with agreed-upon specifications for reserve management. When the inspection missions find that the safeguards are inadequate or that they have been ignored, then the Bank's leverage—the halting of disbursements—can be employed. However, supervision of compliance must be firm, not the delicate task that has sometimes been the case in loan projects.

An advisory committee of experts from organizations such as FAO, UNESCO, UNEP, IUCN, and WWF might be established to assist the World Bank with technical matters pertaining to the programme and to lend their weight to encouraging the developed nations to subscribe. With broad and immediate support from the interested nations, this is a plan that can be implemented almost immediately, with major components in place within 3 years, under ideal circumstances.

Initially, the programme will be applied only to natural, unmodified, tropical moist forest ecosystems. Later, as more subscriptions to the programme from developed and middle-income nations are forthcoming, auxiliary reserves may be added, including those involving varying degrees of management of the drier, open-canopy types of tropical forests. The International Tropical Moist Forest Reserve System would accept registration applications from the following nations (broadly defined).

South and Southeast Asia and Melanesia. Australia, Bangladesh, Brunei, Burma, Indonesia,* India, Kampuchea, Lao P.D.R., Malaysia,* Melanesia, Papua New Guinea, Philippines, Sri Lanka, Thailand, Vietnam.

Tropical Latin America. Belize, Bolivia,* Brazil,* Colombia,* Costa Rica, Cuba, Dominican Republic, El Salvador, Ecuador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru,* Puerto Rico, Suriname, Trinidad–Tobago, Venezuela.*

Tropical Africa. Cameroun, Congo, Gabon,* Ghana, Ivory Coast, Kenya, Liberia, Madagascar, Nigeria, Sierra Leone, Tanzania, Uganda, Zaire.*

An enormous area is contained within the political entitles just listed; unfortunately, in many cases, the remaining tropical forests have already been disturbed and grossly disrupted. There are remnant forests in all of these countries which should be preserved, but 80% of the world's tropical forests are found in the nine countries asterisked (*) above and they would form the core of the new programme.

DISCUSSION

There is precise enough information about the seriousness of the conversion of tropical forests to justify the common interest of all nations in the selection and establishment of the forest reserve system. What is now needed is a change in political perceptions, a political breakthrough in the North–South dialogue—one that will make a significant contribution to the world's stability in both economic and ecological terms.

Is this possible?

It is now 10 years since the authors of *The Limits to Growth* presented their World Model of the relationships between industrialization, population growth, malnutrition, depletion of non-renewable resources, and the deterioration of the environment, Meadows *et al* (1972). Their models generated much criticism and many world conferences, but very little in the way of new national or international policies designed to develop or even to question the need for viable alternatives to a global growth economy. Its publication did produce an increased awareness that some resources might indeed, by the end of the century, be reaching scarcity levels, and that the limited regeneration potential and carrying capacity of the world's ecosystems might negatively impair the quality of life the inhabitants of the developed nations of the world have come to expect. Many subsequent examinations of aspects of the global resource base have been published and, undoubtedly, more can be expected. In 1980, the Independent Commission on International Development Issues (The Brandt Commission) published its report that dealt with a variety of problems arising from the disparity between the nations of the developed North and the generally less-developed South. A good case was made for the participation of the developed world in a World Development Fund, which would be the mechanism for transfer of assistance funds designed to speed the development of Third World nations and to reduce the extent of world poverty. In spite of the advantage and long-range economic self-interest that would accrue to the developed world by stabilizing the Third World markets, with almost three-quarters of the world's population, there has not been a rush to adopt the Brandt Commission report. Nor, following the Charter of Algiers in 1967, has the plethora of international conferences succeeded in developing an operational system of compensating the developing nations for the costs of maintaining their environments at the expense of their trade and development (Nicholls 1973). However, action on the part of the developed nations to protect the world's environment is not entirely without precedent. The world-wide alarm which developed over radioactive fallout after the 1954 series of U.S. hydrogen bomb tests resulted in a Partial Test-Ban Treaty that prohibits detonations of nuclear weapons in the atmosphere, underwater and in outer space. In force since 1963, this treaty, at least for those nations possessing nuclear weapons, must be an expensive concession to the world's environmental quality and to their own future generations.

It seems clear that, in the short run, the developed world will not help the developing countries in any appreciable way until the threat for not doing so is immediate and personalized, to the extent that the quality of life of the developed world is immediately at risk or already seriously deteriorated. At present, the Organization for Economic Cooperation and Development–Development Assistance Committee nations are only contributing 0·34% of their GNP annually with the objective of promoting economic development in low income countries. Indeed, the contribution of the United States has been reduced from 0·32% to 0·18% of its GNP during the last 10 years, and there is even a threat by the present administration to reduce further its contribution toward multilateral organizations as the existing commitments expire.

Achieving the goal of enclosing some of the tropical forests will benefit everyone. The additional costs, while small in terms of the overall productivity of the developed nations, are nevertheless substantial. Three billion dollars annually will not easily be parted with, particularly at a time of high inflation and reduced government spending. To succeed, the plan will require the vigorous lobbying of non-governmental conservation groups for the subscription of their nations to an International Tropical Moist Forest Reserve System.

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REFERENCES

Allen, R. (1980). *How to Save the World.* Kogan Page. London.

Brandt, W. (1980). *North–South: A Program for Survival.* The Report of the Independent Commission on International Development Issues under the Chairmanship of Willy Brandt. Pan Books, London.

Council on Environmental Quality (1980). *The Global 2000 Report to the President: Entering the Twenty-First Century.* Prepared by the Council on Environmental Quality and the Department of State. Vol. 1, p. 47; Vol. 2, 766.

Council on Environmental Quality (1980). *Global Future: Time to Act.* Report to the President on Global Resources, Environment and Population. Council on Environmental Quality, Department of State. U.S. Government Printing Office. Washington, D.C.

Gentry, A.H. & Lopez-Parodi, J. (1980). Deforestation and increased flooding of the Upper Amazon. *Science*, **210,** 1354–1356.

Goldsmith, E. (1980). W.E.A.P. World Ecological Areas Programme: a proposal to save the world's tropical rain forests. *The Ecologist*, **1 & 2,** 1–4.

IUCN (1980a). *1980 United Nations List of National Parks and Equivalent Reserves.* International Union for Conservation of Nature and Natural Resources. Gland, Switzerland.

IUCN (1980b). *World Conservation Strategy.* International Union for the Conservation of Nature and Natural Resources. United Nations Environmental Program. World Wildlife Fund. Gland, Switzerland.

IUCN (1982). *1982 United Nations List of National Parks and Protected Areas.* International Union for the Conservation of Nature and Natural Resources. Gland, Switzerland.

Meadows, D.H., Meadows, D.L., Randers, J. & Behrens, Wm W. III (1972). *The Limits to Growth.* A Report for the Club of Rome's project on the predicament of mankind. Pan Books. London.

Myers, N. (1979). *The Sinking Ark.* Pergamon Press, Oxford.

Myers, N. (1980). *Conversion of Tropical Moist Forests.* National Academy of Science, Washington, D.C.

Nicholls, Y.I. (1973). *Source Book: Emergence of Proposals for Recompensing Developing Countries for Maintaining Environmental Quality.* International Union for Conservation of Nature and Natural Resources Environmental Policy and Law Paper, No. 5. Morges, Switzerland.

Nigh, R.B. & Nations, J. (1980). *Tropical Rain Forests.* The Bulletin of the Atomic Scientists, March, pp 12–19.

Sommer, A. (1976). Attempt at an Assessment of the World's Tropical Moist Forests. *Unasylva*, **28** (112+113), 5–24.

UNESCO (1972). *Convention concerning the protection of the world cultural and natural heritage.* General Conference, Seventeenth Session. Paris.

U.S. Interagency Task Force on Tropical Forests (1980). *The World's Tropical Forests*. A Policy, Strategy and Program for the United States. Report to the President. Department of State Publication 9117.

White, P.S. & Bratton, S.P. (1980). After preservation: philosophical and practical problems of change. *Biological Conservation*, **18,** 241–255.

Whitmore, T.C. (1980). The conservation of tropical rain forest. *Conservation Biology* (Ed. by M. E. Soule & B. A. Wilcox), pp. 303–318. Sinauer Associates, Massachusetts.

Willis, E.O. & Eisenmann, E. (1979). A Revised List of Birds of Barro Colorado Island, Panama. *Smithsonian Contributions to Zoology*, **291,** 31.

World Bank (1978). *Forestry, Sector Policy Paper*. The World Bank. Washington, D.C.

World Bank (1980). *World Development Report 1980*. Published for the World Bank. Oxford University Press. Oxford.

Woodwell, G. (1978). CO2-deforestation relationships. *Proceedings of the U.S. Strategy Conference on Tropical Deforestation*, pp. 34–37. U.S. Department of State and U.S. Agency for International Development. Washington, D.C.