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SRI LANKA

BIOLOGICAL DIVERSITY AND TROPICAL FORESTS

Status and Recommended Conservation Needs.

Prepared for

USAID/SRI LANKA

by

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BIOLOGICAL DIVERSITY AND TROPICAL FORESTS IN SRI LANKA:

Status and Recommended Conservation Needs

1.0 Introduction

Sri Lanka has a wide array of valuable and productive natural resources which include tropical forests, grasslands and fresh water, marine and coastal wetland ecosystems, all of which contribute to the rich biological diversity of the island. However, by and large, the natural climax vegetation for almost the entire country is closed tropical forest. Therefore, the nation's biological diversity is reflected largely (but not exclusively) on the state and extent of its forests.

This report is presented in fulfillment of new Mission Country Development Strategy Statement preparation requirements included in the 1986 amendments to Sections 118 (tropical forests) and 119 (biological diversity) of the U.S. Foreign Assistance Act of 1961. This report was compiled from documented information available in the country.

This paper provides: (1) a brief discussion of the historical, physical, legislative and institutional aspects affecting biological diversity and tropical forests in Sri Lanka; (2) a summary statement on the current status, relative importance and major issues related to conservation of the country's forests and other biological resources; and (3) a listing of major actions required to promote future conservation and sustainable management of these resources. This paper concludes with a brief statement of priority areas for future resource conservation support in Sri Lanka given existing needs and constraints.

The time is ripe for the great variety and number of concerned national and international environmental and natural resource management and academic organizations and interests to step in and begin to establish the type of long term, collaborative relationships required to facilitate the successful completion of the remaining resource conservation/consolidation work in Sri Lanka. It is interesting to note, in this regard, the comparative lack of such inputs in the past. In this manner, it is hoped that the international donor community can work together to provide all of the necessary assistance inputs to facilitate the ultimate realization of the country's important resource management objectives.

2.0 Physical Situation

Sri Lanka is blessed with conditions conducive to natural biological productivity and diversity. The nation's tropical

location (Figure 1) and prevailing climate (Figures 2, 3 and 4 and Table 1 and 2) results in conditions that are generally favorable for substantive year-round biological growth throughout most parts of the island.

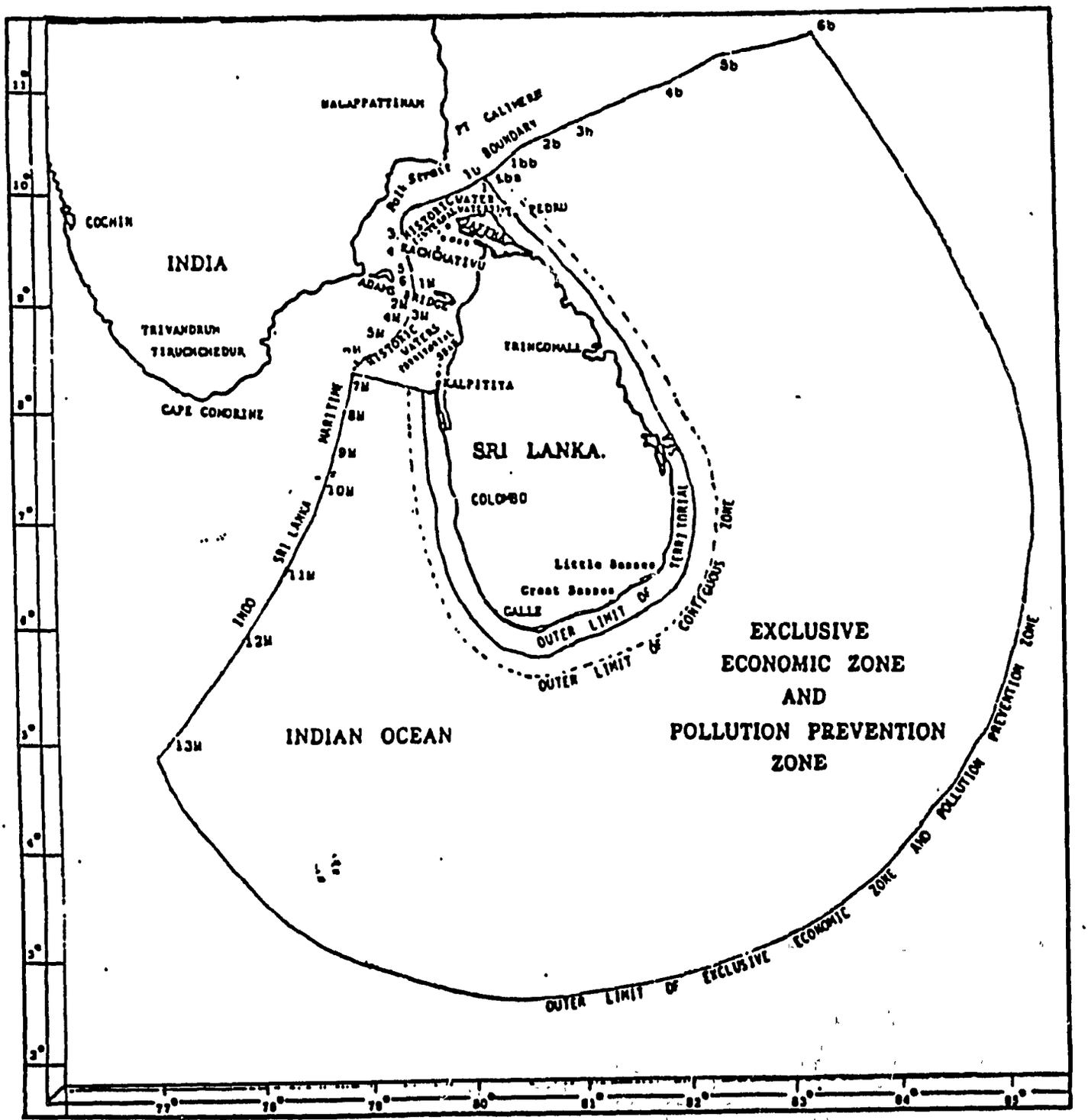
The island's varying surface relief is characterized by a centrally situated mountainous massif surrounded by a coastal plain of varying width (Figures 5 and 6). The Central Massif consists essentially of a main ridge running in a general north-south direction and a traverse ridge with a more or less east-west direction at the southern tip of the main ridge. The central mountain massif plays an important role in determining the climatic conditions of the island.

The combined application of these physical parameters permits the recognition of seven different agro-ecological zones into which the island could be divided (Figure 7 and Table 3). Further sub-division of these seven zones is possible using additional environmental criteria such as expectancy of rainfall/drought and other more specific edaphic and terrain characteristics. Another feature of considerable importance is the network of rivers which radiate from the Central Massif. Thus, it is not difficult to understand why Sri Lanka possesses such a great diversity of natural flora and fauna relative to its comparatively modest size (65,600 sq. kms. or 25,000 sq. miles).

3.0 Historical Perspectives

Conservation of plants and animals are age-old traditions in Sri Lanka that date back to about 300 B.C., the time Buddhism was first introduced into the country. At the same time, or slightly earlier, the foundations for a system of irrigated agriculture were also being laid down. The dry lowlands in the northern and eastern sectors of the country were the first areas that underwent changes in land use. A network of reservoirs and channels were built by the early Sri Lankan kings. These formed the base for a system of water distribution and associated land use that formed the basis for a "hydraulic civilization". Most parts of the lowland dry zone which were originally in forest, progressively gave way to crop production. However, these changes were gradual and the pattern that emerged was a stable one that was sustained without causing much damage to the island's biological resources and environment as a whole.

In this ancient pattern of agriculture, a large forest component formed an integral part of the system. Valley bottoms and the command areas of reservoirs were cultivated with paddy, while the highlands were used as homesteads and associated mixed gardens. The forest component was used on a small scale for shifting cultivation. This system of agriculture was both protective and sustained and stood the test of time.



Survey Department, Sri Lanka

Fig. 1 Territory of Sri Lanka (including maritime zones)

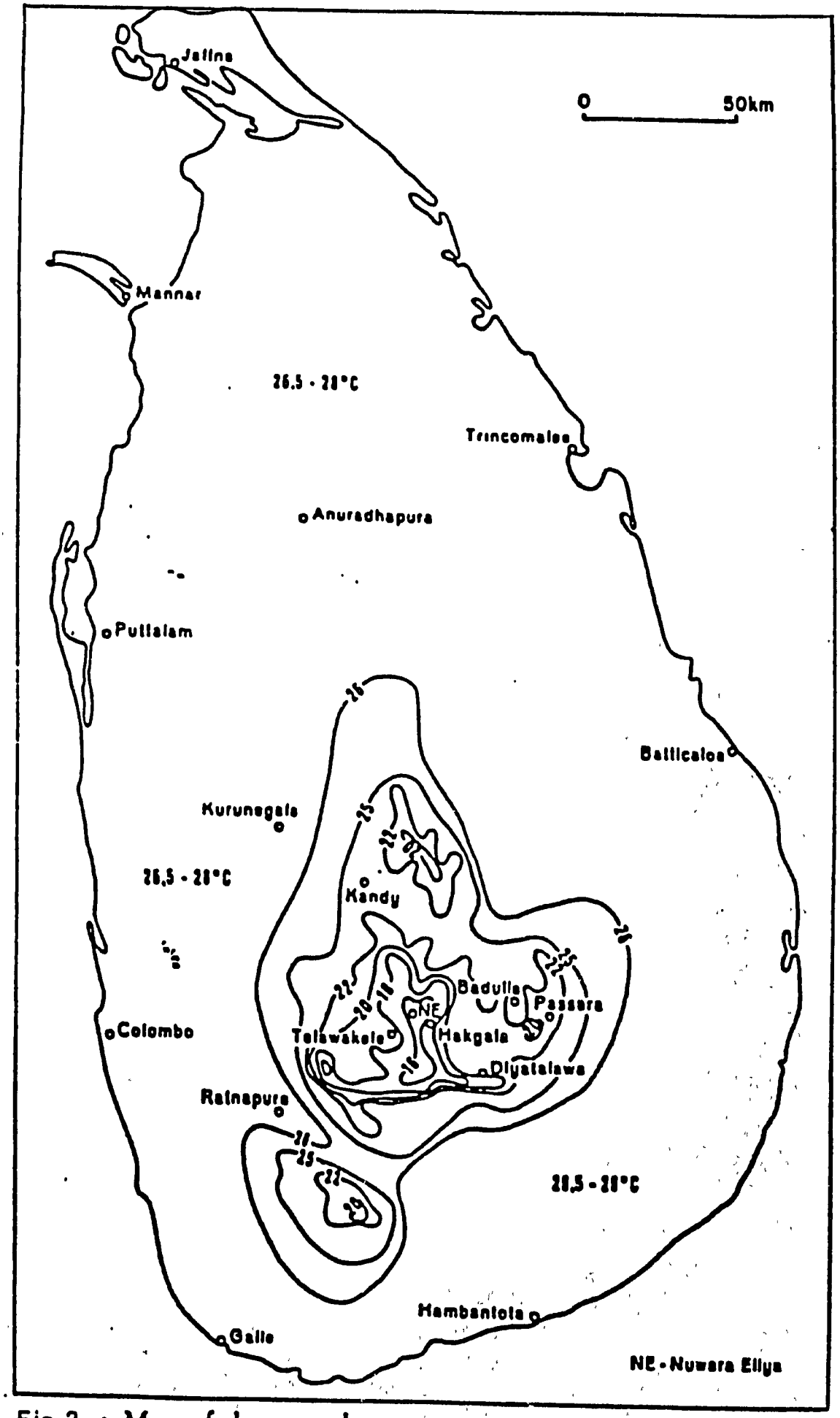


Fig. 2 : Map of the annual average temperatures in Ceylon, isotherms in

(after Domroes)

Table 1. Selected Indicators of Thermal Conditions in Sri Lanka

Meteorological Station (with altitude in m)	Avr. Annual Temperature (°c)	Mean monthly temperature range (°c)	Mean diurnal temp. range The month with the:	
			highest range	lowest range
Colombo (7)	26.9	1.8	8.2	4.4
Galle (12)	26.5	1.8	6.3	3.2
Ratnapura (34)	27.1	1.5	11.2	6.7
Hambantota (16)	27.1	2.0	7.1	5.2
Trincomalee (3)	28.0	4.3	8.4	2.8
Jaffna (4)	27.6	4.0	7.3	3.2
Anuradhapura (93)	27.2	4.0	11.2	7.6
Mannar (4)	27.8	3.5	7.6	4.1
Kandy (477)	24.3	2.9	11.7	6.2
Badulla (670)	23.2	3.2	12.2	6.6
Diyatalawa (1,248)	20.2	3.2	10.9	7.3
Nuwara Eliya (1,896)	15.4	2.4	13.8	5.4

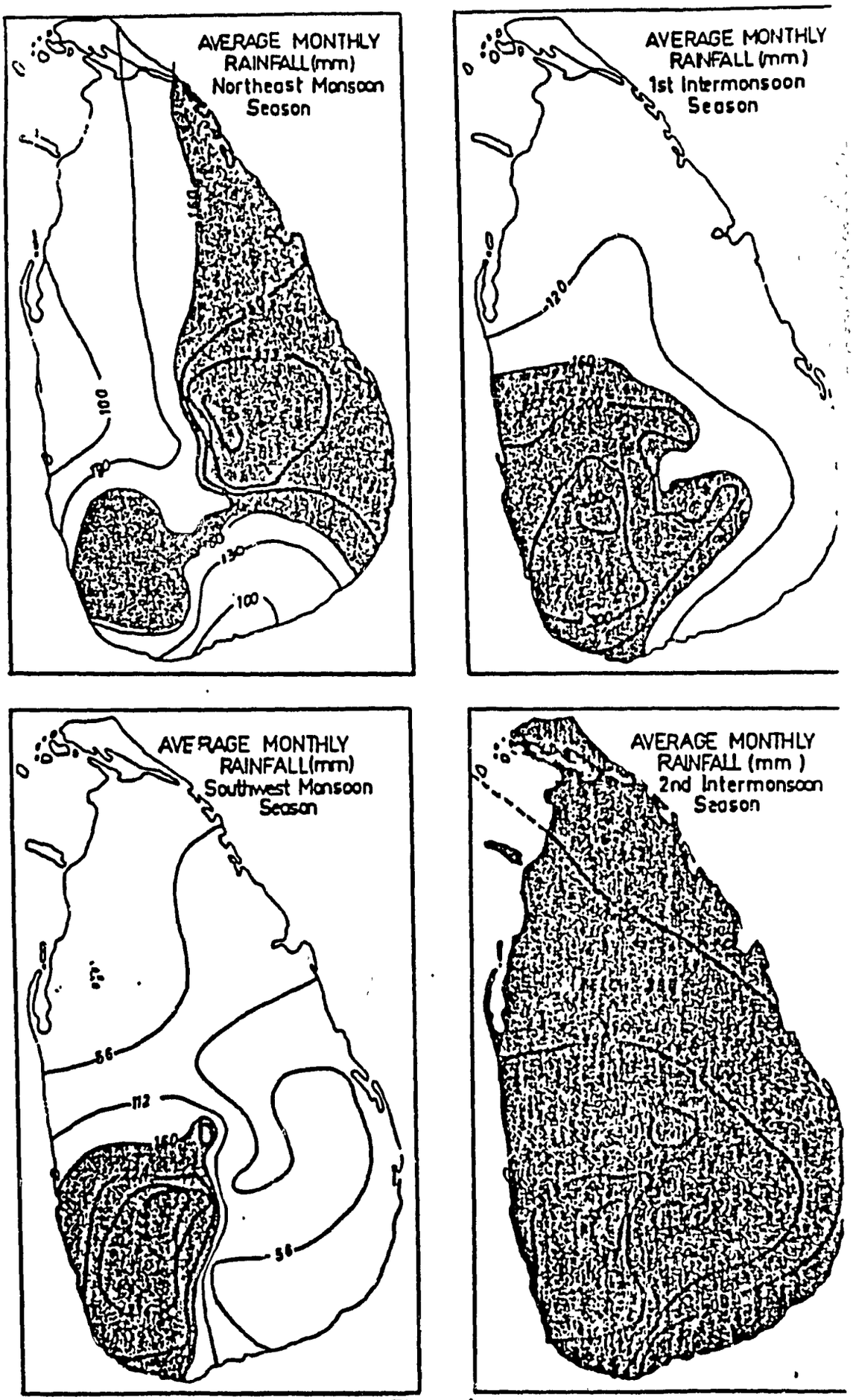


Figure 4

The shaded areas receive an average monthly rainfall of at least 160 mm

These maps are based on Seasonal Rainfall Distribution maps from Domroes,

Table 2

Seasonal Climatic Variations of Sri Lanka

Climatologists have thus identified 4 or 5 seasons into which the climatic year of Sri Lanka may be divided. The widely accepted among these seasonal divisions are as follows:

1. First Inter-Monsoon Period (March to mid-May)
2. Southwest Monsoon Period (mid-May to September)
3. Second Inter-Monsoon Period (October & November)
4. Northeast Monsoon Period (December to February)

1. Convectional-Convergence Period (March to mid-April)
2. Pre-Monsoon Period (mid-April to late May)
3. Southwest Monsoon Period (late May to September)
4. Convectional-Cyclonic Period (October & November)
5. Northeast Monsoon Period (December to February)

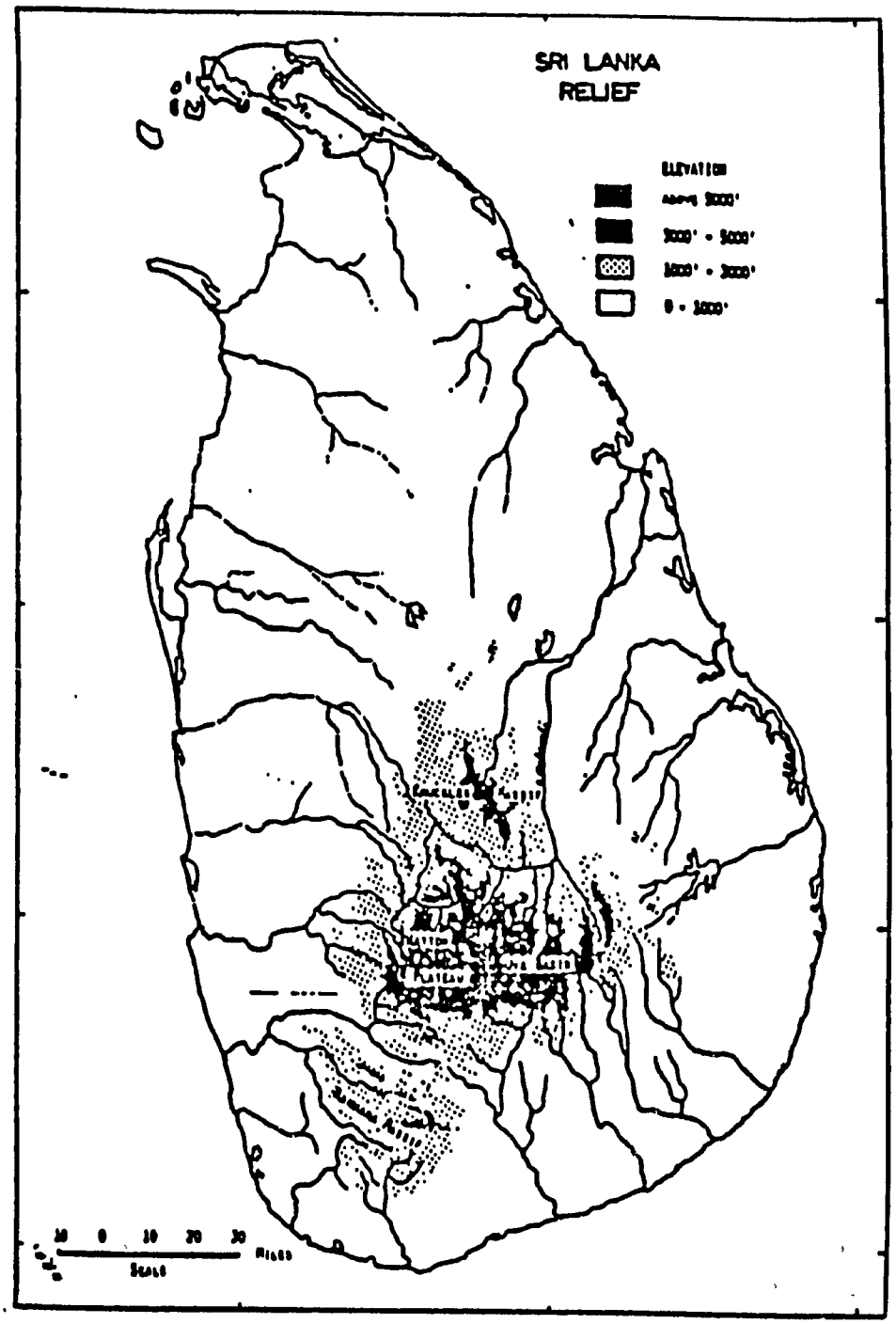


Figure 5

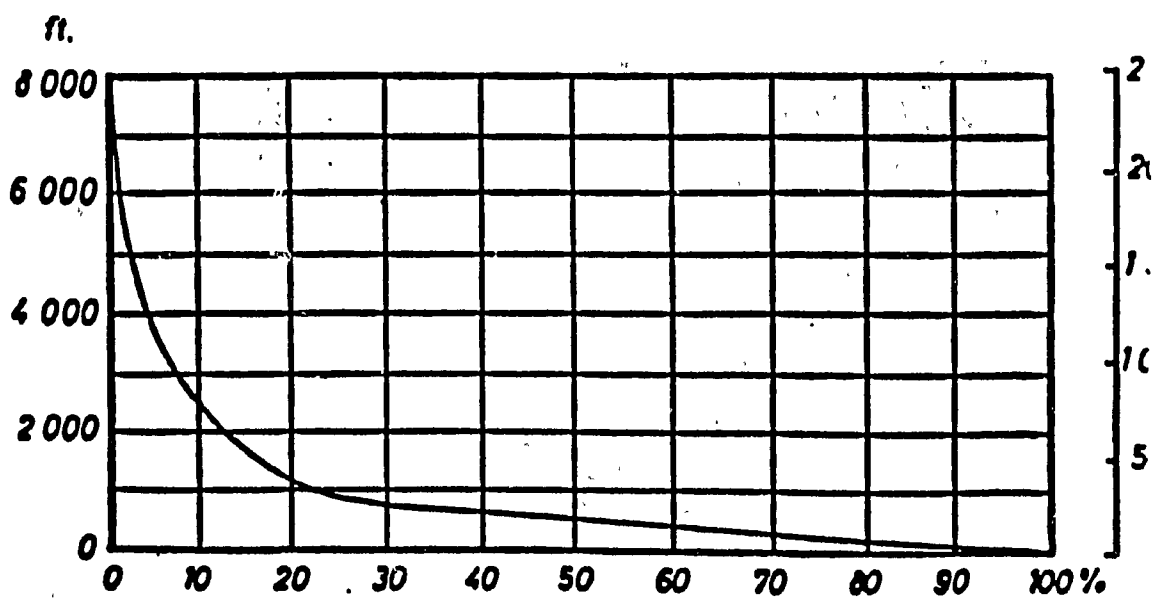


Fig. 6 Altimetric Frequency of Sri Lanka

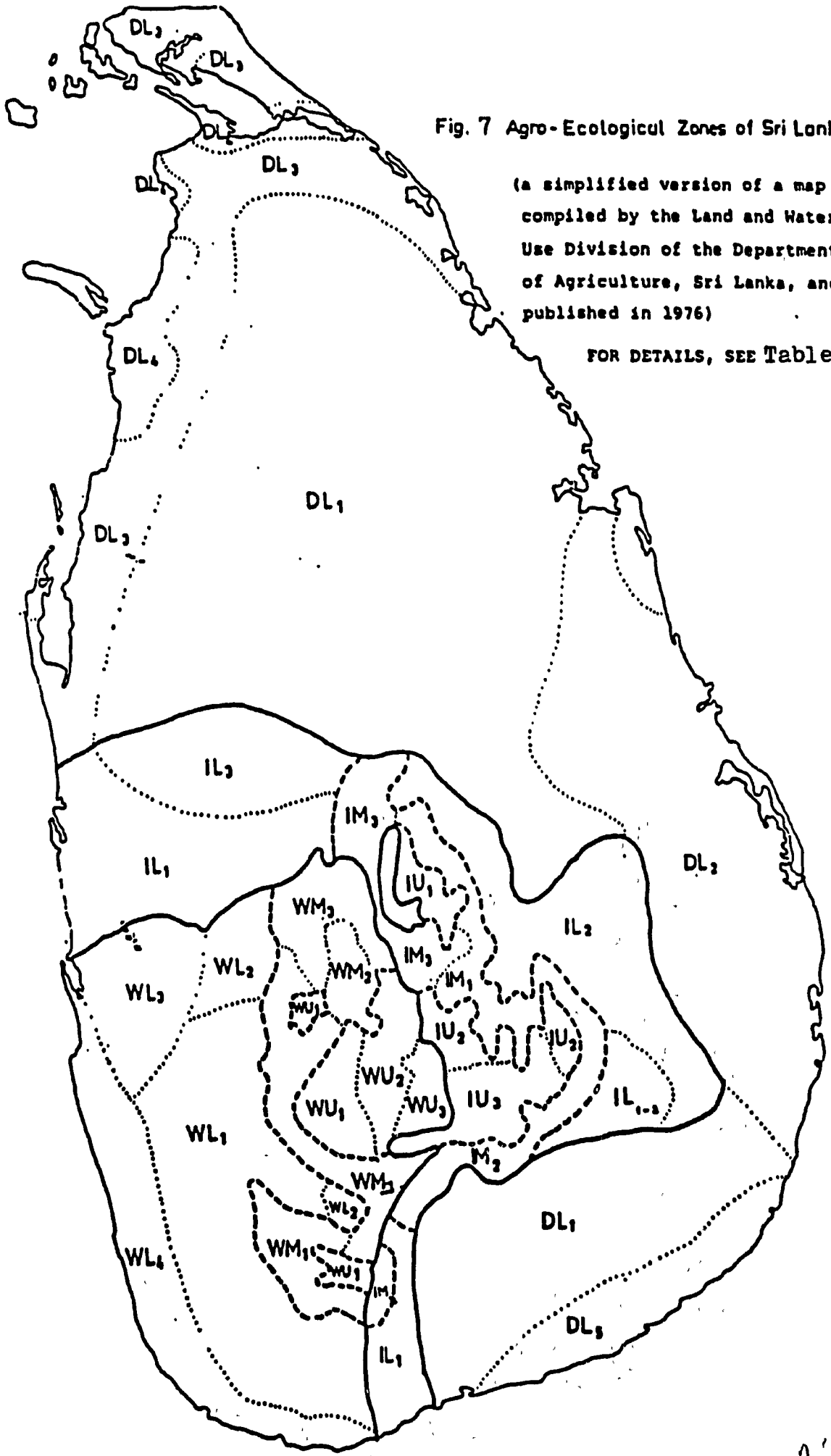


Fig. 7 Agro-Ecological Zones of Sri Lanka

(a simplified version of a map compiled by the Land and Water Use Division of the Department of Agriculture, Sri Lanka, and published in 1976)

FOR DETAILS, SEE Table 3

Table 3

Agro-Ecological Zones of Sri Lanka

INDEX TO FIGURE 7

	W WET ZONE	I INTERMEDIATE ZONE	D DRY ZONE
	75% expectancy value of annual rainfall (inches)		
L LOW COUNTRY	1. over 100	1. over 40	1. over 30
	2. " 75	2. " 45	2. " 35
	3. " 60	3. " 35	3. " 23
	4. "		4. "
			5. " 20
M MID-COUNTRY	1. over 125	1. over 55	
	2. " 55	2. " 45	
	3. " 50	3. " 35	
U UP COUNTRY	1. over 125	1. over 85	
	2. " 75	2. " 55	
	3. " 55	3. " 45	

This hydraulic civilization declined during the three hundred years from 1,200 - 1,500 A.D. due to calamities, malaria, invasions, or other reasons. The population thereafter began to shift from the dry lowlands to the central highlands and the southwest coastal areas.

The first major changes in land use patterns in the wet lowlands and hill country came after British conquest. The forests were cleared for the cultivation of coconut and rubber in the lowlands, and coffee in the uplands. Coffee was subsequently devastated by a fungal leaf disease and was replaced by tea. The introduction of tea to the hill country in 1869 virtually changed the economy of the island. Tea is today grown in Sri Lanka, practically from the coast in the south west up to the slopes of Piduruthalagala (2,250 m). In contrast to the earlier land use changes, the new patterns of plantation agriculture, namely that of tea, rubber and coconut, changed landscapes over large areas rapidly, and the impact on the environment therefore was marked. In the Hill Country, a century of tea planting has taken its toll on the forests and on the erodible slopes and has drastically changed the life styles and economic base of the people.

With tea as the predominant crop in the central highlands, a new enterprise in land use developed, namely the growing of European vegetables. The following years saw the cultivation of potatoes and of barley (for the breweries), dairy farming and afforestation programs using exotic species such as Pines and Eucalypts developed in the Central Highlands.

In 1873, the Colonial Government was warned against the indiscriminate felling of crown forests for the establishment of plantations and its serious impact on the climate (Hooker, 1873). Consequently, many years later, in 1938, the law prohibiting the clearing of forests above 1,500 m was enacted. Despite all these efforts, forest degradation continued and even as late as in the 1960's the lumber potential of the forests were fully explored.

By the time of Independence in 1948, the optimal potential lands in the central highlands and low country wet zone (south west sector) had already been completely utilized. The dry zone however remained vastly untapped, after having been abandoned in the 13th and 14th Centuries, as a result of the decline of the hydraulic civilization. The Government then began large-scale water resources development projects in the dry lowlands and a shift of populations was set in motion from the populated wet lowlands and hill country to the sparsely populated dry lowlands. The first of the major water resources activities was the Gal Oya Scheme in the Eastern Province.

The diversion of the Mahaweli Ganga, the island's largest water resource, to irrigate extensive lands in the dry zone is by far the most ambitious recent project. The project was initiated in 1970. The basic aim of the project is to maximize the agricultural

and hydro-power potential available in the Mahaweli Basin. The project will, when completed, have resulted in the resettlement of nearly a million persons, the generation of 500 mg. watts of power and the agricultural development of 200,000 hectares of land in the dry zone of Sri Lanka.

Sri Lanka's effort in the last decade or so to accelerate development as well as technological advances and social changes have brought about new and rapid changes to the environment. One of the principal causes of this has been the rapid growth of population. The population of the island has doubled in the last 25 years and is over 16 million today. Although the increase of population and changing social patterns of living have made it necessary for people to change the natural environment, such changes, without due regard to the protection and management of the environment, has led to the rapid degradation of natural resources and the island's environment as a whole. Forests have been cleared and stripped for shifting cultivation, village expansion and large scale water resources development; steep and vulnerable hills have been haphazardly cleared for annual crops; grazing lands have been overburdened while corals and mangroves have been exploited above the threshold depriving them of their capacity for renewal. In addition, uncontrolled urbanization and the spread of unplanned human habitations have led to the proliferation of high density suburbs and slum conditions. Waterways are being polluted by discharge of untreated raw sewerage, garbage and industrial effluents. A renewed effort with an awareness of the close relationship between development and environment is imperative for the long term sustenance of the natural resources of the country.

4.0 Legislative and Institutional Structure

From the golden era of Sri Lanka's great ancient kings, animals have always been accorded a special status deemed worthy of protection. This cultural tradition continues even to this day and is perhaps best manifested in the central role played by the elephant in the "perahera", the most important religious event on the island. In the island's past history, the earliest recorded nature conservation legislation goes back to the reign of King Kirti-Nissanka-Mala (12th Century A.D.). In one of his edicts, the King proclaimed that no animals should be killed within a radius of 7 gava (1 gava = 5.1 km.) from the city of Anuradhapura (Crusz 1973). In the more recent history of the island, the first modern day step towards conservation was taken in 1885 by the enactment of the Forest Ordinance. From then onwards, the conservation of the island's biological resources advanced amidst increasing population growth and pressures on these very same resources. The strong national commitment to conservation is also reflected in the sizeable number of governmental and non-governmental organizations associated with one or more aspects of resource conservation and/or management in Sri Lanka.

4.1 Host Country Government

4.1.1. Laws

In Sri Lanka, there are nearly 100 Statutes that deal with matters concerning the environment. Some of these Statutes date back nearly a century. However, most of these Statutes have only scattered provisions for natural resources management, pollution control or environmental planning.

The important Statutes that relate to the conservation and management of the biological resources in Sri Lanka are:

Chank Fisheries Act 1890/1956
Forest Ordinance 1907
Plant Protection Ordinance 1924
Land Development Ordinance 1935
Fauna and Flora Protection Ordinance 1937
Fisheries Ordinance 1940
Crown Lands Ordinance 1947
Felling of Trees Ordinance 1951
Ayurveda Act 31 of 1961
Agrarian Services Act 58 of 1978
Control of Pesticides Act 33 of 1980
National Environmental Act 49 of 1980
National Aquatic Resources, Research & Development Agency Act 54 of 1981.
Coast Conservation Act 57 of 1981
Marine Pollution Protection Act 59 of 1981
Natural Resources, Energy & Science Authority of Sri Lanka Act 78 of 1981.
National Wilderness Act of 1987

There are only a very few laws which, apart from the National Environmental Act of (1980) that are essentially environmental in character. Two of the more recent laws, the Coast Conservation Act and the Natural Resources Energy and Science Authority Act can be considered totally environmental in character. The majority of the other Statutes are not primarily on the subject of the environment, but merely touch on it. Legal measures adopted for environmental protection in Sri Lanka have been either of a preventive, regulatory or punitive nature. They have been enforced administratively as well as judicially. However, it was not until 1978, that the need to rationalize the functions of state agencies for an effective, coordinated and integrated system of environmental policies and management was recognized, resulting in the National Environmental Act. This Act deals with the environment in Sri Lanka in its totality and not on a fragmented basis. Its primary concern is the establishment of management policies and institutional arrangements for the environment.

The Government of Sri Lanka is interested and committed to the conservation and protection of the nation's biological resources and environment. This is best exemplified within the Constitution of the Country in Chapter 6 Article 27 (14) which makes the following provisions: "The State shall protect, preserve and improve the environment for the benefit of the community". Article 28 F of the same constitution goes on to mention: "The exercise and enjoyment of rights and freedom is inseparable from the performance of duties and obligations and accordingly, it is the duty of every person in Sri Lanka to protect nature and conserve its riches". Sri Lanka's policies on the environment have emerged from this commitment on the part of the State to maintain and improve the environment in order to enhance the quality of life.

The Statutes that have a direct impact on conservation and management of biological diversity and natural forests, are the Forest Ordinance, Fauna and Flora Protection Ordinance and the new National Wilderness Act. The Forest Ordinance has provision for the establishment of forest reserves and for the regulation and preservation of forests. However, unlike the Fauna and Flora Protection Ordinance, where different categories of reserves could be established, each being afforded different degrees of protection, in the Forest Ordinance only a single reserve category is recognized, namely the Forest Reserve. These Forest Reserves can be released for controlled timber exploitation by the order of the Conservator of Forests. There is, therefore, no legal mechanism to ensure the continued and complete preservation of plant species under the Forest Ordinance. To overcome this shortcoming, the National Wilderness Act was created in 1987. This new Act has provision for the declaration of forests as National Wilderness Areas, where no human disturbance, except entry for scientific purposes would be permitted. Under the Act, forests in steep watersheds; those having endemic plant and animal species such as the montane and lowland rainforests and those of historical and cultural value could be declared as National Wilderness Areas. It is expected that some of these national sites would eventually receive International World Heritage Status. The Forest Ordinance and National Wilderness Act are both administered by the Forest Department. The Fauna and Flora Protection Ordinance provides for the absolute protection of all fauna and flora within the National Reserves and Sanctuaries declared under the Act. This Act also provides for the protection of prescribed plants and animals outside reserves and lays out controls for the export of wild animals, birds, beasts and reptiles and wild products such as ivory. This Act is to be amended to provide for the creation of new categories of reserves such as buffer zone, refuges, wetlands and marine reserves and for the protection of certain rare species of fresh water fishes and for the overall enhancement of fines and other punitive measures for offences committed under the Act.

Three Statutes that pertain to land use and agriculture (the Crown Lands Ordinance, Land Development Ordinance and Soil Conservation Act) have scattered provisions relating to the protection and conservation of forest and other biological resources. The Crown Land Ordinance provides for framing of regulations for declaration of reservations for protection of public streams, tanks, reservoirs, canals and the foreshore. The Land Development Ordinance deals with, among other activities, the mapping out of state land for forest resources and for preservation of catchments and for other ecological purposes and also provides for framing regulations against the alienation of crown land above 1,500 meters. The Soil Conservation Act deals with regulations for the prohibition of the exploitation of forests and grasslands in the interest of conserving soil. However, these three Acts suffer in their implementation in that although provision exists, few or no regulations have been framed under them.

In respect to aquatic resources, the Chank Fisheries Act has provision for regulating the taking of Chanks, Beach-de-mer, corals and shells. Regulations have been framed only in respect to banning of coral mining and transport of coral under the Coast Conservation Act. The Marine Pollution Prevention Act concerns itself with the prevention, reduction and control of pollution in Sri Lanka waters and to give effect to international conventions for the prevention of pollution of the sea. The International Conventions are the Prevention of Pollution of the sea by oil, 1954; Civil Liability for Oil Pollution Damage, 1969; Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971; Intervention on the high seas in case of oil pollution casualties, 1969; and the Prevention of Pollution from Ships, 1973. The Fisheries Ordinance concerns, among other matters, the restriction of exploitation of live fish or the eggs, roe or spawn of specified species of fish through the prohibition of use of explosives or poison in fishing and through restriction of import of non-indigenous fish. Another important Statute dealing with aquatic resources is the National Aquatic Resources Research and Development Agency Act which provides for the creation of an Agency which is charged with the responsibility for promotion and conduct of research activities towards the management, development and conservation of aquatic resources in the inland waters, coastal wetlands and offshore areas. This Agency is mandated to coordinate all the activities of institutions engaged in the exploration, planning, research, development, control and management of aquatic resources. Another agency, the Coast Conservation Department created under the Coast Conservation Act is responsible for conducting coastal zone surveys, preparing a Coastal Zone Management Plan, regulating and controlling all development activities in the coastal zone and ensuring that Environmental Impact assessments are produced for all projects deemed to potentially have a significant impact on the coastal environment.

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In 1984, the Government made Environmental Impact Assessments (EIA) mandatory for all development projects. The Central Environmental Authority (CEA) was responsible for developing guidelines for EIA, providing training and procedures to carry out the EIA. The responsibility for approving development projects was subsequently delegated by the CEA to 15 Project Approving Agencies under different Ministries. Each of these approving agencies were expected to create their own environmental appraisal systems and to develop their own environmental capabilities for analyzing, examining and monitoring project development. However, of these 15 approving agencies only the Coast Conservation Department has provisions to compel the mandatory compliance with the EIA. The National Environment Act has no legal provisions to ensure compliance with environmental requirements which is a serious drawback to effective environmental management in Sri Lanka.

Although at first glance it appears that the island's natural forests and other biological resources are well protected by virtue of the above Statutes, in actual fact it is not so. Most of the laws relating to natural resource issues, especially those enacted prior to the last ten years are oriented towards exploitation of the resource rather than its sustainable use. Most of these laws are outdated and have not kept abreast of changing times. Some of the Acts have suffered in implementation for various reasons such as manpower and financial shortages and for social, economic and political reasons. Often laws remain fragmented and scattered among a multitude of different agencies and institutions.

4.1.2 Institutions

There are a multiplicity of Government institutions responsible for biological diversity and tropical forest issues and management of natural resources in the country. This arrangement has resulted in unplanned and uncoordinated efforts by each of the diverse institutions to handle resource conservation problems within their own compartments of authority. This apparent lack of coordination is in itself a factor responsible for the failure to evolve clear policies in dealing with the problem of biological and forest resource degradation. When several institutions are called upon to deal with a given problem under their respective Statutes, quite often there is divided responsibility and loyalty as well as lack of proper definition and direction.

In recognition of the pivotal role that natural resources and environment plays in sustainable national development, the Government created the Central Environmental Authority (CEA) in 1981 under the provisions of the National Environmental Act. This Authority which is located in the Ministry of Local Government and Housing was intended to be the apex of Governmental organizations connected with the environment and was expected to collaborate with, and coordinate the work of several Ministries involved with

the subject of environment. Among its functions, the Authority is therefore mandated to coordinate and formulate policy; carry out research, education and public awareness programs; play a pivotal role in the incorporation of environmental considerations into development planning; act as an information base for data on natural resources and the environment; and to encourage the creation of District based organizations for the protection of the environment. However, in practice, this Authority has largely served only in an advisory capacity. It has inadequate staff and technical personnel, little or no laboratory facilities and has a very small budget to work on, but its effectiveness has been largely hampered by its inability to influence the actions of agencies outside of its own Ministry.

Tropical forest issues come under the purview of both the Forest Department and the Department of Wildlife Conservation (DWLC). The Forest Department which is under the Ministry of Lands and Land Development is responsible for the protection of forests and forest plantations; the establishment of utility, firewood and protection forests; for the development of social and agro forestry; for watershed management; silvicultural research; forest education and training and extension. Although the department is responsible for implementation of the Forest Ordinance, there is no legally defined forest policy, although such a framework does exist in the way of a declaration, which recognizes the following objectives:

> to maintain, conserve and create forests for the preservation and amelioration of the environment, soil and water resources and for the protection of local fauna and flora when they are required for aesthetic, scientific, historical and socio-economic reasons.
>
> to ensure and increase, as far as it is possible, the supply of small wood and firewood for domestic and industrial consumption.
>
> to maintain, as far as possible a sustained yield of timber and other forest produce for general housing, communication and defense requirements.
>
> to work the forest to the highest possible economic advantage as is consistent with the above objectives.
>
> to involve the local community in development and conservation of forests.

The Forest Department is headed by a Conservator of Forests and supported by Deputy Conservator of Forests (7), Assistant Conservators of Forests (13) and a number of Foresters and Forest Rangers. The Department has a small research division which is headed by a Chief Research Officer and Research Officers (3). A major drawback faced by the Department is the inadequacy of staff to provide protection and to effect sound silvicultural management. In recent years, the Department has effectively

carried out a number of foreign funded projects which have helped in the upgrading of technical capabilities. The commercial exploitation of forest resources are carried out by the State Timber Corporation which is also under the Ministry of Lands and Land Development.

A forestry master plan for the development of the forestry sector of Sri Lanka has just been completed. However, this plan which seeks financial assistance for its implementation, has been the subject of much criticism. The criticism is based on the fact that it is biased to the exploitation of the timber and fuelwood resources of the forest with very little consideration to the other values of forestry such as its ecological, hydrological, social and aesthetic values.

The Department of Wildlife Conservation (DWLC) although a small institution controls around 40% of the natural forest area of the country (12% of the land extent of the country). This department which is under the Ministry of State derives its authority from the Fauna and Flora Protection Ordinance. The Department is responsible for implementing Government policy pertaining to the protection and preservation of the fauna and flora of the island. The Department maintains an array of protected areas and is responsible for protection of wildlife both in, and outside reserves. Although its other functions include research, promotion of public awareness and interest in wildlife, training and education, the Department has little or no in-house capabilities to conduct the above activities. It is poorly staffed, lacks adequate financial resources, vehicles and equipment. Encroachment and poaching are two major problems faced by the Department. The Department is headed by a Director and is supported by Deputy Directors (3 positions, only one of which is currently filled), Assistant Directors (5), Wardens, Rangers and Game Guards.

In the past, the DWLC has almost exclusively been geared towards law enforcement within the reserves. This is perhaps reflected in the staff allocations where senior and middle technical and management grades are inadequate . The organizational structure of the Department needs to be reorganized and strengthened at the senior and middle levels in order to gear it to meet the new demands of wildlife conservation. The Department should take a more active approach towards wildlife conservation, one that would strengthen planning and management, training and education, and research capabilities. Future conservation policy should be geared towards bringing benefits of conservation to people as well. An initial step has already been taken in this respect with the USAID funded Mahaweli Environment Project where assistance is being provided to the Ministry of State to develop its managerial, training and education and research capabilities. The project seeks to give a new meaning to wildlife conservation in Sri Lanka, a shift from the traditional concept of exclusive protection to one that recognizes the needs of people as well. This project is implemented by the Mahaweli Environment Project Office, a separate

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unit set up under the Ministry of State and draws on largely (particularly at the field level) from personnel from the DWLC. It is believed that with the termination of the project, the stage would be set to incorporate these two units (MEP and DWLC) into one consolidated functional institution that would now be able to cope up with the new demands placed on it.

National Zoological Gardens which manages the Zoological Garden at Dehiwela and an Elephant Orphanage and Rehabilitation Centre at Kegalle. The Zoological gardens features a worldwide selection of animals and runs an animal hospital to attend to the zoo animals, but directs very little effort to research and breeding. The Gardens has an exchange program with foreign zoological gardens. The Elephant Orphanage has around 25 elephants and has an active elephant breeding program which has had some success in recent years. There are proposals to shift part of the Zoological Gardens and Elephant Orphanage to Kandy.

The aquatic resources of the country come within the purview of the Ministry of Fisheries through its different agencies, except for those water resources that are located within reserves administered under the Fauna and Flora Protection Ordinance. The Department of Fisheries is responsible for development and protection of inland, marine and brackish water fisheries; research and extension and raising fish fingerlings and for stocking of inland water bodies; fisheries training and education. The Coast Conservation Department is mandated to protect the island's coast from sea erosion and other development activities. The Department is therefore responsible for planning and management of activities within the coastal zone and for conducting research in collaboration with other agencies for the purpose of coast conservation. The Department has a small staff, but has been carrying out a very effective coastal protection program and has received donor financial assistance for its development activities.

The National Aquatic Resources and Research Agency (NARA) is the main agency responsible for aquatic resources and oceanographic research. It has a mandate to undertake exploration of living and non-living resources in inland waters, in the 200 mile exclusive economic coastal zone and in the deep seas. One of its main objectives, among others, is the development, management and conservation of aquatic resources of the country. At present NARA has been chiefly concentrating on oceanographic research, including geological and geophysical offshore surveys; research on living marine biological resources and environmental studies related to industrial effluent discharges into aquatic systems.

The Department of Agriculture is responsible for the development of economic crops, other than tea, rubber, coconut, sugar and spice crops. The major activities of the Department are research, education and training, crop production, extension and publicity and production and certification of seed and planting material.

The Department has a Research Division at the Head Office, which is supported by Regional Research Stations in each of the nine major agro-ecological zones and a Central Rice Breeding Station at Batalagoda. In addition, there are 15 research stations and 24 adaptive research units. There is a close link between extension and research. The Department maintains three Botanic Gardens where there is both exotic and indigenous species of plants of interest. These Botanic Gardens have programs for ex-situ preservation of wild genetic material. In the plantation sector, the Coconut Research Institute, Tea Research Institute and Rubber Research Institute have their own research and breeding programs. The Department of Minor Export Crops is particularly involved in economic crops such as Cocoa, Coffee, Cinnamon, Pepper, Cloves, Nutmeg, Citronella and Papaya and is concerned with promotion of cultivation of these crops through research, training, extension and supply of planting material.

Other agencies involved in natural resource issues are the Natural Resources, Energy and Science Authority of Sri Lanka (NARESA) and the Institute of Fundamental Studies (IFS). NARESA was set up to coordinate scientific activity in Sri Lanka, and to advise the President on matters pertaining to the application of science and technology, to initiate and sponsor research and to study and report on matters of importance in science, technology, natural resources and energy. This Authority is presently concentrating largely on coordinating and supporting scientific research in the fields of natural resources, agriculture, health, etc. The Authority functions as the focal point for international activities in science and technology. The Authority has ten working Committees including those on Natural Resources, Biological Sciences, Agriculture and Animal Husbandry and Medical and Veterinary Sciences. The National Man and Biosphere Committee for Sri Lanka is located under this authority. This Committee coordinates research and studies under the program including botanical and zoological studies. The Institute of Fundamental Studies in mainly involved in research and in information dissemination pertaining to physical, biological and social sciences.

Most of the biological research in the country has been conducted by universities, particularly research within the tropical natural forests and other ecosystems. The lowland and montane rainforests have been the chief areas of research concentration by universities.

In recent times, the State has taken the initiative to safeguard the environment and its natural resources amidst its extensive development activities as is best illustrated in the Mahaweli Development Project where environmental considerations were incorporated into the development scenarios. The State has also made Environmental Impact Assessments mandatory for all development projects, although some difficulties still exist in ensuring compliance with this requirement. Central to these activities is the formulation of a National Conservation Strategy based on

guidelines of the World Conservation Strategy. The strategy which is being compiled by the Central Environmental Authority is nearing completion. It is expected that the Conservation Strategy will provide the means to integrate conservation issues into the development process. This is to be accomplished by incorporation of aspects of the strategy into the planning process from project identification, design and construction phases to the operational and monitoring phases.

4.2 Non-Governmental Organizations

Non-Governmental organizations have recently been playing an active role in mobilizing public opinion on matters of national environmental concern. They have, to a limited extent, been able to directly support some conservation programs mainly related to creating conservation awareness and tree planting. Their efforts, although small in magnitude, have had far reaching impacts. Most of these voluntary conservation-oriented non-governmental organizations have been registered with the Central Environmental Authority. These organizations have received much recognition for their untiring efforts and have now become an important force in Sri Lanka. Some of the more important voluntary organizations have now obtained representation on various National Committees such as the Fauna and Flora Advisory Committee, the Environmental Council of the Central Environmental Authority, and on a number of technical panels.

These voluntary organizations have canvassed much public opinion against state sponsored projects that have environmental concerns. In the 1970's these groups successfully canvassed against the destruction of the Sinharaja Rainforest - Sri Lanka's only extensive remnant of tropical rainforest. These groups are presently mobilizing public opinion against the proposed strip mining project at Elahera; the saltern project at Hambantota; the coal fired project at Trincomalee and the National Forestry Master Plan based on environmental issues.

The Wildlife and Nature Protection Society (WNPS) is Sri Lanka's oldest conservation-oriented voluntary organization. The Society was established in 1894 by individuals interested in hunting as a sport. Gradually the society evolved a new image and became a major force in mobilizing public concern on matters of national interest pertaining to conservation and protection of the island's biological resources. The present objectives of the Society are to ensure the perpetuity of wildlife and to preserve the island's natural conditions through negotiation and cooperation with the State and by promoting research, study and awareness programs. The Society sponsors lecture and study programs, undertakes conservation projects and produces a biannual wildlife journal called LORIS. The Society receives its financial resources from membership fees and sale of publications. The Society has a membership of about 4,000.

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MAHAWELI ENVIRONMENT – PROPOSED SYSTEM OF NATION PARKS UNDER PROJECT

Figure 8

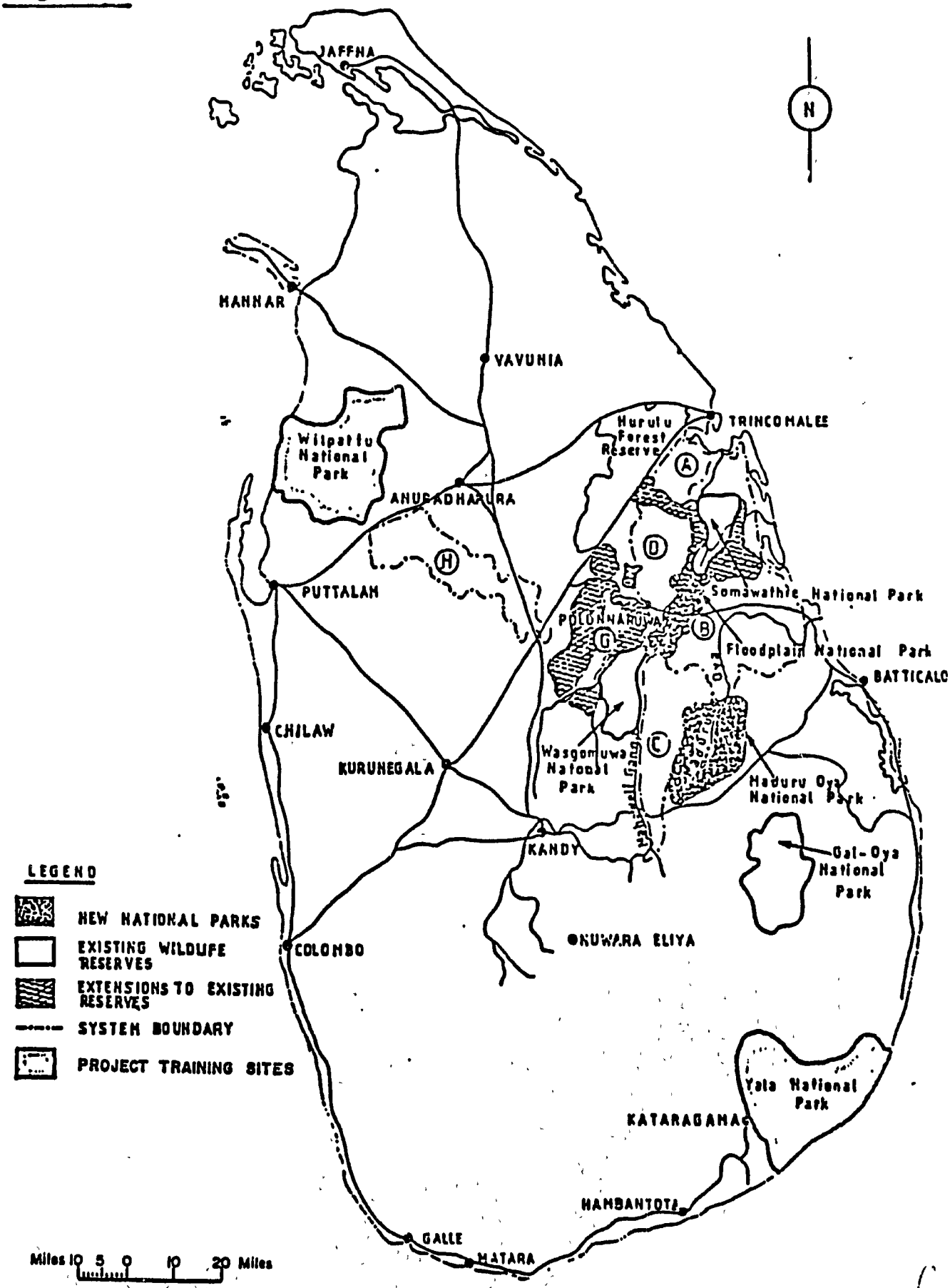
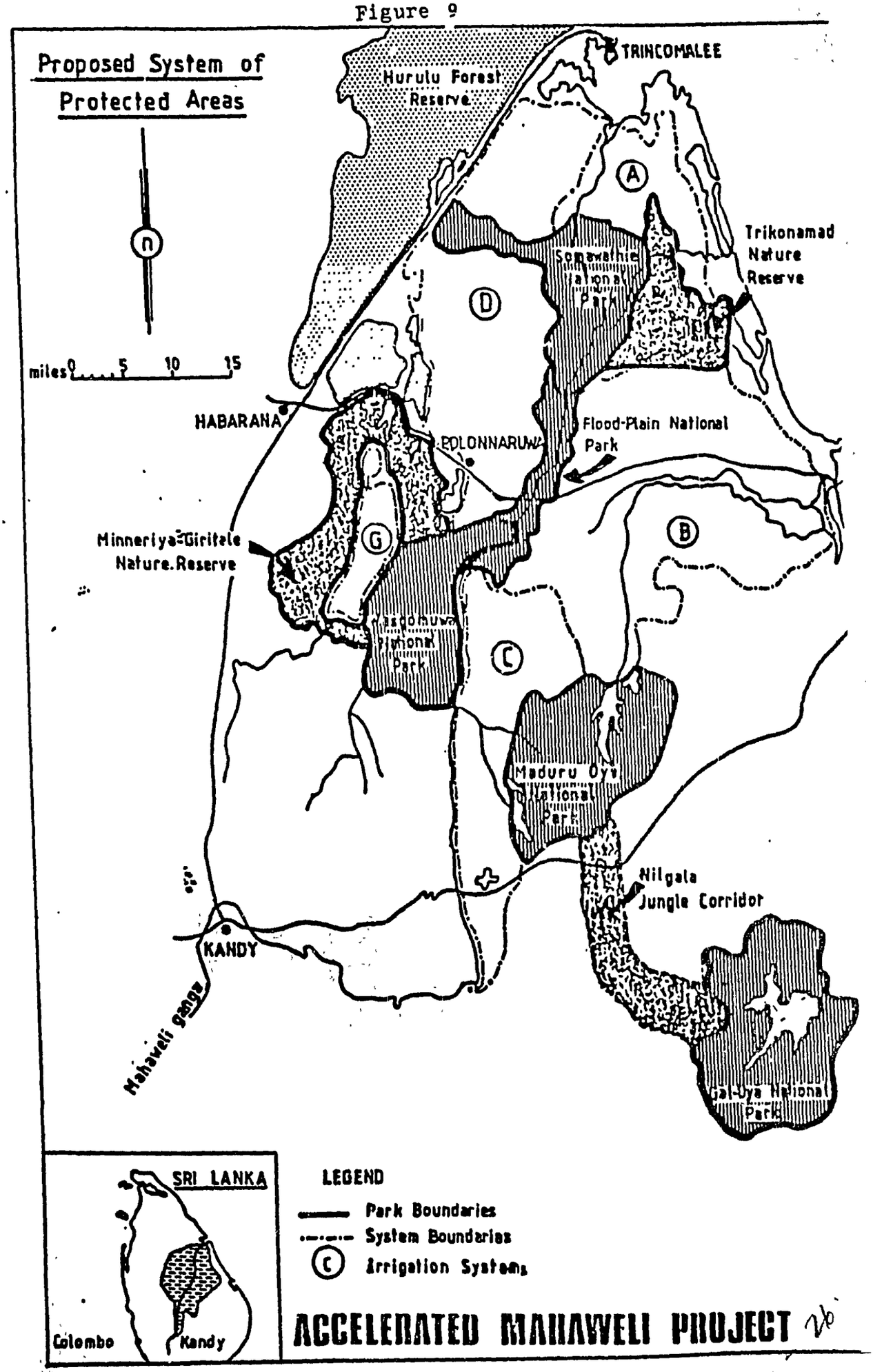
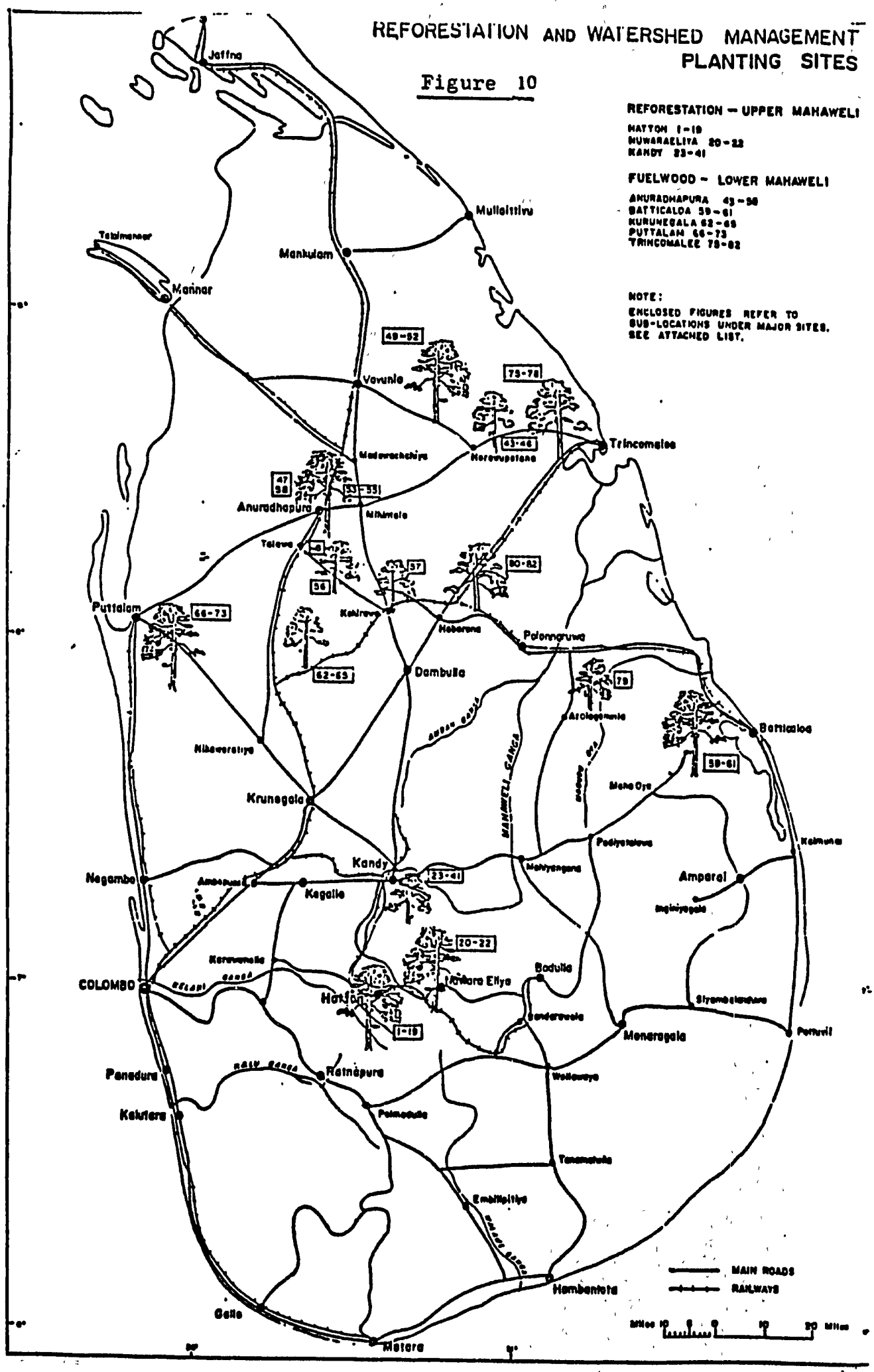


Figure 9


Proposed System of Protected Areas
miles 0 5 10 15
TRINCOMALEE
Hurulu Forest Reserve
A
Trikonamad Nature Reserve
Somawathie National Park
D
HABARANA
POLONNARUWA
Flood-Plain National Park
Minneriya-Giritale Nature Reserve
G
B
Wasgomuwa National Park
C
Maduru Oya National Park
Nilgala Jungle Corridor
KANDY
Mahaweli ganga
Gal-Oya National Park
SRI LANKA
Colombo
Kandy
LEGEND
Park Boundaries
System Boundaries
Irrigation Systems
ACCELERATED MAHAWELI PROJECT


REFORESTATION AND WATERSHED MANAGEMENT
PLANTING SITES
Figure 10
REFORESTATION — UPPER MAHAWELI
HATTON 1-19
NUWARAELIYA 20-22
KANDY 23-41
FUELWOOD - LOWER MAHAWELI
ANURADHAPURA 43-46
BATTICALOA 59-61
KURUNEGALA 62-69
PUTTALAM 66-73
TRINCOMALEE 75-82
NOTE:
ENCLOSED FIGURES REFER TO SUB-LOCATIONS UNDER MAJOR SITES. SEE ATTACHED LIST.
Jaffna
Mullaitivu
Mankulam
Mannar
Vavunia
Trincomalee
Anuradhapura
Puttalam
Dambulla
Polonnaruwa
Batticaloa
Kurunegala
Kandy
Negombo
Kegalle
Amparai
Badulla
COLOMBO
Hatton
Nuwara Eliya
Monaragala
Ratnapura
Panadura
Kalutara
Hambantota
Galle
Matara
MAIN ROADS
RAILWAYS
Miles 10 0 10 20 Miles

A newer conservation organization is March for Conservation (MfC). This organization was set up in 1980 and aims to focus attention on the rapid degradation of the island's natural resources through conservation education and training and research. This organization draws its strength from the fact that it is university based. Its membership of around 300 includes University teachers, researchers, undergraduates, students and nature enthusiasts. MfC is the only non-governmental organization that has a strong research capability. Members of MfC have been active in research in the lowland Sinharaja rainforest, in national parks and coastal zones, and in the Mahaweli River Basin Development area. The organization has also published literature and scientific papers on natural resources issues. MfC has also been instrumental in forming rural based conservation societies, particularly around the Sinharaja rainforest.

The Sri Lanka Association for the Advancement of Science (SLAAS) is a forum for scientists of all disciplines such as medicine, agriculture and forestry, natural sciences, engineering and social sciences. This organization has as its objectives the promotion and advancement of science, dissemination of scientific knowledge, provision of direction of scientific enquiry and promotion of contact between scientific workers.

A rural based organization involved in forestry activities is the Nation Builders Association (NBA). This organization, which is active mainly in the Kandy District, is largely composed of village youth. NBA has a strong leadership training component in its program of work. The Sri Lanka Environmental Foundation provides the legal teeth to the non-governmental environmental movement. This organization comprises a group of young lawyers who have a mandate to preserve and protect the country's natural resources from activities that damage it through legal action. This group has already taken a number of environmental issues to the law courts.

Other important voluntary conservation organizations are:

Tree Protection Society
Ceylon Bird Club
Soil Conservation Society
Young Explorers' Club
Young Zoologists' Association
Parisarikayo
Environment Brigade
Environmental Foundation
Sea Anglers' Club

In 1985, a number of these voluntary groups joined together under the umbrella of the Sri Lanka Environment Congress with the

intention of providing more force to the environment movement. The individual conservation organizations are largely composed of voluntary members, most of whom are constrained by the lack of time to devote to the conservation effort. This, coupled with the limited financial resources at the command of these organizations, has been a serious constraint. However, the dedication and commitment by these groups have been impressive and are reflected in the recent success in influencing environmental decisions in the country. The creation of the Environmental Congress has been a step in the right direction. The Congress is partly supported by the British based PANOS organization.

4.3 AID, Other Donor and International Organizations

4.3.1 USAID's Activities related to Natural Resource Management

Over the years, USAID has proven itself to be quite responsive to Sri Lankan resource conservation needs and interests. A variety of projects and lesser initiatives have been implemented and/or are currently underway which, when taken together, comprise a substantive contribution to conservation of tropical forests and biological diversity objectives in the island nation.

AID's two major and most directly applicable initiatives in this area, the Mahaweli Environment Project and the Reforestation and Watershed Management Projects, are both closely associated with the Government of Sri Lanka's Accelerated Mahaweli Development Program (AMP). In fact, both were largely designed to address various environmental implications of the AMP. The Environment Project was developed in response to wildlife impacts identified by the AID-funded TAMS Environmental Assessment of the overall AMP, requested by the government of Sri Lanka in response to donor community concerns regarding the potential significant negative environmental impacts associated with the massive proposed AMP initiative. Completed in 1980, the $1.0 million TAMS Assessment (and resultant Action Plan) represents one of the most ambitious and successful such assessments to date in the field of international development. The 5-year, $6.9 million, grant-funded project represents one of the first major efforts in conventional international development assistance to be based on environmental consideration. The project proposes reconciling development and wildlife conservation interests through a combination of parks development and strengthening the institutional capabilities of the GSL Department of Wildlife Conservation (DWLC). Under the project, four new national parks (Maduru Oya, Wasgomuwa, Somawathiya, and Flood Plain), comprising approximately 180,000 hectares total land area, will be established and developed with supporting infrastructure in and around the AMP area (Figures 8 and 9). Although ostensibly intended to mitigate agricultural development-related wildlife displacement in AMP areas by providing quality wildland habitat, it is expected that the project will also accomplish much towards strengthening wildlife planning and

management capabilities islandwide through its substantive DWLC institutional strengthening component and its concerted efforts at improved interinstitutional collaboration in resource monitoring and conservation awareness education/promotion with local University and private voluntary organization assistance.

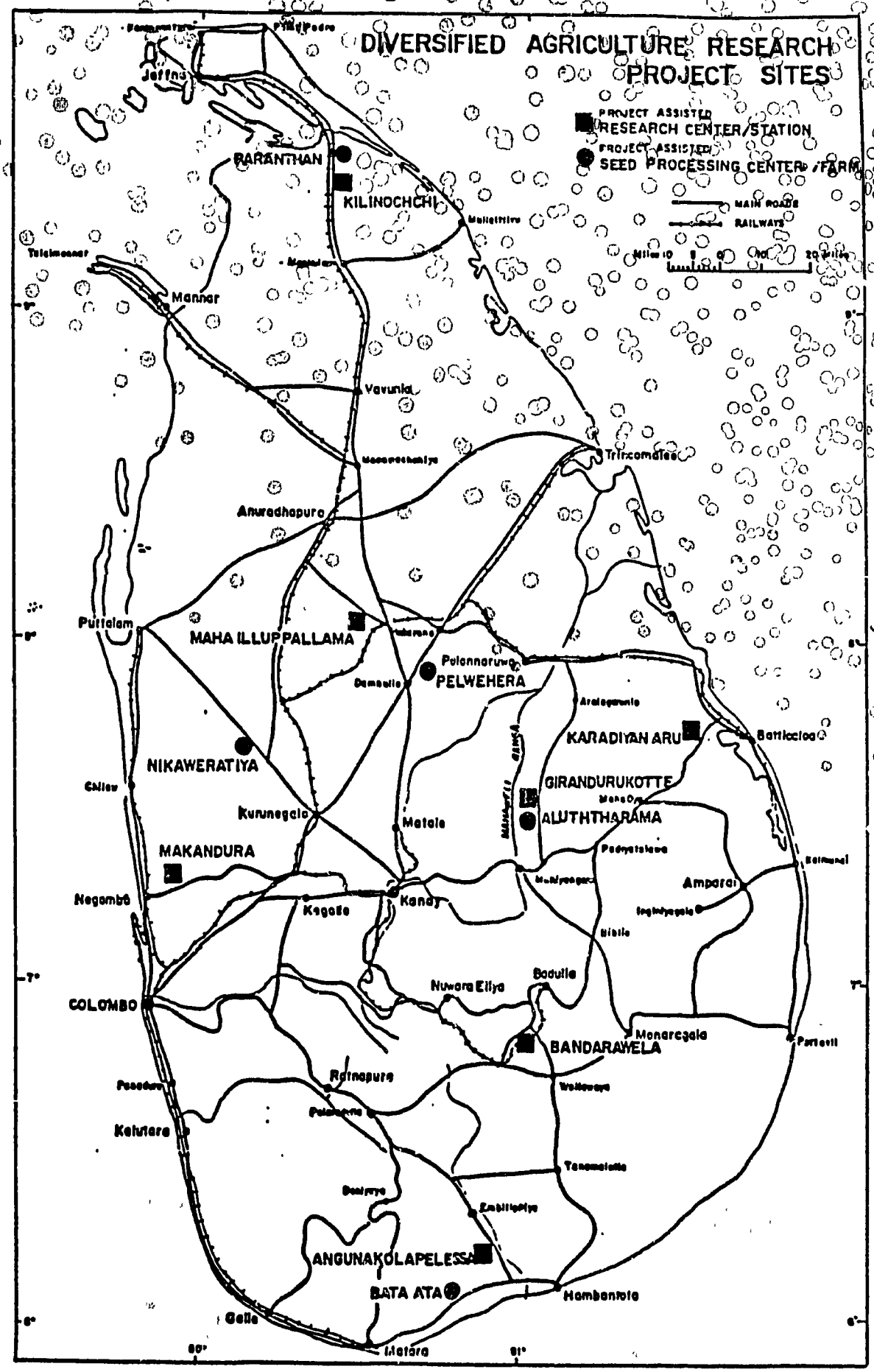
AID's other major resource management initiative in Sri Lanka, the Reforestation and Watershed Management Project, was started in 1980. The 8-year, $8.6 million, funded project proposes: (a) to conserve and stabilize watershed areas in the highland regions of Sri Lanka, and (b) to provide a natural renewable energy and commercial resource for Sri Lanka by strengthening the institutional capacity of the GSL Forest Department and undertaking selected reforestation activities. Project institutional development elements include: establishing fuelwood plantations on 25,000 acres of degraded "chena" lands, reforesting 24,000 acres of degraded tea lands in the Upper Mahaweli Catchment Area, and establishing village-run fuelwood plots in about 15 selected villages (Figure 10).

Other activities include construction of additional training support buildings, construction and establishment of seven divisional forest extension service field offices, and construction and establishment of two forestry field research laboratories, in addition to continued assistance in developing adequate manpower resources to fully staff these facilities, constructing and establishing two fire control centers and a radio network for enhanced reforestation management. The overall aim of the project is the establishment of a viable Forest Department in Sri Lanka while assisting in mitigating some of the adverse environmental effects of the AMP. As the Forest Department is also the key Governmental agency charged with the management and protection of the nation's tropical forests, institutional benefits accrued within AMP areas can ultimately be expected to have a significant positive impact in this important area of concern as well.

AID's ongoing program in Sri Lanka also includes a number of smaller-scale, yet equally important, environmental/natural resource management activities as well. Through a series of short-term consultancies, policy seminars and training workshops over the last five years, AID has been assisting in the establishment of the GSL's national environmental coordinating and policy-making body, the Central Environmental Authority (CEA). AID's initial work with the CEA resulted in an 8-point Action Plan for establishing the Authority's framework of operations. AID assisted the CEA in carrying out one of the Plan's priority recommendations; development and implementation of a practical mechanism for integrating environmental impact assessment procedures into the national development process.

More recently, AID has been assisting the CEA in development of a Sri Lanka National Conservation Strategy (NCS), modeled after

Figure 11


DIVERSIFIED AGRICULTURE RESEARCH PROJECT SITES
PROJECT ASSISTED RESEARCH CENTER/STATION
PROJECT ASSISTED SEED PROCESSING CENTER/FARM
MAIN ROADS
RAILWAYS
Miles 10 0 10 20 Miles
Jaffna
PARANTHAN
KILINOCHCHI
Mullaitivu
Talaimannar
Mannar
Vavunia
Trincomalee
Anuradhapura
Puttalam
MAHA ILLUPPALLAMA
Polonnaruwa
PELWEHERA
Batticaloa
KARADIYAN ARU
NIKAWERATIYA
GIRANDURUKOTTE
ALUTHTHARAMA
Kurunegala
Matale
MAKANDURA
Negombo
Kegalle
Kandy
Amparai
Badulla
Nuwara Eliya
COLOMBO
Monaragala
BANDARAWELA
Ratnapura
Kalutara
ANGUNAKOLAPELESSA
BATA ATA
Hambantota
Galle
Matara

IUCN's World Conservation Strategy. When completed in 1988, this document will provide the overall operational framework for future resource conservation/utilization in Sri Lanka. A great deal of the information contained in this analysis was obtained from various background papers done in support of the development of the Sri Lanka NCS. USAID is also providing a grant to Prof. Peter Ashton of Harvard University for the study of the floral biology of selected rainforest plant species. This work is being carried out by biologists from the University of Peradeniya.

An additional AID-assisted area in Sri Lanka is coastal resources management (CRM) - a critical development sector for the island state. For the past several years, AID has been assisting the GSL Coast Conservation Department (CCD) in identifying key national CRM issues and formulating an appropriate strategy for dealing with those issues (e.g., coastal erosion, sand replenishment, tourism development, wetlands management, etc.). This work has now culminated in a five-year, $448,000, grant-funded initiative to assist the CCD in the development and implementation of a comprehensive national Coastal Resources Management Plan. Completed in 1986, this Plan now serves as the basic national CRM policy/strategy document guiding future coastal zone development throughout Sri Lanka.

Within the agricultural sector, AID has assisted in several development projects which also contribute in some fashion to improved biological resource management in Sri Lanka. Past related efforts include the Rice Research and Agricultural Education Development Projects. The 5-year Rice Research Project provided $4.2 million in AID loan funds to assist the Agricultural Research Division of the Department of Agriculture to expand local technological capabilities for improved rice cultivation in Sri Lanka. This was to be accomplished through the establishment of an islandwide institutional network for improved rice research, including six regional/national research centers and associated commodities support, and technical assistance and training for research staff in such areas as germplasm collection, storage and evaluation, rice breeding and potential new cropping systems. The general success of this effort is largely documented through the significant local accomplishments in this area presented in Section 9 of this analysis. This critical importance of this work to international biological diversity interests, as well as the economic and social prosperity of Sri Lanka, cannot be overstated.

Another more indirect, yet equally fundamental, contribution in this area was USAID's recently completed Agricultural Education Development Project. Originally designed in 1978 to provide $6.0 million over a 5-year period, in 1982 this grant-funded project was amended to provide additional time (+3 years) and funds ($1,500,000) for the attainment of its important institutional development objectives of upgrading and expanding University and postgraduate level agricultural education in Sri Lanka. The

successful achievement of this project's educational strengthening goals will ultimately provide for better trained agricultural personnel and increasing the quality and quantity of local agricultural research, thereby furthering ongoing efforts in plant breeding and genetic conservation so crucial to a viable biological resource conservation program.

Two ongoing Agency agricultural project initiatives also merit recognition in this regard. The first of these, USAID's Diversified Agricultural Research Project, is providing $11.4 million over an 8-year period to strengthen the local institutional capability of the Department of Agriculture (DOA) to generate and effectively transfer technologies and inputs required to increase and sustain the production of subsidiary field crops in Sri Lanka. This will be accomplished through technical assistance and training in sound agroclimatological and farmer-relevant research techniques, and improved facilities and equipment for the existing DOA national research network (Figure 11). By focusing on subsidiary field crops, such as coarse grains, grain legumes and oil crops, the project will begin to redress the longstanding agricultural imbalance in favor of rice in Sri Lanka, thereby diversifying its agricultural base while simultaneously allowing for increased foodcrop production on unirrigated, "marginal" lands. This, in turn, will allow for a significant expansion in current efforts to collect, inventory, evaluate and conserve potentially valuable agricultural germplasm throughout the country in heretofore relatively neglected foodcrop areas. The final related USAID agricultural initiative, the Agricultural Planning and Analysis Project, is providing $6.6 million over a 6-year timeframe to develop an integrated national-level agricultural planning system which will provide a rational basis for future policy formulation and decision-making in Sri Lanka's agricultural sector. Based on USAID's prior assistance in the development of the nation's first comprehensive National Agriculture, Food and Nutrition Strategy, the project will provide technical assistance, training and limited commodities support for the establishment of a high-level, interministerial Agriculture Planning Group to augment the current limited Government national planning capability and overcome the institutional fragmentation and competition which severely hinders present efforts at integrated planning and rational resource allocation. In so doing, it will begin to address one of the most serious obstacles to improved resource conservation in Sri Lanka described above - lack of institutional coordination for integrated resource planning and management. Given proper emphasis, project-related resource conservation gains could prove substantial, especially when one considers that "planned" and unplanned agricultural development is probably the leading cause of natural habitat degradation and loss in Sri Lanka today.

The preceeding discussion amply serves to demonstrate USAID's substantial, continuing commitment to improved resource management and conservation in Sri Lanka. Indeed, given existing Agency resource constraints and program priorities, the sustained amount

and widespread nature of AID's assistance in this area is considered exemplary. Moreover, present Mission plans indicate that AID's leadership role in this important area of Sri Lankan development will continue into the future.

4.3.2 Other Donors

In addition to USAID, other donor groups and agencies have been active in promoting programs towards improved resource management and conservation in Sri Lanka. In this respect, donor assistance has been largely targetted towards forestry and to some extent to the agriculture and coastal sectors. With few exceptions, most of this assistance has been directed towards resource utilization activities, rather than resource conservation per se.

In the forestry sector, the World Bank with Finnish International Development Agency (FINNIDA) assistance supported the establishment of the Forest Resources Development Project in 1983. This project is aimed at enhancing the planning and management capacity in the forestry sector and includes the preparation of a National Forestry Master Plan for Sri Lanka, the expansion of technical and professional training facilities and the establishment of industrial plantations. With a view to provide the required number of professionally trained staff the project has supported the introduction of a two-year post graduate course in forestry leading up to an Master of Science degree at the University of Sri Jayawardenapura. The project is further supporting the Sri Lanka Forest College which is presently being constructed with financial support from USAID. The Forestry Master Plan which has now been concieved as a consequence of the project, has been the subject of much criticism, particularly from non-governmental conservation groups, who argue that it is biased towards timber and fuelwood exploitation while ignoring the other values of forestry such as watershed and aesthetic value, biological diversity, traditional uses etc. The government is currently seeking further donor assistance to implement the initial 5 years investment plan of the Master Plan program. The Food and Agricultural Organization (FAO) and United Nation's Development Program (UNDP) jointly supported a three year program which commenced in 1982 for "Forestry Inventory for Management Planning", the main purpose of which was to complete forest inventory work on selected natural and plantation forests in different climatic zones of the country. The results of this study formed the basis for the National Forestry Master Plan.

The Overseas Development Agency (ODA) of Britain is also becoming increasingly involved in assisting forestry and environmental programs in Sri Lanka, particularly in the Upper Mahaweli Catchment areas. ODA's interest stems from its involvement in the construction of the Victoria dam, which was the cornerstone of the Accelerated Mahaweli Development Program (AMP). ODA is providing assistance in a) new air photography, b) land use planning and

mapping and c) forestry. New air photography mapping, funded by ODA, was done for the Upper Mahaweli Catchment in the first quarter of 1987 and it is anticipated that this will be used in a land use planning and mapping project to be carried out with ODA assistance in 1988. Under the land use and mapping project a total of Pounds 100,000 in Capital Aid and Pounds 663,000 in recurrent expenditure is to be utilized over two years to provide thematic maps and to prescribe improved land use practices for the Victoria reservoir catchment and the whole of the Knuckles forest range.

The Forestry Project with ODA assistance of Pounds 2.54 million which is expected to run for 5 years (1988 - 1992) will include provisions for the improved management of existing forest plantations; the establishment of new plantations; support for a poverty-focussed social forestry program, socio-economic and technical research; and environmental studies. The project which will be located in the Upper Mahaweli catchment will be implemented through the Forest Department.

Other projects have indirectly tried to address the problem of rapid denudation of forest cover caused by commercial extraction, shifting cultivation and illegal fellings. The Asian Development Bank is supporting a Community Forestry Development Project in the five districts of Badulla, Nuwara Eliya, Kandy, Matale and Batticaloa where there is a general fuelwood scarcity. The project is designed to be completed in 6 years starting from the year 1982. The project costs are estimated at $13.67 million of which the foreign exchange cost is $5.1 million.

The balance $8.57 million equivalent is the local currency cost of the project. From the total cost of the project $10 million is provided by the Asian Development Bank on a loan and the balance $3.67 million equivalent is provided by the Sri Lanka government. Although the projects' main objective is to augment fuelwood supplies and thereby relieve pressures on the natural forests, it has as other objectives to increase the supply of poles and construction timber and edible fruits. The project is expected to act as a catalyst by creating community awareness and developing a permanent institutional capacity within the Forest Department.

The main components of the project are the establishment of farmers' woodlots on state land and village nurseries, community woodlots, demonstration woodlots, block fuelwood plantations and a community forestry research unit and Central Research Nursery. Donor agencies like the Netherlands, Finland, Norway, Sweden and the World Bank are further involved in the replanting of deforested and degraded lands as a component of the Integrated Rural Development Programs they are funding at district levels. From 1980, these programs have been introduced in the districts of Hambantota, Nuwara Eliya, Matara, Matale, Puttalam, Monaragala, Vavuniya, Mannar and Ratnapura.

The International Development Research Center (IDRC) is supporting a Bamboo and Rattan Research Project for a three year period with a grant for Canadian $77,370. The main intent of the project is to increase the production of bamboo and rattan species to supply the local industry in order to satisfy the demand of the population for low cost bamboo and rattan products. The project has as its components the taxonomic survey of local species of bamboo and rattan, identification of economic value of these species, development of propagation techniques, germ plasm collection, establishment of arboreta, phenological studies, information dissemination and training.

Direct donor support to preserve biological diversity in the country is exemplified by the efforts of the International Union for the Conservation of Nature and Natural Resources (IUCN) which is providing around $250,000 each for the conservation of the Sinharaja Man and Biosphere Rainforest Reserve and the proposed Knuckles Montane Rainforest Reserve. The Sinharaja reserve represents Sri Lanka's only remaining patch of tropical lowland rainforest and contains a high percentage (60-70%) of endemic plant species, while the montane rainforests of the Knuckles Range also have high plant endemism.

Both projects will include the preparation of management plans for the conservation of the respective forest reserves, boundary demarcation, resettlement of persons presently living within the reserves and awareness and education programs. Both these reserves are also important watershed areas. There is also some probability that similar programs may be extended to other biologically important forest areas in the future.

In the coastal sector, the Danish International Development Agency (DANIDA) has supported the formulation of a Master Plan for Coastal Erosion Management. DANIDA has provided further assistance for implementation of Stage I of the Master Plan Project which includes construction of physical erosion control measures in the coastline around Moratuwa and Negombo. DANIDA has further indicated financing Stage II of the Project ($17-20 million) for work in the West and South-West Coasts. Preliminary agreement has also been reached with the West German government for technical assistance for Coastal Erosion Management in the South Coast particularly for conducting Morphological Studies and strengthening local institutional capability.

Donor support has also been forth coming for a number of other projects which are either directly or indirectly related to conservation of the biological resources of the country. The Swiss have supported the establishment of a Center for Remote Sensing at the Survey Department. This center is presently developing land use maps on a district level, monitoring forest cover changes

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and have assisted in the mapping of coastal habitats and resources, all of which have become useful for future planning and management purpose. These maps have been used by a number of agencies in their remote sensing activities related among other things to resource conservation.

The Canadian International Development Agency (CIDA) has plans to support a Catchment Rehabilitation Program in the Kotmale Reservoir catchment under the Mahaweli development project. The project, expected to be funded to the value of Canadian $12 million, will support the protection of valuable montane forests and promote the growing of medicinal plants. The Overseas Development Mission of Britain is also active in the Mahaweli basin, and has supported the thematic mapping of the river catchment. The Swedish International Development Agency (SIDA) is providing some funds for research to the Natural Resources Energy and Science Authority of Sri Lanka (NARESA), part of which goes for study of the biology and reproduction of selected plant species in the Sinharaja rainforest. The UNESCO-Man and Biosphere Program is active also supporting research in the Sinharaja MAB reserve and in the zoological survey project for Sri Lanka. The Smithsonian Institution of Washington has in the past supported the Botanical Survey Project for Sri Lanka, which has been instrumental in the revision of the Handbook to the Flora of Sri Lanka.

5.0 Biological Resources

The island has a varied composition of fauna and flora, a rich diversity and high biological productivity. The biological resources, will be discussed in the subsequent section of this report under the headings; Forest Resources, Agricultural Crop and Livestock Resources, Wildlife Resources, Coastal and Marine Resources and Wetland Resources.

5.1 Forest Resources

As might be expected, the distribution of the many different natural forest types in Sri Lanka is largely governed by the specific local combination of the location, climate and topographical factors noted above. Thus the natural forests have been variously classified by different authors from time to time. Gunatilleke and Gunatilleke, 1986 (unpublished) classify the forests into four main groups:

i. Low Country Wet Zone Forests (below 1,000 m) - Tropical Wet Evergreen Forests)

ii. Montane Zone Forests (above 1,000 m) - (Tropical Lower and Upper Montane Forests).

iii. Intermediate Zone Forests - (Tropical Moist/Wet Semi Evergreen Forests).

iv. Dry Zone Forests - (Tropical Dry Mixed Evergreen Forests).

To this classification may also be added the mangrove forests of the coastal and near coastal parts of the island which are a natural vegetation type dominated by trees whose distribution is largely dependent on soil and edaphic conditions.

The indigenous flora number over 3300 flowering plants, comprising 25% which are endemic, 65% with affinities to the Indian flora and 5% having Malaysian, African or Australian affinities (Abeywickrama, 1956). Among the lower plant forms, liverworts and mosses include 190 and 575 species respectively (Abeywickrama & Jansen, 1978), Pteridophytes 324 species (Abeywickrama, 1978) and only a single indigenous species of Gymnosperms.

Of the over 3,000 species of flowering plants found in Sri Lanka, 24% are endemic to this country (i.e., only found in this country) (Peiris, 1975). If the geographical distribution of these endemic plants is examined, it is found that 92% of these species inhabit the low-country wet zone and montane zone forests while a mere 8% are confined to the intermediate and dry zone forests of the island (Table 4). Table 5 illustrates the relatively high proportion of endemic species composition within these forests. Thus, from a biological diversity perspective, it would appear that the island's most valuable forests are those of the low-country wet and montane zones of the country. Although prevalence of endemic species alone does not necessarily indicate the overall biological importance of an area, it is one of the more useful available measures in this regard. Additional evidence in support of the relative biological importance of these regions of the country is provided in Table 6, where botanists rate the relative floral richness of Sri Lankan wet zone forests as "high" as compared with a "low" rating for the nation's dry zone forests. Additional information regarding the most important of these wet zone forests, the Sinharaja and Peak Wilderness Forest Reserves, is provided in Annex 1. These data indicate that the nation's low country wet zone and montane zone forests are important not only for their relative great biological diversity but also for their relatively large number of endemic species, many of which are rare and/or of proven medicinal or commercial value

In structure, species composition and complexity, the forests of different climatic zones are found to be quite distinct. The low country wet zone depict the tallest tree stands, with the largest number of tree species and the greatest complexity. Unfortunately these forests are amongst the most fragile and least resilient systems in nature, possibly because they have evolved slowly over a

Climatic Zone / Life Form Group	Montane only	Common to Montane and Moist Low Country	Moist Low Country only	Common to Moist Low Country and Dry	Dry only	Common to Dry & Inter-mediate	Inter-mediate only	Total in Each Life Form Group
Trees	72	46	156	15	9	6	2	306
Shrubs	84	32	82	15	13	3	1	230
Herbs	128	51	88	9	12	4	2	294
Total in each Zone	284	129	326	39	34	13	5	830

Table 4. Number of Endemic Species of Trees, Shrubs and Herbs in Different Forest Types of Sri Lanka (Peeris, 1975).

Natural forests of each zone, locations & extent of areas sampled / Contribution of endemic species to:	Montane zone Hakgala 1.9 ha	Low country wet zone Sinharaja 25 ha Gilimale 5 ha Kottawa 4 ha Kanneliya 5 ha Hiniduma 5 ha	Intermediate zone Daragoda 2.5 ha Barigoda 2.5 ha	Dry zone Ritigala 2.5 ha
Floristic composition i.e. Proportion of species endemic in samples studied	44	66	17	13
Density i.e. Proportion of individuals of endemic species in samples studied	50	75	11	10
Basal area i.e. Proportion of wood from endemic species in samples studied	51	80	15	8

Table 5. Contribution of endemic species to floristic composition, density and basal area of each forest type in Sri Lanka. (Numbers given denote percentages. Data from Peeris, 1975; Gunatilleke & Gunatilleke, 1984a; Gunatilleke & Gunatilleke, 1984b; Wijesundara; personal communication).

Table 6 : Biological Importance of Indo-Malayan Biounits

Unit	Name	Plant		Mammals		Birds	
		spp.	%end.	spp.	%end.	spp.	%end.
Indian Sub-region							
1.	Western Ghats	high	high	32	12	57	9
2.	Ceylon Wet Zone	high	v. high	20	10	39	15
3.	Bengal	high	mod.	55	2	112	1
8.	North India	mod.	low	42	–	66	–
11.	Eastern Ghats	mod.	mod.	19	–	52	–
12.	Coromandel	mod.	low	28	–	33	–
13.	Ceylon Dry Zone	low	low	20	10	41	3
14.	Deccan Plateau	mod.	low	28	–	47	4
15.	Thar/Indus	low	low	26	–	64	5
H.	S. Himalayas	mod.	v. high	48	–	124	6
Indo-Chinese Sub-region							
4.	Burmese Coast	mod.	low	50	2	89	–
5.	S. Indochina	mod.	high	59	–	113	–
6.	S. China	low	mod.	35	10	95	1
9.	Irrawaddy	high	mod.	55	2	144	3
10.	Indochina	high	mod.	65	2	152	3
20.	Andamans	mod.	c.10%	–	*	29	10
27.	Taiwan	mod.	25%	18	16	44	5
Sundaic Sub-region							
7.	Malay Peninsula	820	15	208	3	480	1
21.	Sumatra/Nicobars	820	11	221	12	466	2
22.	Java/Bali	630	5	133	12	362	7
25.	Borneo/Palawan	900	34	221	19	440	10
Wallacean Sub-region							
23.	Lesser Sundas	510	1	41	12	242	30
24.	Sulawesi/Sula	530	7	114	60	268	32
26.	Philippines	700	27	127	66	367	39

The table presents data on the relative richness and levels of endemism among plants, mammals and birds in the respective biogeographic divisions of the realm. The figures above the line (Indian and Indo-Chinese sub-regions) are not directly comparable to those below it (Sundaic and Wallacean sub-regions) which are calculated in a different way. Above the line, information on plants is only qualitative, data on mammals is based on selected groups (primates, ungulates and carnivores) and for birds is based on selected groups only (21 passerine families). Below the line, plant data are based on the total flora within all 118 families that have been revised in the Flora Malesiana, mammal data is for all mammal species and bird data is for all resident bird species.

**Andamans lack any native mammals in the selected groups but do have high endemism in the rather impoverished mammalian fauna.*

very long period of time. With time, their component species have optimally exploited the environment while allowing many others to live alongside them. In this way the maximum diversity of species have been achieved in these ecosystems. Consequently, if these ecosystems are disturbed, the diversity and stability of the components are affected, sometimes irreversibly.

The climax forests of the dry zone are however of secondary origin, having developed only during the past 500 - 800 years (de Rosayro, 1961), after the abandonment of ancient irrigation systems that were prevalent in the country prior to that period. In contrast, the climax forests of the wet zone are truly primeval, with a long ancestry that may be traced back to the Deccan flora, when a vast unbroken stretch of forest covered both peninsular India and Sri Lanka. It may be therefore stated that from a biological standpoint, the island's most valuable forests are those of the wet zone and among them are the low country wet zone forests and the Hill Country montane forests.

Each of the major forest types in the country can be sub-divided into several sub-types. The major sub-types are:

Low Country Wet Zone (after de Rosayro, 1942)

1. *Dipterocarpus* community in the coastal plain and lower slopes arising from it, hardly ever extending above 800 m eg., Kottawa, Beraliya, parts of Sinharaja.

2. *Mesua - Doona* community between elevations of 500 - 1,000 m. eg. Kanneliya - Dediyagala - Nakiyadeniya; Sinharaja.

3. *Campnosperma* and other species community on the lower slopes of the southern flanks of Adams Peak range confined to the steep slopes leading up to the second plateau and the plateau itself best represented in Bambarabotuwa.

4. *Vitex - Wormia - Chaetocarpus - Anisophyllus (Dillenia)* community showing a distributional range as the *Dipterocarpus* community.

Dry Zone Forests (after Koelmeyer, 1957)

1. The *Manilkara* community in the moisture regions of the arid zone along a narrow coastal belt.

2. The mixed community widely distributed in the dry zone.

3. *Alseodaphne - Berrya - Diospyros* association along streams and moisture conditions in the dry zone.

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Intermediate Zone Forests (after Koelmeyer, 1957)

1. The Kurunegala group of forests (Artocarpus - Vitex - Filicium - Pterospermum - Nephelium community (after de Rosayro, 1950).

2. The Moneragala group of forests (similar to above but with a better representation of dry zone species such as Chloroxylon and Chukrasia (after de Rosayro, 1950).

These forests have virtually disappeared and except for degraded patches as seen at Barigoda near Kurunegala and Daragoda near Moneragala, representative samples can hardly be found.

Montane Zone Forests

Forests of the montane zone may be sub-divided into those of the lower montane zone where the elevational range extends between 1,000 - 1,500 m, and upper montane zone above 1,500 m elevation.

The forest communities that have been recognized in these regions are the following:

1. Doona (Shorea) - Calophyllum - Syzygium series (after Gaussen et al, 1968). Examples of these forests are seen along the Maratenne - Bogawantalawa road; above Hapugastenne group in Ratnapura District and adjoining Morey and Fairlawn Groups near Maskeliya in Kandy District.

2. Myristica - Cullenia - Aglaia - Litsea zone (after Greller and Balasubramaniam, 1980), eg. forests of the Knuckles range and Madugoda.

Upper Montane Zone Forests

1. Syzygium - Gordonia - Michelia - Eleocarpus series (after Gaussen et-al, 1968) eg. Forests in Horton Plain and Hakgala Strict Natural Reserve.

2. Stemonoporus zone (after Greller and Balasubramaniam, 1980). eg. Forests adjoining Gartmore group, Morey group and Kotiyagala group in Kandy District.

Mangrove Forests

Apart from preliminary descriptive studies of the vegetation and species found in them detailed ecological studies have not been carried out in these Mangrove Forests. However, on a very broad basis, they may be classified as mangrove forests of the wet zone and those of the dry zone. The mangroves are worthy of attention, though of less floristic diversity. The mangroves are best represented around Trincomalee, and around the Negombo and Batticaloa lagoons.

Forest Degradation

The major causes of forest degradation in Sri Lanka all stem from one or more forms of human activity. These causes are:

- Settled agriculture and shifting cultivation
- Introduction of Plantation Crops
- Expansion of Urban Areas
- Selective logging
- Reservoir and hydropower projects
- Mining for Precious Stones.

The cumulative result of these various impacts is that Sri Lanka's forests are decreasing at an alarming rate. In 1956, the total national forested area was estimated at 2.9 million hectares or 44% of the total land area (Andrews, 1961). Corresponding estimates for 1980 are 1.6 million hectares or 24% of the total land area, respectively. Thus, over the past 25 years, Sri Lanka has lost nearly 1.3 million hectares, or nearly half, of its total forested area, at a rate of some 52,000 hectares per year. These trends are presented in tabular form on a wet zone/dry zone regional basis in Tables 7 and 8, and illustrated in Figures 12 and 13.

The most recent estimate of the extent of natural forests in Sri Lanka is 24.9% of the total land area (based upon Figure 13). Table 9 provides an approximate breakdown of this total amount into the four major natural forest types listed above (Gunatilleke and Gunatilleke, ibid). These figures clearly illustrate that the nation's most biologically valuable forests (low-country wet zone forests) comprise only a very small proportion (1.45%) of the nation's total forested lands. Moreover, it should be noted that much of this remaining forest area has been degraded or otherwise disturbed as illustrated in Figure 14. Thus, it is estimated that at present a maximum of one percent of the nation's total area consists of natural undisturbed low-country wet zone forests, much of which is fragmented into many smaller areas. The need for appropriate forest conservation measures, therefore, is most critical if any of this valuable resource is to be safeguarded for future research and productive use.

In addition to forests, the island has a great variety of other natural vegetation types including grasslands and wetlands, the latter consisting of freshwater and coastal types. Natural grasslands vary much in character according to edaphic and hydrological conditions and include Montane, Savannah, Talawa, Damana and Villu grassland communities. With the exception of the Montane grasslands (wet and dry) which occur at elevations above 1,000 m, the other types are found scattered in the lowland dry zones. The Villu or swamp grasslands are associated with the floodplains of rivers and occur almost entirely in the basin of the Mahaweli Ganga. The fresh water habitats are poor in terms of fauna and flora.

TABLE 7 - FOREST AREAS IN 1956 & 1980

Zones	Forest Area (ha) 1956	Forest Area (ha) 1980	Reduction in forest area (1956-1980) (ha)	Percent Reduction (1956-1980)
Wet zone (including montane)	251,000	141,000	110,000	46%
Dry zone (including intermediate)	2,649,000	1,435,000	1,214,000	44%
Total	2,900,000	1,576,000	1,324,000	45%

TABLE 8 - FOREST AREA IN RELATION TO LAND AREA

(1956 - 1980)

Zone	Total Land Area (ha)	Forest Area (ha) 1956	Forest Area (ha) 1980	Forest Area (ha) / Total Land Area of the zone (ha) 1956	Forest Area (ha) / Total Land Area of the zone (ha) 1980
Wet (including montane)	1,525,000	251,000	141,000	16%	9%
Dry (including intermediate)	5,045,000	2,649,000	1,435,000	53%	28%

1956 Figures based on Andrews (1961)[2]

1980 Figures based on Andrews & Pushparajah (1980) (Personal communication)

Figure 12
Natural Forest Cover
Map of Sri Lanka

(From Gaussen et al.,1964). -Lowland Wetzone Forests, -Montane Forests, -Dry zone Forests, -Intermediate zone Forests.

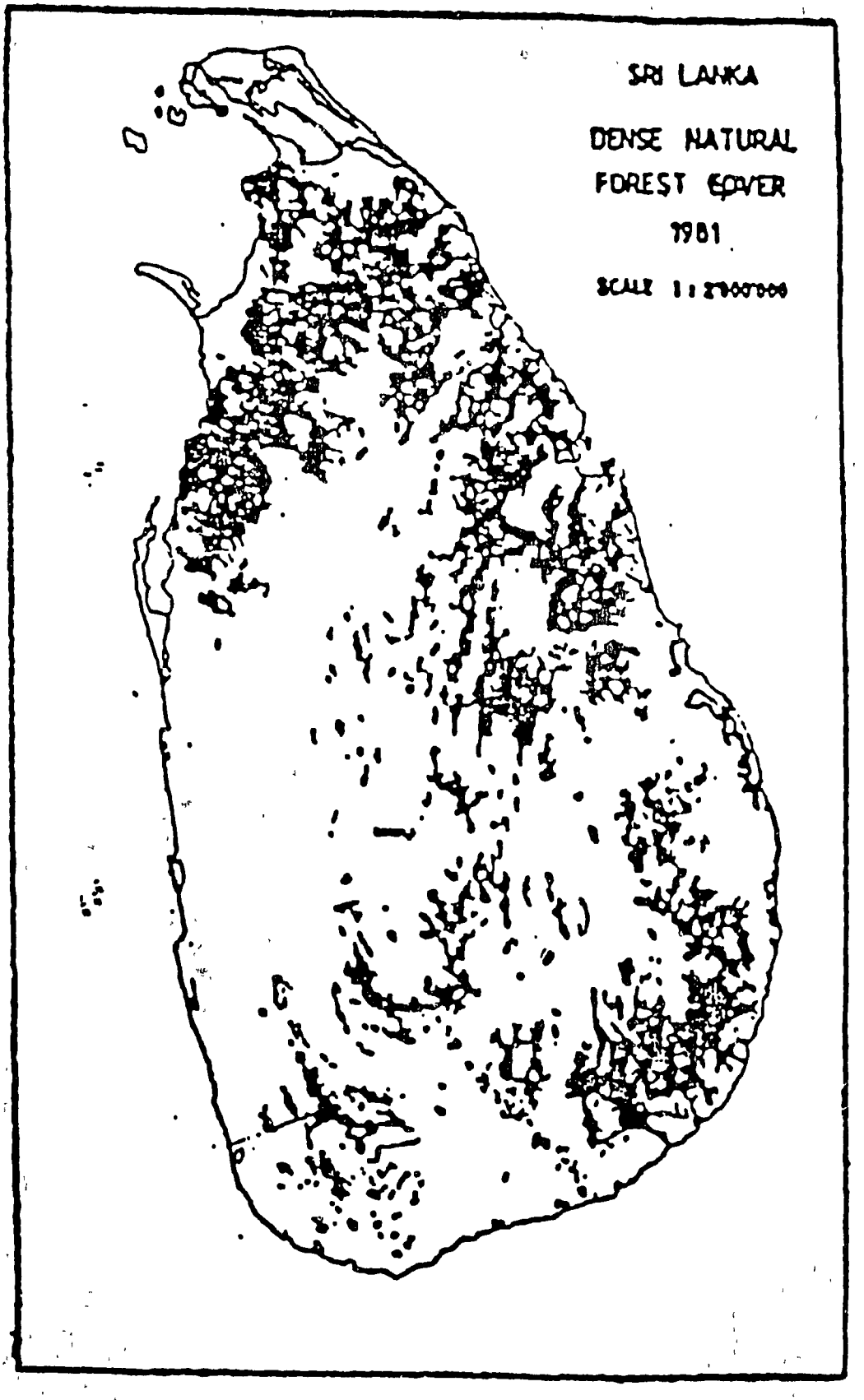

Figure 13. Dense Natural Forest Cover Map of Sri Lanka.
(Source: Survey Department,1981).

Table 9. Present proportion of natural forests in Sri Lanka

Forest Type	Proportion forested with respect to the total land area in each zone	Proportion forested with respect to the land area of the whole island
Forests of the low country wet zone	9.1%	1.45%
Forests of the montane zone	17.6%	1.54%
Forests of the intermediate zone	1%	Negligible
Forests of the dry zone	30.3%	21.97%

From Forest Cover Map of Survey Department (1981).

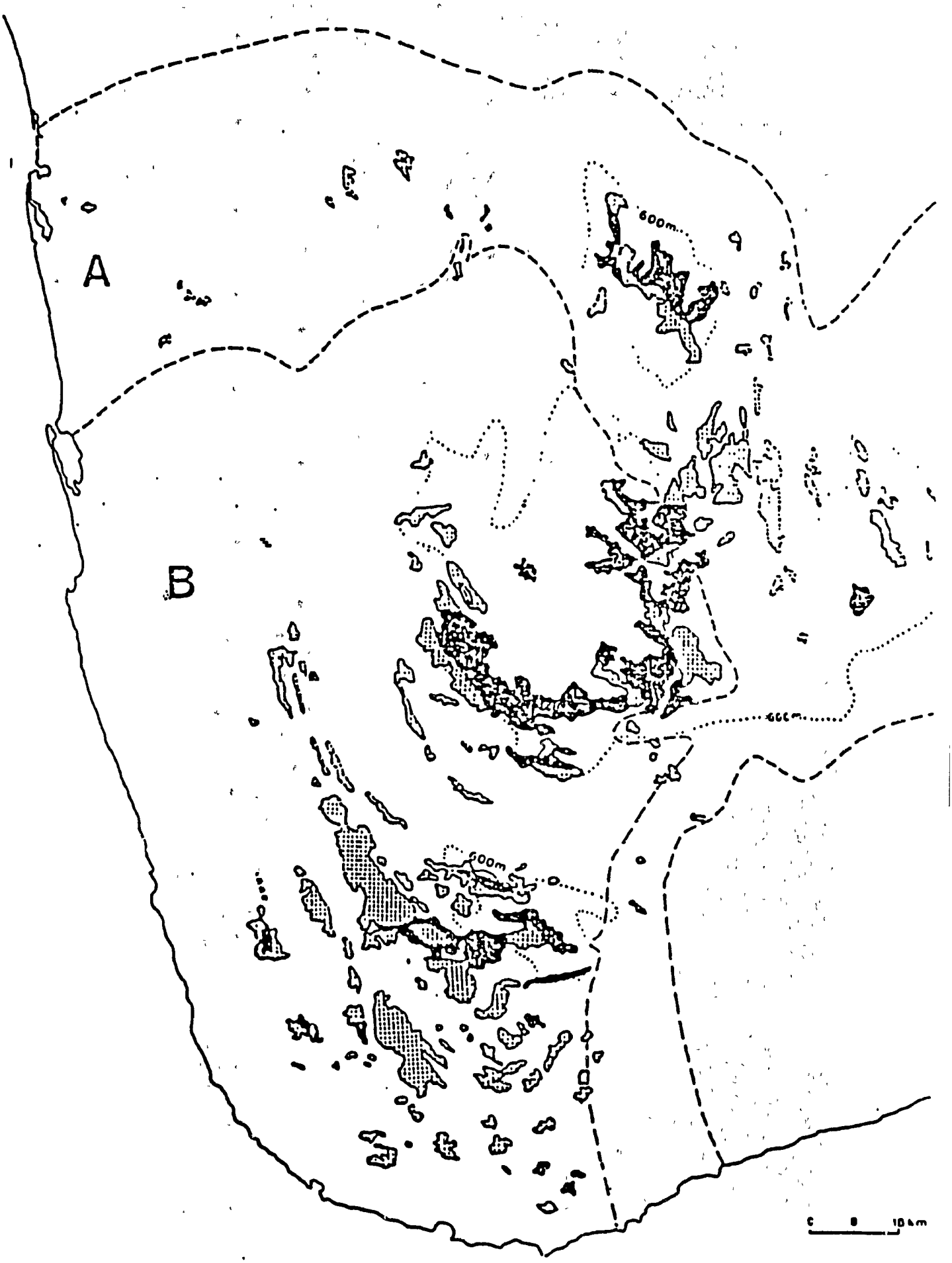

FIGURE 14 Distribution of natural forests in the Intermediate (A) and Wet (B) zones of Sri Lanka. Relatively undisturbed primary forests represented by shaded areas and selectively felled and/or disturbed forests by checked areas, based on authors' field experience (Source: Ashton & Gunatilleke, Unpublished).

5.2 Agricultural Crop and Livestock Resources

Agriculture has always played a major role in the Sri Lankan economy, accounting in 1985 for some 26% of the total GDP, over 50% of total employment and 47% of export earnings. In addition, currently some 90% of the island's rural population and 70% of its total population are either directly or indirectly dependent on agriculture as their major source of livelihood. Generations of farmer's selection and cultivation of plant species, enriched by traditional farming practices, have produced a wide variety of crop cultivars which blended ideally with the ecological balance generated by natural selection. The dynamic equilibrium so achieved has been further enhanced by centuries of gene inflow through plant introduction by travellers, traders, explorers, invaders and other visitors to the country. The nation's island format has provided a relatively isolated geographical matrix facilitating genetic differentiation and maintaining genetic diversity, thereby providing conditions favourable for the evolution of a large number of agricultural species.

The "green revolution" in Sri Lanka and the related drive to increase crop yields has forced agriculture to rely increasingly on a few improved varieties with a narrow genetic base, displacing traditional crop varieties. In the case of rice, the present extent of indigenous varieties under cultivation has dwindled to about 5% of the total paddy acreage. The spread of genetically uniform varieties, while helping to achieve high yields, has increased the vulnerability of crops to pest and diseases and eliminated genetic diversity upon which crop breeding programs depend. All of the improved rice varieties carry the same cytoplasm genes introduced from Chinese varieties. The conservation of genetic variability is thus crucial to the success of future crop improvement programs in Sri Lanka and, hence, assumes national importance. This was foreseen by the Research Division of the Department of Agriculture as far back as 1967. Initial efforts were directed primarily towards the conservation of local rice germplasm as wild species became threatened by the spread of new improved rice varieties. A total collection of over 2,000 accessions has since been made, including primitive and wild species of rice. Promising sources of resistence to pests, diseases and environmental stresses have been recorded among these strains. Currently, genetic conservation activities are being expanded to include coarse grains, pulses, fruit crops, oil crops, root and tuber crops and various spices, in addition to the research already underway on rice varieties and plantation crops.

The need for genetic resource conservation has been succinctly put forward by N.W. Simmonds who stated that "the basic need for genetic conservation arises from two processes, human pressure on natural ecosystems leading to destruction of wild species of plants and animals and the spread of technological agriculture leading to loss of variability in crops and stock". "Human pressures on

natural ecosystems" are essentially the consequence of population increase leading to the displacement and destruction of wild species of plants and animals. As regards the "spread of technological agriculture", the principal elements of concern are:

(i) The transformation from subsistence agriculture to intensive agriculture which has been accompanied by the spread of a single, or a group of closely related, crop varieties adapted to a wide range of environments. Consequently, the less productive traditional varieties either have already, or are in the process of being, rapidly displaced.

(ii) The transition from traditional varieties to high-yielding varieties has affected the genetic base of many crop species. Important technological break-throughs, for example, in rice breeding have been achieved by breeding within a restricted, but well adapted gene pool. Moreover, the use of the back-cross technique to introduce specific characters, like disease resistance, has further narrowed the genetic base in new cultivars. The capacity of the new improved Cultivars to adapt to ecological changes are thus highly limited, resulting in a serious genetic vulnerability to adverse eco-edaphic conditions.

(iii) Current efforts to develop additional agricultural lands through new irrigation scheme have posed a severe threat to wild crop genetic resources by depriving them of their natural habitats. This trend is particularly endangering the valuable wild rice species found mainly in abandoned tank beds. Regrettably, this devastation is taking place at a time when innovative genetic engineering techniques are being developed and implemented to transfer the race traits of wild crop species to cultivated species.

Thus, it is evident that while many have benefitted from the new, improved technologies associated with the "green revolution" of Sri Lanka, these gains have exacted a price in terms of the increased risks inherent in the ever-increasing agricultural reliance upon a steadily shrinking gene pool. Clearly, in this priority area of national economic concern, more needs to be done to ensure the long-term sustainability of the cropping varieties and technologies upon which Sri Lanka's future depends.

Brief mention should also be made here regarding the current status of animal husbandry practices in Sri Lanka. It is most interesting to note that Sri Lanka possesses wild species of buffalo, cattle, fish and fowl. However, with perhaps the notable exception of marine fisheries, the country continues to rely heavily on imported strains of each of these valuable sources of protein for meeting its domestic consumptive requirements. With a few limited exceptions (e.g., the buffalo breeding program of the Mahaweli Authority of Sri Lanka), little or no effort has been made to exploit the genetic potential of these native species for integration into the existing animal husbandry program. This

consideration would apply equally to other Sri Lanka wildlife which might also utilized within a national domestication and/or breeding program, such as boar, elk, sambur and deer. As a result of continuing stock depletion and intermingling with imported germplasm, several of these potentially valuable sources of genetic contribution are rapidly disappearing. Thus, it would appear that additional conservation efforts would also be appropriate in this important area of concern as well.

5.3. Wildlife Resources

Sri Lanka possess a great wealth and abundance of wildlife. However, to date, no comprehensive systematic study has been completed with regard to the number and status of the various species and their respective geographical distributions throughout the country. According to the current best available estimates, the Sri Lankan fauna includes some 763 species of terrestrial vertebrates. This figure includes some 86 species of mammals, 427 species of birds (including 175 species of migrants), 158 species of reptiles, 38 species of amphibians and 54 species of fish (March for Conservation, 1984). Of this total, some 18% of these species are endemic to Sri Lanka (i.e., 11.5% of mammals, 5%, of birds, 47.5% of reptiles, 42% of amphibians and 26% of fishes). Little statistics are available on the number and types of invertebrate fauna of the country.

In general, the animals of the dry zone areas of the country exhibit a great affinity with the fauna of the neighbouring sub-continent, while those of the low country wet zone and montane zone are more distinctive to Sri Lanka. Crusz (1970) estimates that close to three quarters (75%) of Sri Lanka's endemic fauna inhabit the low country wet zone rain forests, with most of the remainder (25%) occupying the upper montane forests of the country. It is significant to note, therefore, that these same two regions of the country support the great preponderance of the nation's endemic faunal species as noted above in regard to the distribution of the island's endemic flora. This fact serves to further highlight the necessity for proper management and conservation of these regions of the country as major repositories for its unique and valuable biological resources.

The Sri Lankan government appears to be seriously attempting to meet this challenge. Table 11 lists by agro-ecological zone the amount of government lands currently under some type of "protected" status with "special" management/administration. The total 1,550,000 hectare (or approximately 15,000 sq. kms. or 6,000 sq. miles) protected area represents some 40% of the total land area of the country. Moreoever, some 40% of this total area (613,000 hectares) is devoted to various different types of wildlife reserves. This latter figure represents some 10% of the total land area of this relatively modest-sized country and, thus, represents a significant commitment of national resources by almost any

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standard. [By way of comparison, it might be noted that the current equivalently reserved area of the United States amounts to a mere 47% of its total land area]. Annex 2 provides brief information of the wildlife parks and reserves in the country. As might be surmised from the above, this strong national commitment to natural resource conservation is also reflected in the sizeable number of governmental and non-governmental organization associated with one or more aspects of resource conservation and/or management in Sri Lanka. It should be noted that such a significant commitment to this area of the nation's development is not surprising when one considers the predominantly Buddhist nature of Sri Lanka society. From the golden era of Sri Lanka's great ancient kings, animals have always been accorded a special status deemed worthy of protection by public and private sector interests alike. That this important cultural tradition continues today is probably most evident in the central role played by the elephant in the "perahera", perhaps the most important religious event on the island.

Despite this relatively substantial historical commitment of human and physical resources, Sri Lanka's wildlife is disappearing at an alarming rate. While few reliable estimates are available concerning recent in wildlife depletion in Sri Lanka, the sizeable list of threatened Sri Lankan animal taxa presented in Annex 3 provides some indication of the magnitude and seriousness of the situation. Included within this list are the Asian elephant (Elephas maximus), leopard (Panthera pardus), blue whale (Balaenoptera musculus), dugong (Dugong dugong), and several species each of crocodiles, turtles and birds which are all of international importance and concern. The fact that many of these threatened species are also endemic to the island nation serves to underscore the necessity for effective remedial measures to slow and halt the loss of wildlife on a priority basis.

As mentioned above, most of the requisites for appropriate ameliorative action regarding this problem have already been initiated by the government. Significant amounts of land have been set aside under some type of reserve status and an adequate institutional and regulatory framework exists for effective management of these resources. With regards to this latter point, it is worth noting that Sri Lanka is a signatory to the CITES treaty governing the commercial exploitation of threatened and endangered species throughout the world. This lends important international support to the country's own regulatory efforts in this area (Table 10).

However, despite these admirable intentions, the loss of wildlife in Sri Lanka continues. The causes of this problem may be outlined as follows:

(i) loss of wildlife habitat

TABLE 10

List of Animals Absolutely Protected During Both the Close and the Open Seasons

Class	*Order*	*Scientific name*	*English name*
Mammalia	Insectivora	1. *Feroculus feroculus* (Kelaart)	Long-clawed Shrew
		2. *Suncus etruscus fellowes-gordoni* Phillips	Ceylon Pigmy Shrew
		3. *Suncus murinus zeylonicus* Phillips	Ceylon Jungle Shrew
		4. *Crocidura miya* Phillips	Long-tailed Shrew
		5. *Crocidura horsfieldi* (Tomes)	Horsfield's Shrew
		6. *Solisorex pearsoni* Thomas	Pearson's Shrew
	Chiroptera	7. *Rousettus seminudus* (Gray)	Ceylon Fruit-bat
		8. *Murina cyclotis eileenae* Phillips	Ceylon Tube-nosed Bat
		9. *Kerivoula hardewickei malpasi* Phillips	Malpas's Bat
	Primates	10. *Loris tardigradus* (Linnaeus)	Slender Loris
		11. *Presbytis senex monticola* Kelaart	Bear Monkey or Hill Wanderoo
	Pholidota	12. *Manis crassicaudata* Gray	Indian Pangolin
	Rodentia	13. *Petaurista petaurista lanka* Wroughton	Grey Flying-squirrel
		14. *Petinomys fuscocapillus layardi* (Kelaart)	Small Ceylon Flying-squirrel
		15. *Ratufa macroura macroura* (Pennant)	Highland Giant Squirrel
		16. *Tatera indica ceylonica* Wroughton	Ceylon Gerbil or Antelope Rat
		17. *Bandicota bengalensis gracilis* (Nehring) (= *Gunomys gracilis* Phillips)	Lesser Bandicoot Rat or Mole Rat
		18. *Mus fernandoni* (Phillips) (= *Leggadilla fernondoni* Hill)	Ceylon Spiny Mouse
		19. *Mus mayori mayori* (Thomas) (= *Coelomys mayori* H·	Highland Spiny Rat
		20. *Mus mayori pococki* Ellerman (= *Coelomys bicolor* Hill)	Bicoloured Spiny Rat
		21. *Rattus montanus* Phillips	Nillu Rat
	Carnivora	22. *Paradoxurus zeylonensis* (Pallas in Schreber)	Golden Palm Civet
		23. *Felis rubiginosa* (Is. Geoffrey)	Rusty-spotted Cat
		24. *Felis viverrina* Bennet	Fishing Cat
	Sirenia	25. *Dugong dugon* (Müller)	Dugong
	Artiodactyla	26. *Axis porcinus porcinus* (Zimmermann)	Hog Deer
	Perissodactyla	27. *Equus caballus* Linn.	Delft Island Pony
Aves	There are about 379 species of birds in Sri Lanka. Of these, 340 species are absolutely protected during both the Close and Open Seasons, 25 are protected during the Close Season only, while the remaining 14 are not protected at all.		
Reptilia	Testudinata	28. *Dermochelys coriacea* (Linn.)	Leathery Turtle
		29. *Lepidochelys olivacea olivacea* (Eschscholtz)	Olive-back Loggerhead
		30. *Caretta caretta gigas* Deraniyagala	Giant Brown-red Loggerhead
		31. *Eretmochelys imbricata* (Linn.)	Hawksbill Turtle
		32. *Chelonia mydas* (Linn.)	Green Turtle
		33. *Testudo* (*Geochelone*) *elegans* (Schoepff)	Starred Tortoise
	Squamata	34. *Varanus monitor* (Linn.)	Water Lizard or Water Monitor

TABLE IV

List of Plants Protected Absolutely by Law in Sri Lanka

Family	*Scientific name*	*English name*
Orchidaceae	*Dendrobium heterocarpum* Wall. ex Lindl.	Primrose Orchid
	Dendrobium maccarthiae Thw.	Wesak or May Orchid
	Ipsea speciosa Lindl.	Daffodil Orchid
	Rhynchostylis retusa (Linn.) Bl.	Foxtail Orchid
	Vanda spathulata (Linn.) Spreng.	—
	Vanda tessellata (Roxb.) Lod. ex. G.Don	Anuradhapura Orchid
Euphorbiaceae	*Cleistanthus collinus* (Roxb.) Hook.f	Madara Tree
Bombacaceae	*Adansonia digitata* Linn.	Baobab Tree
Sphagnaceae (Bryopsida)	*Sphagnum zeylanicum* Mitt.	Sphagnum Moss

- major agricultural development schemes
- encroachment of shifting subsistence cultivation
- miscellaneous resources extraction activities

(ii) institutional deficiencies

- lack of institutional coordination (among both public and private sector organizations) for integrated planning and management of wildlife resources.

- inadequate trained staff and resources for effective research, management and regulation of protected area resources.

(iii) educational shortcoming

- need for renewed emphasis on conservation awareness/education at all levels and fora to promote a greater general understanding of the importance of wildlife resources and the need for their proper management and conservation

Thus, while a good start has been made towards safeguarding Sri Lanka's wildlife resources, it is also evident that a great deal remains to be accomplished without delay to ensure that this nation's substantial, and internationally important, biological resources continue to be available for research, utilization and the great enjoyment of future generations.

5.4. Coastal and Marine Resources

Structurally, Sri Lanka is a continental island and is related to India to which it was united through a greater part of geological time when both were a component of the super continent of gondwanaland. Subsequently in the Jurassic, the Indo-Lanka rift appeared which has resulted in the creation of the Palk Strait, Palk Bay and Gulf of Manner. The island is surrounded by the continental shelf - a submerged plateau which extends to an average width of 20 km. The coastline with some 1700 kms of shoreline, coastal and marine resources comprise an important facet of the island nation's economic potential. Fish, provided through a substantial captive fishing industry, provides a major source of protein for a majority of the population due to its relatively reasonable cost. Though substantial stocks exist, Sri Lanka is only just begining to attempt to exploit its offshore fish resources for commercial advantage. Export of tropical fish is also an important growth industry in the country.

Nine tenths of the island consists of highly metamorphosed pre-cambrian crystalline rock, while sedimented rock is found along the Northwest coast where limestone of the Miocene period is found. Along considerable portions of the west coast is a shallow coastal reef closer than 1.5kms.from the shore, which has been a stabilizing factor against coast erosion. One of the features of the coastal zone is the presence of extensive fresh and salt water lagoons on both the eastern and western coasts, at the northern extremity of the island, and to a limited extent on the southern coast. In the north, the Jaffna peninsula is joined to the rest of the island by a narrow sand bar. Vast expenses of marshlands are in the centre and east of the Penninsula. Along the greater part of the south western and eastern coastline, beaches are situated between rocky headlands of gneiss or granite, and in many locations these beaches are backed by lagoons, estuarine deltas, bays and marshes. Coral reefs are found along parts of the north, south west and southwest coasts. Most coral beds are dead, but live coral is still found north of Mannar, and in parts of southwest coast. The coral reefs generally grow in small and discrete colonies that form banks or small platforms and attain a thickness of upto 3 metres. These grow on the seafloor and are often centered on a nucleus of rock. Fringing reefs and barrier reefs are rare and atolls are not found (Swan 1981). Although the reef systems is known to support marine fisheries, its influence on the fisheries of the island, especially the coastal fisheries, which accounts for a large component of the fish catch has not been investigated. Coral reefs have been subject of much destruction in Sri Lanka the chief cause being the extraction of coral to meet the demand for lime in the construction sector. Coral destruction has been the most severe along the South west coast. A recent survey carried out in a 60 km stretch in the south west coast reveals that 2,282 tons of coral and 5,377 tons of coral debris are collected annually. In addition to this 10,400 tons are excavated from the inlands deposits of coral annually. (Premaratne, 1984).

It is also commonly known that this stretch of beach experiences severe sea erosion during the monsoon season. Corals and shells are also collected on a limited scale for the tourist industry, while coral reef fishes and other invertebrates which form a vital component of the food chain in the corals are being removed and exported to Europe. Uncontrolled spearfishing could have a serious impact particularly on resident species such as groupers Epinephalus sp. Experienced spearfishermen who hunt for sport take the pelagic fish such as barracuda Sphyraena sp and mackeral Scomberomorus sp and trevally Caranx sp. Pollution from industry and illegal dumping of sewage and other wastes may have a negative effect on the coral reefs.

Numerous lagoons and estuaries are located around the coasts of the island. According to Pillai (1965) brackish water areas cover 80,000 ha of estuaries and large deep lagoons and about 40,000 ha of shallow lagoons, tidal flats and mangrove swamps. All such water bodies which are not permanently connected to the sea are

called lagoons, while estuaries are coastal water bodies which are connected to the sea and has a input of freshwater usually from major river channels. For purposes of discussion, both lagoons and estuaries are considered as brackish water resources. Pillai (1965) has recorded 132 species of brackish water fish of which 65% are migrants from the sea and 5% are migrants from freshwater sources. Majority of these species (80%) are edible. Besides the fish fauna crustacea, molluscs and holothurians form a considerable portion of the island's brackish water resources. Several species of prawns harvested from the lagoons and estuaries, account for a significant proportion of the island's fish production in monetary terms. Fry resources in these brackish waters are considerable and of significance for the development of mariculture. Other important species are the lagoon crabs Scylla serrata and a few species of holothurians which are collected primarily for export. Several species of bivalve molluses are also exploited as foods. Demands placed on the estuarine and lagoon systems by virtue of their economic benefits have created many environmental problems resulting in the depredation of these resources. The affects of improper planned development of these resources have resulted in economic losses and opportunity costs foregone. One major contributory factor to degradation has been changes in sedimentation and sedimentation patterns within the water body and at the mouth caused by activities such as dredging, reclamation and land fill in peripheral areas, increased soil erosion due to devegetation and agricultural practices in the upstream watersheds and damming and river diversions. Other sources of degradation of these coastal waterbodies have been pollution from industrial effluents, which is reported to be severe around the Valachchenai lagoon which receives discharges for the paper mill located nearby. Over exploitation of living resources is significant in some of the estuaries and lagoons particularly on the crab and prawn fishery. Destruction of mangrove communities too has a significant impact on the productivity of the brackish water system.

Mangroves occupy around 6,000 ha being discontinuously distributed along the coastline. They are absent along the exposed south west, South and North East coastlines which are affected by seasonal high winds. In these sectors they occur within embayments and along tidal creeks. The most extensive mangrove areas are around Jaffna, Batticaloa and Trincomalee. Species diversity amongst the island's mangrove ecosystems is extremely poor when compared to those in tropical coasts in other parts of the world. Typical species like Rhizophora, Avicennia, Excoecaria, Lumnitzera and associates like Tamarix, Acanthus, Sphaeranthus and Sonneratia are widely distributed all around the island's coast. Xylocarpus is found in the West and east coast. Other species have restricted distribution; Ceriops tagal is absent from the north, while Bruguiera cylindrica is found only on the West Coast. Nypa fruticans which has a very narrow range of tolerance to sea water is found in restricted locations on the west coast. Limited information is available for animals associated with the mangroves. The mangrove communities play a very significant role in the production and maintenance of coastal fisheries in Sri Lanka. The

mangrove brush pile industry, a traditional method to create artificial habitat for fish and make harvesting easier is clearly a highly visible form of coastal activity around Negombo on the western coast. In Sri Lanka, human activities affect the mangrove in many ways. Over exploitation of the resources is the most common and this is particularly for timber, firewood and for the brushpile industry. During the recent years increasingly large areas of mangroves have been reclaimed for urban and industrial development. One of the greatest threats to this ecosystem could come from the conversion to brackish water fish ponds. Upland activities such as deforestation and agriculture are also affecting the mangroves, so does deposition of sewage and other wastes. River diversions and reservoir construction can also deplete the mangrove, through changes in the hydrology, although no direct investigation of their affects have been studied so far.

Other coastal ecosystems worth recording are the seagrass beds, salt marshes and coastal dunes. Seagrass beds occur most extensively on the western, northern and north western coastal zones. The extent of seagrass beds are not well known, but certainly it is a very critical coastal habitat. Seagrass beds in Sri Lanka have evoked much interest because of their importance as the only habitant of the endangered dugong Dugong dugong. The seagrass constitute a part of the diet of the turtles that seasonally coexist with the dugong. Seagrass beds are economically extremely important in that they support a very productive fishery serving as nurseries for shrimp and fish. The fishery productivity of the coastal lagoons, estuaries and nearshore waters are maintained by the seaward migrants from estuarine seagrass beds. The major threat to the seagrass beds arise from damage due to trawling, beach seining and propellors. Seagrass are also damaged by excessive deposition of sewage or nutrient loading and by excessive siltation. The seagrass beds along the western and north western coasts have been repeatedly identified as requiring conservation in view of the endangered status of the dugong. Salt marshes and sand dunes like all other coastal habitats are also under threat, the former being converted to salt pans while the latter to agriculture and settlements.

The most serious constraints towards coastal management and conservation is the general lack of quantitative and qualitative information on the resource. There is inadequate understanding of the ecological principles underlying the healthy maintenance of the system and the role played by each system in the total coastal environment. Information on the utilization levels of the resources are also insufficient.

5.5 Wetland Resources

Sri Lanka being a tropical island with large water resources and a varied topography has developed a wide array of different wetland

types. These include fresh, brackish and marine wetland forms. The brackish and marine wetland categories such as lagoons, estuaries and associated types are described in section 5.4 of this report. The fresh water wetland types are composed of a complex array of different habitat types natural or man-made, permanent or temporary with water that is static or flowing.

The island is drained by 103 river systems, a majority of which originate in the central highlands and then wind its way to the coast. The largest river is the Mahaweli Ganga which is 305 km in length and carries about one-sixth of the total water resources of the island. By virtue of its volume and length, the Mahaweli Ganga has developed an extensive floodplain area in its downstream reaches. This floodplain has an extensive array of habitat types which include fresh water marshes and swamps, seasonally flooded grassland and forests, estuarine and delta systems, mangrove swamps and intertidal mudflats. These habitat types are biologically very productive systems that support a rich and numerous life forms and are of particular importance for large mammals such as the elephant and for birds. The floodplains of the major Asian rivers are considered to be the ancestral home of the Asian elephant, and the Mahaweli Ganga floodplains may perhaps be the only floodplain left in Asia where the wild elephant still occurs because the floodplains of other rivers have all been developed and support high human population densities.

The Mahaweli floodplain is important also because, it supports a majority of the 251 resident bird species in from the country. In addition during winter, about 75 migrant species visit the floodplains from lands in the northern hemisphere. The migrants include plovers, sandpipers, pipits, wagtails, terns, gulls, geese, ducks, rails, eagles and harriers. An important feature of the floodplain habitats is that wildlife use the floodplain habitats disproportionately more than any other type of habitat, because the presence of water lends importance to the zone. The floodplains are also important as they provide migration routes for wildlife such as elephant, deer and sambur. Elephants use this floodplain corridor to move from their dry season watering grounds to their wet season feeding grounds. The floodplains of the Mahaweli are home to about one-thirds of the islands wild elephant population of 2500.

Dam construction and diversions along the Mahaweli rivers under the Mahaweli development project is expected to seriously alter the hydrology and ecology of the floodplain system. A major part of the floodplain has been demarcated as a National Park in 1985 to protect these important wetland habitats.

With the the exception of the Mahaweli Ganga floodplain swamp marshes, all other fresh water wetlands in the country are man-made. These include over 10,000 man-made reservoirs that literally dot the lowland landscape of the country. These reservoirs form an

intricate network that constitute part of an ancient hydraulic system of irrigation built by the ancient kings of the country. So efficient was this system that not a drop of water that fell on the land was lost to the sea before being used a number of times to irrigate the land. Usually the drainage and overflow from one above would flow into the reservoir below. In recent times a number of larger and new reservoirs have been build and a number of the ancient abandoned tanks have been restored and recommissioned.

The wide array and number of fresh water habitats have contributed profoundly to the biological diversity of the island. Although the Mahaweli Ganga floodplain and a few of the other freshwater bodies are under some type of protection, these habitats are under severe threat. The biggest threat comes from changes in the river hydrology due to dam construction and river diversions, of particular concern is the change in hydrology of the Mahaweli floodplain due to activities connected with the Mahaweli Development Project. Other activities such as increased agricultural run-off, land reclamation, road construction and siltation from poor upstream land uses could threatened these wetland types. Wetland have in the past been largely considered as only wastelands with little or no value. In this connection it is worth stating that Sri Lanka has still not ratified the RAMSAR convention, although there are indications that this will be done soon. A number of the coastal lagoons and estuaries which are important waterfowl habitats have however been afforded some protection under the Fauna & Flora Protection Ordinance.

6.0 Status and Management of Protected Areas

In Sri Lanka's ancient history, nature protection was part and parcel of the religion and the way of life of the people. Traditional philosophies enjoined man to respect, or ever revere nature, and work in partnership with it. Forests were protected by Royal edicts, tree felling and the collection of forest products were controlled; and the delicate and fragile ecosystems of the wet zone forest areas were left practically undisturbed. Overexploitation of resources actually began during the colonial period. The more valuable timber trees were removed almost to extinction. Later extensive areas of montane forests and lowland rainforests were cleared for the establishment of plantation crops. It was in 1873 that the first steps were taken in the recent past towards any type of nature conservation in Sri Lanka. That was the instructions given by the British Colonial Secretary that no forests above 1500 m elevation should be cleared. A few years later (1887) the Forests Ordinance was enacted and a Department of Forestry was established. This Department was entrusted with control of timber extraction from the forests. A natural reserve, the first in recent history was established in Yala in 1900. Five years later a similar one was set up at Wilpattu. In 1937, a Fauna and Flora Protection Ordinance was passed and when the country

regained independence in 1948 a Department of Wildlife Conservation (DWLC) was set up. Today, the conservation of wildlife is under the jurisdiction of the DWLC which belongs to the Ministry of State. Forest Conservation on the other hand is the responsibility of the Forest Department which belongs to the Ministry of Lands and Land Development.

The natural forest resources in the country receive different degrees of protection depending on legislation and the convictions of the authorities who administer them. Of the total natural forest cover of 1,549,000 ha. (TAMS 1980) over 90% are administered by the Forest Department and DWLC. Each of these departments have somewhat different management policies which are reflected in the way they are administered. The extent of natural forests now remaining in the country as given by TAMS (1980) is presented in table 11.

Table 11: Extent of Different Types of Protected Areas of Sri Lanka

	Wet Zone	Intermediate & Dry Zone	Total (1000 ha)	Percent
Forest Dept Reserves	92	589	681	44
Other Natural Forests (Crown Forests)	-	118	118	8
Small Natural Forests*	22	-	22	1
Wildlife Dept Reserves	27	586	613	40
Forests in Mahaweli Systems A-D	-	115	115	7
Total	141	1408	1549	100
Percent	9	91	100	100

The forests areas being administered by the Forest Department fall into three categories as follows:

(i) Reserved Forests

These forests have been set apart to ensure that they are managed for perpetuity according to the the principles of scientific forestry. Thus they are permanently dedicated to forestry. Under this category there are two types of reserves namely Forest Reserves and Proposed Reserves. However, in both these reserve categories scientific timber

exploitation is permitted. These forests are usually over 200 ha in extent. The distribution of the Forest and Proposed Reserves are given in Figure 15.

(ii) Village Forests

These forests have been demarcated to ensure that a village community or group of communities may enjoy their benefits.

(iii) Other Crown Forests

Any forest not included in reserved forests or village forests are classed as other Crown Forests. These forests are now called other State Forests and are administered by the Forest Department until a better a more productive use is found for them.

Although one may tend to believe that a sizeable extent of forests are being protected as a consequence, in actual fact it is not so. Most of the Reserved Forests have from time to time being released for development, others have been severely encroached upon and depleted and many now contain very little valuable timber. The valuable upland reserves particularly those above 1500 m elevation have also not been spared - expanding villages, potato cultivation and vegetable farms are gradually decimating these valuable watersheds. Some of the Forest Department forests have now been given the status of Man and Biosphere Reserves.

Over 12% of the land area of the island and over 40% of the forest area are administered by the Department of Wildlife Conservation (DWLC) under the categories of National Reserves and Sanctuaries. When wildlife habitats are proclaimed as National Reserve they are given one of five legal statuses and afforded different degrees of protection. These statuses are Strict Natural Reserve, National Park, Nature Reserve, Jungle Corridor and Intermediate Zone. Among these, a Strict Natural Reserve provides the greatest degree of protection to wildlife. In this type of reserve neither fauna nor flora can be disturbed in any way, and entry is prohibited except on a permit obtained specifically for the purpose of conducting scientific research. A National Park also provides full protection to fauna and flora and contains no permanent human settlements, but people may enter it upon payment of a fee to observe wildlife. A Nature Reserve affords the same protection to wildlife as a National Park. However, it is not developed like a National Park for wildlife observations, and it allows existing rights to human land usage. A Jungle Corridor mainly provides animals with safe paths of movements, and like a Nature Reserve affords full protection to fauna and flora and accomodates existing land rights. The classification of an Intermediate Zone, wherein hunting was permitted in the past has now lost its effectiveness.

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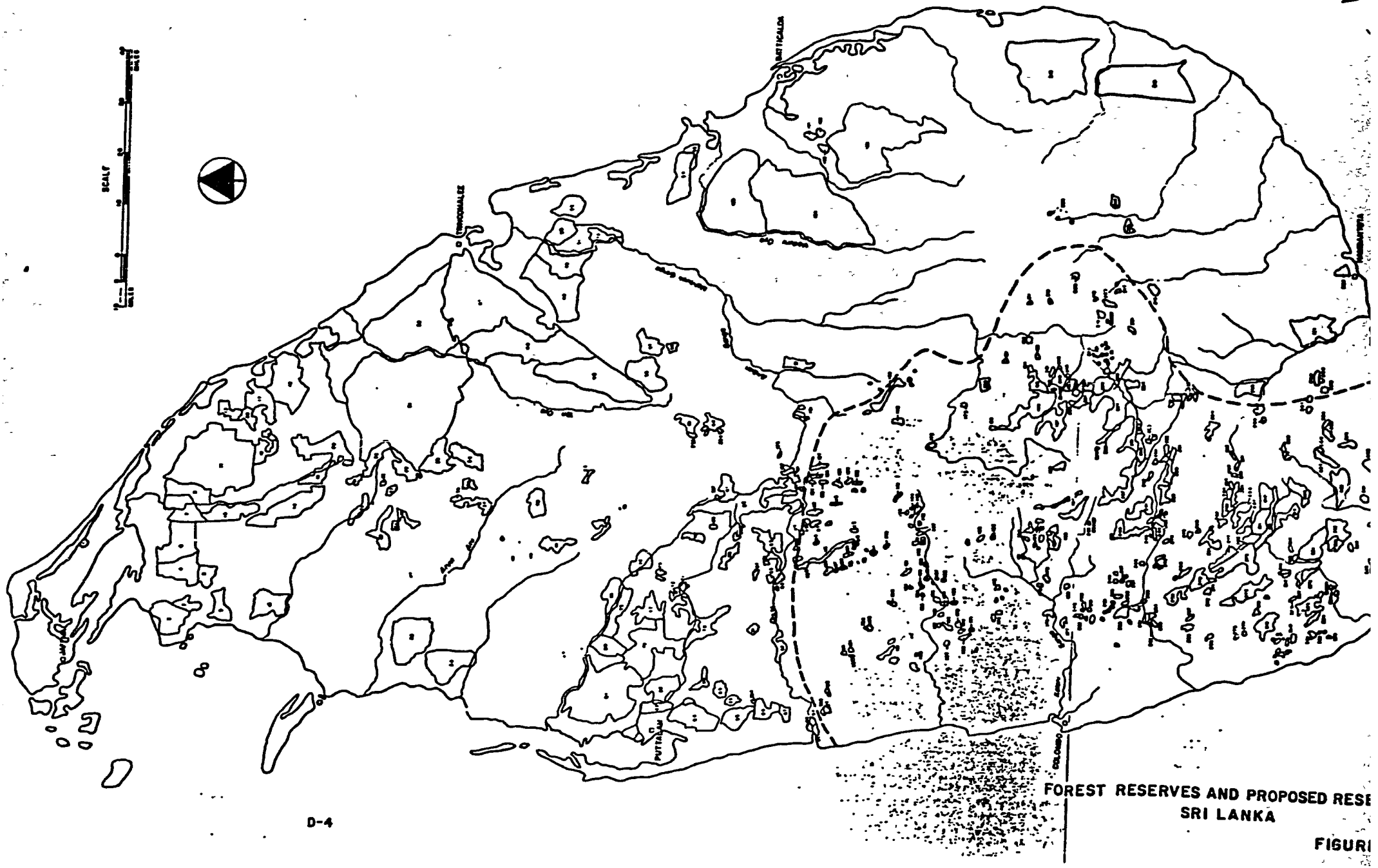


FOREST RESERVES AND PROPOSED RESE
SRI LANKA

FIGURI

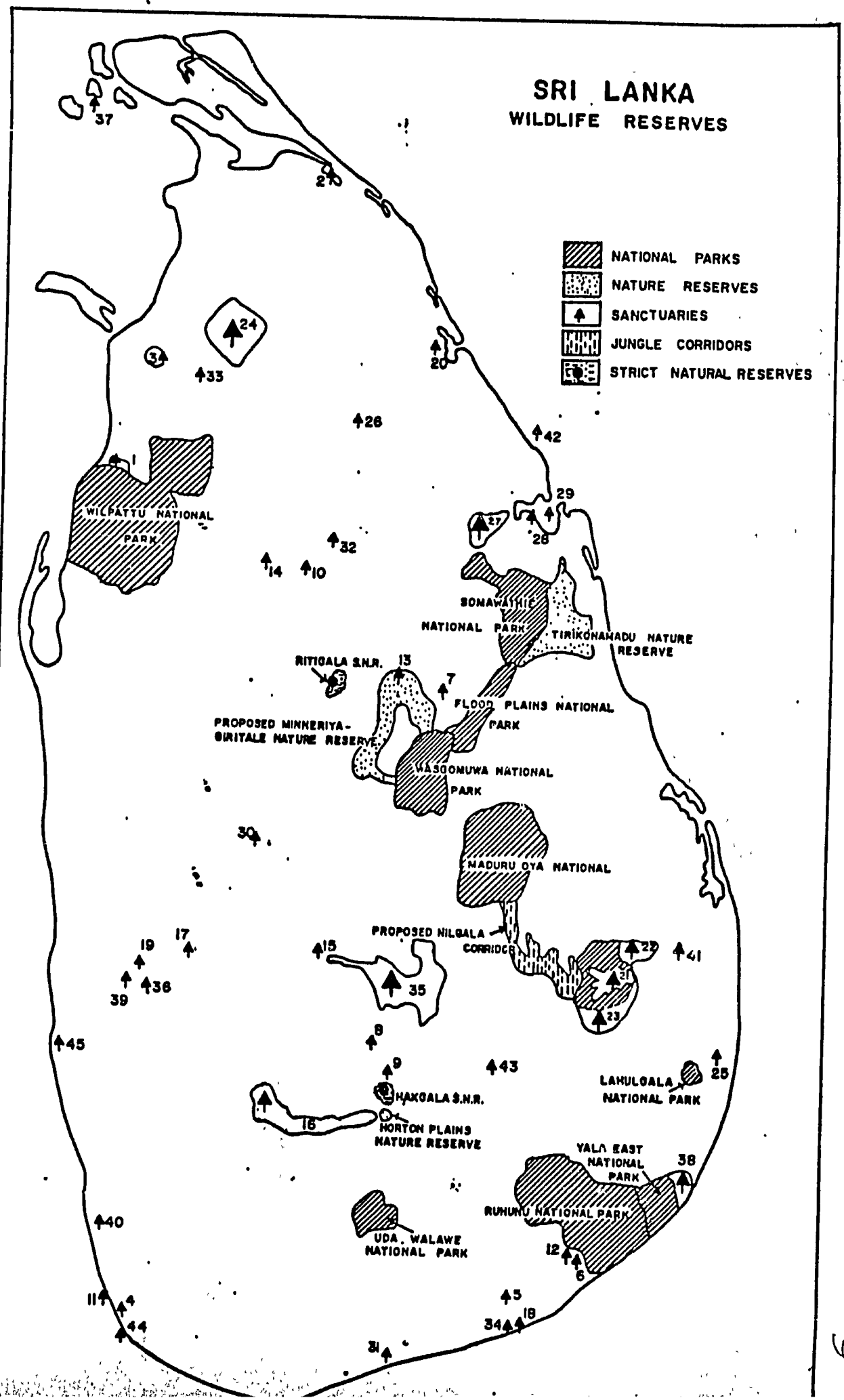
A Sanctuary is a wildlife reserve where animals cannot be disturbed in any way, but where all other human activities and private ownership of land are allowed. The distribution of wildlife habitats under the different categories of reserves are seen in Table 11 and Figure 16.

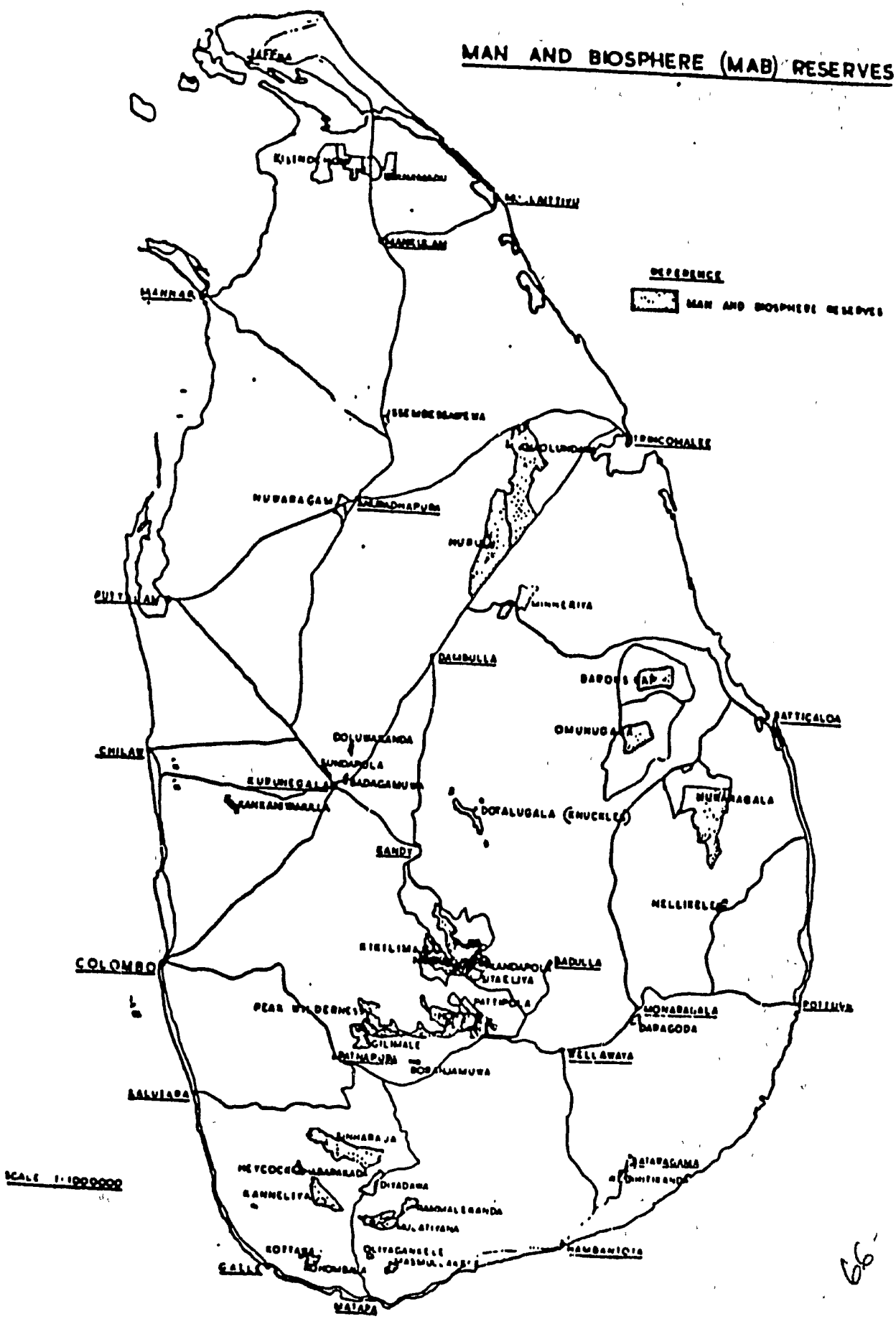
There are 10 National Parks at present in the island, all situated in the dry lowlands of the country. Presently there are nearly 50 sanctuaries with an extent of about 250,000 hectares. Not all the sanctuaries are forests, most of them are wetlands or water bodies which have been demarcated to protect the waterbirds; others serve as buffer zones to National Parks. The preponderance of the coverage of heavy forests in the dry lowlands and the relative negligence in the wet and semi-wet areas is reflected in the distribution of wildlife protection areas in the country. There are 46 wildlife protected areas in the dry and intermediate zones but only 4 in the montane zone and none in the lowland rainforest zone.

In 1969, the Committee of the International UNESCO Biological Program demarcated 20 ha arboreta of forests in the main bioclimatic zones of the island and excluded such areas from timber exploitation and other forms of interference (Sri Bharathi, 1979). In 1975 this program was renamed the Man and Biosphere (MAB) program and large extent of natural forests and some planted forests were selected and declared as MAB Reserves. At present there are 36 such reserves (Figure 17) encompassing a total area of 131,000 ha. Two of these reserves namely the Sinharaja and Hurulu Forest have been granted international MAB status. The extent of relatively undisturbed natural forests in these MAB reserves include only a fraction of the total demarcated area and in some cases even these have been selectively felled. Consequently a majority of these MAB Reserves may not include adequate natural forests areas characteristic of each bioclimatic zone. Furthermore representative samples of all forest communities in the island have not been included in the list of MAB Reserves. Additionally some areas of forests of cultural value have been demarcated as Archaeological Reserves and are administered by the Department of Archaeology.

Statistics show that Sri Lanka is one of only five countries from around the world that have over 12% of its land area devoted exclusively for wildlife protection. This is particularly appreciative when one views the fact the country has one of the highest population densities amongst the developing countries, and population pressures on the limited land resources are mounting day by day. As a comparison, the United States with its vast last resources has only 4% of the land area under protection, while closer home, India has 2.48% and Indonesia 3.47% of their respective land areas under protection. One thing, however can be stated clearly that despite all the past efforts at conservation, there has been no sound, scientifically tested, ecological basis

FIGURE 16


SRI LANKA
WILDLIFE RESERVES
NATIONAL PARKS
NATURE RESERVES
SANCTUARIES
JUNGLE CORRIDORS
STRICT NATURAL RESERVES
WILPATTU NATIONAL PARK
SONAWATHIE NATIONAL PARK
TIRIKONAMADU NATURE RESERVE
RITIGALA S.N.R.
FLOOD PLAINS NATIONAL PARK
PROPOSED MINNERIYA-GURITALE NATURE RESERVE
WASGOMUWA NATIONAL PARK
MADURU OYA NATIONAL
PROPOSED NILGALA CORRIDOR
LAHULGALA NATIONAL PARK
HAKGALA S.N.R.
HORTON PLAINS NATURE RESERVE
YALA EAST NATIONAL PARK
RUHUNU NATIONAL PARK
UDA. WALAWE NATIONAL PARK


MAN AND BIOSPHERE (MAB) RESERVES
REFERENCE
MAN AND BIOSPHERE RESERVES
JAFFNA
MANNAR
TRINCOMALEE
NUWARAGAM
PUTTALAM
CHILAW
DAMBULLA
BATTICALOA
COLOMBO
BADULLA
MONARAGALA
POLONNARUWA
WELLAWAYA
BALUGAMA
GALLE
MATARA
HAMBANTOTA
SCALE 1:1000000

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for most of the steps taken.

In the initial half of this century the main force behind conservation has been the sportsman, executives in both the public and private sectors, and amateur naturalists. Despite this, Sri Lanka has been fortunate in that the basis has already been established towards nature conservation. This is bound to yield good results in the future, if nutured with vision and seriousness of purpose.

It is worth mentioning that the majority of protected area, both administered by the DWLC and Forest Department are in the dry zone of the country (91% in extent). However, in the wet zone of the country where the forests (montane and lowland forests) are the most important in terms of its biological diversity, endemism and watershed value, they represent only 9% of the extent under protection. Most of the original forests in the wet zone have already been eliminated to make way for agriculture and plantation crops. In the montane zone the only forests still left are those above the 1500 m contour protected by the 1887 British government decree. Yet so, there is still an annual loss of around 52000 ha of forests from the face of the island through both illegal and legal means and even in those forest patches remaining with the exception of perhaps only a few, most of the valuable timber in them have been removed.

How effective have these areas been in protecting the plant and animal resources is worth considering. In this content one has to venture back to the immediate post independence period when the forests reserves which were established and administered by the Forest Department were mostly recognised for their timber potential for commercial forestry and not for their biological value. Wildlife reserves on the other hand were mainly set up for game hunting until 1929. Since then however the emphasis has changed and these areas are now mainly managed for the conservation of animals. In most of these reserves the full biological wealth has not be ascertained and little attention has been paid to the functioning of the ecosystems in its entirety. It is only in the recent years that the initial steps have been taken to change this thinking.

There are in addition a number of constraints to effective protection of the reserved areas. Both the DWLC and Forest Department are severely handicapped by the inadequacy of financial and manpower resources to effectively administer these areas. Most of the reserves, particularly the forest reserves have more often than not, no staff at all on site in most of them. It is therefore no surprise that with the exception of only a few, most of the smaller forest reserves do not exist on the ground. Even the larger forest reserves and some of the wildlife reserves have been so severely encroached upon, that they no longer are of any conservation value. The financial situation is even more alarming as seen in the case of the DWLC which has received only $50,000

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from the state budget for capital works in 1988. Although however the Forest Department has a larger capital budget a major share of it goes for establishment of forest plantations and little seeps down for protection of the natural forests A further obstacle to resource conservation is political interference. Very often forests are degraded or totally eliminated as a consequence of political influence. These are most often done for short term gains of a few individuals at the expense of the country's wealth.

Most reserves do usually not have clear cut boundaries that could be easily recognisable on the ground. This leads to encroachments by villagers followed by legal action which usually takes considerable time. Reserves, or part of them, are also lost due to poor coordination between state agencies involved in development work and those responsible for protection. An example is the conflict of interests between the Forest Department and the State Timber Corporation, the latter is concerned only with the exploitation of timber and has no concern whatsoever with the state of the forest once its exploitation is over.

Although terrestrial protected areas have received considerable attention, there are only a few examples of coastal reserves being established. These coastal reserves which have all been established under the Fauna and Flora Protection Ordinance are very small in extent and have been largely set aside for the purpose of protecting rocky islets frequented by sea birds. One exception is the Hikkaduwa Sanctuary, off the coast on the southern sea front which has been declared primarily to protect the coral reefs. However, the effectiveness of the protection measures leaves much to be desired. In recent times there have been proposals to extent the boundaries of the Yala and Wilpattu National Parks off shore to include the coastal waters as well.

On the larger issues of resources conservation, it must be borne in mind that with very few exceptions, most of the forest and wildlife reserves in the country have in the past been established on an 'ad hoc' basis rather than on the basis of definite conservation principles. A case in point is the Yala and Wilpattu National Parks which were established because forests existed in these areas, and fortunately they still survive because the land on which they stand are largely not suitable for agricultural use. This unscientific approach is manifested by the fact that most of the remaining forests and protected areas are in the low country dry zone which comparatively are far less of value for either biological diversity or watershed reasons than the wet lowland and montane forests. This stems from the fact that there had been no clear cut scientifically based land use policy and principles to guide resource use and protection. Even today, although attempts have been made to evolve a national land use policy and plan for the country, resource use and management issues are largely made on a 'piece meal' basis without active consideration of other parameters and values of the resource. Unless urgent steps are taken to base

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future development strategies on a proper land use framework, forests and other ecological resources would continue to be depleted to levels at which they will not be able to sustain further developments.

7. Status and Protection of Endangered Species

Historically, most of the land surface of Sri Lanka was believed to have been once part of the ancient continent of Gonwanaland, which later broke up in the early tertiary and redistributed to form the different continents and subcontinents. However for sometime, perhaps up to the end of the Pleistocene the island remained as part of the Indian Subcontinent. In this way as the island separated from the Indian mainland it naturally retained within it a portion of the South India fauna and flora. During the long geological history following separation, the fauna and flora that was isolated for the mainland began to develop their own peculiar evolutionary trends even though there are indications that the island temporarily rejoined the mainland through land bridges on a few occasions thereafter. Topographic and climatic isolation within the island itself further influenced specification. Consequently the island's fauna and flora provides an arena of great scientific interest and study as several species appear to be of very ancient origin. A few of the plants are considered to have been derived directly from the original Gondwana flora.

The island's flora has at least one species belonging to each of the most primitive vascular plant groups still extant namely Psilotum, Equisetum, Isoetes, Selaginella, Lycopodium and representative types from most fern families, including some of the most primitive fern genera such as Helminthostachys, Ophioglossum, Botrychium, Angiopteris, Marattia and Cyathea. Among the ferns, 57 out of the 314 species are endemic (Sledge, 1982). The island also has around 2900 species of indigenous flowering plants belonging to around 1070 genera and nearly 180 families (Abeywickrama, 1984). Although none of the plant families are endemic to the island, there are 26 endemic genera and about 850 endemic species. These endemics constitute the most interesting feature of the island's flora. As one could expect, there are few endemics in the northern and eastern plains and the majority of species present here are Pennisular India ones and the number of endemic species in this area is only about 50. The balance 800 endemic species are in the wet zone of the island. Willis (1915, 1916) from a statistical analysis of their distributions concluded that they were all new species. Ridley (1916) on the other hand was of the view that they were mainly relics. Certain people consider that some of the island's endemic are of a very ancient stock. Raven and Axelrod (1974) for example state that the genera Hortonia and Schumacheria are probably derived from the original Gondwanaland stock of about 100 million years ago. They are of the view that these may be the only vascular plants that might have survived the passage of the South Asia Plate from its original position near Madagascar northwards to Asia.

A large number of plant species recorded from the island by earlier botanists have not been collected or observed subsequently for the last hundred or more years, because of selective removal, and the destruction or severe disturbance of the habitats. According to the present knowledge 12 of the 26 endemic genera have endangered species. These genera include Hortonia referred to above (Abeywickrama, 1984). About 230 of the 850 endemic flowering genera are now very rare and could be considered as threatened. In addition the island has about 250 non-endemics and about 90 Pteridophytes falling into this category. This adds up to a total of between 500 to 550 vascular plants that are endangered. It is apparent that if the present casual factors continue, most of the above species are likely to become extinct by the end of the current century. Some species are probably already extinct, about 50 or more species have not been collected for over a century such as the endemics Cyathula ceylanica, Ellipanthus unifoliatus, Mesua stylosa, Willughbeia cirrhifera, Ceropegia elegans, Blumea angustifolia, Anaphalis fruticosa, Senecio gardneri etc. Many more species, formerly common and widely distributed, have over the last few decades become rare or restricted to a few small locations. There are other species of the wet zone that have a restricted or localised distribution and they may be confined either to one or few habitats (Gunatilleke & Gunatilleke, 1986) a few examples being:

Diospyros oppositfolia	-	Top of Hinidum Kanda
Schumecheria augustfolia	-	"
Eugenia pedunculata	-	Top of Knuckles
Syzygium fergusonii	-	"
Dichilanthe zeylanica	-	Sinharaja
Atalantia rotundifolia	-	"
Mapania immersa	-	"
Cinnamomum sinharajensis	-	"

Another species at the brink of extinction, or even perhaps extinct by now is Vatica obscura, belonging to the family Dipterocarpaceae. It is an unique species, as it was the only dipterocarp found on the eastern side of Sri Lanka, the rest being confined to the west and to the south. For many decades this plant occurred in gregarious masses especially in the Eastern Province along small streams. Today there are no location records of this species. The recent-most record of this species was made by one of the co-authors, when 4 or 5 trees of this species were located on the banks of the Maduru Oya near Welikanda. These trees have since been cut down.

The most important factor causing the loss of biological density and threatening plant species is habitat destruction. About three quarters of the island has already been cleared for agriculture, settlement and other activities. A further 52,000 ha are being deforested each year and in certain areas coastal swamps are being reclaimed. All clearing is not for meeting man's essential needs.

Large areas of delicate and fragile ecosystems on ridges and steep hill slopes, and on mountain plateaux are still being destroyed for cultivation of commercial crops. Since many of the characteristic primary forest species are unable to get established in secondary forests, with clear felling or large scale disturbances in them such species would gradually disappear. Major disturbance in the tree cover also affects the species in the lower strata. Some epiphytes are selective of the species of host trees on which they grow. Replacement of the multistoried forest by even-aged monocultures of plantation crops such as tea, rubber and coconut and exotic forest species like Pines and Eucalypts have drastically reduced the species diversity and destabilized the system. Another problem is the erosion of genetic diversity. In the past traditional varieties of paddy were cultivated, which have now been replaced by a few genetically narrow based high yield varieties, which are said to cover 95% of the cultivated area. Loss of local varieties could cause a serious loss of genetic material which has the potential to help plant breeders against the war on new pests and diseases.

In the wet zone the forest now covers only 9% of the land, yet they are the most interesting in terms of species diversity. Even this has not been left undisturbed. Logging operations in them although selective, have severely affected sensitive species, epiphytes and associated plants. Only a small area - perhaps around 25,000 ha is still relatively undisturbed. These now serve as the last refuges of many of the island's endangered plants, especially the endemics. All efforts are necessary to protect them.

Over the last 2 or 3 centuries most of the valuable timbers of the forest have been removed. Consequently very slow growing trees thereby have become scarce or extinct. Calamander Diospyros quaesita the finest of the island's variegated timbers is now extremely rare. The closely related D. oppositifolia is now confined to a small stand at Hinidum Kanda (Kostermans, 1977). The Madara tree Cleistanthus collinus seems to have been exploited almost to extinction. Many species of medicinal plants and ornamentals are also being overexploited. Others become genetically degraded by the selective removal of the more desirable individuals. The more beautiful orchids are often selectively removed for planting in gardens or for sale. Some of the species endangered in this manner are Dendrobium maccarthiae, D. heterocarpum, Ipsea speciosa and Rhynchostylis retusa. Sumithraarachchi, 1986 states that of a total of 170 species of orchids in the island 74 are endemic, 99 are considered rare, 7 species are vulnerable and probably 13 species could be regarded as extinct. The introduction of alien plant species and chemical pollution are two other causative agents for loss of species. Alien species such as Salvinia molesta, Eupatorium odoratum and Mikania cordata among others have spread so rapidly after introduction that they have ousted native species. Chemical pollution of air, land and water have also resulted in loss of species. Some mosses and liverworts, earlier common as epiphytes have disappeared or become much less common in and around Colombo.

Similarly Schizaea digitata have disappeared in most areas in the Western Province due to use of chemical weedicides in rubber plantations.

As stated in the earlier sections of this report, the island has a total of 763 known species of terrestrial vertebrates (86 mammals, 427 birds, 158 reptiles, 38 amphibians and 54 fish). Collectively 18% of these vertebrate species are endemics. With few exceptions, most of the endemic fauna are confined to the lowland wet zone and hill country. The montane hill country represents final elements which have been least influenced by connection with the Indian mainland. Compared with South India the recent island's fauna is less diversified. However, it was much more varied in the Pleistocene. Fossil and sub-fossil remains indicate that the island once had a hippopotamus Hexaprotodon, two species of the genus Rhinoceros, the Indian lion Panthera leo, the red dog Cuon javanicus and the gaur Ribos gaurus (Deraniyagala, 1958). It is a well known principle that diversity of a fauna and especially of larger mammals is related to the size of the land area. Under natural conditions the island has not been able to retain many of its larger mammals. Today we are left with but a few which include the elephant Elephas maximus, sloth bear Melursus ursinus, spotted deer Axis axis, sambur Cervus unicolor, wild buffalo Bubalus bubalus, wild boar Sus scrofa among the terrestrial forms and Dugong dugong among the aquatic animals. Therefore it is necessary that although the assemblage of mammals is not exceptional every effort should be made to ensure their continued existence.

Despite conservation efforts, the island's wildlife is disappearing very rapidly as a consequence of habitat destruction, poaching, pollution and introduction of alien species. The sizeable list of threatened Sri Lankan animal taxa presented in Annex 3 provides some indication of the magnitude and seriousness of the situation. Included within this list is the Indian elephant leopard Panthera pardus, blue whale Balaenoptera maximum, dugong and several species each of crocodile, turtles and birds which are all of international importance and concern. The fact that many of these threatened species are also endemic to the island serves to underscore the necessity for effective remedial measures to slow the halt of loss of wildlife on a priority basis.

One of the most serious constraints to developing effective measures for protection of the endangered species is the inadequacy of data on the status and distribution of most species. Although there is at least some information on the flowering flora, the fauna remain inadequately studied. Not much is even known about the numbers of each of larger mammal species and even the wild elephant population in the country has varying estimations of between 1500 - 5000. The invertebrate fauna also remain virtually little known.

As stated earlier, most of the requisites for appropriate ameliorative action regarding the protection of species have already been initiated by the government. Significant amounts of

land have been set aside under some type of reserve status. It is also worth noting that Sri Lanka is a signatory to the CITES treaty governing the commercial exploitation of threatened and endangered species throughout the world. This lends important international support to the country's own regulatory efforts in this area (Table 10). Under the Fauna and Flora Ordinance 34 species are absolutely protected along with 340 species of birds and 9 species of plants. Some attempts have also been made for ex-situ conservation in botanical and zoological gardens which will be discussed in later sections of this report.

8.0 Conservation Outside of Protected Areas

This section reviews activities that influence the conservation and management of forest and other biological resources outside of designated protected areas.

8.1 Managed Natural Ecosystems

Natural areas within the country that have been provided some form of legal status, fall into two categories, firstly those that are designed specifically with the primary objective of protection of the biological resources contained within them and include National Reserves and sanctuaries declared under the Fauna & Flora Protection Ordinance. The second category are the managed natural areas, in this case almost exclusively the Forest Reserves and Proposed Reserves that have been established by virtue of the Forest Ordinance which are managed to provide for the sustained production of one or many products such as water, timber, recreation etc, where the conservation of nature is primarily oriented to the support of the economic activities.

The Forest Reserves and Proposed Reserves have been discussed in Section 6 and illustrated in Figure 15. Although these reserves are categorized as managed ecosystems, the level of management with few exceptions are very low or non-existent within them. These areas particularly those in the wet and dry lowlands were originally set aside in order to preserve the wood resource for future commercial extraction to meet local timber and fuelwood needs. In actual fact there was no management exercised at all in the past in these reserves, which were released for timber exploitation to the State Timber Corporation as and when required. In most instances no active consideration was given to the regeneration capability of the forest nor to the impact of these activities on the other values of forestry. Although the Forest Reserves established in the hill country especially those above the 1500 m contour are considered to serve primarily as protection reserves to conserve water and important ecosystems, these have no exclusive legal status that could guarantee this. In fact they are categorized as either Forest Reserves or Proposed Reserves under the Forest Ordinance and enjoy protection from exploitation

exclusively and merely through only an administrative arrangement. This does not therefore guarantee total and permanent protection to these very important ecosystems. Legislation in the form of the National Wilderness Act has recently been passed by the government to overcome this shortcoming. By virtue of the Act, all reserves declared as National Wilderness Areas will enjoy total legal protection and would be excluded from all exploitative activities. It is anticipated that most of the high elevation forest areas and other valuable forests such as Sinharaja, Knuckles, Ritigala and Hakgala would be included within this category of reserves.

It is only in the recent years that an attempt has been made to actively manage some of the Forest Reserves. The National Forestry Master Plan has recommended the scientific management of natural forests and forest plantations of the wet zone to meet the wood demands of the country. Each Forest Reserve and Plantation in the wet zone would have its own forest management plan and which would form the basis for future timber cutting operations. Similar management plans are expected to be prepared for all Man and Biosphere Reserves and for all other categories of protection reserves chiefly the montane watershed forest areas.

There are still appreciable extents of forests outside protected and managed natural areas. These are Village Forests, Other Crown Forests and other areas that have low status. These forests are largely to provide benefits in terms of wood and fuelwood to village communities, and are usually released when a better and more productive use is found for them.

It is worth mentioning that although a majority of the major forest types have representative samples under protection, a number of important ecosystem types have been forgotten and thereby are fast disappearing. It is therefore imperative that urgent attention be given to preserve portions of these ecosystems before they are destroyed and lost from the face of the country. Mangrove forests today occupy less than 6000 hectares within the country and are fast being converted to other uses. Similarly there are no protection areas among the coastal ecosystems such as coral reefs, sea grass beds, salt marshes and mudflats, all of which are ecologically and economically very important habitats. Similarly there are few small and isolated patches under protection within the intermediate forest belt as well as amongst the damana, savannah and villu grasslands and fresh water marsh forests. It is therefore necessary that the entire system of protection and managed ecosystems be reviewed and new areas added in order to ensure that all representative habitat types within the country are effectively brought under protection.

The natural forests and other ecosystems are as we know complex systems where animals, plants and the abiotic environment are very closely tied together. Therefore any change in any one of these components could seriously affect the functioning of the whole system. Changes made within a particular ecosystem are not only felt within the area, but its repercussions extend to the

surrounding area as well and affect not only the ecological status of the area, but also the economic and social spheres as well. In this context when one views the role of these natural ecosystems in maintaining the life support systems on which the people of the country are dependent on, it becomes clear that these natural areas, are indispensable for maintenance of the economic base of the island as a whole.

In the context of the island's natural forests, with a stature of 40 m is the lowland wet zone and with a height of 10-20 m in the montane zone but profusely clothed with lichens, mosses and liverworts, they play a crucial role in the water balance of the country as a whole. Most of the island's perennial rivers originate from these natural forests. Therefore to ensure a continuous water supply in them, particularly during dry weather, it is essential that a natural forest cover be maintained at least around the headwaters of these rivers. Of particular importance are the maintenance of all existing natural vegetation in the headwaters of Sri Lanka's major rivers namely the Mahaweli, Kalu and Kelani Gangas. Similarly marsh forests and wetlands in valleys influence the height of water table beneath its own vegetation cover as well as that around it. Most of these marsh forests in the wet zone have been converted to paddy, now subject to alternate flooding and drying. In contrast the natural vegetation cover maintained fluctuations in the water table to a minimum level, but once converted to paddy there is almost complete drying out of these soils after harvest. These changes in the level of ground water table at one point often adversely influences the level of the water table in the surrounding areas. This is one of the reasons why wells do not have water in the heart of the wet zone during the intermonsoonal periods. A further influence of forests on the hydrology is seen in the patterns of local conventional rains. Outside the monsoon periods, rainfall is the result of intermonsoonal rains brought about by the heating of the lower air masses and its consequent rising upwards to cooler temperatures resulting in local rainfall. The air above natural forests are normally laden with moisture due to evaporation from the ecosystems and therefore induces precipitation and thereby maintains a favourable water balance in the wet zone of the country. These intermonsoonal rains occur regularly at Sinharaja and environs where substantial land is still under forest, whereas in some parts of the districts of Gampaha, Kalutara and Colombo where there is little or no forest left, the frequency of such rain is much less. Natural forest cover in the wet zone further ensures continuous stream flow during intermonsoonal periods. These among other factors, it maintains the annual water regime in these downstream fresh water and coastal systems such as lakes, rivers, mangroves and lagoons. Any change in the water available upstream during these intermonsoonal periods could result in the drying up of these fresh water and coastal systems and only those species which could

face adverse conditions of drought would be able to survive. These adverse affects on the water regime of downstream systems also influence urban and agricultural activities in these areas as so often experienced in the form of power and water cuts.

The natural forests play an important role in regulation of erosion of the soil base. Clearance of permanent vegetation cover in the montane zone for vegetables and other cash crops which poorly cover the soil has led to extensive soil erosion. These immature brown loams with a slope of 30 - 40% and some over 45% having a relatively sandy 'A' horizon is very susceptible to erosion. Complete clearing of forests for tobacco cultivation and clean weeding of the undergrowth for cardamom cultivation on these steep slopes lead to much surface soil erosion. In most of the wet zone, the parent bed rock being close to the surface, deforestation leads to disturbance of the normal drainage pattern, resulting in landslides and earthslips as recently evidenced in the Matale, Kalutara and Ratnapura districts. Lands under natural forests are hardly affected by these phenomena despite the fact that these areas are subjected to heavy rainfall.

The island of Sri Lanka is predominantly an agricultural land where cultivation is based on rainfall and irrigation. Provision of water to some extent and soil altogether for agriculture is largely dependent on natural forests. Therefore a balance must be struck on the extent of land in the country which can be converted to agriculture without jeopardizing optimum production due to ill effects of large scale deforestation. In the respect for optimum supply of irrigation water for agriculture the upper watersheds of the perennials rivers at least must be under natural forest cover. The upper catchment of the Mahaweli Ganga is an important case in point, because of its importance in the Mahaweli Development Project which aims at irrigating 360,000 ha of land in the dry zone and producing 500 megawatts of hydropower. Of the extent of 316,000 ha of the Upper Mahaweli watershed which is characterised by steep slopes, nearly 30% is occupied by Tea and less than 13% is under forest cover, of which three-fourths of the latter is degraded and in need of replanting and improvement. Based on the TAMS report (1980) nearly 40% of the Upper Mahaweli catchment is very poorly managed and in need of rehabilitation. All this proves that this watershed should be rehabilitated to ensure that necessary steps be taken to improve dry season flows that are so necessary to maintain the downstream agriculture.

Gunatilleke and Gunatilleke (1986) report that the several combinations of plants are grown together within the island in multicropping systems. The natural forests serve as nature's model for multi-cropping where every conceivable space in the system has been maximally used. Investigating the different plants, in the different strata of the forest one can simulate them into multicropping agriculture. This is the basis for the Kandyan homegarden which is in fact an agricultural forest where mango,

jak, and breadfruit forming the dominants with Goraka Garcinia spicata, nutmeg, cloves and coffee as sub-dominants. The ground layer is grown with cardamom, ginger and aroids while vanilla, pepper, weniwel Coscimum fenestratum and betel are grown as climbers.

Wildlife parks and forest reserves have become a major tourist attraction. They have been included as a standard part of tours organized for local and foreign tourists. Prior to the recent ethnic strife, wildlife parks such as Yala and Wilpattu were heavily visited with an annual level of over 100,000 and 30,000 visitors respectively. Other preserves such as Sinharaja, Horton Plains, Bundala and Hakgala also attract nature lovers. This has led to a problem of over visitation to the parks particularly Yala and Wilpattu. The question of complete open access needs to be reviewed. On the other hand, financial support is required for the upgrading and maintenance of existing parks and the creation and development of new parks, link forests and corridors.

8.2 Impact of Development Projects

One of the principal causes of loss of forests and biological diversity in Sri Lanka has been the rapid growth of population on a total land area of 65,610 sq. kms. A population density of around 240 per sq. km. is indeed high for any agricultural country and the people have to be provided with the benefits of development programs such as employment, higher incomes, better housing, water and other essential amenities. The accelerated development effort undertaken by the government has at the same time generated its own disturbance on the natural ecosystems and the environment as a whole. Being an agricultural country, the major development efforts have been diverted towards river basin developments which provide many benefits like irrigation for increased food production, hydro-power for development, more employment opportunities etc. These projects have however caused some adverse charges such as the total loss of valuable forests to reservoirs, deforestation in the lower irrigable areas, the creation of artificial water bodies which can often become the habitats for disease vectors and the displacement of large populations away from sometimes populated areas to forested areas and the process of land degradation is set in motion. Another environmental affect of development has been the pollution of aquatic systems with sewage sludge as well as wastes from factories, chemical plants and agricultural lands. Consequently fresh water, coastal and marine receiving waters have been adversely affected as evidenced by the recent fish kills in a number of waterways around Colombo. As a result, fresh water has become increasingly scarce due to greater contamination by pollution and by the deterioration of river basin catchments and watersheds. The coastal and marine environment has also been polluted and decimated. Coastal industrial and tourist facilities have expanded while coastal mining has increased. These developments have drastically reduced the diversity, productivity

and stability of the marine and coastal environments. The use of fuelwood has also had widespread impact on the biological resources. The increasing prices of fossil fuel has raised the demand for firewood. Consequently this has led to the abuse of forests and other ecosystems such as mangroves.

In the past environmental considerations had not been actively considered in the development planning process. One of the major reasons for this was the absence of effective environmental legislation. Also another obstacle was the lack of knowledge on environmental issues at the policy making level. Realization of environmental implications has developed only in the last decade or so. While hitherto major river basin projects were undertaken with little or no consideration to the environment, we now see efforts being made to incorporate some level of environment based integrated planning in development projects. A good example to illustrate this increasing awareness is seen in the planning and development of the Accelerated Mahaweli Development Program (AMP). Plans for the project provide for the cultivation of paddy and other crops along with programs for rational use of water for irrigation and for fish production, development of homestead gardens, development of fuelwood plantations, development of pasture-lands for dairy production, community forestry, plantation forestry and the development of lands for wildlife conservation. USAID provided the financial resources for completing an Environmental Impact Assessment of the AMP and for subsequently developing a Environmental Plan of Action to support the identification of programs and activities that would be necessary within the framework of the Accelerated Program to conserve and protect the biological resources and environment of the region. The follow up action is best exemplified by USAID's subsequent support to develop a system of environmentally sound and socially acceptable system of protected areas, within and around the AMP, with the intent of conserving biological resources and protecting investments made towards agriculture and settlement. This represents a text book example of a project which incorporates the opposing elements of conservation and development in a manner that would best serve the interests of both.

By virtue of the National Environmental Act of 1980 the government established the Central Environmental Authority (CEA) as a policy making and coordinating agency for environmental protection and management and to fill a wide gap created by the absence of an institutional framework to coordinate environmental policy making and programming in Sri Lanka. The CEA was mandated to ensure that development projects undertaken in the country did integrate environmental, economic and social considerations within the planning and decision making process. Consequently, the government in 1984, made Environmental Impact Assessment (EIA) mandatory for all development projects launched by the private and public

sectors. As part of the development plan for the EIA system, basic guidelines for the environmental assessment procedure was developed. These are implemented through 15 Project Approving Agencies. The list of Project Approving Agencies are given below:

(i) Urban Development Authority
(ii) National Planning Division of Ministry of Finance and Planning
(iii) Foreign Investment Advisory Committee of the Ministry of Finance and Planning
(iv) Greater Colombo Economic Commission
(v) Ministry of Industries and Scientific tific Affairs
(vi) National Aquatic Resource Agency
(vii) Coast Conservation Department
(viii) Ministry of Textile Industries
(ix) Ceylon Tourist Board
(x) State Gem Corporation
(xi) Ministry of Lands and Land Development
(xii) Ministry of Agricultural Development and Research
(xiii) Ministry of Plantation Industries
(xiv) Ministry of Mahaweli Development
(xv) Ministry of Health

Each of these 15 approving agencies are expected to adopt its own procedures and develop specific guidelines taking into consideration any specific environmental requirements. The Environmental Assessment procedure consists of five distinct phases:

a) Initial Environmental Examination (IEE)
b) Scoping
c) Environmental Assessment
d) Environmental Action Plan
e) Supplemental Environmental Report

The IEE will provide a brief statement of key environmental issues based upon readily available information and will mainly serve to recommend whether or not further in-depth study, in the form of an Environmental Assessment, is needed. If an Environmental Assessment is needed, then a Scoping meeting will be set up among relevant agencies and parties with the objective of identifying the important issues which must be addressed in detail in the Environmental Assessment (EA). The EA will provide a detailed study of the probable significant effects both beneficial and adverse which a proposed project will have on the environment. The EA will also provide recommendations for establishing environmental safeguards, minimizing detrimental impacts, enhancing beneficial aspects of the project and for effective management of the environmental resources affected by the project. The Environmental Action Plan which would be subsequently developed will spell out in detail how the specific mitigation, protection and enhancement measures which were recommended in the EA should be designed and

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operated, and the resources required and the schedule for implementation. If a major change in a proposed project has to be made after the EA and Plan of Action has been completed, then a Supplemental Environmental Report should be prepared to evaluate specific impacts which may arise due to the new change.

At the Initial Environmental Examination stage the development projects will be screened to identify if an EA will be necessary. The projects that are automatically exempt from Environmental Assessment procedures include emergency relief or assistance, most research activities, training and other educational programs, nutritional or health care services, minor legislation and security measures.

It is worth mentioning that although environmental procedures have been developed for development projects, with the exception of the Coast Conservation Act, none of the other statutes have the legal provision to compel the developer to incorporate environmental planning and safeguards into the development project. This has been a serious drawback to effective management and conservation of the biological resources. However, it is expected that new legislation would be enacted soon to ensure that the developer complies with this need.

8.3 Ex-situ Conservation

Although ex-situ conservation is by no means an ideal substitute for in-situ conservation, it still has an important role to play in preservation of rare and endangered plant and animal life. Ex-situ conservation efforts in Sri Lanka have been confined to programs of botanic gardens, zoological gardens, medicinal gardens and a small number of captive breeding programs.
The arboretum in the Botanic gardens at Peradeniya is said to contain about 10,000 trees and shrubs belonging to 1179 different species (Gunatilleke & Wijesundera, 1982). Some of these plants are as old as the gardens itself, introduced in 1821 when the garden was established or soon afterwards. In this auboreum, trees of Sri Lanka's dry zone are grown in the same neighbourhood as wet zone species. The primary reason for the establishment of this arboreum and other such as those at Gampaha and Hakgala was for the introduction and dissemination of economic and ornamental exotics while recreation and research were of secondary importance. At the early stages the need for ex-situ conservation of species were unnecessary then as pressures on natural ecosystems were low. Within the recent past however the additional role of ex-situ conservation has become an integral part of the activities of the arboreta. Sri Lankan trees and shrubs at the arboreta include both endemics and non-endemics. About 14% of the total number of local endemic tree and shrub species have been planted at the Peradeniya Botanic Gardens. An effort therefore must be made to grow the remaining endemics in suitably located arboreta.

At present the Botanic Gardens at Peradeniya is the last recorded habitat for five endemic plant species of Sri Lanka. The natural habitat of these plants collected during the last century are no longer to be found in these locations due to the destruction of the natural vegetation in these habitats. This Botanic garden is therefore the last refugium for these species and if these species could be successfully propagated these relict species could be rescued from extinction. The five species are :

Crudia zeylanica (Leguminosae)
Dicellostyles axillaris (Malvaceae)
Diospyros atrata (Ebenaceae)
Memecylon macrocarpum (Melostomaceae)
Mesua stylosa (Clusiaceae)

Gunatilleke and Gunatilleke (1984) report that several plant collectors from overseas Botanic Gardens, realizing both the potential horticultural value and threat to their survival in their natural habitats, have collected rare and valuable native plants from Sri Lanka and not only successfully cultivated them in their own gardens, but have also used them for breeding improved hybrids. Lucas (1983) of the Pacific Tropical Botanic Gardens of Hawaii recently collected 16 species of Sri Lanka Strobilanthes, all exceptionally ornamental and some very rare to be cultivated in USA. Similarly, other species like Exacum trinervium and Gordonia sp. have been collected for breeding with their own local related species to obtain horticultural hybrids.

In 1987, the Mahaweli Authority of Sri Lanka along with the Orchid Society of Sri Lanka initiated a program for the ex-situ conservation of indigenous orchid species in an island arboretum located within the Randenigala reservoir. Twenty four species of orchids including three endemic species whose habitats were under threat, were introduced into the 70 ha aboretum at Randenigala. The results have been encouraging with over 60% of the species surviving and establishing themselves. This pilot project is to be further extended to cover a further number of indigenous orchid species as well. The island itself could later serve as an important recreation and education area particularly for persons interested in orchids.

Among the native flora there are over 500 species of plants used in the traditional ayurvedic system of medicine. However, the rapid loss of natural habitats have depleted the wild stock of these plant species. Ekaweriya Rauvolfia serpentina was a common shrub in the wet zone upto an altitude of about 600 m, but has now become rare due to over-exploitation. Other medicinal plants such as Saraca asoca, Goda-Kaduru Strychnos nux-vomica, Rodanti Capparis moonii, Malitha Woodfordia fruticosa among a host of other plants have become very rare in the wild. However, it is encouraging to

note that the Ministry of Indigenous Medicine have formulated plans to conserve, develop and promote research and cultivation of these medicinal plant resources of Sri Lanka. The Ministry has set up a number of arboreta in various climatic zones of the country for growing and propagation of indigenous medicinal plants.

Ex-situ conservation of fauna have been almost exclusively limited to activities of the National Zoological Gardens, which however had been for recreation and education purposes. In recent years however, the activities of the gardens have been expanded to include breeding programs. Captive breeding programs have concentrated on the propagation of the Sri Lanka elephant, a species that is fast dwindling in numbers in their natural habitats. The captive breeding program has made some initial successes and augurs well for the future survival of the elephant. Under the USAID supported Mahaweli Environment Project plans have been made to set up an elephant captive breeding program around Angamedilla in the Polonnaruwa district. This program has three components namely the capture and holding of troublesome elephants from conflict areas; a captive breeding program, and a research and extension program. The captive breeding program envisages the release of the captive elephants to mingle and breed with the wild elephant populations in their natural environment.

Although initial attempts have been made towards ex-situ conservation in Sri Lanka from very early times, these efforts should be reviewed and expanded. As the three main Botanic Gardens at Peradeniya, Hakgala and Gampaha have limited space for extension, similar gardens should be opened in each of the different ecological zones where native medicinal, agricultural, horticultural and other species threatened with extinction could be conserved. Setting up of these botanic gardens will expand the educational and research opportunities in plant sciences. Similarly, active breeding programs should be initiated for conservation of endangered animal species as well. However it must be borne in mind that although ex-situ conservation of selected groups of plants and animals is a laudable attempt to arrest species depletion, it can never be an adequate substitute for in-situ conservation where the entire biological spectrum of a particular habitat is conserved together in its natural environment.

9.0 Conservation of Economically Important Species and Germplasm

Conservation of germplasm in Sri Lanka, has largely been related to agricultural crops and are best described by W.E. Ratnayake (1986, unpublished) which is summarized later in this section of the report.

Perhaps, the most important landmark in plant genetic engineering history in the 20th Century is the construction of the island's first Plant Genetic Resources Centre which is nearing completion.

This Centre which is being located near Kandy has been entirely funded by the Government of Japan at a cost of $14 million. The Centre will employ around 95 workers by 1991 and will be supported by Japanese expertise for the next 5 years. The project itself has been arranged into two phases. Phase 1 will involve the establishment of a gene bank and appropriate green house facilities. Phase 2 will involve the establishment of evaluation laboratories for complex research such as bio-technology and bio-chemistry. In addition conference halls, libraries and computer facilities are to be provided.

The gene bank which is the nucleus of this project will systematically collect, preserve and evaluate raw materials or the genes of the economically important agricultural crops including rice, coarse grains, vegetables and fruit trees. The gene bank is expected to conserve some 25,000 varieties of genetic resources by the end of the first ten years. Legislation to restrict the free export of genetically valuable plants is being prepared as an urgent priority measure.

9.1 Agricultural Crops

Rice is the staple food and "backbone" of Sri Lankan agriculture. The nation's long agricultural history based on rice culture and its eco-edaphic variability have endowed it with a wide variety of indigenous rice stocks. Indigenous rice varieties have shown great adaptability to adverse soil conditions such as salinity, alkalinity and acidity. Traditional varieties grown in uplands areas are well known for their drought tolerance, while others, grown in coastal and river flood plain areas, possess a good tolerance to submergence and flash floods. At higher elevations, a few rice varieties are preferred largely due to their demonstrated tolerance to low temperatures.

Rice is the most potent threatened foodcrop genetic resource in Sri Lanka. As the nation's staple diet and its most important source of nutrition, constant attention has been paid over many centuries to improve the cultivation of rice and increase its production. In addition to local efforts, research in other countries has contributed much to the understanding of the rice plant, which enabled researchers to modify its genetic composition to obtain higher yields. Sri Lankan scientists evolved the first local hybrid rice variety (H4) in 1957 and recommended it for island-wide cultivation. Since that time, many improved rice varieties with higher yield potentials have been developed and put into production. As a result of the steadily increasing demand for rice in combination with improved agricultural extension services, today, some 95% of Sri Lanka's rice lands are cultivated with improved rice varieties. Research efforts are continuing to improve the existing varieties and extend rice cultivation to the

remaining "marginal" areas. An analysis of the genetic base of the new rice varieties, however, reveals that the indigenous germplasm has yet to be substantively integrated into the country's rice production program.

In the 1950's, limited collections of traditional varieties were maintained in the Rice Research Stations at Bathalagoda, Maha Illuppallama and Gannoruwa. Systematic collections were initiated in 1967, and by 1983, the number of collections had risen to 2,745 accessories, including wild rice varieties. Conservation of rice germplasm in medium-term cold storage became possible with a cold storage facility donated by the Government of Japan in 1972. This facility at the Central Agricultural Research Institute (CARI), Gannoruwa, functioned well for almost 10 years. However, in 1981 there was a total breakdown of this unit. As a result, researchers were compelled to attempt to maintain these varieties in the field on a seasonal basis. Due to various field planting constraints and other financial and administrative limitations, the total number of collections of rice germplasm maintained at present has dwindled to a few hundred and, thus, a great number of potentially valuable genotypes have already been irrevocably lost. The Japanese are funding construction of a new Regional gene bank at CARI which will be completed in 1988.

Sri Lankan rice germplasm has generated outstanding gene sources for various traits. Foremost among these are the cultivars with broad-based resistance to serious pests like the brown plant hopper, leaf roller and thrip, and tolerance to iron toxicity and other adverse soil conditions. Long ago, photo-sensitive rice varieties with excellent grain quality ("samba" types) excited considerable interest in research workers. Grain types and qualities in local "Heenati", "Al wee", "Madaluwa", "Muththsamba" and "Lumbini" stocks are also of great interest in current efforts to produce improved quality rice varieties. Oryza nivara, a wild rice whose resistant genes have helped fight the grassy stunt virus in Asia, is also found in Sri Lanka. The Director of the International Rice Research Institute at Manila recently underscored the international importance of the great diversity of rice germplasm found in Sri Lanka in stating that "Sri Lanka is a gold mine for rice genes. While there are 120,000 cultivars of rice in the whole world, this small island has 2,800 varieties recorded so far".

The present emphasis in the screening of rice germplasm material is focused largely on the identification of source material with good potential resistance and/or adaptability to eco-edaphic limitations. However, there are numerous other attributes for which genetic material will be sought in the future. Medicinal properties claimed for such local varieties as "Kaluheenetti", "Dhanahala", etc., use of "Al wee", "Heenetti", etc. as weaning and recuperative food after illness, fragrance emanating from varieties like "Swanda al", eating quality attributes of "Susuru samba", "Muthu samba", "Kuruluthuda", etc. cannot be dismissed simply as biased opinions of illiterate farmers and consumers. It is worth noting in this respect that farmers, over the centuries, have been the only plant breeders in Sri Lanka. Similarly, observations have

been made by field collectors of tilling at higher modes in varieties cultivated in shallow tank beds, varieties with rhizomatus roots, varieties growing in soils consisting of almost pure silica near Pulmoddai, and varieties growing in the highly saline and peaty marshes of Muturajawela.

Wild species of rice are widely distributed throughout the island. Small collections and herbarium samples of O.rufipogon, O. nivara. O. officinalis, O. granulata are being maintained. Wild rice has been found in aquatic lowland soils as well as in drier sites in the hill country.

Active introgressive hybridization between cultivated and wild forms has also been reported in the literature. Much of this superior foreign genetic material has proven to be invaluable in furthering the local rice breeding program. Mas, an Indonesian variety, and Murungkayan 302 were inter-crossed to produce the popular, higher-yielding H4, a landmark in the rice improvement program of Sri Lanka. Similarly, Dee-geo,woogen, the dwarf mutant from China which revolutionized rice research in Asia, is another variety employed in the local research program

The importance of conserving this valuable local resource deserves the highest priority commensurate with rice's primary importance in meeting Sri Lankan as well as international nutrition requirements.

Millets, Sorghum and Maize are the other cereals presently grown in Sri Lanka. The types of millets grown from ancient times are Finger millet (Eleusine coracana), Foxtail millet (Sectaria italica), Common millet (Paspalum milicaceum) and Koda millet (Paspalum scrobiculatum). These types are found distributed throughout the island at the lower altitudes. With the exception of the finger variety, the local millets generally provide relatively poor yields. This may be due to the fact that these grains are grown largely under poor conditions on marginal lands. Further, unlike rice, they have not undergone much selective pressure by farmers, as millets have traditionally been relegated to a supplementary role in the nutrition of the country. In fact, ancient people considered millets, especially finger millets, to be "famine food". This can be understood when the high degree of drought tolerance possessed by these crops is taken into consideration, along with these grain can be stored for months without deterioration.

Of these millets, finger millets are most popular in Sri Lanka, where they are grown under a number of ecological conditions. In Jaffna, they are grown as an irrigated and transplanted crop, whereas in other areas they are cultivated as a shifting, chena crop, either alone or in a mixed cropping system with maize, rice or legumes. Some diversity is evident in the panicle shape and seed color. Collections have been made and tested at the Angunukolapellessa, Maha Illupallam, Karadian Aru and Kilinochchi

Research Stations. Finger millet genomes have also been introduced from India and Africa. Kodo millet is still grown in Jaffna in isolated pockets. Foxtail millets and common millets may still be found in very small patches in the dry zone.

Relative neglect of the millets over the years has resulted in their poor genetic variability and present limited distribution. Millet germplasm needs to be collected to assess their utility and breeding value. This is especially relevant in the context of the recent development of dry zone agriculture under such program as the Mahaweli Development Scheme.

Sorghum is grown to a very limited extent in the low country. The only diversity encountered is the red and white-seeded compact panicles and "rice sorghum". The "rice sorghum" has loose panicles with rice-shaped seed with glumes and can be cooked like rice. This latter cultivar may well have potential for future exploitation in Sri Lanka and merits further investigation.

Maize is also grown in dry zone areas both for human consumption and for animal feed. Four samples have been collected by the Angunukolapelessa Research Station. Coix lachryma (Kirindi) and Echinochloa frumenacea (Rajamarata) varieties have also been reported growing in the wild state.

Legumes constitute an important source of protein to the vast majority of people of Sri Lanka. Pulses are in short supply necessitating large imports. Pigeon pea (Cajanus cajan) is grown in isolated areas as a backyard crop, but its cultivation is not widespread. Short-duration and determinate-type improved cultivars, introduced during the 1960's, faced acute pest problems which also devastated the local cultivars. Cultivars with yellow flowers and green pods, and orange-colored and small-seeded types are commonly found in Sri Lanka. Yellow-flowered species with broad pods and medium-size speckled-seeds have also been observed. Wild relatives of pigeon pea such as Atyosia, Rhynchosia, Viscosa and Dunbaria have been recorded. A. scarabaeoides, found commonly in the dry zone, has the potential for introgressive hybridization to develop insect-resistant cultivars.

Groundnuts (Arachis hypogaea) are grown [illegible] in the dry zone areas, mainly for confectionary purposes. The red-yellow latosol region of Mullativu contains a substantial area of groundnut cultivation. Groundnut improvement work has been initiated at the Research Station in Angunukolapelessa where some promising foreign introductions and mutants are currently being tested.

Introduced cultivars of green-gram (Vigna radiata) and black-gram (Vigna mungo) are presently under limited cultivation in the dry zone. White, brown and black-seeded cultivars of cowpea (Vigna unguiculata) have been reported in the Anuradhapura districts. Soya bean cultivars with demonstrated adaptability to different

ecological conditions were introduced in the 1970's. Chick pea (Cicer arietium) introductions with adaptability to dry zone conditions were carried out in 1980. Successful introductions of bush beans and broad beans have also been undertaken.

Winged bean (Psophocarpus tetragonolobus) is another widely distributed legume in Sri Lanka. Traditionally, it is used as a vegetable. A program of collection was initiated at CARI during a 1975 rice collection expedition. Twenty-one (21) local "Dara dambala" accessions were made from the dry and intermediate zone areas of the country. Variations in seed color, pod size and flower color are noticeable. Promising germplasm from Papua New Guinea and Nigeria has also been obtained for evaluation. These collections were subsequently transferred to the Faculty of Agriculture, University of Peradeniya.

Grain legumes are rightly afforded a high status in the current important dry zone crop diversification programs. Emphasis should be placed on gathering in one place all available local and introduced germplasm material in order to better exploit their genetic variability. Both yield potential and adaptability to varying environmental conditions should be carefully investigated.

9.2 Horticultural Crops

Among the fruit crops there are several varieties of Banana (Musa) under cultivation in the different agro-ecological regions of Sri Lanka. Banana is mainly grown as a home garden crop. "Anamalu", "Bim kehel", (dwarf plantain), "Embul" (Sour plantain), "Hondaravala", "Kolikuttu" (sweet plantain), "Poovalu", "Suvendel" and "Rath kehel", are some of the popular local varieties. The variety "Seeni kehel" has the ability to survive under adverse ecological conditions and to withstand attacks by pests and diseases. Certain other varieties are rapidly disappearing and their collection and propagation is considered essential. A small live collection is maintained at CARI.

The other two fruit crops currently under threat are lime (Citrus aurantifolia) and sweet orange (C sinesis). A large amount of variability in these crops had been reported in the 1950's, however, genetic erosion due to drought, virus and fungal disease has greatly depleted the former diversity displayed by these crops. There is an urgent need to collect the remaining germplasm for conservation. Citrus seeds are recognized as "recalcitrant seeds", hence appropriate methods of conversation for these species have yet to be devised. In recent times, some promising introductions from abroad have also been made. Woodapple (Feronia limona) is another crop which rates a high priority for conservation measures.

The other fruit crops such as Mango (Magnifera sp.), Jak fruit (Artocarpus heterophyllus), Avocado (Persea americana) exhibit a large amount of variability. Mangosteens (Garcinia mangostana), Durian (Durio zibethinus), Rambuttan (Nephelium lappaceum), Guava (Psidium guyava), Papaw (Carica papaya), and Pomegranate (Punica granatum are some of the other popular local fruits. Although none of these latter species appear to be seriously threatened with extinction at present, germplasms collections should be made before it is too late. Some of the other fruit trees found in Sri Lanka are "Beli" (Aegle marmelos), "Nelli" (Phyllanthus emblica), "Anoda" (Abutilon asiaticum), "Goraka" (Garcinia cambogia), and Tamarind (Tamarindus indica) which should all also be collected, propagated and their germplasm conserved.

Numerous types of both temperate and tropical vegetable are cultivated in the different agro-ecological regions of the country. The majority of these species do not appear to be immediately threatened, however, the genetic diversities of curcubits, tomatoes and eggplant (Solanum and Amaranthus spp.) appear to be slowly diminishing. Therefore, a preliminary assessment of the indigenous varieties of vegetable crops and their priority for appropriate conservation measures should be conducted without undue delay.

It has been estimated that there are 170 species of plants of ornamental value in Sri Lanka. Of this total, some 74 species are reported to be endemic. Dendrobium and Vanda species country's jungles are being cleared for cultivation, it would be worthwhile to initiate a systematic collection of these plants (see also other sections of this analysis for further information on this subject).

Under a collaborative program, systematic efforts are currently underway to assemble and evaluate local and introduced root and tuber crop germplasms. At present, 110 accessions of cassava and 71 accessions of sweet potato maintained at CARI are undergoing genetic evaluation. The other important root and tuber crops in Sri Lanka are Dioscorea, Aroids and Solenostemos rotundifolius (Innala) species.

The important Dioscorea yams in Sri Lanka are D. alata, D. esculanta, D.rotundata and D. bulbifera. Twenty-nine accessions of these species are being maintained at CARI, of which 19 are from D. alata. An interesting feature of this project is that a Dioscorea species namely D. trifida, is being cultivated on a small scale in Sri Lanka, the only such attempt to date outside its native habitat in the Americas.

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Xanthosoma, Colacasia and Alocasia varieties constitute the Sri Lankan germplasm of the Aroids. Fifteen accessions of these species have been assembled, including 8 cultivars of Xanthosoma, 6 of Colacasia and 1 of Alocasia. It has been reported that Alocasia macrorrhiza is one of the most ancient crop domesticates of Sri Lanka.

With regards to Innala (Solenostemos rotundifolius), 19 cultivars are undergoing evaluation at present. The other lesser important root and tuber crops found in Sri Lanka are arrow root (Maranta arundinacea), Amorphophallus, and Artichoke (Helianthus arundinacea.

Sri Lanka has long been famous for its spices. It has been suggested that Cinnamomom zeylanicum is native to the southwestern parts of the island. The other spices grown as minor plantation crops are Pepper (Piper nigrum), Cardamom (Elettaria cardamom) and Nutmeg (Myristica fragrans). Genetic resources of these crops are maintained by the Department of Minor Export Crops at Matale.

Pepper is found distributed in the intermediate and the wet zone areas of Sri Lanka. Considerable genetic diversity is apparent in both the cultivated and wild species of the genus Piper. About 500 local selections are currently being maintained, of which 8 are thought to be promising. Ten wild species have also been identified. Varieties recommended for further research and/or utilization are Panniyor 1 and Kuching (introductions from India and Malasia, respectively), and Swarna Lanka 10 and Padukka local selections.

Cardamoms are found cultivated on the mountain slopes of Nuwara Eliya, Kandy and Matale districts. About 40 different selections have been assembled. Ten wild races of Cardamoms collected from the Sinharaja forest and from Badureliya (Kalutara District) are being investigated. Foreign germplasm material has also been introduced.

Germplasm of Cloves (Eugenia caryophyllata) is being maintained from selections made in 10 locations in Kandy and Matale district. No foreign introductions have been made.
Twenty-seven accessions of 5 cultivars of Betel (Piper betel) are currently under investigation.

Field collections of Areca catechu (Arecanuts) are in the process of being made at the Rambukkana and Warakapola research centers.

The other known spice crops of Sri Lanka are Ginger, Turmeric and Chilli. Two accessions each of Ginger (Zingiber officinale) and Turmeric (Curcuma domestica) are presently being maintained at CARI. The three chief species of chillies are Capsicum minimum (birds-eye pepper), C. Frutescens (condiment chilli), and

C. Grossum (Malu Miris). All are quite popular locally as a vegetable. Limited local collections and introductions have been made. Selections made at the Agricultural Research Station, Maha Illupallama, have been released for cultivation.

Considerable attention has also been awarded to the genetic resources of oil crops, such as Sesame (Sesamum indicum), Castor (Ricinus communis) and Sun Flower (Helianthus annuus), and fiber crops, such as Cotton (Gossipium herbaceum) and Kenaf (Hibiscus occidentale) are other important Sri Lankan plant species which have been neglected. Collections of their germplasm, though of a relatively low priority, should be initiated.

9.3 Plantation Crops

The Assam species of tea, Camellia assamica (Masters), was originally introduced into Sri Lanka in 1839, however, it was not commercially grown until 1867 due to the collapse of the coffee plantations (which were attacked by fungus). Tea is now grown on some 242,880 hectares almost continuously from sea level to 1,980 meters in altitude, yielding about 204 million kg. each year. This is the mainstay of the Sri Lankan economy, regularly contributing some 60% of the nation's foreign exchange earnings. Tea is an introduced germplasm from Assam which has undergone selection in this country through various breeding programs. Selected genotypes are being conserved in the various breeding stations and tea estates in Sri Lanka.

Tea, being self-incompatible, shows a high degree of cross compatibility. Use of seed in its propagation would not, therefore, be satisfactory due to a high degree of breakdown in genotypic uniformity from generation to generation. This constraint was overcome in the late 1930s with the development of vegetative propagation. This discovery has since enabled researchers to produce a substantial number of genetic clones with good yield, resistance, adaptability, fermentation and other such desirable traits and characteristics. The following numbers of clones were recommended for planting in Sri Lanka in 1980: high elevation zone - 20. Almost all of these selections were locally produced.

Conservation and improvement of the tea germplasm is carried out in Sri Lanka by the Tea Research Institute (TRIO). However, greater improvements of genetic stocks through new methods of breeding and selection are required. In addition, improved scientific techniques should be used for such purposes. Tissue culture work and genetic engineering should be introduced as soon as possible to further improve the quality and productivity of tea to keep apace with an increasing increasingly competitive market. Moreover, the germplasm of the old varieties and clones can be more economically conserved with tissue culture techniques. The clonal genotypes must be properly conserved and preserved for future breeding and genetic engineering programs at TRI.

Wickram introduced the rubber plant to Sri Lanka in 1876 from the Kew Gardens (Great Britain), where it had been propagated from seeds obtained from Brazil. Almost all of the subsequent rubber clones used in Sri Lanka have been bred from these original 1919 seeding. However, between 1955 and 1959, direct introductions of certain Latin American clones were made, providing vital new inputs to the local breeding program. The total number of clones at the present are:

i)	RRIC 1 to RRIC 98	98
ii)	RRIC 100 series (100 - 133)	34
	Total	132

Hevea braziliensis germplasm collection was initiated in 1981, with the assistance of the member countries of the International Rubber Research and Development Board (IRRDB). The conservation of rubber germplasm is now, therefore, well under way.

The responsibility for this work in Sri Lanka is currently entrusted to the Coconut Research Institute (CRI) at Bandirippuwa Estate, Lunuwila. The International Board for Plant Genetic Resources (IBPGR) initiated consultations on coconut genetic resources at FAO Headquarters in 1978. Although suitable plans have since been drawn up for future research in this important area, little concrete action has occurred. Implementation of plan recommendations should be awarded a high priority. A great deal of breeding work was carried out by CRI in the 1960's and 1970's and a variety of rubber hybrids were developed. Tissue culture work is absolutely essential to keep such genotypes alive as they cannot be vegetatively propagated. This objective is presently being pursued with the establishment of a new tissue culture laboratory at CRI.

10.0 Major Issues in Biological Diversity and Tropical Forest Conservation

The preceding sections of this report clearly indicate that in-spite of its small size, Sri Lanka possesses a great wealth and diversity of biological resources. Sri Lanka's biological resources include a relatively high proportion of endemic plant and animal species, some of which are of ancient origin. The island's biological resources may have survived into the modern era due to the influence of Buddhism, which eschewed the taking of any form of life. It is also apparent that the government and the people of the country recognize and appreciate the need for the careful management and conservation of these resources as is best reflected by the substantial extent of declared protected land. Despite all these praiseworthy efforts, it is clear that the island's plant and animal species are gradually being decimated to the future

detriment of all. It is also evident that unless urgent measures are taken to reverse this trend, the future holds little prospect for the survival of these resources.

Although there a number of factors that contribute to resource depletion in Sri Lanka, the over-riding factor that influences all of them, is 'economics'. Like all other developing countries, economic development in Sri Lanka, relies crucially on the island's natural resources and on the productivity of its natural systems. This economic growth is accompanied by increasing stress on the natural systems and significant adverse affects on environmental quality. Burdened with a rapidly burgeoning population, the country continuously faces the dilemma of having to choose between the more short-termed economic gains associated with unsustainable development approaches and the longer termed, sustainable benefits achieved through proper resource management and conservation. In the face of these mounting pressures, it must be acknowledged that for at least the immediate future the approaches favouring short-term economic benefits will prevail. Consequently, additional areas of forests and other biological habitats will give way to economically productive developments such as agriculture and industry as the government progressively moves towards uplifting the standard of living of its people.

Attempts to rectify Sri Lanka's current resource management problems must recognize and respect the contextual constraints under which they must operate. Conservation programs and techniques which are almost exclusively geared towards resource protection and conservation without recognition of socio-economic considerations can only hope for marginal or little successes. The basic underlying factor is that unless people can derive some benefits from resource conservation programs, there is little chance these programs would be accepted. In such circumstances, the logical attempt will be to balance conservation and development goals and seek to achieve an optimal, yet realistic, compromise between these two approaches. The ultimate goal of this effort should be to give the people of this country a reasonable living standard, one that will then guarantee a better understanding and appreciation towards natural resources and its conservation, and offer the best chance of future sustenance of the island's resource base. However, there is much that should be done while this worthwhile aim is being pursued to ensure that the nation's resources remain available for future use and enjoyment.

An integrated multidisciplinary approach to land use and conservation is needed covering the development and utilization of the resources that land, water and forest have to offer us leading to development without destruction. Where such destruction has already taken place, development efforts should lead to scientific restoration and reconstruction.

At the present juncture, there are a number of casual factors that retard the progress of marrying conservation and development into the developing planning process which would favour an integrated approach to resource utilization and conservation. These factors are discussed under separate sub-headings in the following sections.

10.1 Future Areas for Legal Development

As discussed earlier in this report, Sri Lanka possesses a great number of laws that pertain to resource conservation and environmental protection, illustrating the varied development of environmental awareness among legislators. These cover a variety of situations ranging from management of resources and preservation of national heritage to prevention of pollution and improvement of environmental health. Although, one would expect that the extent and detail of legislation should reflect the island's commitment to environmental and resource management, in actual fact implementation is often inadequate, due to a variety of reasons ranging from inadequate funds and personnel to the lack of a singleness of purposes and the mixture of priorities.

In view of the serious shortcomings and deficiencies in the existing legislation, a thorough review of the legislation is necessary with a view to introducing reforms to cover all legislation with a bearing on the environment. The reforms should incorporate the principles of conservation and resource management including sustainable development. Most of the laws are inadequate in the present day context of resource management. For instance there is only one law for enforcement of environmental quality standards and environmental impact assessments of development projects. On the other hand certain laws lack provisions that are basic and fundamental to good resource management. For example there is no provision in the Irrigation Ordinance to adequately protect catchments and watersheds.

Many of the laws remain fragmented and scattered among several agencies. Consequently when several institutions and organizations are called upon to deal with a given problem under their respective laws, quite often there is divided responsibility and loyalty as well as lack of proper definition and direction. Coordination therefore becomes extremely difficult. This results in different agencies attempting to redefine their boundaries, territorial limits and safeguard their rights and privileges without getting down to work in the national interest. Therefore there is an urgent need to examine all legislation pertaining to the environment with a view to amalgamation, rationalization and integration so as to reduce the number of laws and make them more effective and easy to coordinate. There are other drawbacks to effective legal enforcement that need to be addressed. They have their roots in lack of finances, transport, trained staff and other

economic, social and political reasons. There are also institutional problems that affect the legal process such as the inadequacy of supporting services. A case in point is the Pesticide Act, where there is a registration process but no institutional arrangement for analyzing toxicological data, monitoring toxic residues and taking offenders to court.

10.2 Future Areas for Institutional Development

One of the most important constraints to effective resource management is the lack of coordination among the concerned public and private sector interests for integrated resource planning and management. There are scattered and uncoordinated attempts made by each individual institution to handle natural resource management problems within its own compartment of authority. Consequently there are divided interests and overlap of activities among these agencies which often is not conducive to effective resource management. These agencies have functioned in a competitive, rather than integrated manner, according to each agencies' priority areas of interest. As a consequence, data is not shared and planning proceeds in a relative vacuum and consequently scarce resources are wasted. There is therefore an urgent need to establish a central body to coordinate programs of action geared towards proper resource conservation and management. This can only be achieved through an integrated approach. There is a need for rationalization of the functions of existing agencies in order to optimize the use of available resources, even if it results in the reorganization and merger of some of them. In view of the national importance of the question of natural resource conservation and degradation and in order to avoid inter-ministerial and inter-department rivalries, it would be desirable to place this institution under the highest political authority. The Central Environmental Authority was created in 1980 with the function of collaboration and coordination in the work of the different agencies concerned with natural resources utilization and conservation. This Authority was also expected to also play an important policy making role. Although, one wouldn't expect that the authority should be conferred with enormous administrative and regulatory powers, but rather serve a pivotal role in policy formulation and coordination, yet this authority remains weak due to inadequate resources and political commitment. Consideration might be given to strengthening this Authority with increased financial and trained manpower resources, and may be provided with more powers to direct and coordinate all resource management issues within the country and powers to enforce compliance of environmental safeguards on mitigation measures.

Management of natural resources might also be assisted by the GSL commitment to the development of an Integrated National Land Use plan formulated on the basis of appropriate and sustainable use of the natural resources. Considerable work has been done by the Survey Department, Irrigation Department and the Land Use division of the Ministry of Agriculture on surveys and data collection in

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selection to land use. However much of this information is not readily available. Its value is impaired because the data is not integrated and analysed. Therefore it is necessary that all information on land use must be collected, analysed and updated. Appropriate surveys should be carried out to fill the data gaps. Subsequently, an Integrated Land Use Plan should be developed for the island as a whole, on the basis of integrated land use data. This integrated plan should take into account the varying needs of agriculture, irrigation, energy, housing, watershed protection, biological diversity, climate, soil and other ecological parameters.

Complimentary to the above, is the need to divert adequate financial and manpower resources towards the effective monitoring, management and regulation of the biological resources. Although there are a number of agencies concerned with direct resource conservation, their activities have been severely affected by the non-availability of adequate or matching resources. Consequently, even though there may be a commitment towards resource conservation, such as the demarcation of protected areas, implementation of effective resource management is restricted for the above reasons. Requirements therefore primarily concern the expansion and upgrading of existing staff capabilities, strengthening of existing legislation, and provision of logistical support facilities. The increased delegation or decentralization of authority from the center to the district or local-level would also be useful in this regard in providing for the utilization of all available in-country resources while simultaneously promoting the most effective and efficient means of administering resource policies, management programs and regulations. In this respect the need to upgrade some of the agencies concerned with resource issues is imperative. A case in point is the Department of Wildlife Conservation, which manages nearly 12 percent of the land extent of the country, yet is considered a low-grade department having a small budget allocation to manage all its diverse activities and programs. Consequently, resource conservation issues are only marginally addressed, most protection areas remains poorly staffed and little effort and energies are diverted to non law-enforcement activities.

10.3 Future Development of Conservation Awareness

Paradoxically, the island which has a tradition that supports the conservation of natural resources, now faces a burgeoning population that is driven by poverty to exploit the same natural resources that were grudgingly protected by their ancestors. In such a situation, the lack of appreciation of the importance of biological resources and the need for appropriate conservation will largely prevail as long as there is no solution to the question of poverty. Therefore, programs that are developed with the intent of increasing appreciation and understanding of biological resources and the need for its conservation, must concurrently be supported by programs that are aimed at eliminating poverty and improving the

standards of living of the people. There is a corresponding urgent need to strengthen formal environmental education programs at all levels of the education system; to expand informal conservation awareness enhancement programs for politicians, decision-makers, government officials and the general public and to improve local community participation in regional conservation initiatives.

Poor planning by politicians and planners with an overemphasis on short-term economic gains without regard for environmental consequences have been in the past an important reason for degradation of the biological resources. Fortunately, environmental problems are no longer considered inevitable and it is acknowledged that many problems could be avoided or mitigated. International donor agencies and institutions that support development in third world countries must share an equal responsibility for ensuring that environmental considerations are included in the developed scenarios. Their assistance should include designing environmentally sound development projects, encouraging appropriate technology alternatives, funding technical training opportunities, conducting environmental assessments and supporting environmental research. In many cases, however, large donor agencies tend to neglect one very crucial aspect namely the application of community education to environmental management. Frequently, education is an afterthought in environmental projects and are usually only included in the event of a surplus of project funds. This is a critical omission, because community education is vital to the success of environmental management efforts.

Education efforts must be addressed to all community members including village leaders, farmers, the general public, school children, village societies etc so that they be motivated to do their own part in managing their environment wisely. The most reliable way to obtain people's cooperation in this endeavour is to demonstrate how it will benefit them.

In Sri Lanka, there are many voluntary organizations that are not only interested in resource conservation, but are actively furthering conservation education as well. These organizations should be encouraged and their views on conservation issues should be given serious attention. Their resources of manpower, in addition to other means, should be fully tapped to disseminate conservation education throughout the country. It is also important that these conservation groups and Universities should be actively consulted in national issues that relate to biological resource use and conservation.

10.4 Future Development of the Resource Information Base

The lack of adequate information on biological resources is a major constraint towards good management. Although achievements have been made in inventories of forests, flowering plants and agricultural species there is a need for inventories of fauna and lower plant groups. There is little, if any, reliable and

comprehensive data regarding species distribution, abundance, status or national trends available. However, this information particularly on the fauna is important and critical for any serious management improvement program.

Little is known regarding the numbers, distribution and behaviour even of the large mammal groups such as the elephant, leopard, bear, spotted deer, primates etc. The invertebrate fauna is even less understood.

The absence of such resource information, including factors that influence the distribution and abundance of plant and animal species makes accurate prediction of environmental effects on them due to various development initiatives impossible and only speculative. Similarly, little is known about the behaviour and reproduction of fish, amphibian and reptile species. A priority need therefore is to support the collection of baseline resource information on the plant and animal species, so that future decisions for biological resource management could be made on sound resource information.

11.0 Recommendations for Proposed Actions

Sri Lanka already has taken a number of laudable steps to further the goal of improved resource management and conservation. The creation of a central administrative body responsible for overall environmental coordination; the large number of agencies involved in resource conservation; the allocation of an extensive area of land for resource conservation needs and the number of people involved in this interest, shows that there is at least commitment amongst the government and its people towards resource conservation. Indeed, it is suggested that few developing countries could claim an equivalent level of demonstrated commitment towards the fulfillment of these important objectives. However, there is still much that can be done for improved resource management in Sri Lanka. The Government with the assistance of international donors, should be encouraged to support the activities listed below.

The recommendations for proposed action are listed into two categories viz. high priority and lesser priority needs, and within each of these categories recommendations are listed in descending order of priority.

11.1 Revisions of Current Legislation

There are serious shortcomings and deficiencies in the existing legislation covering environment and resource management. Many of the laws are archaic and obsolete and were not enacted with

conservation and resource management in mind. Some laws have been woefully inadequate, many remain fragmented and scattered among several agencies and there are no serious shortcomings in law enforcement.

(a) High Priority Needs

(1) Review these laws with a view to introducing legal reforms covering all legislation with a bearing on the environment

(2) Incorporate new concepts of conservation, resource management, monitoring, quality standards, impact assessments and regulation into the revised laws

(3) Examine all legislation with a view to amalgamation, rationalization and integration so that the number of laws are reduced and made more effective and easy to coordinate

(4) Provide support for improving law enforcement such as finances, transport, trained staff etc

(5) Provide institutional arrangements for analyzing and monitoring the regulatory process.

11.2 Institutional Needs

(i) There is a lack of coordination among the different agencies involved in a resource planning and management in Sri Lanka. The need to improve the coordination and functioning of existing institutions is directly linked to the above legislative issues.

(a) High Priority Needs

(1) Complete and implement the National Conservation Strategy for reconciliation of the conflicts between conservation and development

(2) The Central Co-ordinating body, the Central Environmental Authority (CEA) could be strengthened and made to play a more positive role in coordination and policy formulation and should be provided with regulatory powers

(3) Develop environmentally sound technologies for successful integration of development and environment goals

(4) Incorporate environmental analyses at appropriate stages of planning and development

(5) Develop environmental standards as well as monitoring and assessment methodologies

(b) Other Priority Needs

(1) Increase involvement of Non-Governmental organizations into environmental planning and development processes

(2) Decentralize the environmental planning, implementation and regulatory functions to the regional or district levels

(ii) There is an inadequacy of financial and trained manpower resources for effective resource management and conservation

(a) High Priority Needs

(1) expand and upgrade staff capabilities in key state and non-state agencies such as the Central Environmental Authority, Forest Department, Department of Wildlife Conservation, Coast Conservation Department, National Aquatic and Research Agency, Agriculture Department, Ministry of Indigenous Medicine etc.

(2) provide increased training opportunities for staff from these institutions and technical assistance

(3) provide increased finances, equipment and other logistical support to key governmental and non-governmental agencies, such as transport, monitoring and research equipment, communication equipment, data processing, surveillance equipment etc

11.3 Resource Information Needs

There is inadequate information available in the country on the status of biological resources. This has been a constraint to effective resource planning and management.

(a) High Priority Needs

(1) Promote increased biological research within the country. These should include resource surveys and inventories, critical habitat assessments, distribution analysis, ecosystem dynamics, succession patterns etc.

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(b) Other Priority Needs

(1) establish a central collection-house for all research and resource base information in Sri Lanka. This Agency should also be responsible for collection, storage and dissemination of information

(2) promote increased collaboration among research scientists at national, regional and international levels through information exchange, workshops and exchange programs

11.4 Environmental Awareness Promotion

There is a lack of appreciation of biological resources and their values among the public and our policy makers.

(a) High Priority Needs

(1) strengthen formal environmental education programs at all levels of the education system

(2) strengthen publicity campaigns on a nation wide basis through available media such as T.V., radio, newspaper etc.

(3) promote conservation programs that bring tangible benefits to communities such as productive buffer zones, eco-development, eco-tourism etc.

(4) improve local community participation in local conservation initiatives including planning, implementation and maintenance of conservation programs that have a direct relevance to a community

(5) expand informal, locally-targetted conservation awareness programs in priority regions of the country, emphasizing benefits of proper resource management

11.5 Direct Resource Conservation

(i) Forest Resources

Forestry sector activities are largely geared towards the exploitation of the wood resources of forests and the establishment of monoculture plantations to meet local needs with little considerations to the other values of forestry

(a) <u>High Priority Needs</u>

(1) Legally define a meaningful and worthwhile forest policy for Sri Lanka, one that would consider the hydrological, biological, ecological, production and utilization values of the forest in the best interest of sustained development

(2) Strengthen legislation to ensure better protection for critical forest areas

(3) Develop management plans for all large and critical forest areas particularly for the high elevation montane forests

(4) Review existing categories of forest reserves in light of need to include areas of critical watershed, ecological, biological value and other life support systems under protection
Representative samples of all ecosystem types need to be protected

eg Knuckles Range
Mangroves
Savannah grassland
Riverine forests
all Montane forests
Lowland rainforests

(5) Redemarcate existing boundaries of forest reserves incorporating additional forested areas and excising encroached land

(6) Strengthen education and training for implementation of <u>in-situ</u> conservation

(7) Promote the development of agro-forestry system particularly to buffer zones adjacent to important forest areas

(8) Increase conservation awareness programs on the need to conserve forests and other biological resources

(9) Promote the development of community woodlots, particularly on degraded lands, to meet the energy needs of the people

(10) Improve the forest resources data base

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(b) Other Priority Needs

(1) Initiate an active biological research program

(2) Enhance measures for ex-situ genetic conservation of rare and vulnerable species through setting up of additional botanic gardens, herbaria and refugia and strengthening of existing ones

(3) Identify alternate sources of energy and promote their use to lower demand on firewood and other wood based products

(4) Promote the concept of mix-species forest plantations and promote silvicultural research to identify alternate fast growing indigenous species for large plantations

(5) Promote the use of energy efficient stoves and cooking devices

(ii) Wildlife Resources

Although an appreciable extent of land has been set aside for wildlife protection, wildlife resources are being depleted at an unprecedented rate.

(a) High Priority Needs

(1) Elucidate a national policy for the development, management and conservation of the wildlife resources of the country. The policy should be based on a long term commitment to conservation through a statement of goals, priorities and strategies for preserving the country's biological resources

(2) Develop a National Master Plan for the development and management of the wildland resources based on sound principles of sustainability, limited use and conservation

(3) Examine the current functions, organization, policies and staffing of the Department of Wildlife Conservation on the basis of restructuring the agency to meet the current and future demands of wildlife conservation.

(4) Review the legislation related to wildlife conservation with the aim of improving enforcement and responding to changing needs and objectives of conservation and wildlife management

(5) Undertake a thorough re-evaluation of existing protected area classification in light of changing needs and in the context of international standards

(6) Review existing protected areas, and as appropriate, reclassify, redemarcate and include newer ecosystems and areas that are not presently covered by existing protected area classification

(7) Identify critical habitats, missing or inadequately represented ecosystems including marine and coastal areas that should be provided protection status

(8) Develop an integrated, co-ordinated and active research and management program to deal specifically with the perpetuation of the elephant population

(9) Sponsor, encourage and utilize research and surveys to provide the scientific basis for protection and develop management plans for each of the protected areas

(10) Develop a comprehensive training program for staff involved in resource management

(11) Initiate co-operative efforts with neighbouring people and other groups to gain support for protected areas

(12) Initiate programs in buffer zones of protected areas where direct benefits of conservation could accrue to adjacent communities

(b) <u>Other Priority Needs</u>

(1) Develop and improve appreciation towards the reserves and wildland resources through appropriate programs of interpretation, education and publicity

(2) Secure boundaries of protected areas

(3) Provide additional support for vehicles, equipment and housing to protected area personnel and programs

(4) Promote the concept of contiguous and linked systems of forests, forest reserves and wildlife reserves

(5) Develop active programs for breeding and re-introduction of rare and endangered species

(6) Pursue measures to ratify, implement and maintain programs to comply with international conventions related to wildlife protection

(iii) Coastal and Marine Resources

The marine and coastal ecosystems are under severe stress through habitat destruction, interference with flow of food, energy or materials through the ecosystem and the destruction of physical conditions such as water quality, circulation patterns and instability of the shoreline.

(a) High Priority Needs

(1) Strengthen the Coast Conservation Department in management and planning capabilities through training and technical assistance programs

(2) Develop planning and management guidelines for activities that directly or indirectly affect these resources

(3) Survey the existing extent of resource use and the magnitude of the impact of these actions on the resources

(4) Identify critical and vulnerable habitats requiring special attention and develop management plans for each of them

(5) Expand the system of protection areas to include mangroves, sea grass beds, estuarine and lagoon systems, coral reefs, sand dunes and salt marsh ecosystems

(6) Develop a more comprehensive understanding of coastal and marine resource systems through surveys of resource distribution, utilization and resource dynamics

(7) Develop a program for creation of awareness among the coastal dwellers on the importance and value of coastal resources

(8) Identify alternate sources of livelihood for persons presently involved in destruction of coastal and marine resources

(9) Map out all coastal habitats and develop management plans for the more important and critical areas

(10) Provide additional facilities such as transport, monitoring equipment etc to the Coast Conservation Department

(b) Other Priority Needs

(1) Redefine the Coastal legislation to include total coastal ecosystems

(2) Develop a program for regular assessment and monitoring water quality in coastal areas and develop standards for effluent discharge and loadings

(3) Devise plans and means to regulate upland activities that have the potential to alter or degrade coastal systems

(iv) Wetland Resources

Although fresh water wetlands are one of the most productive biological resources they have not been afforded the attention they need and consequently are being destroyed.

(a) High Priority Needs

(1) Identify threats and disturbances to these wetlands and devise measures to protect them

(2) Inventorize all the wetlands within the country, identify their value to a wide variety of wildlife, birds and humans

(3) Include important wetlands within the protected area network and develop plans for the management of them

(b) Other Priority Needs

(1) Promote research on the wetlands in order to understand better how these ecosystems function and their dynamics

(2) Ratify the RAMSAR convention for the protection of important wetlands

(v) Agricultural Crops and Livestock Resources

Wild crop genetic resources with potential for improvement of agriculture and horticulture are being rapidly lost through the destruction of their natural habitats.

(a) High Priority Needs

(1) There is an urgent need to catalogue potential wild species with value in agriculture and publicize their importance

(2) Enact legislation for the strict protection of important resource areas

(3) Develop programs to exploit the genetic potential of native species for integration into existing animal husbandry programs

(4) Strengthen the capabilities of research institutions to expand work on conservation of natural resources

(5) Create public awareness on the importance of wild species and the need to preserve them

(6) Promote the concept of gene banks

(7) Accelerate the program for propagation of promising economically important species like cane, bamboos, medicinal plants etc

(b) Other Priority Needs

(1) Identify a National Agency to be responsible for the coordination of genetic conservation activities.

(2) Initiate and promote research on the preservation of seeds, pollen and other sources of germplasm of the native species

(3) Establish arboreta and clonal gardens to preserve valuable plant species

(4) Promote collaborative research between universities and research institutions with regard to genetic conservation

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Only rainforest in India, Sri Lanka

Annex 1

Depletion of Singharaja has gone on apace, says don

4/30/87 (From D. G. A. Perera Senkadagala special correspondent) "Daily News"

Sinharaja is the only rainforest left in Sri Lanka as well as the whole subcontinent of India and it provides one of the best rainforest study areas in Asia today, said Dr. I. A. U. (Upali) N. Gunatilaka of the Dept. of Botany of the University of Peradeniya, addressing a research colloquium at the Institute of Fundamental Studies, Hantana, Mahanuwara.

Dr. Gunatilaka was speaking on the subject "A decade of botanical research at Sinharaja, and its contribution to conservation and utilisation of plant resources".

Prof. S. Balasubrmaniam who presided, introduced Dr. Gunatilaka as one who with his wife to assist him in the research, had spent about fifteen years to study our forests, of which nearly a decade has been devoted to Sinharaja

The flora of Sinharaja has developed in a climatic isolation for it does not have the monsoonal climate of the rest of the island, and the nearest climatic pattern is to be found only in the Congo.

The depletion of this rainforest has gone on apace so that what remains today is only 22,000 hectares out of a total of 8000 square kilometres of forest that once existed in this part of the country. The agents of this depletion were mainly rubber cultivation during the colonial period and logging after the Second World War, while shifting cultivation also contributed to it to a very much lesser extent

Out of a total of 231 species of plants that have been classified here, only seven can be described as being out of danger of extinction, while 141 are vulnerable and 72 are positively endangered. 142 species of trees, or 61%, of the total recorded for the lowland wet zone happen to be endemics confined to the Sinharaja today. Forty four species are yet unidentified.

Fifty three species of plant are of use to the local village population for medicine, food, fuel-wood, and oil etc. 'Wenivelgeta', wild ginger, kitul, Hal (Vateria copallifera) and wevel (Calamus rotang) are some of these. There is no danger of over exploitation of these by the local people, but the real danger is from the big mudalalis doing illicit felling or selective logging It would be ludicrous to punish the local sprats while the real sharks do the damage unhindered.

The area of forest left is too small to sustain much large fauna, but some sambhur, wild boar, purple faced leaf monkeys, an occasional leopard and even very small herd of elephants are on record to have been seen here.

In experiments for reforestation, it has been found that growing Kenda (Macaranga peltata) and Geduma (Trema orientale) as fast growing nurse trees provides the necessary shade for other species of natural vegetation to grow.

Name of property: SINHARAJA FOREST RESERVE

Country: Sri Lanka

Universal significance: Sinharaja is the last surviving example of a viable size of Sri Lanka's tropical rainforest. As a remnant of Gondwanaland vegetation (descending from the time when the southern continents were all joined together), it has had an extremely long evolutionary history which is quite separate from that of nearby southern India. About 60 percent of the tree species are endemic (found nowhere else), and 16 of these species are considered very rare; many of the plants are of medicinal or agricultural importance. Related to plant endemism, there are many endemic animals, including mammals such as the golden palm civet and the rusty-spotted cat (possibly the world's smallest), 18 of Sri Lanka's 21 endemic birds (including 3 which are endangered), and dozens of endemic reptiles and amphibians.

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PROTECTED AREA SYSTEM OF THE CEYLON WET ZONE *

a. Extent of Unit
The unit consists of the south western corner of the island of Sri Lanka (see Fig.10) which enjoys everwet climatic conditions. The unit has a total area of 18,600 km².

b. Administrative Divisions
The entire unit falls within Sri Lanka.

c. Natural Vegetation
Most of the area was originally clothed in lowland rainforest. Montane areas were covered in sub-tropical broadleaf hillforest and the highest peaks in montane wet temperate forests. Fig. 10 shows the distribution of these original vegetation types.

d. Current Land Use
Most of the original vegetation has been destroyed or modified by the high density of human inhabitants. Lowland areas are under extensive rice fields, farms and coconut plantations. Hilly areas support tea, teak and other crops and the mountains are mostly under secondary forest. Only 1% of the unit still supports its original vegetation cover and that is mostly in the mountains.

e. Biological Richness and Endemism
The unit is less rich in species than comparable areas of mainland India, as one would expect for an island, but is quite rich in species and very rich in endemic forms, particularly among rainforest trees and other plants (see Table 6 -). For instance all but one of the primitive dipterocarp trees on Sri Lanka are endemic (Kostermans, 1983). Endemism among selected mammal groups (primates, ungulates, carnivores and pangolins) runs at 10% whilst the endemism among selected bird groups (passerine families) runs at 15%.

f. Distinct Sub-units
We have recognised no distinct sub-units within this small unit.

g. Species Considerations
The unit contains two mammals of high conservation importance, listed in the Mammal Red Data Book of IUCN, namely:- leopard *Panthera pardus* and elephant *Elephas maximus*. The unit contains several bird species listed as candidates for the ICBP/IUCN Red Data Book for Birds including:- Sri Lanka wood pigeon *Columba torringtoni*, red-faced malkoha *Phaenicophaeus pyrrhocephalus*, green-billed coucal *Centropus chlororhynchus*, forest eagle owl *Bubo nipalensis*, Ceylon whistling thrush *Myiophoneus blighi*, ashy-headed laughing thrush *Garrulax cinereifrons*, white-headed starling *Sturnus senex* and Sri Lankan blue magpie *Urocissa ornata*.

The fate of these bird species will be determined by the fate of the very tiny remaining area of rainforest in the unit. The very large number of endemic rainforest trees would also be lost if we fail to save these forest remnants.

The following reptiles of the unit are listed in the IUCN Red Data Book of Amphibia-Reptilia:- mugger *Crocodylus palustris*, estuarine crocodile *Crocodylus porosus*, leatherback *Dermochelys coriacea*, hawksbill turtle *Eretmochelys imbricata* and olive ridley *Lepidochelys olivacea*.

One swallowtail butterfly from the unit is listed as vulnerable in the IUCN Red Data Book – Ceylon Rose *Atrophaneura jophon*.

h. Additional Features for Protection
There are numerous ethnic shrines, temples and prehistoric sites in the unit in need of protection.

i. The Protected Area System of the Unit

Table 1.1 lists the details of the protected areas system of the unit. The total area protected is very small, amounting to less than 1% of the unit but there is little more remaining natural habitat suitable for protection and no additional proposals.

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Table 1.1 Protected Areas in the Ceylon Wet Zone

Country	Name	Category	Gazetted	Altitude (m)	Vegetation	Habitat area (km²)	Total area (km²)	Management	Contrib. score	Priority
SL	Peak Wilderness	4	.T.	500-2176	MWT	40	223	2	71	B
					SBLH	103				
SL	Sinharaja	8	.T.	300-1150	LR	50	200	2	10	A

j. Analysis of Coverage versus Threat

Table 1.2 shows the degree of protection afforded to each of the vegetation types of the unit and the threat faced by each (expressed as % remaining). The most threatened habitat – lowland rainforest – is the least protected, but almost all remaining original habitat is protected. Even the last patch of rainforest in Sinharaja Biosphere Reserve has been partly logged.

Table 1.2 Habitat Coverage for Unit

Habitat	Orig.area (km²)	Rem.%	Prot.area (km²)	Prot.%	Prop.area (km²)	Prop.%
LR	14500	0	0	0.0	50	0.3
MWT	500	12	40	8.0	0	0.0
SBLH	3600	3	103	2.8	0	0.0
Totals	18600	1	143	0.7	50	0.2

k. Evaluation of Protected Area Importance

Sinharaja, as the last custodian of a wide range of endemic fauna and flora, is a site of the highest conservation importance. Loss of this site would result in the extinction of a long list of species.

l. Evaluation of Protected Area Effectiveness

The only two protected areas of the unit are quite well managed and protected. In view of their importance, however, they deserve even greater support and more vigorous protection.

m. Assessment of Status Suitability

The status of Sinharaja should be raised to strict nature reserve (IUCN category 1), largely closed to the public and maintained for research only.

n. Identification of Major Gaps in the System

The protection system of the unit is completely inadequate in relation to the biological importance of the unit. Unfortunately, there is so little natural habitat remaining that there is now no possibility of any major extensions to the protected area system of the unit.

o. Recommendations for Reserve Additions and Extensions

All remaining forest in the Sinharaja area should be included in the reserve. A buffer should also be established around the reserve where forest species can recolonise neighbouring land to increase the area of rainforest habitat, last refuge of several vulnerable species. Some of the tree species are so rare they are literally known from only one or two specimens. They could be saved by careful management in such buffer zones.

p. Additional Conservation Needs

1. Management plans should be completed for the two reserves and further improvement could be made to the guardforce in terms of recruitment, training and equipment.
2. Efforts to promote public awareness and support for conservation matters should be intensified at all levels of society. NGOs such as the Wildlife and Nature Protection Society are very active in Sri Lanka and have played an important role in mobilising public opinion.

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3. A National Conservation Strategy is needed and is being prepared by the Central Environment Authority.
4. Environmental impact assessments should be mandatory on all major developments.
5. Greater local involvement should be encouraged in protected areas to enhance their effectiveness.

VEGETATION TYPES

Tropical Wet Evergreen Forest	LR
Tropical Semi-Evergreen Forest	SER
Tropical Moist Deciduous Forest	TMD
Littoral Forest	Mn
Tropical Dry Deciduous Forest	TDD
Tropical Thorn Forest	TS
Tropical Dry Evergreen Forest	TDE
Sub-Tropical Broad Leaved Hill Forest	SBLH
Sub-Tropical Pine Forest	SPF
Sub-Tropical Dry Evergreen Forest	SDE
Montane Wet Temperate Forest	MWT
Himalayan Moist Temperate Forest	HMT
Himalayan Dry Temperate Forest	HDT
Alpine/Sub-Alpine	SA
Seasonal Marsh	SM
Seasonal Salt Marsh	SSM
Freshwater Swamp	FS
Desert	SD

* Adapted from MacKinnon & MacKinnon, 1986(I.U.C.N.)

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LIST OF WILDLIFE RESERVES & SANCTUARIES OF SRI LANKA

		EXTENT HA
A) STRICT NATURAL RESERVES		
1.	YALA	28,904
2.	RITIGALA	1,528
3.	HAKGALA	1,142
		31,574
B) NATIONAL PARKS		
1.	WILPATTU	131,692
2.	RUHUNU	97,877
3.	MADURU OYA	56,802
4.	SOMAWATHIYA	36,337
5.	WASGOMUWA	33,765
6.	UDA WALAWE	30,821
7.	GAL OYA	25,900
8.	YALA EAST	18,148
9.	FLOODPLAIN	17,350
10.	LAHUGALA	1,554
		450,246
C) NATURE RESERVES		
1.	TIRIKONAMADU	25,027
2.	HORTON PLAINS	3,160
		28,187

		EXTENT HA
D)	SANCTUARIES	
1.	VICTORIA -RANDENIGALA- RANTAMBE	41,600
2.	MADHU ROAD	26,677
3.	PEAK WILDERNESS	22,380
4.	TRINCOMALEE NAVAL	18,130
5.	SERUWILA-ALLAI	15,540
6.	GAL-OYA SW	15,280
7.	GAL OYA NW	12,432
8.	KOKKILAI	12,400
9.	CHUNDIKULAM	11,150
10.	SENANAYAKE SAMUDRA	9,324
11.	MINNERIYA-GIRITALE	6,692
12.	PADAVIYA TANK	6,475
13.	BUNDALA	6,216
14.	VAVUNIKULAM TANK	4,851
15.	KUDUMBIGALA	4,403
16.	WIRAWILA-TISSA	4,165
17.	GIANTS TANK	3,942
18.	ANURADHAPURA	3,502
19.	MAHAKANDARAWEWA	2,000
20.	RAVANA ELLA	1,932
21.	BUDDHANGALA	1,841
22.	POLONNARUWA	1,523
23.	TELWATTE	1,424
24.	KATAGAMUWA	1,005
25.	MIHINTALE	997
26.	KATARAGAMA	837
27.	KALAMETIYA KALAPUWA	712
28.	WILPATTU NORTH	624
29.	SEGAMAM	616
30.	KIMBULWANA OYA	492
31.	SRI JAYAWARDENAPURA	449
32.	WELHELLA-KATAGILLA	135
33.	TANGAMALAI	132
34.	KEGALLE	114
35.	UDAWATAKELLE	111
36.	GREAT-SOBER ISLAND	65
37.	GALWAYS ISLAND	57

		EXTENT HA
38.	HIKKADUWA	45
39.	MAIMBULKANDA - NITTAMBUWA	23
40.	PARATITIVU ISLAND	18
41.	PALLEMALALA	13
42.	HORAGOLLA	13
43.	HONDUWA ISLAND	8
44.	LITTLE SOBER ISLAND	6
45.	PIGEON ISLAND	5
46.	ROCKY ISLETS	1
		240,358
	TOTAL	750,365

PROPOSED

MINNERIYA-GIRITALE NR	42,000
NILGALA JUNGLE CORRIDOR	28,000

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List of Threatened Animal Taxa From CMC

15 March 1985

SRI LANKA

Taxon name	Common name
Order LEPIDOPTERA	
Family Papilionidae	
Atrophaneura(pachlio jophon	
Family Danaidae	
Idea iasonia	
Parantica taprobana	
Order HYMENOPTERA	
Family Formicidae	
Aneuretus simoni	Sri Lankian Relict Ant
Order VENEROIDA	
Family Tridacnidae	
Tridacna maxima	Small Giant Clam
Order CETACEA	
Family Balaenopteridae	
Balaenoptera musculus	Blue Whale, Sulphur-bottom Whale
Family Ursidae	
Melursus ursinus	Sloth Bear
Family Felidae	
Panthera pardus	Leopard
Order PROBOSCIDEA	
Family Elephantidae	
Elephas maximus	Indian Elephant, Asian Elephant

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Taxon name	Common name
Order SIRENIA	
Family Dugongidae	
Dugong dugon	Dugong
Order CYPRINIFORMES	
Family Cyprinidae	
Barbus cumingi	Cuming's Two-Banded Barb, Pothaya
Barbus nigrofasciatus	Black Ruby Barb, Bulath Sapeya
Barbus pleurotaenia	Side Striped Barb, Hitha Massa
Order CYPRINIFORMES (cont.)	
Family Cyprinidae (cont.)	
Barbus titteya	Cherry Barb, Dola Tittaya
Labeo fisheri	Green Labeo, Gadaya
Rasbora vaterifloris	Vateria Flower Rasbora, Hal Mal Tittaya
Family Cobitidae	
Lepidocephalus jonklassi	Spotted Loach
Order PERCIFORMES	
Family Gobiidae	
Sicydium halei	Red Tail Goby
Family Belontiidae	
Belontia signata	Combtail, Pulutta
Malpulutta kretseri	Ornate Paradisefish
Family Channidae	
Channa orientalis	
Order TESTUDINES	
Family Cheloniidae	
Caretta caretta	Loggerhead Turtle, Tortuga de mar, Cares, Tartaruga domar, Uruana, Suruana
Eretmochelys imbricata	Hawksbill Turtle, Carey, Tortuga Carey, Tartaruga verdadeira & de Pente
Lepidochelys olivacea	Olive Ridley Turtle, Pacific Ridley Turtle, Tortuga verde, Parlama
Family Dermochelyidae	
Dermochelys coriacea	Leatherback, Leathery Turtle, Luth, Tortuga Tora, Barriguda, Tartaruga

Order SERPENTES	
Family Boidae	
Python molurus	Indian Python, Burmese Python
Python molurus molurus	Indian Python
Order CROCODYLIA	
Family Crocodylidae	
Crocodylus palustris	Mugger, Marsh Crocodile, Broad-snouted Crocodile
Crocodylus porosus	Estuarine Crocodile, Salt-water Crocodile