BIODIVERSITY CONSERVATION IN SRI LANKA

A Framework for Action

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Biodiversity Conservation in Sri Lanka: A Framework for Action

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Message of the Hon. Minister of Forestry and Environment

The word biodiversity is of recent origin. However, we have a strong tradition in our culture in conservation of our biological wealth. Our ancient records have numerous references to the initiatives taken by the rulers to preserve flora and fauna. For instance, King Devanampiyatissa declared an animal sanctuary in 3rd century BC.

Sri Lanka has a rich diversity of flora and fauna, owing to the varied climate, topography and soils. The high diversity of ecosystems has provided habitats for rich species diversity, and edaphic and climatic variants of individual species. Sri Lanka is heavily dependent on her biological resources to sustain its economy, making it incumbent upon us to take very serious note of the threats to our indigenous biota and to the natural ecosystems of which they are a part.

In the modern times, there have been various developmental activities in the country. There was the development of settlement agriculture in the 50's and 60's, followed by industrial development and the 'green' revolution. These coupled with the phenomenal increase of human population have placed severe stress on the environment, resulting in today's crisis predicament. As a result of these development processes, we are losing wild populations, and thus the genetic diversity. Many endemic species, including medicinal plant species which have been used for centuries in our traditional systems of health care are either lost or under threat. Indeed, these losses cannot be valued.

The Convention on Biological Diversity (CBD) is a welcome move to arrest the erosion of biodiversity worldwide. Indeed, Sri Lanka, being proactive to the needs, was one of the early countries to ratify the CBD in 1994. As a first step in implementing the CBD, Sri Lanka has prepared a framework for action for the conservation of biodiversity (BCAP), which has been approved by the Cabinet of Ministers in August 1998.

I am particularly pleased that the government has now a definite policy framework for the conservation of biodiversity. It necessarily brings out a commitment from all stakeholders to achieve the goals of this document. In the current context of our economy, it is of paramount importance to proceed with the stated development plans of the government. This framework document has provided the background to plan the strategy to balance the forces between conservation and development.

There are numerous state agencies managing Sri Lanka's natural resources. Indeed, some resources such as forests are managed by more than one agency. It is therefore of utmost importance to seek ways and means of integrating sectorial plans and policies within the common framework of the BCAP so that all those who have a stake in natural resources understand their responsibilities towards conservation and sustainable use of biodiversity. An equally important facet is to bring in the provincial administrations into the framework of the BCAP - for they are all managing the country's biological wealth.

As the national focal point for the CBD, my Ministry fervently hopes that this endeavour will bring about the coordination and promotion of this national effort to conserve the nation's beleaguered biodiversity.

Nandimithra Ekanayake
Minister of Forestry and Environment

Message by the Secretary to the Ministry of Forestry and Environment

I am pleased to provide this message on the occasion of the publication of "Biodiversity Conservation in Sri Lanka - A Framework for Action" prepared by my Ministry. This document heralds a new era in focusing on the Government's programmes on conservation and sustainable use of Sri Lanka's rich biological diversity.

The publication of this document is the culmination of a long and arduous preparatory process. The Ministry with technical assistance provided by IUCN - The World Conservation Union, Sri Lanka began this important activity with the preparation of a strategy document setting out the steps and actions needed for the preparation of a plan of action for biodiversity conservation. The preparation of this strategy was an intensely participatory process involving many discussions and consultations with relevant agencies and stake-holders, which was completed in 1994.

The preparation of "Biodiversity Conservation in Sri Lanka - A Framework for Action" began in early 1996. Once again, with the technical assistance provided by IUCN, my Ministry took the initiative to consult all stake-holders, in the participatory process. Several drafts were reviewed over a period of one year, and the final document resulting from these consultations was approved by the Cabinet of Ministers in August 1998. It should be noted that for expediency, this document uses statistics and data that were widely available in the early 1990's. Much of the data, and in particular those relating to statistics on genera and taxa have been used more to underscore the status and trends in biological diversity. These have been helpful in formulating the final recommendations contained in this document. It is understood that research on plant and animal taxonomy is, of course, a continuing activity, and new species are regularly discovered and added to existing listings. For example, a considerable number of new amphibian species have been discovered recently by local scientists. Thus some of the statistics on species given in the publication may be different to that recorded at the present time. Some readers may therefore get a feeling of unreality and may consider it a rebuff to the inquiring mind; yet, however, such discrepancies will not materially affect the general trends encompassing the final recommendations. To the discerning mind, updated information on our biological wealth will be continuously available in various technical publications.

I hope that this publication will catalyze the relevant agencies to reflect biodiversity in their respective plans and programmes in order to facilitate my Ministry's efforts in this important national endeavour.

K. A. S. Gunasekera
Secretary, Ministry of Forestry and Environment

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Introduction

The term Biological Diversity or Biodiversity is new. However, in Sri Lanka, the basic concept of biodiversity and its conservation is as old as the recorded history of the country, dating back to over 2000 years. When the monarchs of old proclaimed edicts for the preservation of wildlife in defined areas, they were, in today's context, establishing "protected areas". When the village communities systematically organized their landscape, with the irrigation tanks and cultivated areas in the low-lying land, the settlements at higher levels, and the catchments in the hilly areas left under forest, they were recognizing the environmental value of conserving the natural forest in the catchments. When the farmers cultivated many different varieties of rice, recognizing their special qualities regarding food value, cooking properties, palatability, medicinal value, etc., they were in fact conserving the genetic diversity of this species; and this diversity remains to this day, but is now under threat due to the preference for high-yielding varieties with a narrow genetic base. When the households raised multi-tiered crops in their home gardens, they were conserving and using sustainably a multitude of species for food, medicine, fuel and fodder, while at the same time replicating the structure of a natural forest.

The Convention on Biological Diversity, which aims to conserve the planet's biological species and provide for their sustainable use by present and future generations, was placed before the heads of state for signature at the United Nations Conference on Environment and Development, or Earth Summit, on 5 June 1992. The nations of the world gave a clear expression of their concern "that biological diversity is being significantly reduced by human activities" when over 150 of them signed the Convention within two weeks, and subsequent ratification proceeded so fast that, within 18 months, the Convention came into force. Sri Lanka ratified the Convention in March 1994.

Biodiversity is the variety of organisms found on earth. The definition given in the Convention is more explanatory; it is: "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems."

Article 6 of the Convention requires each contracting party to: "(a) Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, inter alia, the measures set out in this Convention relevant to the contracting party concerned: and "(b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral plans, programmes and policies."

The preparation of this Biodiversity Conservation Action Plan (BCAP) was undertaken in response to Article 6 of the Convention. Agriculture, the plantation industry, and fisheries are vital sectors of Sri Lanka's development programme. The use of biological resources is therefore of critical importance to the sustenance of the country's economy. What the plan proposes is a course of action to ensure that the biological diversity within the country is conserved and used sustainably and that development programmes pursued by the different sectors do not cause serious or irreversible damage to the indigenous biodiversity.

The value of the nation's biodiversity has not gone unrecognized by the government and people of Sri Lanka. There are many legislative enactments that deal with the protection of biological resources. In 1980, the National Environmental Act constituted the Central Environmental Authority. Soon after, in response to the World Conservation Strategy, Sri Lanka began preparing a National Conservation Strategy (NCS), one of the first countries in Asia to do so. In 1988, after a lengthy process of survey and consultation, the NCS was adopted as the centre-piece of the government's policies to deal with environmental degradation in the country. Then, in 1991, based on the recommendations of the NCS, a National Environmental Action Plan (NEAP) was

adopted for a four year period. The implementation experience led, in 1994, to a revised NEAP, for the period 1995-98. Over the years these environmental policy frameworks have influenced and helped shape several generations of sectoral and national development strategies.

The National Conservation Strategy, the National Environmental Action Plan, the Forestry Sector Master Plan, the National Coastal Zone Management Plan, and Coastal 2000, are some of the policy instruments that have addressed biodiversity conservation. There are many government institutions whose responsibility it is to translate these policy initiatives into action. These include the Forest Department, Coast Conservation Department, Department of Wildlife Conservation, Central Environmental Authority, Department of Agriculture, Botanical Gardens and Zoological Gardens. However, despite the legal, policy and institutional support for its conservation, the country's biodiversity is continuing to get depleted. There are many causes for this; the growth and movement of populations, the opening of economic markets, and new trends in industrial development will have a growing adverse impact on biodiversity unless more systematic and stringent corrective measures are taken.

The BCAP recognizes the many projects and programmes currently in progress for the conservation of biodiversity. However, some of these activities are stalled or not proceeding at the expected rate, and the main reason for this is resource limitations. In the course of BCAP preparation, the problems of depletion of biodiversity in the different ecosystems were subject to causal chain analyses to determine the issues, proximate causes, underlying causes, and action needed.

The BCAP sets out the range of activities needed for addressing biodiversity as a co-ordinated, holistic exercise. Many of the activities are at present in progress, and their inclusion in the Plan will add strength and a sense of urgency to the current efforts. Other proposals address gaps in the current programmes, which the relevant institutions should take up for implementation. Yet others are new activities which the concerned institutions should undertake so as to ensure the success of the national effort for biodiversity conservation. The BCAP urges that biodiversity conservation is of critical importance for the ecological and economic sustenance of the nation, and brings together within a single framework all the activity areas that need to be addressed. The Plan should, therefore, serve as a policy instrument for securing financial support both nationally and from foreign donors.

The BCAP presents a framework for action. It has not attempted to spell out in detail each activity and to set out the financial budget and other resources needed. Such a step, it is argued, would not only be impractical but would have been counter-productive had it been attempted. As stated earlier, many of the activities are ongoing, and many others, with very little additional resources, could be accommodated in the ongoing programmes. Setting out resource needs and financial budgets for each activity would discourage the institutions concerned from undertaking the tasks unless substantial additional resources are made available. For activities where new resources are in fact needed, the institution concerned should have the expertise and would be in the best position to prepare project proposals.

In preparing the BCAP, the ecosystem diversity of Sri Lanka was categorized into four broad areas: forests, wetlands, coastal and marine systems, and agricultural systems. This classification, besides signifying an ecological differentiation, is useful in terms of the division of responsibilities between different organizations of government.

Chapter 2 which follows this Chapter gives a broad overview of the country and its biodiversity.* Chapter 3 describes the four major ecosystems, the species diversity within them, the relevant policies relating to them, and their jurisdictional institutions.

Chapter 4 presents the results of a study carried out in the course of BCAP preparation to divide the island and its offshore territory into bio-regions, and, using various criteria, to determine the bio-regions that should be given high priority in addressing biodiversity conservation issues. Chapter 5 sets out the guiding principles, the goal and the overall objectives of the Plan. Chapter 6 sets out the proposals for action. In respect of each activity area, the section dealing with it has four parts: identifying the issues; the objectives; the recommended actions; and the main implementing institutions. Chapter 7 deals with the intersectoral and inter-institutional integration needed for the implementation of the BCAP. Chapter 8 is on implementation. It sets out the

proposed institutional arrangements for implementing the Plan and sets time frames for achieving various outputs. A two-year inception phase is proposed, followed by a ten-year implementation phase, the latter broken down into two phases of five years each. In practical terms, it is recommended that the Plan be subject to a review and revision at the end of the first five-year period. It is also recommended that a comprehensive review of progress be made three years after the commencement of the first phase.

The BCAP has been prepared by IUCN Sri Lanka in collaboration with the Ministry of Transport, Environment and Women's Affairs. The National Environmental Policy Project of the Ministry carried out two preparatory studies - on valuation of biodiversity and biodiversity information. In preparing the BCAP, IUCN's core staff was supported by a team of national consultants, many of whom worked for brief periods on the tasks assigned to them. Two international experts were brought in by IUCN at different times during plan preparation to advise the consultancy team.

The preparatory process was intensely participatory. The members of the consultancy team met with several heads of institutions to discuss their mandates and programmes as they relate to the conservation and use of biodiversity and the programmatic gaps that exist. In addition, they had discussions with many well-informed individuals. Several workshops and seminars were held, commencing from the early stages of plan preparation, to seek the views of NGOs, government organizations and the public. The collaborating Ministry wrote to over a 100 NGOs scattered across the country explaining the task in hand and seeking their views on the national efforts needed for conserving the country's biodiversity. A round-table was held to discuss in depth the Convention and the implications of its implementation in Sri Lanka. The BCAP is the product of these many consultative processes. (See Appendix 1 for details).

The Ministry of Forestry and Environment (MFE)** and IUCN Sri Lanka wish to thank the Global Environment Facility and the World Bank for providing assistance for the preparation of this Plan.

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* In chapter 2, the main source of figures for species is Wijesinghe et al. (1993), Biological Conservation in Sri Lanka: a national status report, IUCN, Sri Lanka, the figures for flowering plants are from MALF (1995), Sri Lanka Forestry Sector Master Plan; the figures for birds are from Kotagama, S. W. (pers. com.); the figures for amphibians are from Dutta, Sunil K. and Manamendra - Arachchi, Kelum (1996), The Amphibian Fauna of Sri Lanka, Wildlife Heritage Trust, Sri Lanka.

** In the text where the abbreviation ME is used, it refers to the Ministry in charge of the subject of Environment, which prior to 10 June 1997 was the Ministry of Transport, Environment and Women's Affairs (MTEWA), and since then is the Ministry of Forestry and Environment (MFE).

Sri Lanka and its Biodiversity - an Overview

2.1 Physical Features

Sri Lanka is located at the southern point of the Indian sub-continent, between 5° 54' and 9° 52' North Latitude and 79° 39' and 81° 53' East Longitude. Its land area is 6,570,134 ha. Topographically, the island consists of a south-central mountainous region which rises to an elevation of 2500 m, surrounded by broad lowland plains at an elevation of 0 - 75 m above sea level. From the mountainous region nine major rivers and 94 other rivers drain across the lowlands into the Indian Ocean.

The climate is tropical overall, but it shows variations across the island due mainly to differences in rainfall and elevation. The rainfall shows seasonal fluctuations and is dependent on the southwest and northeast monsoons and on convectional and cyclonic effects. The mean temperature in the lowland areas is 27^{0}C in the wet region and 30^{0}C in the dry zone. It decreases with increase in altitude, and in the montane region the mean monthly temperature varies from 13^{0}C to 16^{0}C, with the night temperature occasionally dropping to around zero.

The country has been divided into climatic regions in many different ways. Generally three broad climatic regions are recognized: the wet zone, dry zone and intermediate zone. Whereas the dry zone is all lowland, the other two zones are further subdivided on the basis of altitude. Figure 2.1 shows a division of the island into a large number of agro-ecological regions, where the annual rainfall and its seasonal distribution and the altitude are taken into consideration.

Geologically, 90 per cent of the island consists of Precambrian crystalline rocks. The other main rock types are Miocene limestone deposits that extend from the Jaffna peninsula and the adjoining offshore islands to the northwest coast as far as Puttalam and down the northeast coast to Mullaitivu, and a small area of Jurassic deposits at Tabbowa andw Andigama, near Puttalam. The overlying soils are of many different types, but the red-yellow podzolic soils (lateritic red loams) in the wet region and reddish brown earths in the dry zone are the most common.

Geomorphologically, Sri Lanka is part of the ancient continent of Gondwanaland. India and Sri Lanka broke off from the disintegrating continent as what is called the Deccan Plate, and, as this plate drifted northwards, the two countries became isolated around 20 million years ago. Sri Lanka has retained its present outline for the last ten million years, since the end of the Miocene. Today, Sri Lanka is separated from India by the narrow Palk Strait, but it is likely that there had been oscillations of the relative levels of the land and sea resulting in land connections with India for short periods.

Sri Lanka, despite its small size, has a rich diversity of soils (Figure 2.2). Fourteen of the Great Soil Groups have been recognized within the country. The Great Soil Groups in the dry zone and the drier part of the intermediate zone are Reddish Brown Earths (occupying the largest area), Low Humic Gley Soils, Non-calcic Brown Soils, Red-Yellow Latosols, Alluvial Soils (in the flood plains of the larger rivers), soils of the Old Alluvium, Solodized Solonetz (in the arid areas), Regosols (in the coastal areas), and Grumusols and Rendzinas which are found in relatively small extents.

The Great Soil Groups in the wet zone and in the wetter parts of the intermediate zone are the Red-Yellow Podzolic Soils (which is the dominant type), Reddish Brown Latosolic Soils, Immature Brown Loams and Bog and Half-bog Soils (found mainly in the tidal marshes).

2.2 History and Culture

The recorded history of Sri Lanka goes back to the advent of Indo-Aryans from India in 543 BC. Until the sixteenth century AD, the country had an independent, monarchical system of governance. From 1505, the maritime areas were dominated successively by the Portuguese, Dutch and British. In 1815, the British assumed control of the entire island after they annexed the central

A temple painting at the *Mirissa Sumudragiri Viharaya* depicting biodiversity as a part of the wider human environment (Jinie Dela).

kingdom. Sri Lanka regained political independence in 1948 and became a Republic in 1972.

During the time of monarchial rule, the concepts that we now recognize as biodiversity conservation were ingrained in the cultural and religious beliefs of the people of Sri Lanka. According to the Mahavamsa, the great chronicle of Sri Lankan history, the protection of forests and animals was esteemed highly by both rulers and subjects. This respect for all forms of life is fostered by Buddhism which spurns animal slaughter. As far back as the third century BC, wildlife 'sanctuaries' for the protection of fauna and flora existed in this country, while the concept of 'urban nature reserves' was promulgated in the twelfth century AD.

With the onset of the colonial era, there was a dramatic change in the cultural and socio-political climate in the country. During this period of foreign rule there was large scale destruction of the forests, particularly for the

Box 2.1

"Conservation of Biodiversity" in Ancient Lanka

In centuries past, during the time of the Sinhala Kings, forests and animal life were an important part of the social fabric. They were accorded a special status and protected under the law of the land. Commenting on this aspect of social life, John D' Oyly (1835) states that "Within Mahanuwara itself there was no doubt that the forest was strictly interdicted as a royal preserve - the ditch marking the limits of the city went round the king's great thicket, Udawattekale, and people were not allowed even to gather firewood and withes in it."

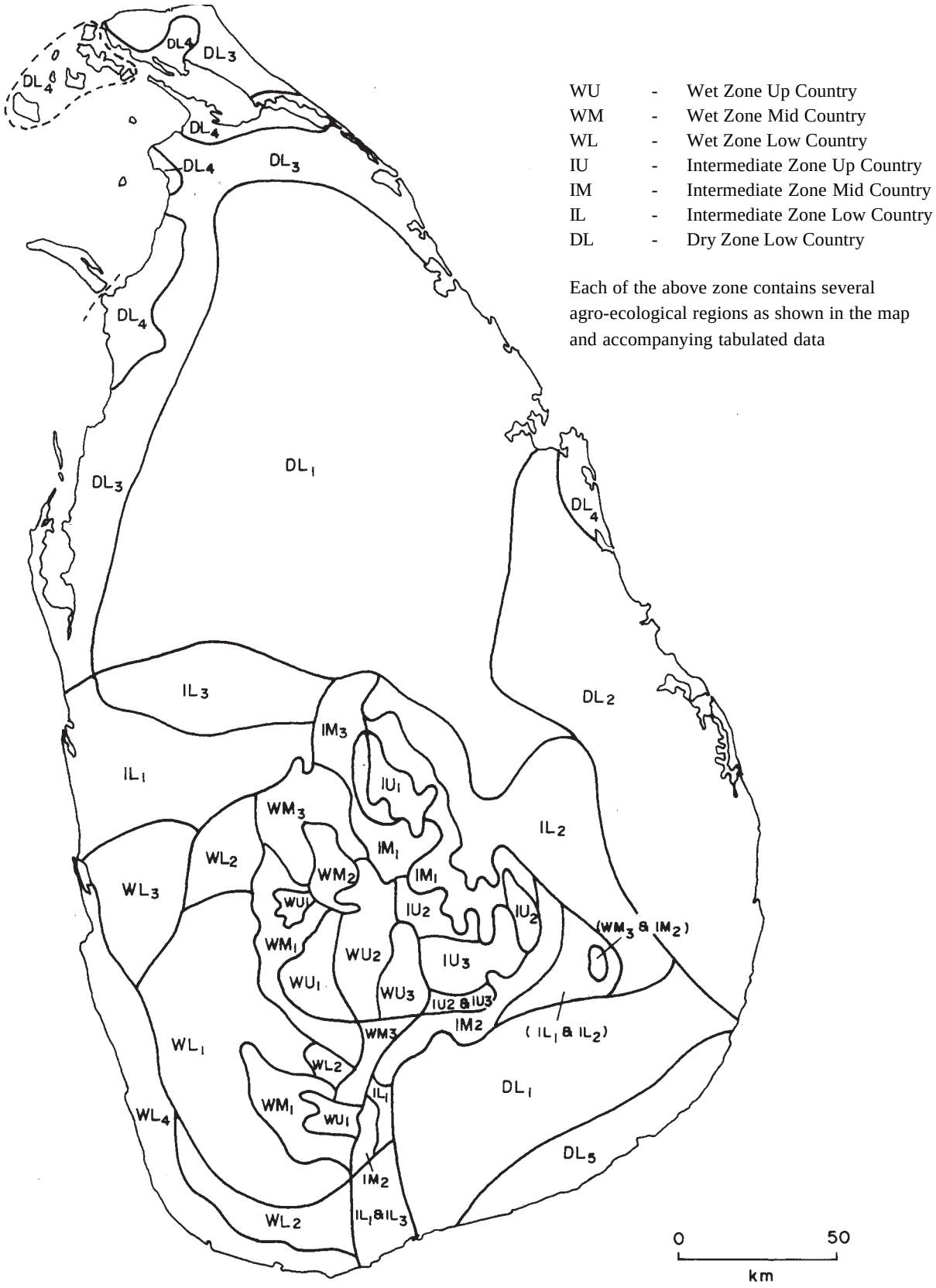
Like the Udawattekalle, other forests were also owned directly by the king, and considered Crown property or Rajasan taka. Any sort of activity within these. Tahansi Kalle", or "Forbidden Forests", was strictly prohibited. Almost every province of the Kandyan Kingdom had several such "protected areas", where any kind of cultivation, felling of trees, hunting or fishing were strictly prohibited, and punishable by a heavy fine. The king ensured that these laws were enforced by a regular Forest Department, comprising the "Kalle Korales" appointed by him. It was the duty of these officers to ensure that the Crown forests were not damaged in any way.

Historical chronicles record that animals, too, were given special protection. The "Niti Nighanduva", which is the repository of ancient Sinhala law, records that all elephants were regarded as the property of the Crown, and killing an elephant was perceived as one of the most atrocious of all crimes. In keeping with the prevalent social fabric, hunting and killing of animals appears to have been generally looked down upon, for the "Niti Nighanduva" statesthat animal slaughter was outlawed during the last 50 years of the Kandyan Kingdom, on the grounds that it was contrary to Buddhist principles.

Respect for forests and all forms of animal life was thus not only deeply enshrined in the moral and legal codes of the ancient Sinhalese, it was also a part of their way of life. When the British began clearing the forests in the mid 19th century, it destroyed an ancient society and a way of life which had existed since the coming of Buddhism to Sri Lanka in the third century B.C.

Source: Tammita Delgoda (1997)

Figure 2.1 Agro-Ecological Regions of Sri Lanka and Rainfall Expectancy (contd on page 8)



Source : C R Panabokke and P Ratnaseeli Kannangara (1996)

Figure 2.1 Agro-Ecological Regions in Sri Lanka (Contd.)

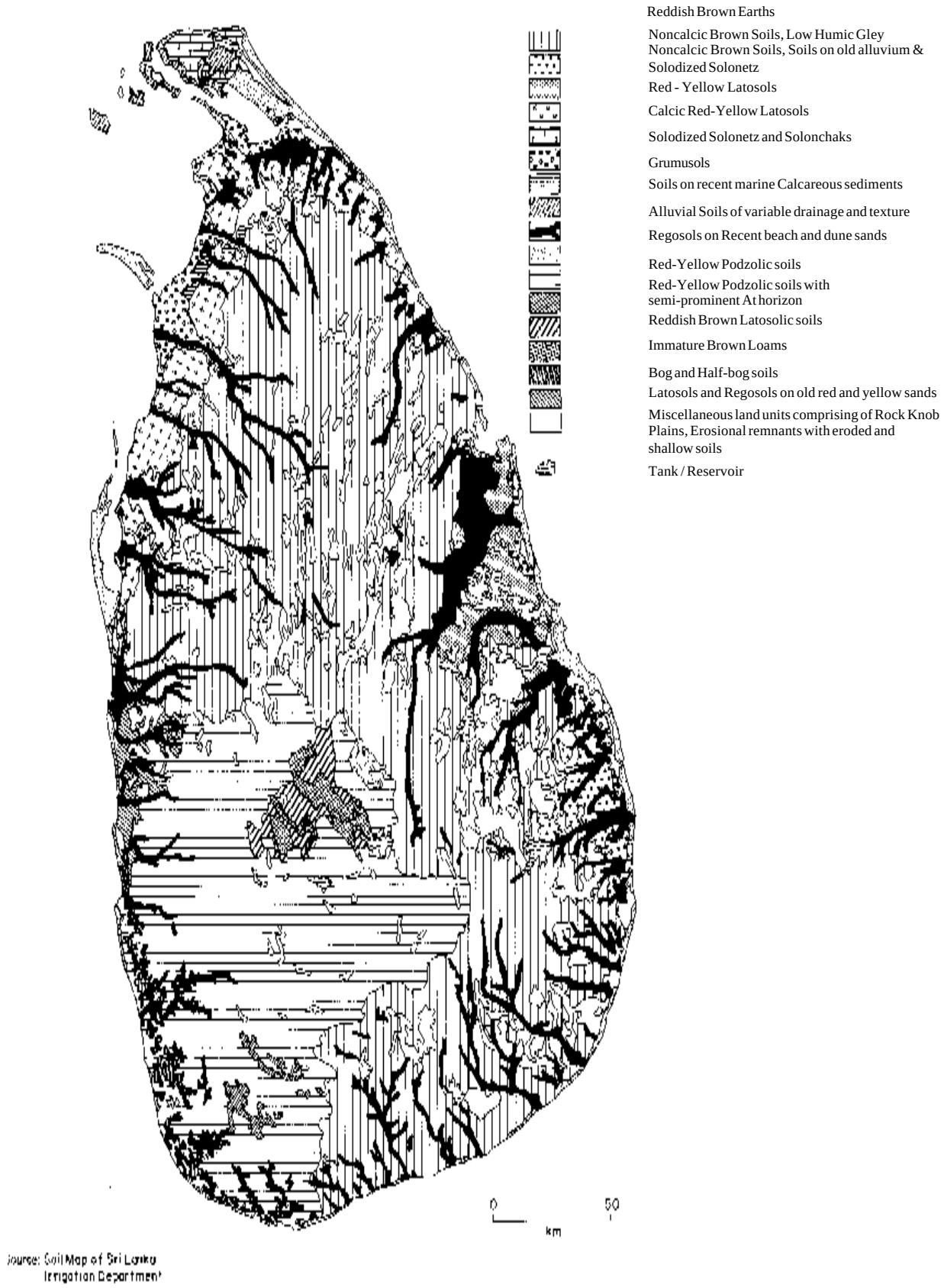
DISTINGUISHING CHARACTERISTICS											
Agro-ecological region & symbol	75% expectancy value of annual rainfall (ins.)	75% expectancy value of dryness for particular months								Major Soil Groups	Terrain
		Jan	Feb	Mar	May	Jun	Jul	Aug	Sep		
WU1	>125	J½	F	•	•	•	•	•	•	Red-Yellow Podzolic soils and Mountain Regosols	Mountainous, steeply dissected hilly and rolling
WU2	>75	J½	F	½M	•	•	•	•	•	Red-Yellow Podzolic soils and Mountain Regosols	Mountainous, steeply dissected hilly and rolling
WU3	>55	J½	F	½M	•	•	•	•	•	Red-Yellow Podzolic soils with dark B horizon; and Red-Yellow Podzolic soils with prominent A1 horizon	Rolling
WM1	>125	J½	F	•	•	•	•	•	•	Red-Yellow Podzolic soils; Red-Yellow Podzolic soils with semi-prominent A1 horizon	Steeply dissected hilly and rolling
WM2	>55	J½	F	•	•	•	•	•	•	Reddish Brown Latosolic soils, Immature Brown Loams; and Red-Yellow Podzolic soils	Steeply dissected hilly, rolling and undulating
WL1	>100	J½	F	•	•	•	•	•	•	Red-Yellow Podzolic soils; Red-Yellow Podzolic soils with semi-prominent A1 horizon	Rolling and undulating
WL2	>75	J½	F	•	•	•	•	•	•	Red-Yellow Podzolic soils; Red-Yellow Podzolic soils with strongly mottled sub-soil; and low Humic Gley soils	Rolling and undulating
WL3&4	>60	J½	F	½M	•	•	•	Aug	•	WL3-Red-Yellow Podzolic soils with soft and hard Laterite WL4-Red-Yellow Podzolic soils with soft and hard Laterite; and Bog and half Bog soils	WL3 - Rolling and undulating WL4 - Undulating and flat
IU1	>85	•	•	½M	•	•	Jul½	Aug	½Sep	Red-Yellow Podzolic soils and Mountain Regosols	Mountainous, steeply dissected hilly and rolling
IL2	>55	•	F½	½M	My½	Jun	Jul	Aug	Sept	Red-Yellow Podzolic soils and Mountain Regosols	Mountainous, steeply dissected hilly and rolling
IL3	>45	•	F	½M	•	Jun	Jul	Aug	½Sept	Red-Yellow Podzolic soils hilly and rolling	Steeply dissected
IM1	>55	•	•	M	My½	Jun	Jul	Aug	½Sept	Reddish Brown Earths and Immature Brown Loams	Rolling hilly and steep
IM2	>45	J½	F	•	•	Jun	Jul	Aug	Sept	Reddish Brown Earths and Immature Brown Loams	Rolling hilly and steep
IM3	>35	•	F	M	My½	Jun	Jul	Aug	Sept	Immature Brown Loams, Reddish Brown Latosolic soils; and Reddish Brown Earths	Steeply dissected, hilly and rolling
IL1	>40	J	F	½M	•	•	Jul	Aug	½Sept	Red-Yellow Podzolic soils with strongly mottled subsoil, low Humic Gley soils, Red-Yellow Podzolic soils with soft and hard Laterite; and Regosols on red and yellow sands	Rolling undulating and flat
IL2	>45	•	F½	M	My½	Jun	Jul	Aug	½Sept	Reddish Brown Earths and Immature Brown Loams and low Humic Gley soils	Rolling hilly and undulating
IL3	>35	J	F	½M	My½	Jun	Jul	Aug	½Sept	Reddish Brown Earths and Immature Brown Soils and low Humic Gley soils	Undulating
DL1	>30	J½	F	½M	My½	Jun	Jul	Aug	½Sept	Reddish Brown Earths and low Humic Gley soils	Undulating
DL2	>35	•	F½	M	My	Jun	Jul	Aug	Sept	Non-Calcic Brown soils, Reddish Brown Earths soils on old alluviu, Solodized, Solonetz, low Humic Gley soils and Regosols	Undulating and flat
DL3&4	>23	J½	F	M	My	Jun	Jul	Aug	½Sept	DL3- Red-Yellow Latosols and Regosols DL4 - Solodized, Solonetz, Solonchaks and Grumusols	DL3-flat to slightly undulating DL4-flat
DL5	>20	J½	F	M	My	Jun	Jul	Aug	½Sept	Reddish Brown Earths with high amount of gravel in subsoil, low Humic Gley soils and Solodized, Solonetz	Undulating and flat

J½ = denotes 2nd half of January

*** = denotes wetness for the month Similarly for other months**

½M = denotes 1st half of March

Figure 2.2 Soil Map of Sri Lanka



Source: Irrigation Department (1988)

establishment of plantations. These activities marked the beginning of environmental problems and large scale biodiversity erosion in the country. After gaining independence, clearing land for development schemes in the dry zone commenced and continued to gain momentum, causing a further loss of indigenous biodiversity. Despite these adverse trends, the concepts which underlie conservation of biodiversity continue to influence the lives of rural people, particularly those of the older generation. Even today, certain species of trees are protected by religious beliefs. Ficus religiosa is considered sacred by Buddhists as the tree or 'bhodhi' under which the Buddha attained enlightenment; Mesua spp., bamboo groves and Ficus benghalensis are some species that are held in high esteem by Buddhists; and the neem tree*(*Azadiracta indica) is revered by Hindus. Most rural people consider it irreverent to fell large trees, due to their belief that such trees are the abodes of lesser gods. Among the fauna, the elephant (Elephas maximus) plays a dominant role in the cultural and religious pageants of the country, especially in the age old annual Esala Perahara (procession) in which about a hundred domesticated elephants participate.

Recent decades have seen a sharp increase in human population, and the overriding need to produce more food has exerted great pressure on the forests which were seen as a source of land for agriculture. There was also a growing tendency towards secularism. These factors, as expected, led to an undermining of the values which are an integral part of the cultural and religious heritage of Sri Lanka.

2.3 Population and People

Sri Lanka is one of the most densely populated countries of Asia, with 292 inhabitants per square kilometre. Estimates for 1996 indicate a total population of 18.3 million. The population growth rate is 1.1 per cent at present and it is projected that the population will reach the 25 million mark by the middle of next century. Although the average per capita GNP is low (US $ 760 in 1996), the human development indicators show values that are exceptionally high for a developing country. The life expectancy at birth is 71 years and the adult literacy rate, 88 per cent. Infant mortality is low (24 per 1000 population), and 93 per cent of the population have access to advanced health care. The Human Development Index is 701, approaching the level of developed countries, demonstrating a high quality of life. Sri Lanka is a multi-ethnic secular state. The major ethnic groups in the country are Sinhalese (74.0 per cent), Tamils (18.2 per cent) and Muslims (7.1 per cent). The majority of the population are Buddhists (69.3 per cent), and the other major religions are Hinduism (15.5 per cent), Islam (7.6 per cent), and Christianity (7.5 per cent).

2.4 Land Ownership and Tenure

In Sri Lanka, 82 per cent of the land area comes under some form of state control. This includes the land alienated under settlement schemes which may be governed by restrictions on inheritance, transfer and subdivision and which accounts for 15 per cent of the total land area of the country. Over the years, state land has been alienated under various schemes, such as village expansion, regularization of encroachments, special leases, etc. The Land Reform Law 1972 limited the extent of freehold land to a total of 50 acres (subsequently increased to 100 acres) per individual, and in the case of paddy land to 25 acres. Land in excess of these limits was vested in the Land Reform Commission, and these areas added up to 6.2 per cent of the total land area of the country.

Except for a few catchment areas in privately owned plantations, and freehold lands in some wildlife sanctuaries, natural forests are under the jurisdiction of the state. Although the species diversity of agricultural lands does not match that of natural ecosystems, the plantations, home gardens and agricultural crop holdings contribute significantly to the in-situ conservation of species and genetic diversity.

2.5 Biodiversity - a Broad Overview

Conservation of biodiversity is of special relevance to Sri Lanka. The country, though small in size, has a varied climate and topography which has resulted in a rich biodiversity, distributed within a wide range of ecosystems. An important feature

of the climate is that there are two basic eco-zones. This is due to the positioning of the central mountains which intercept the monsoonal winds. This has created an ever-wet region in the southwestern quarter of the island and a rain shadow in the remaining area. Since these demarcations are not sharp, but grade off from one to the other, it is customary to recognize an intermediate transition zone termed the intermediate zone. Small sections to the northwest and southeast which escape the monsoons have a climate which approaches arid conditions. Within this broad differentiation of climate types, there is a multitude of ecosystems. Among the terrestrial ecosystems are forests varying from wet evergreen forest (both lowland and montane) to dry thorn forests; grasslands; and a complex network of rivers, wetlands and freshwater bodies. These, together with the coastal and marine ecosystems such as sea-grass beds, coral reefs, estuaries and lagoons, and associated mangrove swamps, constitute the panorama of natural ecosystems in the country. In addition, there are numerous man-made ecosystems related to agriculture and irrigation which have a direct bearing on the conservation, sustenance and survival of biological resources. This array of ecosystems found in the country can also be grouped into four basic habitat classes: forests, inland wetlands, agricultural lands, and coastal and marine systems.

The remaining land is used for living areas, roads, and other infrastructures.

The high diversity of ecosystems has provided habitats for rich species diversity and climatic and edaphic variants of individual species, particularly among the plants. The wet zone rainforests provide habitats for nearly all of the country's woody endemic plants and for about three-quarters of the endemic animals. The inland

Box 2.2

BIOLOGICAL DIVERSITY DEFINED

Biological diversity. The Global Biodiversity Strategy and the Convention on Biological Diversity recognize three functionally related components of biological diversity, or biodiversity :

Genetic diversity within species: Genes are the storehouses of the heritable characteristics of an organism, and form the basis for variation between individuals of a species. The qualitative and quantitative variation of the genetic material between individuals, and the genetic variation between populations of the same species, constitute the genetic diversity of a species.

Species diversity: This is the component of biodiversity that is most widely known and often used as a synonym of biodiversity. Species are populations of individuals within which breeding could take place to produce fertile offspring. Species diversity refers to variation between species, or to the variety of life forms on earth. To date about 1.7 million species have been described, and it is estimated that the total number of species present on earth may be many times this number. The measurement of species diversity provides an important preliminary assessment of overall biodiversity.

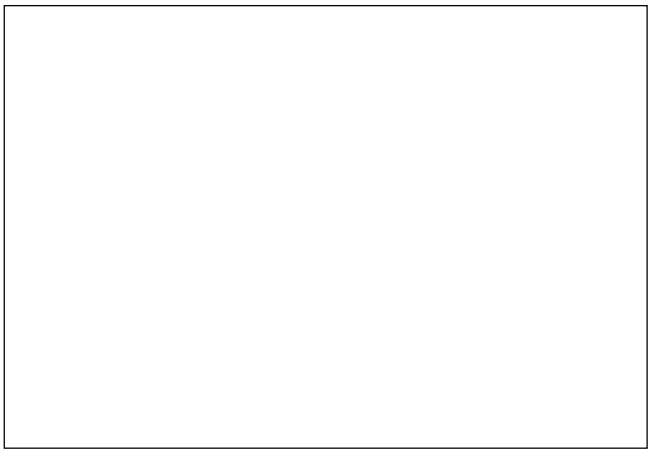
Ecosystem diversity: This refers to the variation between ecosystems. Different species of animals, plants and microorganisms interact to form communities. In concert with the processes that maintain their lives, and interacting with their non living environment, these communities form functional, dynamic and complex units that are termed ecosystems. Different permutations of species and their interrelations, combined with differences in abiotic factors such as climate, soil and water, give rise to different ecosystems.

Conservation of biological diversity covers all human actions ranging from totally preserving any component of biological diversity to using biological resources within sustainable limits so that there is no erosion of biodiversity.

Main source: WCMC (1992)

waters provide aquatic habitats for a large number of freshwater species, notably, the fish fauna. Inland wetlands, both natural and man made, are also the habitats of many species of birds, mammals and plants. Of these, the Mahaweli Flood Plains in the dry zone is the most important habitat in terms of animal biomass in the country.

The many critical marine near-shore



The colourful flower of the endemic *Gordonia speciosa*
(S. Balasubramaniam)

habitats of the coastal areas form the breeding grounds for a host of marine organisms. These habitats contain 183 species of fish, many of which breed in the area. The mangrove areas are relatively small and discontinuous, but are important in terms of the species they contain and the socio-economic importance to local people, and for prevention of coastal erosion. The Exclusive Economic Zone, which covers an area up to 200 nautical miles beyond the coastline, contain the coastal reefs along much of the 1600 km of coastline. The best known coral reefs occur off the northwestern and southwestern coasts, while rich coral reefs are also found in the north and northeast. Sandstone reefs and boulder reefs occur in other parts of the coastline.

In terms of plant species diversity, the vegetation supports over 3368 species of flowering plants (of which 26 per cent are endemic) and 314 species of ferns and fern allies (of which 57 are endemic). Species diversity is also high among mosses (575), liverworts (190), algae (896) and fungi (1920).

Similarly, the country supports a high faunal diversity due to the varied climatic and topographic conditions prevailing in the island.

Box 2.3

Ecosystem Diversity of Sri Lanka

Forest and related ecosystems
- Tropical wet evergreen forest (lowland rain forest)
- Tropical moist evergreen forest
- Tropical dry mixed evergreen forest
- Tropical thorn forest
- Savannah
- Riverine forest
- Tropical sub montane forest
- Tropical montane forest
- Dry montane grasslands dry patanas

Inland wetland ecosystems
- Flood plains
- Swamps
- Streams and rivers
- Reservoirs and ponds
- Wet Villu grasslands
- Wet montane grasslands wet patanas

Coastal and marine ecosystems
- Mangroves
- Salt marshes
- Sand dunes and beaches
- Mudflats
- Seagrass beds
- Lagoons and estuaries
- Coral reefs
- Coastal seas

Agricultural ecosystems
- Paddy lands
- Horticultural farms
- Small crop holdings or other field crops (pulses, sesame etc)
- Crop plantations
- Home gardens
- Chena lands (slash and burn cultivation)

The inland waters support a rich invertebrate fauna. The following information is based on the available data. There are around 140 species of Rotifera. Among the Crustacea are 68 species of Cladocera, 27 species of Copepoda (none endemic), 31 species of Ostracoda (11 endemic) in 19 genera, and over 60 species of decapods (prawns and crabs). There are 31 species of freshwater molluscs, of which 12 are endemic and restricted in distribution. The mayflies are incompletely documented, but 18 species are known to be endemic. The marine

invertebrate fauna are even more diverse; examples are the presence of over 180 species of corals belonging to 68 genera, and over 200 species of crabs.

Among the indigenous terrestrial invertebrates there are over 400 species of arachnids (spiders) in 236 genera, over 242 species of butterflies of which 14 are endemic, 139 species of mosquitos, 525 species of carabid beetles from 140 genera, and 266 species of land snails. Ten genera and 127 species of carabid beetles are endemic, as are 201 species of land snails.

Among the vertebrates, there are 65 species of freshwater fishes indigenous to Sri Lanka, of which about a half are endemic. Many of these species are riverine or marsh dwelling and occur mainly in the wet zone streams. In addition, there are 22 species of introduced fish which are consumed for food. There are also about 350 species of marine fish which include ornamental fishes and food species such as seer, tuna and skipjack.

The species richness of the terrestrial mammalian fauna in the island is high, compared with other islands of similar size. In this category are 86 indigenous and ten introduced species. The indigenous species comprise 30 species of bats, 23 rodents, 14 carnivores inclusive of the leopard and sloth bear, seven artiodactyls (among which are four species of deer), six shrews, four primates and one species each of elephant and pangolin. The 12 species of endemic mammals include two species of primates and one carnivore. It is noteworthy that several of the species show prominent sub-specific variation indicative of high intra-specific genetic variability. Within the territorial waters of the island there are 38 species of marine mammals, including the sperm whale, the blue whale and a rare species of dugong.

A herd of spotted deer at the Yala National Park (H.I.E. Katugaha)

The amphibian fauna number 53 species from 16 genera. Of these, the genus Nannophrys, with three species, is endemic, as are 27 other species including three species of limbless amphibians. A majority of the amphibian species have very restricted geographic ranges and are found mainly in specific ecological niches of wet zone forests.

The reptilian fauna of Sri Lanka show considerable diversity, with two species of crocodiles, five species of marine turtles, three species of tortoises, 92 species of snakes (of which approximately half are endemic), 21 species of geckoes (of which six are endemic), 14 species of agamid lizards (of which ten are endemic), two species of monitor lizards, and 21 species of skinks (all rare, and 17 endemic).

The rich avifauna of the country is reflected by the presence of 435 species of birds which include about 113 migrants. The 23 species endemic to this country are found mainly in the wet zone forests.

Sri Lanka is also a valuable repository of crop germplasm, especially of rice. There are varieties of rice which are resistant to pests and adverse climatic and soil conditions, exhibit variations in grain size and quality, and show differences in rate of maturing. There is also significant crop genetic diversity among spices of commercial importance. Among these are 500 selections of pepper and about seven wild species, 10 wild races of cardamom, and several indigenous varieties of betel and chilli. Grain legumes and root and tuber crops also show a rich genetic variability, as do fruit crops such as banana, mango and citrus. Similarly, there are many varieties of

vegetables such as cucurbits, tomato and eggplant. Out of 170 plant species of ornamental value, 74 are endemic, and many species of orchids and foliage plants of commercial importance occur naturally in forests.

Among domesticated animals of economic value are wild species of buffalo, cattle and fowl. The local cattle show high resistance to disease and tolerance of internal parasites. Likewise, the local breeds of poultry are resistant to tropical diseases.

A significant milestone in the study of the terrestrial species diversity of Sri Lanka is the National Conservation Review (NCR) carried out by the Forest Department with technical assistance from IUCN - The World Conservation Union. This was a sample survey of all the natural forests of the country, barring some areas in the north and east which were inaccessible due to the prevailing civil disturbances. This survey enumerated all the woody plants, vertebrates, and selected invertebrate taxa (molluscs and butterflies) present along gradient directed transects. The NCR data revealed that, among the wet zone forests, Sinharaja, Knuckles, Gilimale-Eratne, and the Kanneliya-Dediyagala-Nakiyadeniya (KDN) complex are foremost in terms of woody species diversity. Knuckles, Gilimale-Eratne, Horton Plains, Mulatiyana and Sinharaja were found to be the most important wet zone forests for faunal diversity. The Ruhuna National Park is important in terms of biodiversity in the dry zone, especially for the large herbivores and carnivores.

For the development of conservation strategies for faunal species, an impediment has been the paucity of data on population status and distribution, especially of vertebrates. In this context, it is important to note that the government has initiated action to set up a national zoological survey, a long-felt need.

Box 2.4

BIODIVERSTIY CONSERVATION - THE GLOBAL PICTURE

The earth's biodiversity is the result of nearly four billion years of evolution. Current estimates of the number of existing species range from 2 100 million, while only about 1.7 million have been documented. Distributed throughout the world's biota are about a billion different genes. This biodiversity is found within an array of ecosystems, both natural and man made. Today, much of this biodiversity is being lost on a global scale at an unprecedented rate as a result of human activity. In the ast 200 years, over six million km 2 of forests have been decimated. About 40 % of the entire photosynthetic productivity on earth is now being used or destroyed. If these current trends continue, a quarter of all extant species on arth will perish or be reduced to unsustainable levels by the mid 21st century.

The consequences of biodiversity erosion of this magnitude are profound. Most significant is the destruction of species and ecosystems that are vital for the functioning of global life support systems. Others are loss of wild relatives of crop plants and domesticated animals that serve as 'gene banks' when economically valuable breeds have to combat disease or adapt to climate change. Many species with potential medicinal or economic value may also become extinct before they are discovered. Developing countries, which are the main repositories of global biodiversity, do not have the financial and technical resources to manage and conserve their indigenous biological resources, and this exacerbates biodiversity loss. Developed countries contribute to biodiversity loss by providing lucrative markets for timber from tropical forests, ornamental fish and other endangered species. While the ultimate prerogative for conservation and management of a country's biodiversity lies with its national government, the global implications of continued biodiversity loss has resulted in increased international cooperation to strengthen national efforts. International efforts comprise bilateral and multi lateral financial assistance for biodiversity conservation, international treaties and conventions such as the Convention on International Trade in Endangered Species (CITES), the Convention on Wetlands of International Importance (RAMSAR Convention) and, most significantly, the Convention on Biological Diversity.

Sources: IUCN (1994a); WCMC (1992); Beazley, M (1993)

Assessments of coral reefs and associated fauna are being carried out by the National Aquatic Resources Research and Development Agency (NARA), from Tangalle to Kandekuliya. Studies on wetland biodiversity have been carried out by the Wetland Conservation Project of the Central Environmental Authority and have resulted in 23 site reports to date, with another three pending.

2.6 The Need to Conserve

Sri Lanka's high population density, high levels of poverty and unemployment, and widespread dependence on subsistence agriculture have exerted considerable pressure on the biodiversity of the country. Extensive deforestation and land degradation and the unregulated exploitation of natural resources (e.g. mining for coral lime, sand and gemstones) are some of the manifestations of the social problems the country faces causing destruction of natural ecosystems and the species they contain.

The conservation of biological diversity is of special significance to Sri Lanka in the context of its predominantly agriculture-based economy and the high dependence on many plant species for food, medicines and domestic products. Over a third of the plant species in the country are used in indigenous medical practice, and many of these species are growing scarce due to habitat destruction and over-collection. The rich and diverse ecosystems of the country harbour many wild relatives of cultivated species, and the gene pools represented by these wild plants are a resource of considerable potential value that could be used for the genetic improvement of cultivated plants. Another valuable genetic resource is the wide range of varieties and ecotypes of cultivated species found in the country. For example, in the case of rice, there are over 2500 accessions of indigenous varieties. These have not been fully characterized, and allowing for the presence of duplicates it would appear that these accessions represent about 1000 distinct cultivars. Plant products such as fruits, fibre, spices, kitul sap, bamboo and rattan are used as raw material for many small scale industries which provide financial security to rural populations. The biological resources of coastal and marine ecosystems provide nearly 70 per cent of the protein requirements of the country and generates employment for about 500,000 people. Biodiversity also contributes directly to the national economy in the form of revenue from National Parks and other wildlife reserves, while its potential to promote eco-tourism could be a significant income generator in the future.

The forests of southwest Sri Lanka (wet evergreen forests) are particularly rich in biodiversity and endemic species, and they are fragmented and under severe threat. On account of this, southwest Sri Lanka has been named as one of the 18 biodiversity hotspots in the world (i.e. an area with high species diversity and high levels of endemism and where species are subject to exceptional levels of threat). Conservation of Sri Lanka's biodiversity, therefore, transcends national interests it is of global relevance.

Appendix 2 gives provisional lists of species of flora and fauna considered to be threatened in Sri Lanka.

The Major Ecosystems

3.1 Forests

Sri Lanka has a long history of protection of wildlife and sustainable use of forests, fostered by Buddhist philosophy that respects all forms of life. One of the world's earliest wildlife sanctuaries was established by King Devanampiyatissa in 246 BC, along with the advent of Buddhism to Sri Lanka. Succeeding kings upheld these traditions, and kele koralas (forest officers) were appointed to prevent poaching and to protect trees belonging to the Crown. In the twelfth century AD, King Keerthi Nissanka Malla proclaimed that no animal should be killed within a radius of seven 'Gau' (equivalent to 35.7 km) of the sacred city of Anuradhapura.

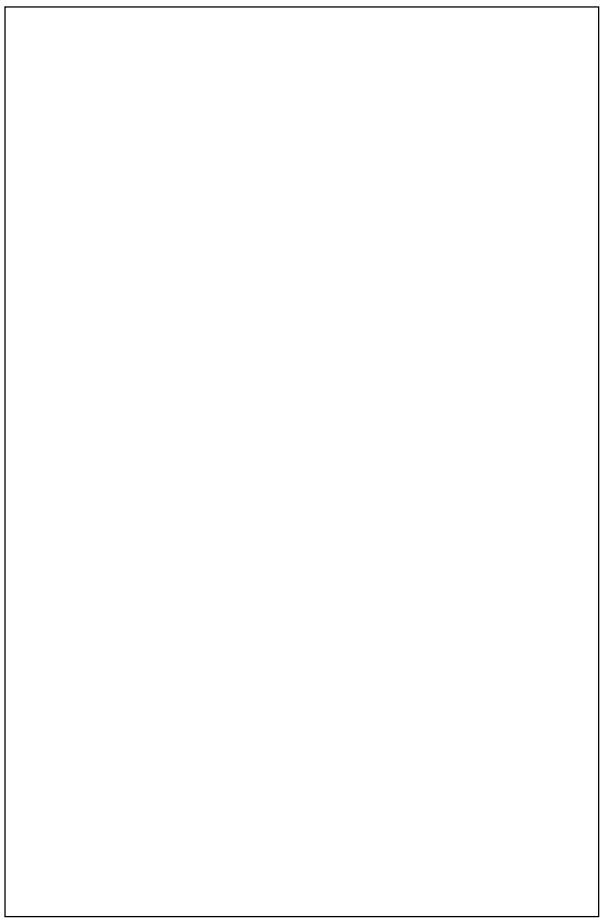
These noble traditions and attitudes changed with the onset of the colonial era, when the rulers were more bent on exploiting rather than conserving the natural resources. This is evident from some of the earlier government ordinances under foreign rule. For instance, the Timber Ordinance (of 1848) created forest reserves for the purpose of timber supply. The Wastelands Ordinance of 1840 vested all lands that were unoccupied and uncultivated (including forests), and previously held by royalty, temples, local communities and individuals, in the British Crown. This effectively paved the way for the clearing of wet zone forests at mid and high elevations for the establishment of tea and rubber plantations, while the wet lowland forests in the coastal areas were cleared for coconut and cinnamon plantations. Similarly, declaration of game reserves in the dry zone, following the enactment of the Fauna and Flora Protection Ordinance of 1937 during British rule, was for protection of game for hunting. During this period, populations of species considered big game, particularly the elephant, declined considerably as a result of hunting for sport, and in some cases, for meat. The destruction of forests during colonial rule contributed largely to the decline of wildlife as well.

A redeeming feature of the colonial period was the scientific contributions of the eminent British botanists Hooker, Thwaites, Alston and Trimen who were responsible for documenting the flora of Sri Lanka. Their influence on government policy led to attention being focused on forest conservation and the inclusion of this concept into policy and legal instruments. Despite these policy initiatives, however, exploitation of forests by logging, quarrying, collecting forest produce, pasturing cattle, and clearing for shifting cultivation (chena) continued. In the colonial period much of the deforestation occurred in the wet zone. In the post-independence period (after 1948), forest clearing took place at an accelerated pace for shifting cultivation, land settlement, and expansion of irrigation agriculture, and this was mainly in the dry zone.

The view through the mist at Horton Plains
(S. Balasubramaniam)

The latest forest survey (in 1992) shows that "dense" natural forests (i.e. with over 75 per cent canopy cover) occupy 23.88 per cent of the total land area. To this may be added the "sparse forests", consisting mainly of scrub vegetation, which cover 7.01 per cent of the land area. The rate of deforestation can be gauged by the fact that 40 years ago the forest cover was nearly double what it is today (Figure 3.1).

Sri Lanka has a striking variety of forest types brought about by spatial variations in rainfall, altitude and soil. The forests have been categorised broadly as tropical wet lowland evergreen forests (at elevations between 0-1000 m); wet sub-montane forests (at elevations between 1000-1500 m in the wet zone); wet montane forests (at elevations of 1500-2500m); tropical dry mixed evergreen forests in the dry lowlands, with riverine vegetation along river banks; tropical moist evergreen forest in the intermediate zone; thorny scrub in the arid areas; and mangrove swamps in the coastal areas, fringing the lagoons and at the river mouths. In addition, different types of grasslands occur in the wet and dry areas, in the lowlands as well as in the hills. As the wet lowland forests transform into sub-montane and montane forests, there is a progressive decline in canopy height, and at the highest elevations above 2000 m, unique pygmy forests may occur. The most extensive forest type, the tropical dry mixed evergreen forest, is characterized by a canopy that is relatively open and seldom exceeds 20 meters in height. A survey based on Landsat imagery carried out in 1992 gave the areas of the main types of natural forest in the country as shown in Table 3.1.



A giant tree (a dipterocarp) in the Sinharaja Forest
(S. Balasubramaniam)

The fragmented wet lowland forests of the country are of particular importance as they constitute the last remnants of the once widespread mid-miocene tropical rain forests of Sri Lanka. In the lower slopes and valleys, these forests are characterised by a dense canopy of tree species reaching 30-40 m in height, with emergents rising to about 45 m, and woody lianas that form an intricate network. Due to the height of the canopy trees and straightness of their boles, wet lowland forests are considered to be very productive in terms of timber. As a result, many of the lowland dipterocarp-dominated forests have been selectively logged in the past.

Wet zone rainforests are exceptionally rich in biodiversity and high in endemism, especially among the dipterocarps which constitute the characteristic tree flora of both wet lowland and hill forests and dominate the structural and floristic composition of these ecosystems. All endemic genera and over 90 per cent of the woody endemic species occur in these forests, as well as about 75 per cent of the endemic animals.

The southern lowland hills and plains extending from the east of Kalutara to the southeast are exceptionally rich in plant diversity, and this area is believed to be, floristically, the richest in South Asia. Another interesting feature is that many endemics are restricted to a single forest or a single cluster of forest blocks. For instance, the forests in the valleys of the foothills of Adam's Peak and Ambagamuwa contain many highly localized plant species. Stemenoporus moonii, a member of an Lendemic genus, is restricted to the Waturana forest, and Stemonoporus affinis, another very rare species, is confined to a small area within the Knuckles forest. Other species of Stemonoporus and species of another endemic genus Glenniea are found in Warukandeniya, but not in Sinhagala and Waturawa, although all three sites are located within

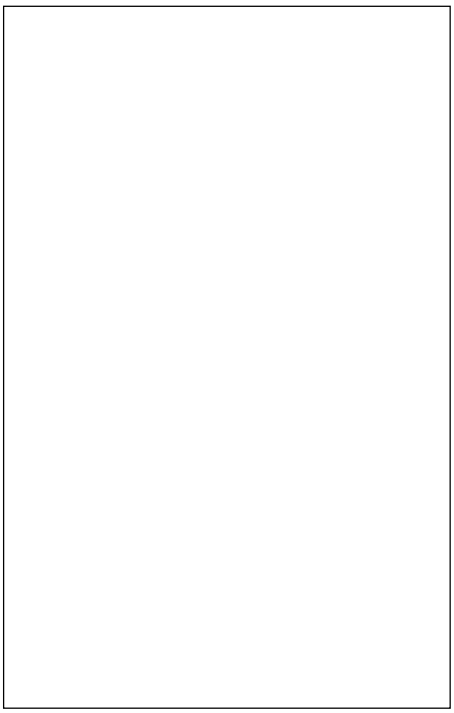
Figure 3.1 Sri Lanka Forest Cover in 1956 and 1992

Source: Adapted from Wijesinghe et.al., (1993)

the Sinharaja forest complex. Many species of endemic fauna are also highly localised; examples are the endemic lizards Cophotis ceylanica, found only in montane and cloud forest above 1300m, and Ceratophora tennenti, found only at elevations above 800 m in the Knuckles forest.

Some of the most important wet zone forests in terms of biodiversity are the Peak Wilderness Sanctuary (22,379 ha), the Kanneliya-Dediyagala-Nakiyadeniya (KDN) Reserve (10,139 ha), the Sinharaja Forest (11,280 ha), the Knuckles Range of Forests (21,650 ha) and the Horton Plains National Park (3159 ha). These forests are also important hydrologically as they protect the headwaters of all of Sri Lanka's main rivers.

The Kanneliya forest is notable for having the highest percentage of endemic woody species (60 per cent) of any single wet zone forest. The streams of this forest contain many species of endemic fish, including several threatened species. Associated with these waterways are a number of rare endemic amphibians such as Nannophrys guentheri, Ramanella palmata and Icthyophis glutinosus. The Sinharaja forest complex is also of special importance because of its high species diversity and the large number of unique and threatened species that it contains. In this forest, species endemism in some plant families (e.g. Dipterocarpaceae) exceeds 90 per cent.



***Polypedates cruciger* - the endemic common hour-glass tree frog** (Ranil Perera)

A view of Peak Wilderness from Horton Plains
(D. B. Sumithraarachichi)

Detailed studies of the floristic composition of the forest demonstrate that no single part of it is representative of the whole, due to microclimatic differences.

The Knuckles forest is important in terms of rare species of woody plants and animals, some of which are unique to this site. In addition, this forest contains 14 of the 23 species of endemic birds; more than 50 per cent of the endemic fish, of which nine are threatened and three are restricted to the forest; and a large number of butterflies and reptiles.

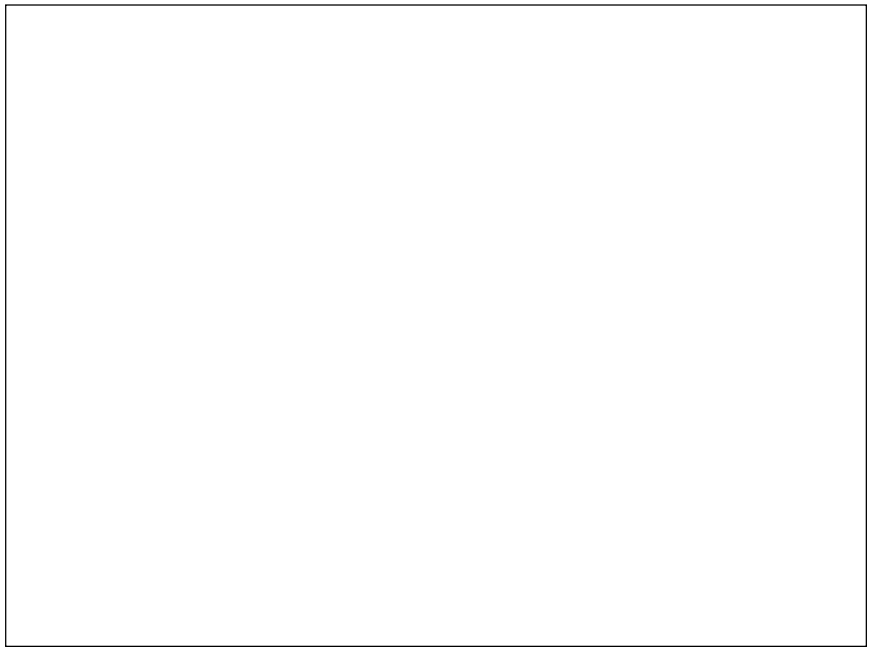
The Peak Wilderness Sanctuary is unique among Sri Lanka's forests in having a range of altitudinally graded, structurally and physiognomically distinct, and biologically diverse forest formations that include tropical lowland, sub-montane and upper-montane rain forests, and natural grasslands. This forest is also floristically important in terms of the large number of rare endemics it contains.

It is unique in having the endemic Stemonoporus spp. growing at high elevations, and Shorea gardneri consociations occurring at altitudes of over 1800 m.

Due to historical factors, the dry zone forests are secondary and seral, although climax vegetation can be found in isolated hills such as Ritigala. Tropical dry mixed evergreen forests are the characteristic vegetation of the dry zone, and

tropical moist evergreen forests constitute a distinct group in the lowland intermediate zone. The northwestern and southeast corners of the island constitute the arid zone in which the characteristic vegetation is thorny scrub.

Among the dry zone forests, Ruhuna National Park (blocks 1-4) is outstanding in terms of woody species and faunal diversity. It is also very rich in the number of rare species it contains. Overall, dry zone forests have a low level of species endemism ranging from 10-16 per cent. In comparison, the levels of endemism are high in wet zone forests, and range from 37-64 per cent for woody plants and 14-52 per cent for animals. Dry zone forests, though less diverse than wet zone forests floristically, are more



Elephants at the Ruhunu National Park (H.I.E. Katugaha)

Table 3.1: Areas of natural forest remaining in 1992, by forest type

Forest type	Total forest area (ha)	% of total land area
Montane forest	3,108	0.05
Sub montane forest	68,616	1.04
Lowland wet evergreen forest	141,506	2.14
Moist evergreen forest	243,886	3.69
Dry mixed evergreen	1,090,981	16.49
Riverine forest	22,435	0.43
Mangrove forest	8,688*	0.13
Total extent of "closed canopy" forest:	1,579,220	23.88
Open canopy: sparse forest	464,076	7.01
Total forest cover in the country:	2,043,296	30.89

The total area of mangrove habitats is around 12,500 ha (Source: Legg and Jewell, 1994) of Sri Lanka's main rivers.

extensive spatially, and they are important as habitats for large mammals like the elephant. Notably, faunal groups such as carnivores, ungulates and primates show their highest species diversity in the dry zone. The wet villu grasslands in the flood plains of rivers of the dry zone are particularly rich in biodiversity, especially among the large grazing and browsing herbivores. For this reason, the dry zone forests merit special consideration for conservation planning.

Considering the protected areas in Sri Lanka, it is encouraging that nearly 14 per cent of the country falls into this category. The major part of the protected area system is under the control of the Department of Wildlife Conservation. However,

Box 3.1

What the NCR Reveals

The National Conservation Review (NCR) of Sri Lanka was carried out by the Forest Department with technical assistance from IUCN The World Conservation Union. This unique exercise constituted a systematic assessment of biodiversity in the natural forests of the country. Its overriding objective was to define a national system of protected areas in which watersheds important for soil conservation and hydrology are protected and forest biodiversity is fully represented, while meeting the cultural, economic and social needs of the country.

The review covered all natural forests in the country of 200 ha or more, except those in sections of the north and east which were inaccessible due to political unrest. Between April 1991 and September 1996, 204 forests were subject to biodiversity assessment by sampling 1,725 plots of 100 m x 5 m along 310 gradient directed transects (gradsects). An important feature of the methodology used is that gradsect sampling optimises the sampling of species in relation to time and effort. Although the biodiversity assessment was restricted to woody plants, vertebrates, molluscs and butterflies, the NCR is hailed as one of the most detailed, comprehensive and innovative evaluations of its kind carried out on a country wide scale to date. The study has yielded 69,400 records of 1,153 woody plant species and 24,000 records of 410 faunal species. A total of 281 forests were also evaluated for their importance in soil and water conservation.

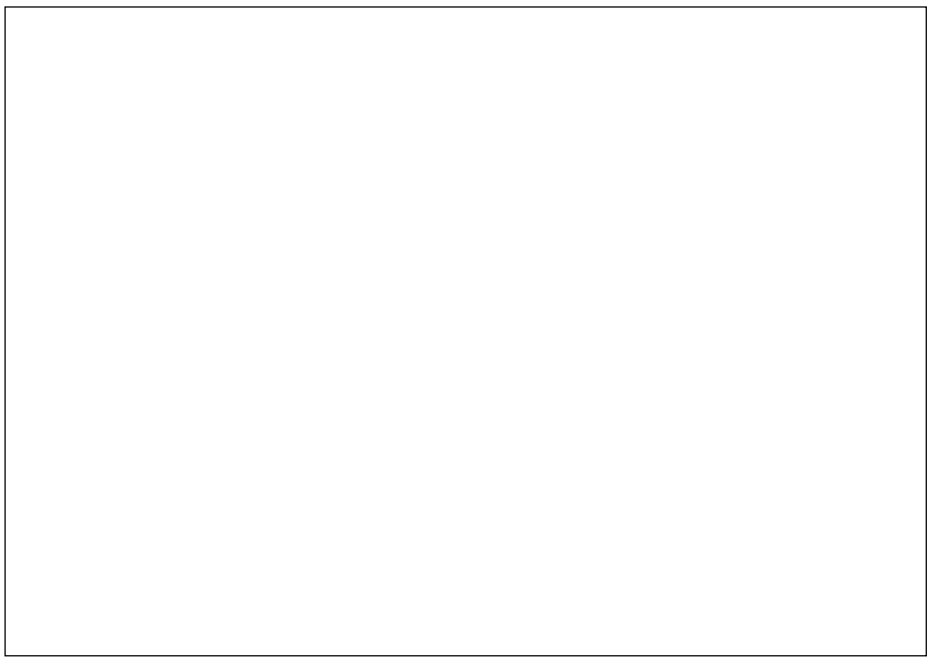
The NCR reveals that, although Sri Lanka has an extensive protected area network covering almost 14% of its land area, critical gaps exist in the context of biodiversity and hydrology conservation. The present protected area network does not adequately represent some floristic regions of the country, including areas that occur within the biodiversity rich wet zone. In addition, about 15% of indigenous terrestrial species diversity is not found within the established protected areas.

The NCR identifies the wet zone forests as the most important in terms of soil and water conservation. As regards biodiversity, the survey has revealed that 79% of the woody plant diversity, 88% of endemic woody plant diversity, 83% of faunal diversity, and 85% of endemic faunal diversity are represented in just eight units of contiguous forests: Bambarabotuwa, forests of the central highlands, Gilimale Eratne, KDN, Sinharaja and Pedro (all in the wet zone); Knuckles/Wasgomuwa (in the intermediate zone); and Ruhuna/Yala (in the dry zone). The comprehensive picture of natural terrestrial biodiversity that has emerged through the NCR will provide valuable information for planning an optimal network of protected areas.

The study has also provided dividends in other ways. Field trips during the survey have served to bring about new discoveries of plants and animals. In 1993 Rock Balsam Impatiens repens an endemic herb not seen for 136 years, was rediscovered. Another "lost and found" plant is Semecarpus pseudomarginata an endemic belonging to the mango family. A new species of lizard, and a new species of ebony are just a few among the 'new' species that were found during this unique survey.

Sources: Green and Jayasuriya (1996); Green (1997)

within the one million hectares of state forests under the jurisdiction of the Forest Department, there are some important protected areas. These include two international Biosphere Reserves (Hurulu and Sinharaja) and many recently designated conservation forests (31 forests so designated up to now). The protected areas under the Forest Department include the Sinharaja, Knuckles, and KDN rainforests which are noted for their high levels of biodiversity and endemism. The Sinharaja forest has been statutorily declared a National Heritage Wilderness Area. It is also a World Heritage (natural) Site, the only one so declared up to now in Sri Lanka. (See Figure 3.2 for protected areas). Until recently, despite the fact that the total area under protection had been large, many wet zone forests that are critically important from the point of view of biodiversity conservation were not within the protected area network. This is being remedied by the Forest Department by the creation of conservation forests.



Wetland blooms (S. Balasubramaniam)

As regards forest plantations, the Forest Department data indicate that the total area of forest plantations raised up to 1991 was 175,443 ha. Recent surveys using aerial photographs, where only the well-stocked plantations were covered, give the area as 117,424 ha. Forest plantations of teak, eucalyptus and pine (none of which are indigenous to Sri Lanka) add up to nearly 90,000 ha. The Eucalyptus species most widely planted were E. grandis, E. microcorys and E. robusta. The pine is mainly Pinus caribaea. Other exotic species have also been used for forest plantations, but on a lower scale. These include Swietenia macrophylla (broad leaf mahogany), Acacia spp. and Cedrela sp.

In the sphere of policy, there have been several positive and encouraging developments in recent years. There are well articulated forestry and wildlife policies declared by the government, which place special emphasis on the conservation of biological diversity. In policy implementation, the Forest Department has assumed a greatly enhanced role in conserving the nation's biodiversity. This is evident in many of the department's recent initiatives, some of which are the creation of an environmental management division within the department, the setting up of a database on forest biodiversity, the creation of a new category of protected areas - conservation forests - through amending legislation and the inclusion of many wet zone forests in this category, and the move towards linking the management of the conservation forests with development activities in the buffer zone. In wildlife conservation, the current project supported by the Global Environmental Facility offers much scope for building capacity and strengthening management. This project has so far not realized its full potential, but much could be done during the remaining period in the life of the project.

The Forestry Sector Master Plan of 1996, in sharp contrast to the earlier Master Plan of 1986, places special emphasis on the conservation of biodiversity both in the forest and wildlife sub sectors. It also advocates a reorientation of the traditional approaches of both the Forest and Wildlife Departments, to permit the involvement of the community in protected area management. In fact, in the management of the conservation forests, the Forest Department envisages an active

participatory role for the communities through community based organizations.

3.2 Wetlands

Wetlands, both natural and man-made, were the centres of Sri Lanka's ancient hydraulic civilization which thrived in the island for over a thousand years and formed the hub of its cultural, economic and social evolution. Due to the system of land use adopted in ancient times, catchment areas and other important wetlands in the uplands were preserved under forest cover, while the dry zone lowlands were irrigated using water from thousands of rainfed tanks dotted throughout this region. This system of land use served to conserve the biodiversity of natural wetlands. There is also evidence that the conservation of biodiversity in man-made tanks was given consideration in Royal Decrees as early as the twelfth century AD. Many of the wetland sites in Sri Lanka are today being recognized as important, both regionally and globally; and one (Bundala) has been recognized internationally as a Ramsar site.

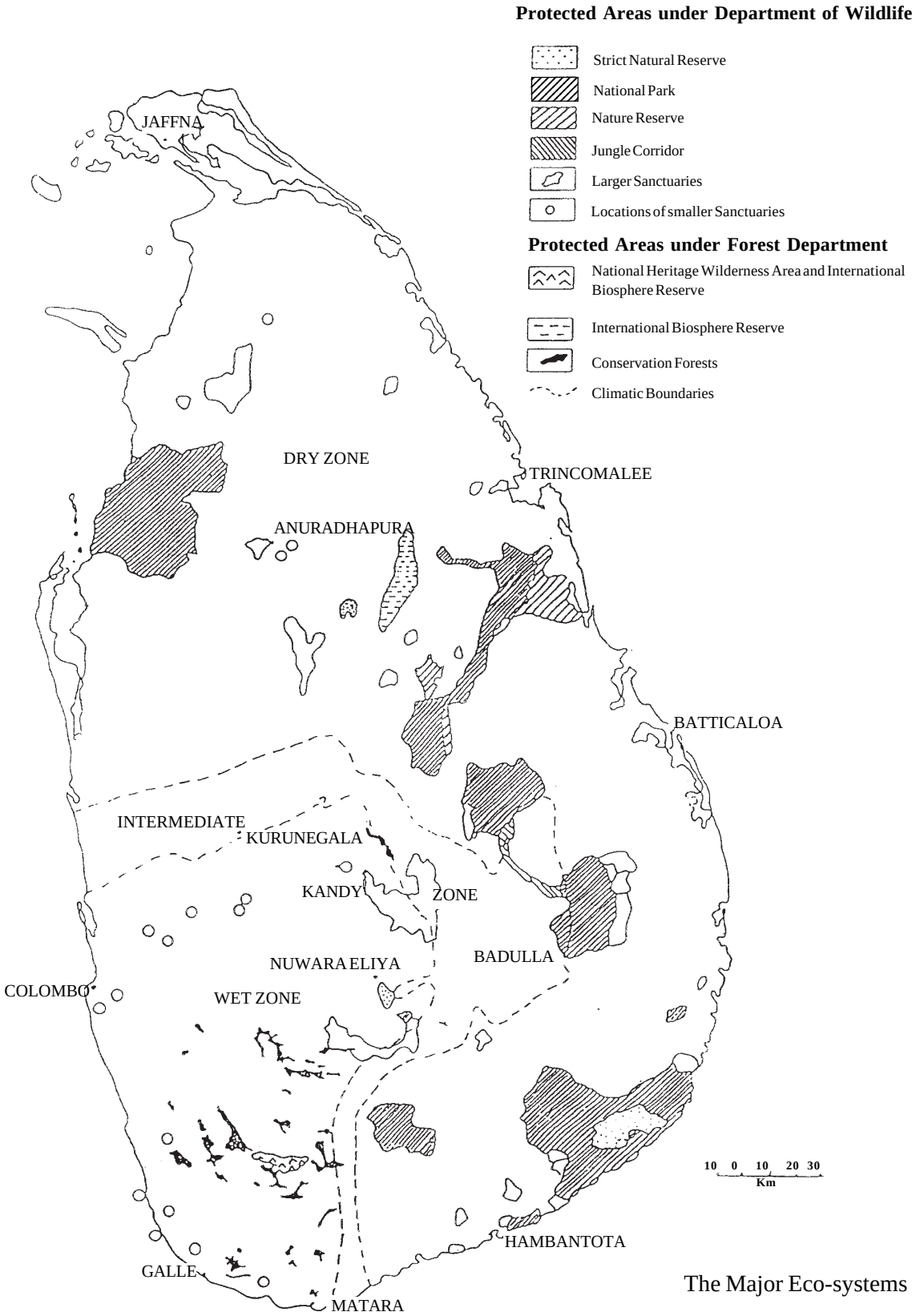
Riverine vegetation (S. Balasubramaniam)

The Convention on Wetlands of International Importance especially as Waterfowl Habitat (also called the RAMSAR Convention) defines wetlands as "areas of marsh, fen, peatland or water, whether natural or temporary, with water that is static, flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed 6 m." Both natural and man-made wetlands occur throughout Sri Lanka, and comprise about 15 per cent of the land area. Rivers and streams, riverine floodplains, small isolated freshwater bodies, freshwater springs, seasonal ponds, and fresh water marshes comprise natural inland wetlands. Coastal wetlands include estuaries and lagoons with associated mangrove swamps, saline marshes, mudflats, and coastal seagrass beds. The man-made wetlands are the rice paddies, irrigation tanks, large reservoirs, canals, and aquaculture ponds. They together make up about two-thirds of the total area of all wetlands. This section deals mainly with the inland freshwater wetlands.

Sri Lanka's river system (Figure 3.3), comprising 103 rivers flowing from the central highlands and making up a total collective length of about 4560 km, plays a dominant role in shaping the wetland landscape. At the coast, where they enter the sea, these rivers form lagoons and estuaries. In the dry zone, the rivers and their tributaries supply water to the floodplains and to irrigation reservoirs. There are extensive marshes and swamps associated with the rivers, which are important in terms of Fig. 3.2 biodiversity. In association with the Mahaweli Ganga and its tributaries alone, there are about 10,000 ha of freshwater riverine marshes which are very rich in biodiversity and are highly productive. Riverine floodplains contain saucer-like depressions (villus) that become inundated with the overflow from rivers during the rainy seasons and contract during drought conditions. The cyclic variation in habitat conditions due to fluctuations in salinity and the depth of water is an important ecological feature that fashions the biodiversity and productivity of villus.

Although Sri Lanka does not have large natural lakes, the total area covered by man-made water bodies exceeds 170,000 ha. There are at present about 10,000 tanks which irrigate over 500,000 ha of land for agriculture. Tanks range in size from 6500 ha down to about one hectare. The vast majority are small; there are less than 100 which exceed 300 ha in size. The tanks were originally constructed many centuries ago. They subsequently fell into disuse and the forest reclaimed the land. Many of the tanks in use today are these old constructions which have been restored. The

Figure 3.2 Protected Areas under the Department of Wildlife Conservation and Forest Department according to available records



The Major Eco-systems

ecological conditions of these tanks vary in terms of depth; degree of siltation; pH; and the calcium, nitrate and phosphate levels of the water. At present, the irrigation reservoirs and their associated canal network add up to about 2400 km^2 . The rice paddies, both irrigated and rainfed, comprise about 780,000 ha and are spread throughout the country.

Wetlands are valuable in terms of hydrology, plant and animal productivity, and biodiversity; and they carry out important functions in terms of sustaining hydrological and chemical cycles. Swamps and marshes function as ground water aquifers and are of indirect use in protecting the shoreline by regulating water flow. Wetlands are also important as gene pools for wild varieties of crop species, such as wild rice.

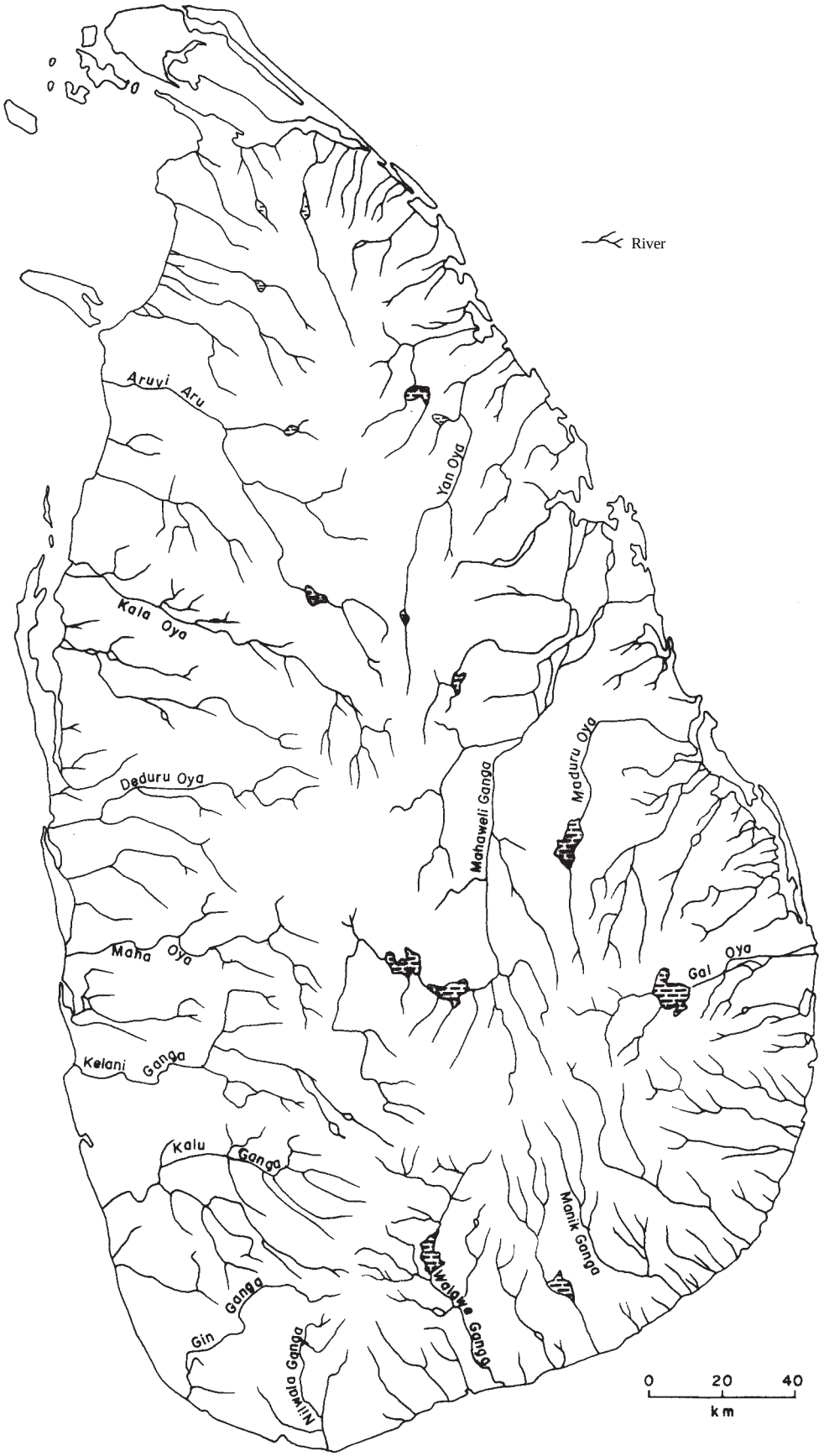
In the uplands where the rivers originate, there is fast-flowing water. These streams and rivulets contain simple aquatic plant communities and species that are segregated based on their degree of tolerance of the speed of water flow. Species such as Dicraea elongata and Podostemum subulatus are found in flowing water. In the lowland streams and rivers, and shallow tanks and ponds, there are various rooted aquatics with floating or submerged leaves such as Nymphaea spp. Nymphoides spp Nelumbo nucifera, Cabomba, Ceratophyllum, Ipomoea aquatica, Asteracantha longifolia, Aponogeton crispum and Monochoria spp. as well as submergent macrophytes such as Jussiaea peruviana, and species of Potamogeton, Chara, Utricularia, Lemna and Najas. The deeper reservoirs contain floating plants such as Neptunia oleracea, Azolla pinnata, Wolffia arrhiza, Pistia stratiotes and Hydrilla verticillata; fresh water algae, including unicellular and colonial chlorophyta and some filamentous forms; and several species of diatoms. When there is high eutrophication due to pollution, fresh water bodies are dominated by the exotic water weed Eichhornia crassipes and a heavy growth of Cyanophyta (blue-greens). The introduced water weed Salvinia molesta was a serious problem in the past, but has been successfully eradicated from most water bodies due to biological control measures. The shallow village tanks often support a rich phytoplankton among which are Oscillatoria, Microcystis, Hyella and Coelosphaerium. Grasses and sedges occur in the shallow submerged areas, with other herbaceous species such as Monochoria and Jussiaea. At the tank margins are sedges such as Cyperus and Fimbristylis spp., rushes such as Typha spp. and emergent vegetation such as Ipomoea aquatica. Shrubs (e.g. Hibiscus tiliaceus) and small trees occur in the adjacent high ground. River banks support gallery forests with tree species such as Terminalia arjuna Mitragyna parviflora, Madhuca longifolia, Polyalthia longifolia and Diospyros malabarica. Further away from the water, the vegetation merges into the natural forest typical of the area.

Faunistically, inland water bodies are important in terms of zooplankton and invertebrates. Diversity is especially high among the Rotifera. There are also several species of Cladocera, Copepoda, Monogenea and Hirudinea, and numerous freshwater crustaceans. Inland wetlands are also home to over 30 species of fresh water molluscs.

Freshwater aquatic systems are among Sri Lanka's most valuable habitats in terms of macrofauna. The structural diversity of vegetation and the availability of water and open spaces has created an ideal habitat for wildlife, especially the larger grazing mammals such as deer, buffalo and elephant. Foremost among such habitats are the flood plains in the dry zone. Of all

Painted stork at Bundala- the only Ramsar Site in Sri Lanka (H.I.E. Katugaha)

Figure 3.3 Sri Lanka's River System



Source: Adapted from NARESA (1991)

wildlife habitats in the country, the Mahaweli flood plains are believed to support the highest animal biomass, especially of large mammals. Wetlands contain numerous species of reptiles, including two species of crocodiles, hard and soft shelled terrapins, the water monitor, and water snakes. The wetlands support almost all of the indigenous amphibian species. They also provide habitats for rare endemic species. Interestingly, the small Waturana swamp forest in the wet zone is the only site in the world where the rare endemic trees Stemenoporus moonii and Mesua stylosa occur and is also the habitat of one of the rarest of endemic fishes, Lepidocephalicthys jonklaasi. Inland wetlands offer food, water and cover to a rich diversity of avifauna, including many migratory species. Wetland fauna also includes a number of endemic reptiles, many of which are known to be threatened - both nationally and internationally.

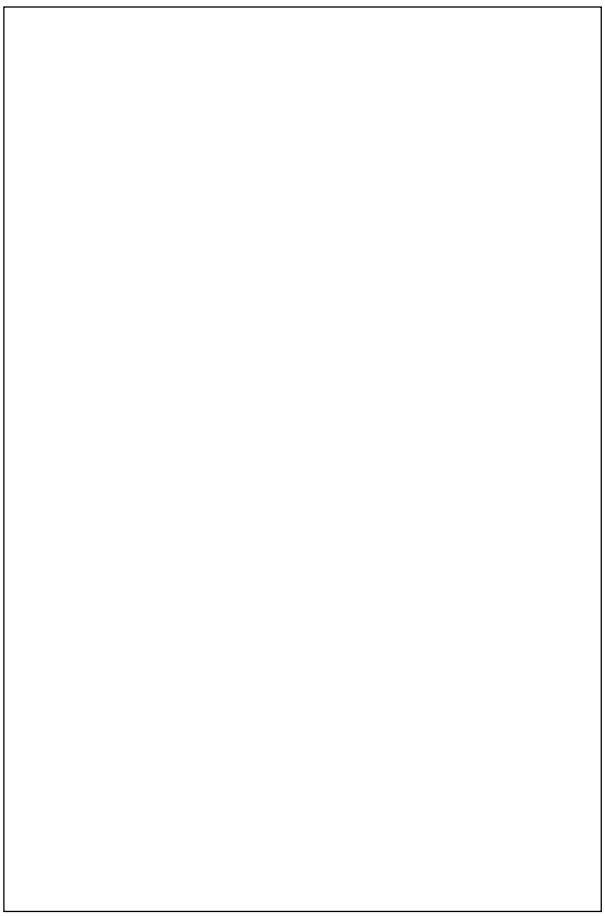
The species composition and biodiversity of a wetland depends on the climatic zone in which it is located and on whether it is at the coast or inland. The rivers and streams that originate in the rain forests of the wet zone constitute the main habitats for indigenous freshwater fish, including almost all the endemic species. The wet patanas in the montane region (typically at Horton Plains) are unique in their characteristic wetland flora, including the patana grasses, reed bamboo, ferns and flowering herbs, as well as the stream fauna, such as the naturalized rainbow trout. The Anuradhapura tanks, in the dry zone, are the home of some species of fish (e.g. Puntius ticto and Labeo porcellus) that are limited to the dry zone. Coastal wetlands such as Bundala, the only Ramsar site in Sri Lanka, host a large number of migrant bird species that winter in this country from August to April annually. Freshwater marshes, such as the Bellanwila-Attidiya sanctuary, provide a habitat for over 150 species of birds. Due to its urban location and ease of access, this site is of great value for conservation education, scientific research and recreation. The Kalametiya sanctuary is of special importance because of its avifauna, which number over 150 species including water birds such as pelicans, cormorants, herons, storks, egrets, ibises, migrant ducks and some rare species such as the Black Capped Kingfisher and the Indian Reef Heron.

Many components of wetland biodiversity are currently or potentially of economic value. They carry out ecological functions that contribute, directly or indirectly, to the well being and development of communities. For instance, they serve to prevent or mitigate floods following heavy rain. Coastal wetlands such as mangroves stabilize the shoreline and prevent coastal erosion, and provide important sites for aquaculture. Due to their key role in the cycling of nutrients, wetlands support a high biomass and provide local people with wood, food, pasture and manure. They often serve as sinks for urban wastes and a medium for transportation, and are of high aesthetic, recreational and scientific value.

Today, wetlands play a significant role in the economy of Sri Lanka. Several of the larger reservoirs provide hydropower that constitutes a large component of the national electricity supply. In addition, the inland fishery in tanks and reservoirs account for about 15 per cent of Sri Lanka's total fish production and provides food and income for the rural population. The importance and productivity of the inland fishery increased with the introduction of fingerlings of many exotic species, such as tilapia and gourami. However, the importance of the inland fishery declined in 1990 due to the withdrawal of state support at that time, but this has subsequently changed.

In the 1960s the environmental value of wetlands began to be recognized in Sri Lanka, at first mainly as a habitat for waterfowl. Since then, there has been a growing interest in conserving wetlands and halting their destruction. A significant step was taken in 1971 when Sri Lanka ratified the Ramsar Convention through which the conservation of global wetlands is secured and governments are committed to conserve and manage their important wetland sites.

In the late 1980s, the Sri Lanka Land Reclamation and Development Corporation carried out a feasibility study on the areas needed to be set apart for flood control in and around Colombo. An initiative to develop the Muthurajawela marsh through a marine and sand fill operation also resulted in a comprehensive study of this marsh and its environs, leading to the preparation of an environmental profile and master plan for this area. However, significant measures for the conservation-management of wetlands were taken only after the commencement of the Wetland Conservation Project by the CEA in 1991. This project spanned a period



The highly produtive mangrove ecosystem plays a vital role in the ecology and economy of coastal and marine systems (S. Balasubramaniam)

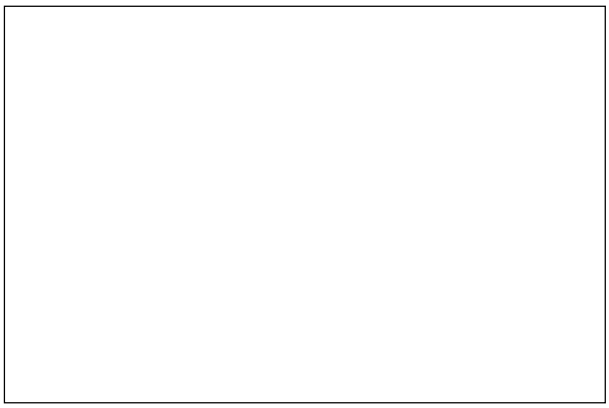
of over six years and was instrumental in prioritizing wetlands for conservation-management, and preparing site reports for 23 wetlands and management plans for ten of these areas. Three other site reports are in preparation. The plans envisage a sustained yield of multiple benefits with a minimum of resource use conflicts and within a framework of preserving the ecological, cultural and social values of the wetlands.

Most wetlands occur on state lands, but some are either wholly or partly under private ownership (e.g. Walauwawatte-Waturana swamp forest; Bellanwila-Attidiya Sanctuary). Some of the most important wetlands occur within protected areas managed by the Department of Wildlife Conservation. These include wetlands in the Mahaweli flood plains, Maduru Oya, Yala East, Ruhuna, Bundala, Horton Plains and Wilpattu, and in the Kalametiya Sanctuary and the Bellanwila-Attidiya Sanctuary. The Muthurajawela marsh is also under the Department of Wildlife Conservation. The Urban Development Authority; the Departments of Forestry, Agriculture, Irrigation, and Fisheries; the Land Reclamation and Development Board; and local government bodies are involved to varying degrees with the use or conservation of wetlands outside the protected area network. The Central Environmental Authority deals with the setting of environmental standards and controls for these areas. The Provincial Councils and the Ministry of Fisheries and Aquatic Resources deal with the fisheries aspects of inland wetlands.

Currently, a National Wetlands Policy is being formulated based on the recommendations of the Strategy for Wetland Conservation in Sri Lanka prepared (in 1994) through the Wetland Conservation Project of the Central Environmental Authority. A draft policy has been prepared within the framework of the conservation and sustainable use of wetland resources. Recognizing the multifaceted and inter-sectoral issues that affect wetland biodiversity, the proposed interventions cover irrigation and drainage, aquaculture, fisheries, clearing of mangrove vegetation, landfills, sand mining, sea shell mining, coral mining, salt production, siltation, livestock grazing, use of minor products, and pollution.

3.3 Coastal and Marine Systems

In ancient times, Sri Lanka was at the hub of several important trade routes from different parts of the world. Some of the most developed cities in the kingdoms of Maya rata and Ruhunu rata - two ancient sub-divisions of the island - were also located along the coastal belt. Since the



The beauty of fire coral: *Dendronephthya* sp.
(Arjan Rajasuriya - NARA)

sixteenth century, due to colonial rule, the coastal areas in the west and southwest coasts were subject to extensive changes in terms of biodiversity, human population density, as well as cultural and socio-economic features.

Sri Lanka's coastal zone is defined by statute as a two km wide band of ocean, and an adjoining strip of land extending 300 m inland; except that where a water body connected to the sea occurs, the zone extends two kilometres inwards from the mouth of the water body. The area defined for management purposes as the coastal region comprises all of the 67 administrative divisions with a coastal boundary. This area extends about 50 km inland from the coast and covers 24 per cent of the land area. It contains 32 per cent of the total population (including 65 per cent of the total urban population), about 90 per cent of the industrial units and over 80 per cent of the tourist infrastructure, but these are concentrated only in certain parts of the region. Much of the coastal region is sparsely populated, and many sections are at present not freely accessible due to conditions of civil unrest.

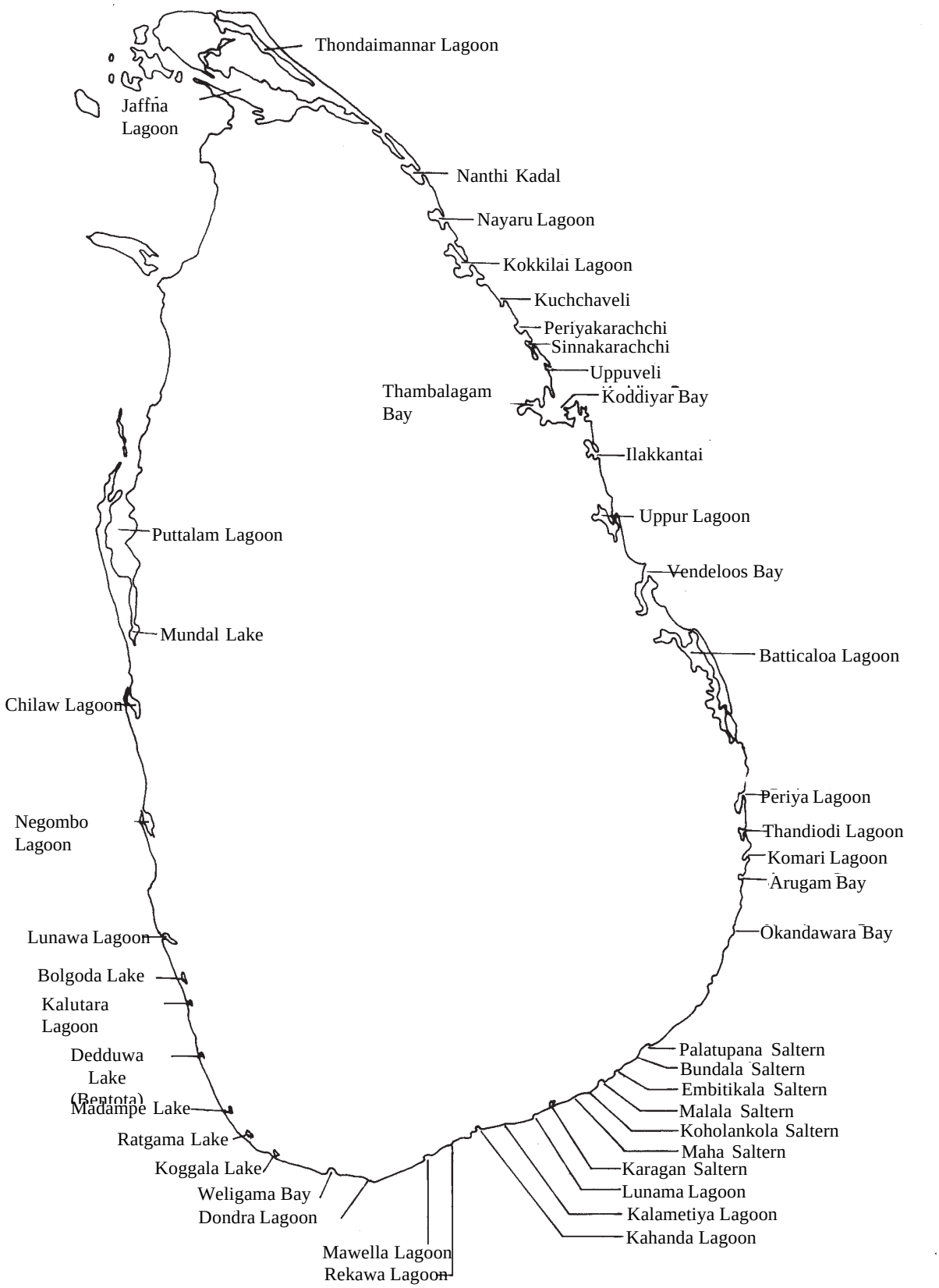
The continental shelf around the island is 20 km in most parts. The Exclusive Economic Zone (EEZ) extends 200 nautical miles from the shore and is almost four times the country's land area. Coastal waters extend from the shore to the edge of the continental shelf, while the offshore waters of the country extend from the continental shelf to the outer limits of the EEZ. The coastline which is about 1585 km in length supports highly productive marine ecosystems such as fringing coral reefs and shallow beds of coastal and estuarine seagrasses. Other coastal habitats comprise an extensive system of estuaries and lagoons (158,017 ha) (Figure 3.4), mangroves (12,500 ha), salt marshes (23,819 ha), sand dunes (7606 ha), beaches (11,788 ha), coastal marshy wetlands (9,754 ha), and other water bodies (18,839 ha).

The globally threatened hawksbill turtle (*Eretmochelys imbricata*) nests in Sri Lanka (Anuok Illangakoon)

Marine fishery is the foremost economic activity in the coastal zone and provides full or part employment for about 100,000 people. Coastal and marine fisheries contribute 85 per cent of all fish production in the island, and provides about 65 per cent of animal protein and 13 per cent of the total protein consumed nationally. Agriculture within the coastal zone is of secondary importance, but the much larger coastal region contains about 21 percent of all paddy lands in the country and the large bulk of the coconut land.

Coral reefs are rich in biodiversity and are important as habitats for flora and fauna, for containing coastal erosion, and for sustaining the coastal fishery. Sri Lanka has well developed reefs, but the majority are of sandstone and rock, and boulder reefs are common along the southern and eastern coasts. In contrast, the extent of true coral reefs is limited: only about two per cent of the coastline has fringing coral reefs (mostly along the southwestern, southern and eastern coasts) but off-shore patch reefs are more extensive. There are also some well-developed off-shore coral reefs, especially in the Gulf of Mannar and west of the Kalpitiya Peninsula. Coral reefs around the Jaffna Peninsula are less well developed, and generally occur around the coastal islands. A total of 68 indigenous coral genera and 183 species have been recorded to date. The common coral genera are Acropora, Echinopora, Montipora, Porites, Favia, Favites, Pocillopora, Goniastrea, Platygyra and Leptoria. Invertebrates that occur among reefs consist mainly of molluscs, sea anemones and sea cucumbers. Marine algae, including Halimeda spp., are found on sandy patches and coral rubble between live coral. Coral reefs may also support around 350 species of reef fishes, such as groupers, snappers, sweetlips, emperor fish, parrot fish, rabbit fish, surgeon fish, butterfly fish, and damsel fish. Several species are harvested in the ornamental fishery, and some, such as Chaetodon bennetti, Chaetodon unimaculatus and Balistoides conspicellum, have small populations though widely distributed.

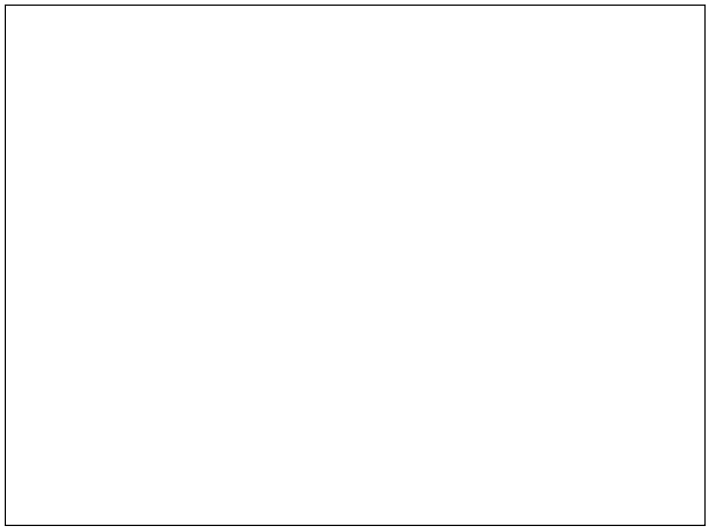
Figure 3.4 Distribution of Basin Estuaries and Lagoons



Source: CCD (1996)

Offshore fish species include large predatory fish such as the black-tip reef shark and the white-tip reef shark, and food fish such as tuna, seer and skipjack. These waters also contain about 37 species of cetaceans, including 20 species of dolphins and the sperm - and blue-whales. The dugong is also present in Sri Lankan waters, but is considered rare, and sightings have been made mainly off the Kalpitiya coast.

The shoreline and near-shore areas contain a variety of marine habitats, including seagrass beds. Among the invertebrate fauna are 201 species of crabs. There are five species of turtles that come ashore for nesting on Sri Lankan beaches. The fauna of the lagoons and estuaries are economically important. They include about five annelids, 28 molluscs and 25 arthropods, none of which is endemic. Sri Lanka has also been known over the years for its pearls from the pearl oyster beds located in the northwestern coast of the island, but these are now much reduced due to over-harvesting and siltation. The mangrove areas are discontinuous, but are important breeding grounds for marine organisms. The flora found here comprise both true mangroves and mangrove associates, and some are limited in distribution to specific parts of the coastline. Sri Lankan beaches vary in size and type. Many are wide and sandy and have high potential for tourism. They also support a distinct littoral sandy shore fauna and flora.



Ornamental fish associated with the productive and complex coral reef ecosystems (Arjan Rajasuriya - NARA)

First efforts at systematic coastal resource management in Sri Lanka commenced in the early 1980s with the setting up of the Coast Conservation Department (CCD). The Coast Conservation Act of 1981 identified the CCD as the prime agency for coastal issues and gave it the mandate to survey and inventory the coastal resources, issue permits for developmental activities in the coastal zone, and prepare management plans. The department is responsible for the conservation of natural coastal habitats and areas of cultural and recreational value and has been successful in attracting funding for its work. Programmes carried out so far include mitigating coastal erosion, policy development and coastal resources management. The CCD is expected to coordinate all sectoral activities in the coastal zone, including the activities of other state departments in the fisheries, shipping and tourism sectors, the Department of Wildlife Conservation, the Forest Department, the Urban Development Authority, the Irrigation Department and the Central Environmental Authority.

The prime national institution for research in the coastal and marine sector is the National Aquatic Resources Research and Development Agency (NARA). Reef research in Sri Lanka is being carried out mainly by NARA. This institution has also initiated research on the ex situ conservation of a few species of the fauna and flora which are becoming rare in their natural habitats. These include the sea cucumber

Paddy fields are an integral component of the Sri Lankan landscape (Channa Bambaradeniya)

Holothuria spinifera, two species of brackish water ornamental fish Scatophagus argus and Monodactylus argentius, and two species of mangrove plants Heritiera littoralis and Xylocarpus granatum.

A landmark event in coast conservation planning was the preparation of the first national Coastal Zone Management Plan (CZMP) in 1990. It dealt mainly with the problem of coastal erosion and the degradation and loss of critical habitats and sites of historic, cultural, scenic or recreational value within the coastal zone. Subsequently, "Coastal 2000: Recommendations for a Resource Management Strategy for Sri Lanka's Coastal Region", was produced in 1992 and endorsed by the Cabinet of Ministers in 1994. This document addresses coastal zone management more holistically than in the 1990 plan, and takes into account social and economic factors in identifying measures to conserve unique natural coastal resources with the long term goal of sustainable use. A deficiency in the plan of 1990 was its failure to recognize the importance of giving a participatory role to local stakeholders in the management of coastal resources. This shortcoming is rectified in the strategy of 1996 which promotes the formulation and implementation of Special Area Management (SAM) Plans for selected coastal sites. At present SAM Plans have been prepared for Hikkaduwa and Rekawa, and implementation of some of the proposed activities has commenced.

TABLE 3.2: EXTENT OF LAND UNDER DIFFERENT AGRICULTURAL USES IN SRI LANKA (1995)

Land Use	Area
Paddy	780,000ha
Vegetables (including root and tuber crops	110,000ha
Fruits	97,000ha
Other field crops	128,00ha
Plantation crops	772,000ha

There are several statutes, in addition to the Coast Conservation Act, that can influence the conservation of biodiversity in coastal and marine areas. These are: the Marine Pollution Prevention Act (1981) that provides for prevention, reduction and control of pollution in Sri Lankan waters and has provision for penal action for any form of marine pollution or damage to live marine resources and wildlife; the Fisheries and Aquatic Resources Act (revised in 1996) that provides for the integrated management, regulation, conservation and development of fisheries and aquatic resources in Sri Lanka, and the declaration of fisheries reserves; the Fauna and Flora Protection Ordinance (revised in 1993) that provides protection to specified threatened species of corals, fish and turtles and all marine mammals in Sri Lankan waters; the National Environmental Act (amended in 1988) that forbids pollution of marine waters; the Crown Lands Ordinance of 1929 that bans the removal of corals; and the Forest Ordinance which can be used for taking action against those responsible for the illicit cutting of mangroves or encroaching on such land. Notwithstanding the multiplicity of statutes that are expected to act as deterrents, degradation of coastal and marine habitats continues to take place due to deficiencies in the laws and law enforcement and the failure to recognize the social dimensions of the problem when attempting to take remedial action.

Several marine areas have been identified as deserving protection, but currently there are only two areas that have been declared as marine sanctuaries. The Bar Reef, located west of the Kalpitiya peninsula in the vicinity of Puttalam lagoon, was declared a marine sanctuary in 1992. The total area of the sanctuary is 306.7 km^2. The core zone, with an area of 70km^2, supports true coral reefs. Around 300 species of reef associated fish have been recorded in the Bar Reef, and some (e.g. Chaetodon semeion) are restricted to this site. The Hikkaduwa marine sanctuary is located in the southern province of Sri Lanka. It is 45 ha in extent, with about 25 ha of corals within and abutting the sanctuary. This area is endowed with a near-shore coral reef with about 60 coral species and 168 reef fish species. The sanctuary is also the centre of lucrative tourist based activities.

3.4 Agricultural Systems

Sri Lanka has been an agrarian-based society for more than 2500 years. At present agriculture contributes 20 per cent to the country's GNP, second only to the manufacturing sector. Currently, an

estimated 1.8 million families are engaged in farming, and nearly 75 per cent of the country's labour force is dependent upon the agricultural sector (including plantations) for its income and sustenance. The Sri Lankan agricultural scene is dominated by small-holders, and over 64 per cent of farming families in the country cultivate small holdings of less than 0.8 ha.

The agricultural landscape of the country consists mainly of rice paddies, covering 780,000 ha of cultivated land, and the plantation sector amounting to about 772,000 ha. The plantation crops are tea, rubber, coconut and sugarcane, and, on a smaller scale, coffee, cocoa, cinnamon, pepper, clove and other spices.

Paddy cultivation receives the highest attention in the agricultural sector. Rice constitutes the staple food of the population and is the backbone of Sri Lanka's agriculture and its ancient culture. Other crops in this sector include over 100 species used as items of food. Many of these, such as onion, potato and vegetables, remain a small farmer activity, and most fruit species are grown in home gardens. A few crops, such as chilli and cashew, are grown on a semi-commercial scale. A good many field crops also continue to be harvested from chena plots in the dry zone. This method of agriculture, involving the "slash and burn" of forest vegetation, has caused widespread forest destruction in the dry zone where it is practised, and adversely affected biodiversity.

Table 3.2 gives the areas of land under agriculture in Sri Lanka.

Over the years there has been an expansion of agriculture resulting in an increase in the cultivated land area from around 1.35 million hectares in 1956 to around 2.02 million hectares in 1995. Home gardens also make a substantial contribution to agricultural production, and it is estimated that there are now a total of around 1.33 million home gardens in Sri Lanka, accounting for about 367,800 ha of cultivated land. Home gardens constitute a traditional system of perennial cropping for a wide range of valuable crops and are considered important sites for in-situ conservation of crop germplasm. Today, however, only those categorized as Forest Gardens or the typical Kandyan home gardens in the districts of Kandy, Matale, Kegalle and Kurunegala are worthy of being recognized as such, and even these are now known to be dwindling due to land fragmentation caused by the rapidly changing socio-economic conditions in these areas.

Sri Lanka's farming systems which have evolved over thousands of years include a rich array of cultivated plants including grains, vegetables, fruits and spices, and livestock. Adding to this, numerous new local cultivars have been developed in the plantation sector during this century.

In terms of crop biodiversity, the long history of rice cultivation and the wide range of eco-edaphic conditions present in the country have resulted in Sri Lanka having a wide varietal diversity of Oryza sativa. Indigenous rice varieties show adaptability to various adverse climatic conditions. For instance, traditional upland varieties are well known for their drought tolerance; varieties grown in the coastal areas and floodplains of rivers possess tolerance of submergence and flash floods; the few rice varieties cultivated at higher elevations (over 1000 m) can grow at low temperatures; and several varieties show broad-based resistance to serious pests and to high salinity and other adverse soil conditions.

Sri Lanka also has considerable biodiversity in terms of other cereals such as millet, sorghum and maize. Finger millet is the staple food of the dry zone chena cultivator, and is grown in almost all the chena holdings. Maize is also widely cultivated in the dry zone for human consumption and animal feed. In contrast, the cultivation of sorghum is very limited in extent and is restricted to the drier parts of the country. Unlike rice, most other cereals have undergone little selection by farmers.

Grain legumes, such as cow pea, green gram, black gram, winged bean, and soya bean constitute an important source of protein for most Sri Lankans, particularly in rural areas, and are increasingly used for crop diversification. Winged bean, in particular, shows much genetic variability as is evident in the seed colour, pod size and flower colour.

Sri Lanka has been world-renowned for its spices for centuries. There are at least eight indigenous species of Cinnamomum, of which the wild species are restricted to the natural forests of

the wet zone. Cultivation of cinnamon for commercial purposes has also been widespread in the south-western coastal areas since the mid fifteenth century. Another important local spice crop is Elettaria cardamomum. Cardamom cultivation and the cultural practices associated with it in the Knuckles forest, where conditions are ideal for the growth of this species, has had very adverse effects on forest biodiversity and the regeneration of canopy species. The spice plant Piper nigrum (pepper) and the betel leaf plant Piper betle are both widely cultivated in the lowland wet and intermediate zones of Sri Lanka. The latter is sometimes grown in forest deniya lands, causing the destruction of wetlands in the forest. Syzygium aromaticum (clove) is cultivated in home gardens of the Kandyan and Matale districts, and Areca catechu (arecanut or betelnut) is a common home garden species in the wet zone. A wild relative of arecanut, A. concinna, is considered endangered in the wild. Among other spice crops found in Sri Lanka are three species of nutmeg (Myristica), two species of chilli, (Capsicum annum and C. frutescens) and one species each of ginger (Zingiber officinale) and turmeric (Curcuma longa).

Among the horticultural crops grown in Sri Lanka, there are several cultivars of banana (Musa spp.) cultivated in the different agro-ecological regions of the country. Interestingly, M. acuminata and M. balbisiana, the parent species of the cultivated banana are both present in Sri Lanka. There is also considerable genetic variation among a wide range of fruit crops, such as citrus, mango, avacado and jak, that are grown mainly in home gardens. Other fruit crops such as durian, pomegranate, rambutan, guava and papaw have also been in cultivation for a long time and exhibit a wide range of genetic diversity. Fruit crops such as wood apple and velvet tamarind are a source of income for the dry zone farmers, and are harvested from forests for sale. Of concern is the fact that harvesting of the latter species from forests is destructive as it involves chopping down of large fruit bearing branches to facilitate collection.

Sri Lanka has a large number of vegetables, including both temperate and tropical species, cultivated throughout the country. Among these, cucurbits, tomato and eggplant exhibit high genetic diversity. There is also a fair number of root and tuber crops, of which cassava, dioscorea and innala show considerable genetic variation. Sweet potato, although introduced to this country, is naturalized and has high genetic variability.

With regard to the ex situ conservation of agricultural germplasm, this activity was placed on a sound scientific footing by the setting up of the Plant Genetic Resources Centre for the cryo preservation of plant germplasm. (See Table 3.3). Other institutions carrying out ex situ conservation of food crops, but only as field gene banks, are the Horticultural Crops Research and Development Institute (for fruit and vegetable species, root and tuber crops), the Rice Research and Development Institute (for rice genes), and the Field Crop Research and Development Institute (coarse grains, grain legumes and condiments). These institutes are under the Department of Agriculture. The Department of Export Agriculture maintains germ plasm of coffee, cocoa, cardamom and clove. There is an inadequacy of field gene banks for traditional species of fruits (e.g. madan, atamba, divul, himbutu), grain legumes, and medicinal plants.

The economy of Sri Lanka has been long dominated by plantation crops, mainly tea, rubber and coconut. Tea germplasm, originally introduced from Assam in 1839, has undergone selection through breeding programmes, and the selected genotypes are being conserved in numerous breeding stations and tea estates in the country. Selection and vegetative propagation have resulted in a series of high-yielding tea clones that are resistant to pests, diseases and drought, and have high rates of fermentation. The rubber plantations in Sri Lanka were initially derived from a highly inbred selection of lines derived from South American seedlings introduced to the country in 1876. Clonal propagation of these lines for selected characters narrowed down this genetic base until, in the early 1980s, 6000 new accessions were introduced from Malaysia from a special collection of wild Hevea germplasm brought in by the International Rubber Research and Development Board from Brazil. With regard to coconut, a number of new varieties and hybrids have been developed in Sri Lanka, and much of this work has been carried out by the Coconut Research Institute. The three crop plantation research institutes and the Sugar Research Institute conserve their respective germplasms as live genebanks at their field stations.

TABLE 3.3 GERMPLASM COLLECTION STATUS BY CROP GROUP AT THE PGRC

Crop Group	Number of		Percentage Collection
	Species	Accessions	
Rice	2	3809	34.0
Other cereals	9	785	7.0
Grain legumes	14	1907	17.0
Vegetables	52	2927	26.1
Spices & condiments	9	500	4.5
Fruits	16	363	3.2
Root & tubers	7	309	2.8
Oil seeds	3	180	1.6
Medicinal plants	12	21	0.2
Wild relatives of crop species	26	308	2.7
Other	-	96	0.9
Total	150	11205	100

Sri Lanka also has about 170 species of plants of ornamental value, of which about 74 species are endemic. Notably, the natural habitats for several Dendrobium and Vanda species and many foliage plants of commercial value are the wet zone forests of the country.

In the livestock industry, the animals commonly reared comprise neat cattle (1,644,000), buffalo (760,900), goats (535,200), sheep (11,400), pigs (84,800) and poultry (9,136,600). The indigenous cattle have a very low genetic potential for milk production, but are resistant to diseases and have the ability to feed on coarse grasses. Several foreign breeds of cattle have been introduced to the country over the last four decades in an effort to boost milk production.

With regard to the local breed of buffalo, there is as yet some uncertainty about its origins. Although it has been stated that it is not indigenous and the wild form is feral, recent evidence from fossil discoveries indicates the existence at some time in the past of an indigenous species of buffalo identified as a swamp type. It is believed that over 95 per cent of the buffaloes in the country are the indigenous "Lanka Buffalo", while the rest are of foreign origin and belong to the river type. The exotic breeds are the Murah and Surti from India and the Nili-Ravi breed from Pakistan. Little is known about the indigenous varieties of goats, sheep and pigs, and there have been only little efforts to identify and conserve genepools of these breeds.

The local backyard breed of scavenging poultry that are resistant to tropical diseases and were commonly found in many village households prior to 1960s are fast disappearing due to the strong preference for imported germplasm.

Efforts have been made by the Department of Animal Production and Health and the Veterinary Research Institute (VRI) to conserve the indigenous animal species of economic value, but they are constrained by insufficiency of funds and infrastructure. The private sector plays an important role in the maintenance of germplasm of livestock, particularly of poultry, and it regularly imports exotic germplasm.

Bio-regions

Sri Lanka's landscape presents a rich mosaic of forests, wetlands, agricultural land, and coastal and marine systems whose character and distribution are conditioned by the wide range of climate, topography, and soil types found in the island. The climatic and geomorphological variations in the country have resulted in a clear demarcation into broad climatic, floristic and faunal zones, and this information was used for identifying bioregions. The biodiversity rich ecosystems in the island, such as the lowland rainforest and the coral reefs, are confined spatially to specific geographic areas. These areas often present special problems for biodiversity conservation. One example is the biodiversity rich wet zone forests that are under threat due to the high population density in the surrounding areas and the acute shortage of land. Another example is the threat to the coastal and marine habitats in the west and southwest caused by overharvesting of marine resources. These problems have to be addressed through location-specific conservation action.

In recent times there has been an increasing commitment by the government to decentralize the state administration to the provincial and district levels. Devolution would mean that biodiversity conservation would have to become an integral part of the regional planning and development process. In this context, and also because much of the action recommended for the conservation of biodiversity focuses on the conservation of species in situ and of habitats, the identification of biodiversity regions for priority action will help the regional administrators and planners to recognize and include in their programmes the areas needing urgent action for biodiversity conservation action. It would also enable national level state institutions directly concerned with biodiversity conservation to identify areas for priority action in terms of implementing the recommendations in the BCAP. Thus biodiversity regions were identified primarily to facilitate the identification of spatially defined areas for conservation action.

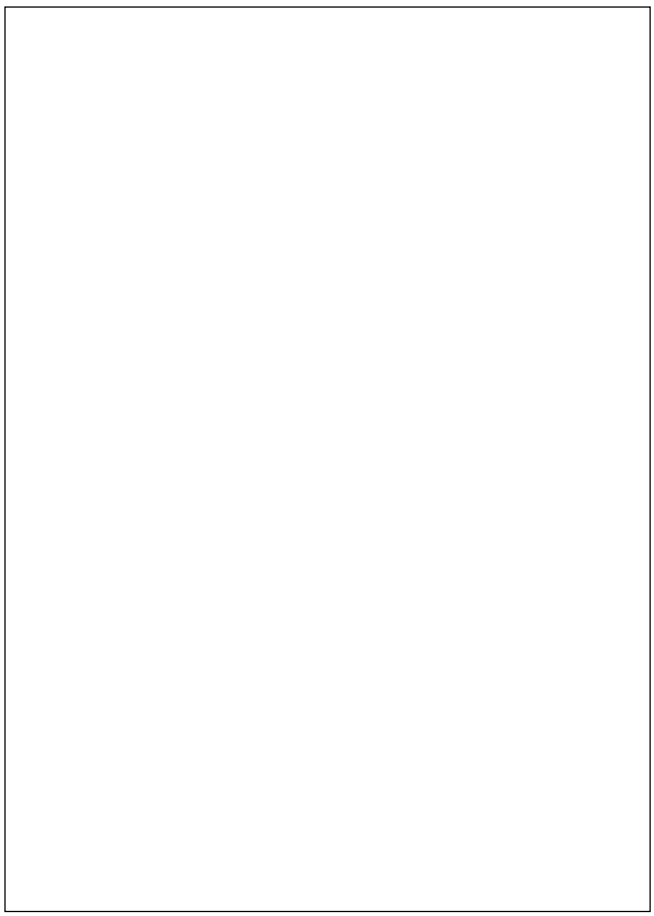
The identification of bio-regions for Sri Lanka is a new concept, and the demarcation into bio-regions as proposed in this Plan should be treated as provisional. A careful analysis of current climatic and geo-physical classifications, the faunal and floral distribution patterns, and the biodiversity richness of different parts of the country led to the identification of the terrestrial bio-regions. The coastal and marine biodiversity regions were defined within a belt extending 300 m inland from the level of high tide through to 22.2 km (12 nautical miles) into the ocean. The bio-regions within this area were demarcated according to the presence of characteristic biological resources (e.g. coral reefs) and their uses, the presence of special habitats, and threats to biodiversity due to human activity. A total of 15 bio-regions was recognized (Table 4.1, Figure 4.1).

In order to assess the relative importance of these bio-regions for biodiversity conservation, different parameters were used based on the available data. In respect of each parameter, priority ratings were assigned to each bio-region. For the terrestrial bio-regions, the criteria used are given below.

- Degree of threat, based on
  - ❑ population density
  - ❑ development pressure, indicated by
    - ❍ percentage of urban population by district
    - ❍ number of schools per 30 km^2 by district
- Biodiversity, based on
  - ❑ available data, including preliminary results of the National Conservation Review
- Economic potential, based on
  - ❑ number of traders by district
- Access, based on
  - ❑ road network, length per 100 km^2, by district

- Forest coverage
- Watershed value

An additional criterion, security risk, was also used since this is important in the current context. A subjective judgement was made in relation to the different districts where civil administration was weak due to disturbances. It is clear that a re-evaluation would have to be made once normalcy is restored in these areas. High ratings for threats, economic potential, access, and species and ecosystem richness contributed positively towards priority rating, while a high forest cover and security risk contributed negatively.



An inside view of the Sinharaja forest (Vimukthi Weeratunga)

A different set of criteria was used for priority ranking of the coastal and marine bio-regions. The geomorphology of the coastal areas, and marine resources, their uses and threats, were the criteria used.

On the basis of the ranking, the regions identified for priority action for biodiversity conservation were terrestrial regions 4,5, and 6, and coastal and marine regions 11, 13 and 14. These bio-regions are described briefly below.

Bio-region 4 (wet lowlands)

This covers the districts of Colombo, Gampaha, Kalutara, Galle and Matara, and parts of the Ratnapura, Kandy and Kegalle districts. The region receives about 2500 mm to 5000 mm of rainfall, with no drought months. The altitude extends from sea level to about 1000 m. The mean annual temperature is 27°C at sea level. The soil type in this region is basically red-yellow podzolic soils with soft and hard laterite in the lower elevations. The terrain ranges from flat to rolling and undulating.

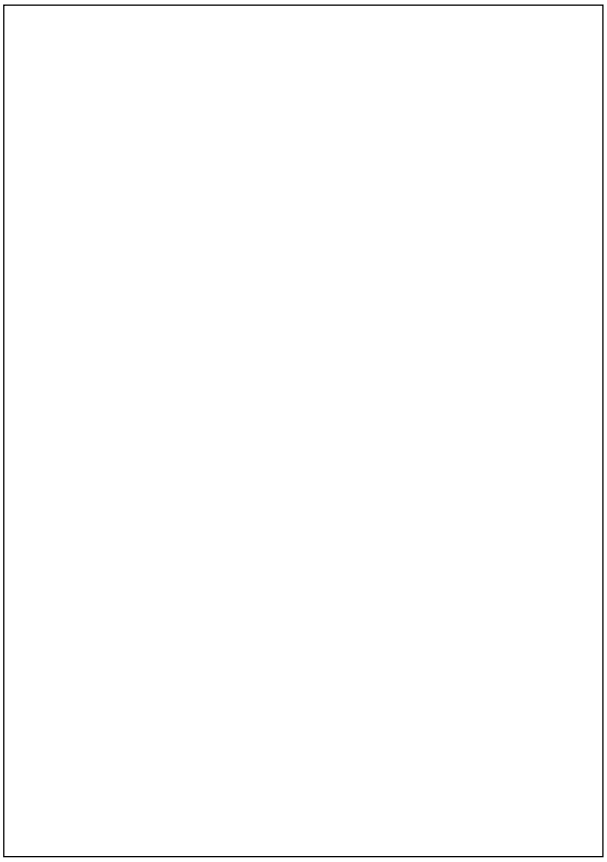
The tropical lowland wet evergreen forest best represents the climax vegetation of this bio-region. The remaining forests are concentrated mainly in the Galle and Matara districts. They are highly fragmented and many of them are small blocks of a few hundred hectares each. The southwestern section of this region is floristically the richest in Sri Lanka, with the highest percentage of endemic species among both the fauna and flora; it has been rated (by Ashton and Gunatilleke) as, floristically, the richest region in South Asia. The climax forests of this bio-region are dominated by Dipterocarp species, among which endemism reaches 90 percent, and some species are very rare and heavily localised. These forests also show considerable micro-climatic differences within a relatively small spatial area. At present, 93 per cent of endemics in the rain forests of this bio-region are either Endangered, Vulnerable or Rare according to the IUCN Red Data Book criteria. This is mainly due to the high human population pressure on the limited land resources of this region and consequent loss of forest habitats, and over-exploitation of forest resources. The Sinharaja World Heritage Site and the KDN forest reserve (one of the richest in terms of biodiversity and endemism) are located in this bio-region.

Bio-region 5 (wet midlands)

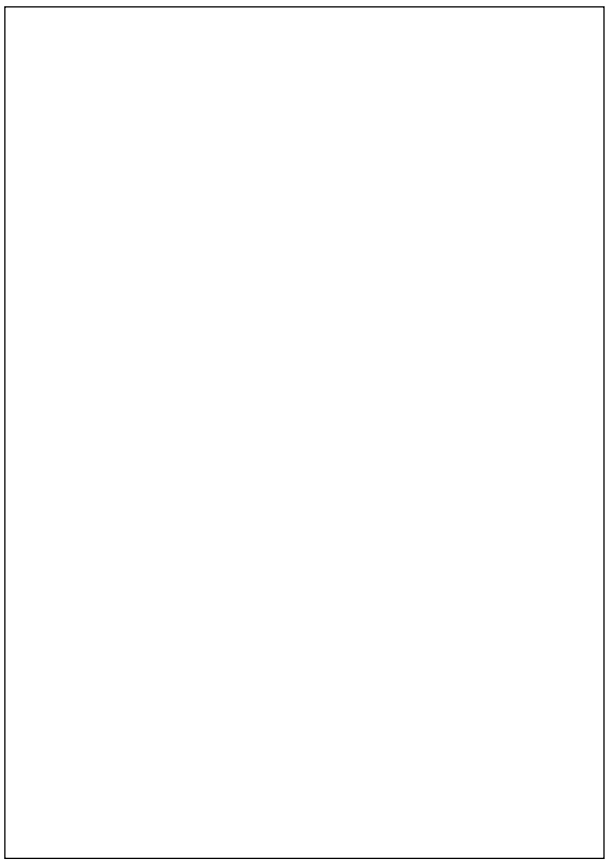
This bio-region occurs mainly in the Ratnapura district and some parts of the Kegalle district. This region corresponds to the wet sub-

TABLE 4.1 THE BIO-REGIONS - BASIC INFORMATION

Bio-region	Identification of regions	Key climatic and biological features
1	Arid zone	Tropical thorn scrub with isolated trees. Altitude 0 100 m. Annual rainfall less than 1250 mm (mainly from Oct. Jan.). More than 5 dry months (month with less than 50 mm rainfall).
2	Dry zone	Dry mixed ever green forest. Altitude 0 500 m. Annual rainfall 1250 - 1900 mm (mainly from Oct.- Jan.). 4-5 dry months.
3	Intermediate zone	Moist evergreen forest. Altitude 0 -1000 m. Annual rainfall 1900 - 2500 mm. Less than 3 dry months.
4	Lowland wet zone	Tropical (lowland) wet evergreen forest. Altitude 0 - 1000 m. Annual rainfall 2500 - 5000 mm. No dry months.
5	Sub-montane wetlands	Sub-montane evergreen forest. Altitude 1000 - 1500 m. Annual rainfall 2500 - 5000 mm. No dry months.
6	Wet highlands	Montane evergreen forest. Altitude 1500 - 2500 m. Annual rainfall 2500 - 5000 mm. No dry months.
7	Intermediate highlands	Dry patanas. Altitude 1000 - 1500 m. Annual rainfall 1900 - 2500 mm. Less than 3 dry months.
8	Kathiraveli to Mullaitivu (mineral sands)	Coral reefs and rocky habitats (comparable to bio-region 9), mangrove habitats, lagoons and estuarine systems (Trincomalee), and mineral sands (Mullaitivu area). Large marine mammals (whales) present. Important for fisheries.
9	Panama to Kathiraveli (eastern lagoon systems)	Near-shore coral reefs (relatively extensive but less than in bio-region 14). The Great and Little Basses reefs, mangrove habitats associated with lagoon systems, multiple lagoons and estuarine systems (Batticaloa). Important for fisheries and has minimal human interference (Panama to Kalmunai).
10	Tangalle to Panama (wildlife habitats)	Rocky and sandstone habitats, shield lagoons and estuarine deltas (Tangalle to Ambalantota), extensive sand dunes (Ambalantota to Dorawa Point), and large lakes and lagoons (lewayas). Conservation areas including national parks and turtle nesting sites. Coastal wetlands include a RAMSAR site, and salt production in lewayas.
11	Hikkaduwa to Tangalle (near-shore coral beds)	Rocky and near shore coral reefs and pockets of mangrove habitats (Koggala, Polwattu modhara in Weligama). Important for fisheries and tourism. Coral beds over-exploited for the lime industry, coastal erosion.
12	Chilaw to Hikkaduwa	Coastal marshes and lagoon systems. (Chilaw to Peliyagoda), pocketed mangrove habitats (Chilaw, Bolgoda, Panadura, Kalutara, Bentota), and sandstone rocky habitats and sandstone reefs (Galle Face to Mt. Lavinia). Beach seine fishery, tourism associated with sandy beaches, and high human population density.
13	Kandakuliya to Chilaw (western marshes)	Coral reefs, sandstone reef habitats, swamp marshes, lagoons and associated mangrove ecosystems (Puttalam), important for fisheries and prawn farming.
14	Mannar to Kandakuliya (large off-shore coral beds)	Extensive coral reefs, sandstone reef habitats, sand dunes, mud flats, salt marshes (Kalpitiya), and limestone rich soil. Dugong sightings.
15	Mullativu to Mannar (limestone beds)	Coral reefs lie off-shore (north of Jaffna Peninsula). Sandstone reef habitats, limestone rich soil, shallow-wide continental shelf, salt marshes, lagoon systems, associated mangrove habitats (Jaffna), and sand dunes. Fish resources unexploited for the past decade.



Foothills of the Adam's Peak Range (S. Balasubramaniam)



The characteristic gnarled trees at Horton Plains (S. Balasubramaniam)

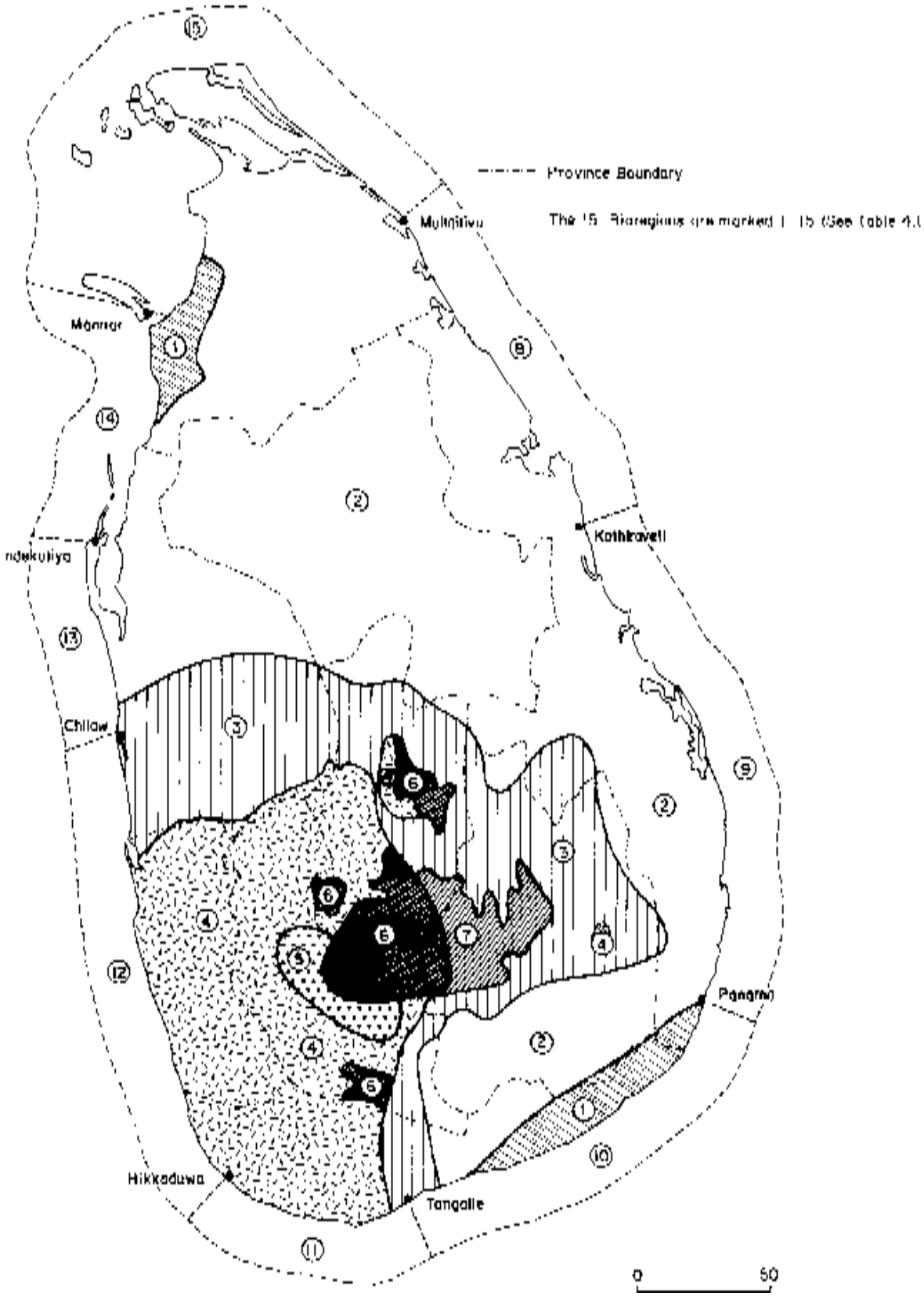
montane area of the country. At around 1000 m altitude in the wet zone, there is a clear transition of the natural vegetation into hill forest or sub-montane evergreen forest, and this forest type is found up to about 1500 m. The rainfall regime is broadly similar to that in the low country wet zone, but the temperature is a few degrees lower. The terrain is steeply dissected, hilly and rolling in the mid elevations. The forests occur on the foothills of the Adam's Peak range around Hatton, Kotagala and Dambakelle, and on the upper slopes of Sinharaja. Some forests of this region are exceptionally rich in heavily localised and rare endemic tree flora. These submontane forests are also important catchment areas for several rivers. Forests of this region have been impoverished due to selective logging. The Eratna-Gilimale Proposed Forest Reserve and the Bambarabotuwa Forest Reserve are located in this area.

Bio-region 6 (wet highlands)

This bio-region covers the Nuwara Eliya district and a part of the Badulla district. Its altitude ranges from about 1500 m to 2500 m, in the wet zone. The rainfall regime is broadly similar to that in the low and mid country wet zone, but the temperature is appreciably lower. At high elevations, on a few days in the year, the temperature drops to below zero Celcius at night and there is the occurrence of ground frost. This region contains the higher elevations of the Peak Wilderness Sanctuary and the Horton Plains National Park and parts of the Knuckles Conservation Forest. The soils in this regions are red-yellow podzolic soils with mountain regosols in the higher elevations. The topography is steeply dissected and rugged in the upper reaches of the hills. The vegetation characteristic of this region is montane evergreen forest. They are important in containing dipterocarps at higher elevations than elsewhere in the world. The forests at the highest elevations in this region are also characterised by unique pygmy forests. Wet patanas or wet montane grasslands containing sub-alpine flora also occur in this region.

The forests of this region are threatened by encroachments for tea planting and vegetable

Figure 4.1 Bioregions of Sri Lanka



gardening. Although village settlements are situated somewhat away from these forests, there is a distinct threat from collection of firewood by villagers.

Bio-region 11 (near shore coral beds)

This bio region covers a 22.2 km (12 nautical miles) wide marine area and a 300 m coastal belt from Hikkaduwa to Tangalle in the districts of Galle and Matara. This region covers a belt of coral reefs which, though relatively narrow, is important due to its proximity to the coast and the richness of its fauna and flora. These reefs are of importance in the tourist industry, and because of easy access they have been well studied. The dominant species of coral found in this area belong to the families Acroporidae, Faviidae, Poritidae, Mussidae, and Pocilloporidae. Most shallow water, near shore reefs are dominated by Acropora sp., Montipora sp., Porites sp., Favia sp., Favites sp., Echinopora lamellosa and species of Pocillopora, Platygyra and Goniastrea. A typical near-shore reef in this area supports 40 to 50 species of coral. The marine plants in the coastal waters of this region include many species of algae found on sandstone, coral reef or rock formations. There is large scale destruction of the coral reefs for the lime industry, and several tons of live coral are collected annually from this area. This region is also famous for the beach seine fishery and the characteristic wide sandy beaches which are a popular tourist attraction. The Hikkaduwa marine sanctuary is situated in this region.

Bio-region 13 (western marshes)

This bio-region covers a 300 m wide inland strip and extends 22.2 km offshore, stretching from Kandakuliya to Chilaw, in the district of Puttalam. It includes mangroves, mud flats, sand dunes and a system of lagoons.

This area is important in terms of the lagoon ecosystems, in which the faunal biodiversity is not high, but is of considerable economic importance. This region is critical because of its economic significance in aquaculture development, which has led to the extensive exploitation of coastal wetland habitats for the establishment of prawn farms.

Bio-region 14 (large off-shore coral reefs)

This covers a 22.2 km wide marine area and a 300 m coastal belt from Mannar to Kandekuliya in the districts of Mannar and Puttalam. It has some of the largest and well developed offshore coral reefs of this country, including the Bar Reef marine sanctuary which contains intact coral reefs and sandstone habitats, and harbours dolphins and turtles. Off-shore coral patches in this region may extend 100 m or more across and are usually found beyond a distance of two kilometres from the shore-line. Although much of the larger coral reefs in this region are spared of excessive destruction, some are severely degraded due to adverse fishing methods and feeding by the Crown of Thorns starfish. This region is also important due to its fringing mangrove vegetation and an extensive shallow lagoon system including Portugal Bay, Dutch Bay and the coastal areas of the Wilpattu National Park. Sea turtles are caught regularly in this area. It is also important due to its abundant fish stock and habitats for diverse fauna. The fauna include juvenile and adult fish and many species of commercially important invertebrates including the spiny lobster and crabs. This region also contains extensive sea grass beds that are the habitat of the endangered dugong.

There is an urgent need for management of activities connected with fishing practices by both national and foreign trawling vessels, and for stringent measures to conserve the valuable coral reefs of this region.

Principles, Goal and Broad Objectives

5.1 Biodiversity Management Principles

The success of biodiversity conservation will depend on how well the overall landscape is managed to minimize loss. The needs of the people and their activities must be reconciled with the maintenance of biodiversity. Protected areas must be integrated into natural and modified surroundings. The management of farms, forests, grasslands and wetlands should be on the same planning framework as development activities like village settlement, irrigation, land restoration, etc. There are no simple prescriptions on how this could be done.

The principles that are likely to provide guidance in biodiversity conservation management are as follows.

- Every form of life is unique; each plays a distinctive role in the web of life and warrants respect and consideration by mankind.
- Conservation of biodiversity is a common concern of all citizens, and the country has a stake in, and the sovereign right to use, its biological resources for its own benefit.
- Biodiversity conservation is an investment that yields substantial benefits to its trustees; ensuring a larger market share of benefits to local communities will foster sustainable use.
- Costs and benefits of biodiversity conservation should be shared equitably; corrections in imbalances in the control of land and resources can reduce biodiversity losses.
- The best long-term economic use of biodiversity is that which will maintain the ecological and cultural values of ecosystems.
- Recognition that both in situ conservation and ex-situ preservation of biodiversity are key tools in management of biodiversity conservation.
- All sectors that influence biodiversity should help plan its conservation.
- Living resources cannot be sustainably managed exclusively by communities or governments. The government must recognize the interests and rights of communities, while the community must recognize that such management is part of a larger political and economic framework.
- Recycling and conservation can directly reduce demand for biological resources and can reduce the pressure on natural habitats.
- Biodiversity conservation can be sustained if public awareness and concern are substantially increased, and if policy-makers have access to reliable information upon which to base policy options.
- Revising public policies that result in the wasteful use of biodiversity or in irreversible loss of biodiversity should facilitate conservation management.

The many principles that set a framework for conservation management lead inevitably to an integrative approach. It involves a variety of interest groups, communities and state agencies on the one hand and a range of natural and modified habitats on the other. These principles have guided the preparation of this framework plan of action for the conservation of Sri Lanka's biodiversity.

5.2 The Goal of Biodiversity Conservation

The recognition of the intrinsic value of biological diversity, and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological systems and their components for the well being and survival of all living beings, was the primary motive force for the development of a global strategy for the conservation and sustainable use of biological diversity. The global community recognizes that:

(a) biodiversity is important for evolution and for maintaining life sustaining systems of the biosphere,

(b) conservation of biological diversity is a common concern of humankind,

(c) biological diversity is being significantly reduced by certain human activities, and that it is vital to anticipate, prevent and attack the causes of significant reduction or loss of biological diversity at source,

(d) where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat, and

(e) all countries have sovereign rights over their own biological resources, and are responsible for conserving their biological diversity, and for using their biological resources in a sustainable manner.

Sri Lanka has endorsed the global concern, and resolved to set its goal and objectives and to deploy the resources at its disposal to evolve its own strategic plan of activities for containing the erosion of biological diversity and ensuring its sustenance for the benefit of present and future generations.

The overall national goal of biodiversity conservation is, therefore, to conserve the biological diversity of Sri Lanka, while fostering its sustainable use for the benefit of the present and future generations.

5.3 The Broad Objectives

In order to achieve the goal in the long term, the following broad objectives are set out.

1. To build capacities and develop programmes for gaining a better understanding of the different components of the country's indigenous biological diversity and the processes that govern their functioning.

2. To identify adverse impacts (including potential impacts) on the different components of biodiversity; to take action to mitigate such impacts and to avert potential adverse impacts.

3. To build capacities and develop programmes to enhance the populations of species that are in demand and are under threat due to excessive collection.

4. To manage bioresources so as to conserve biodiversity while enabling the use of the resources within sustainable limits.

5. To enhance public awareness on biodiversity and encourage public participation in its conservation.

The chapter that follows will identify the issues, set the specific objectives, and propose the action to be taken in respect of the different activity areas for conserving the nation's biodiversity.

Biodiversity Conservation Proposals for Action

6.1 Forests

Identifying the issues:

From the 1940s, the wet zone forests began to be recognized as a rich timber resource, and with the continuing depletion of supplies from the dry zone, exploitation of the wet zone forests gained momentum. This went on unabated until 1989 when a moratorium was placed on all felling in the natural forests of the wet zone in an effort to save this valuable resource for the conservation of biodiversity and hydrology. Based on the ongoing assessment of biodiversity and hydrology, many wet zone forests are being designated as "conservation forests" where no commercial logging will be allowed in the future.

Besides logging, another serious threat to the biodiversity-rich wet zone forests has been encroachment by communities living in the peripheral areas. To arrest this problem the Forest Department is moving towards adopting a participatory form of forest management involving the local communities. With technical support from the IUCN, the Department has prepared management plans for several of the conservation forests. The plans provide for activities in the buffer zones of the forests designed to benefit the communities living in these areas.

The consequences of deforestation in the wet zone are many, of which the depletion of the timber resource is just one. More important is the loss of species and genetic diversity. Wet zone forests harbour most of the endemic reptiles and amphibians, and the natural patchiness of distribution of these species is aggravated as a result of habitat fragmentation. Most endemic amphibians and reptiles are typically forest species and are unable to establish viable populations in disturbed ecosystems. For example, the ground-dwelling agamid lizards Otocryptis wiegmanni and Ceratophora aspera are confined to shady areas within undisturbed forest patches, and changes in soil quality due to deforestation affect fossorial reptiles, such as burrowing skinks, that live in the leaf litter of tropical forests. Similarly, amphibians are very sensitive to changes in temperature and humidity in their forest environments. Of the endemic fish, about 50 per cent live in the wet zone forests, and their distribution is affected by changes in water quality caused by siltation and pollution. Eighty per cent of the endemic birds of Sri Lanka are forest species, and they are usually unable to colonize non-forested areas successfully.

The biodiversity in the wet zone is largely confined to the fragmented blocks of forests which are surrounded by encroaching human settlements and agricultural holdings of tea, rubber and paddy. To compound the problem, many of these forest blocks are already too small to maintain functional ecosystems or to sustain effectively viable populations of animals. Habitat disturbance has also several other implications, as it brings in its wake restricted dispersal of species and pocketing of populations that could lead to genetic erosion, especially among the larger vertebrate fauna. Among the flora, the dipterocarps that comprise the dominant vegetation of wet zone forests are poor dispersers, and their regeneration is threatened when there is excessive disturbance of crown cover. A study by Gunatilleke and Gunatilleke (1991) revealed that, of 184 woody endemics recorded in five rainforests, 93 per cent were judged to be Endangered, Vulnerable or Rare according to the then prevailing IUCN criteria. Wet zone forests also play a crucial role in watershed protection, and deforestation could lead to serious problems in watershed management and river flow.

In the dry zone, the forest areas being larger and the level of biodiversity and endemism substantially lower than in the wet zone, the adverse impacts of forest loss on biodiversity are not as severe, except for the effects on large mammals like the leopard, elephant and primate species. For these species the loss of forests due to expansion of

settlements, irrigated agriculture and chena have caused a reduction of contiguous geographic ranges. Whether in the dry zone or wet, it must be noted that when dealing with the conservation of some faunal species, large mammals for example, it is necessary to take into account their particular characteristics in relation to social organization and range requirements.

Besides deforestation, excessive exploitation for timber has had severe adverse effects, so that even the forests that remain are heavily depleted in terms of biodiversity. The dry zone forests have been logged for many decades, and mature trees of prized timber species like satin wood (Chloroxylon swietenia), halmilla (Berrya cordifolia) and ebony (Diospyros ebenum) are now very rare. Natural regeneration of these species is observed but their establishment is poor. Some species like wewarana (Alseodaphne semecarpifolia) and panakka (Pleurostylia opposita) are so scarce that they could be considered as threatened. In the wet zone, there is now a moratorium on felling, but exploitation had been severe prior to 1989. Although there is no firm evidence of species loss, the fauna and flora of these forests have become markedly depauperate in terms of size and distribution of species populations. For example, nine of 23 species of timber value have become very rare in the past 40 years. One of these is the highly prized calamander (Diospyros quaesita). There is a clear need for a strong research programme on the silvics of selected forestry species.

The National Conservation Review covered 204 forests, and a total of 1153 species of woody plants and 410 species of animals (vertebrates, molluscs and butterflies) were recorded. In the case of the woody plants, it was found that 108 forests are required to conserve all 1153 species. To conserve all 410 species of animals, 72 forests are required, and all but 25 of these are included among the 108 required for the woody plants. Hence a total of 133 forests are required to conserve all the species of plants and animals recorded during the survey. If the endemic species only are considered, 49 forests are necessary for all of the 455 species of plants recorded to be included, and 35 forests for all of the 138 species of animals recorded to be included. For both the endemic woody plants and animals to be included a total of 71 of the 204 forests are required. Based on these data, it is to be expected that the Forest Department would declare more of the wet zone forests as conservation forests.

Human encroachments into the Sinharaja Forest - tea and rubber plantations (S. Balasubramaniam)

Among the major activities that continue to threaten biodiversity in forests is the use of forest land for agriculture, particularly shifting cultivation or chena. Although it is carried out illegally, chena cultivation continues to supply a significant quantity of traditional vegetables, cereals and pulses to the urban markets. While traditional chena cultivation is now limited almost entirely to the dry zone, forest encroachment is continuing in the wet zone for expansion of plantation crops such as tea, rubber and cinnamon, and this has become a very lucrative occupation for small holders living adjacent to forests, particularly when the market prices rise for these commodities. On an average, the size of a forest

Box 6.1

Conservation of Mammals - Action Should Target Threatened Species

Sri Lanka has one of the highest levels of biodiversity among mammals in terms of unit area in the Asian region. Many of these species are considered threatened. Up to now, the conservation action for mammalian fauna has been largely empirical - by protecting what is considered to be sufficiently large areas of natural habitat, it is expected that the species would be conserved. This approach to conservation is far from adequate, particularly when there is a growing pressure to convert natural forests to other uses. This applies specially to mammalian macro fauna such as the elephant, the ungulates, carnivores and primates. For these species, it is vital that population status, behaviour, range patterns and habitat requirements are known in order to formulate meaningful conservation action.

Trachypithecus vetulus, or the purple-faced monkey, is an endemic primate which is considered threatened and is among the species that are given legal protection under the Fauna and Flora Protection Ordinance. Among the Sri Lankan macro-fauna, this species is unusual in showing clear morphological differences in different parts of its geographic range. Naturalists, in the early part of this century, stated that it is almost impossible to give a short characterization of the purple-faced monkey, due to the wide range of genetic variation between the sub-species that inhabit different climatic zones of the country. In fact, an inhabitant of India, previously believed to be a sub-species, has now been recognized as a distinct species and is known as Trachypithecus johnii. Sub-specific variations occur mostly in body size, coat colour and length of fur. There are also variations in food habit - some populations are highly folivorous, while others depend heavily on fruits. It is suspected that social behaviour, which influences population status in this species, may also differ in different environments.

While Trachypithecus vetulus is listed as highly vulnerable in the 1996 IUCN Red List of Globally Threatened Animals, little has been done to investigate or address most of its conservation requirements. The 1987-1991 Primate Action Plan for Asia states that to prevent this species from entering the endangered category by 2000 AD, specific conservation action is needed. It is necessary to determine its abundance, habitat requirements, and the adequacy of the protected area system in the country vis a vis the status of the different sub-species. Populations of the species are fragmented, and this is so to a marked degree in the wet zone which is home to three of the five recognized sub-species. It is therefore vital that populations are monitored in the long term with census work, especially where natural habitats are being converted to other land uses.

These problems and conservation requirements are common to most other large mammals in the country. When addressing issues on in situ conservation of large mammals in particular, it is necessary to determine their distribution and habitat requirements in relation to the size and distribution of the protected areas and to extend conservation measures to areas outside the protected area network wherever necessary. In the case of some species such as the elephant, it may be necessary to prepare management plans for their conservation. It is also vital that, where there are particular threats to the survival of these species, including conflicts with human needs, these should be identified and addressed. In view of the individual conservation needs of some of the large mammalian fauna, it is necessary that species-specific conservation measures are built into the protected area management plans. It is also necessary that conservation initiatives are backed up with education and awareness programmes, specially targeting the local communities.

Source: Dela (1997)

Box 6.2

SINHARAJA - A HAVEN OF BIODIVERSITY AND ENDEMISM

The Sinharaja forest is an International Biosphere Reserve (one of two in Sri Lanka); it has been declared a National Heritage Wilderness Area (the only one so far); and it is Sri Lanka's only Natural World Heritage Site. What is so special about Sinharaja?

The Sinharaja rainforest covers an area of 11,000ha, and most of it is in its primeval condition, representing a biome that dates back in its evolutionary history to the Deccan Plate, a section of the ancient continent of Gondwanaland. It contains lowland, mid-elevational and montane rain forest, and the lowland element is the only primeval (unlogged) ecosystem of its kind in the country. Endemism among the flora of Sinharaja is particularly high; 86% of the individual trees were found to belong to endemic species. Of the herbs and treelets, a survey revealed that there were 259 species, and 156 of these were endemic. Of the 217 endemic tree species and woody lianes in the island, 125 have been recorded at Sinharaja. Not surprisingly, most of the canopy dominants are endemics. The dipterocarps are mainly represented by species of Shorea and Stemonoporus. Among the endemic genera are Schumacharia and Hortonia two ancient gondwanic relicts.

Biodiversity and endemism among the fauna match that of the flora. The number of endemics of the different taxa in Sinharaja, and the percentage compared to the number of endemics in the whole island (given in parenthesis) are: Fishes - 7 (41%); amphibians - 8 (42%); snakes - 14 (36%); tetrapod reptiles - 8 (21%); birds -19 (95%); mammals - 7 (58%). The endemic mammals at Sinharaja are the musk shrew, long-tailed shrew, purple-faced leaf monkey, toque monkey, spiny rat, bicoloured rat, and the golden palmed civet. Among the invertebrate fauna, the endemicity of butterflies is remarkable - of Sri Lanka's 41 endemic species and subspecies 21 are found in Sinharaja. Sinharaja is an important habitat for many of Sri Lanka's swallow-tailed butterflies, and these include the rare endemic Ceylon Rose (Atrophaneura japhon) which is confined to the Sinharaja and adjacent rain forest blocks.

The Forest Department is endeavouring to preserve this forest and to promote research on its biodiversity. Its efforts deserve all support and encouragement.

Sources: various, cited by Wijesinghe (1995)

encroachment by a household in the wet zone is about 0.5 ha. These forest encroachments are established permanently, and this process leads to a significant loss of forest cover and biodiversity over time. Deniya cultivation of wetlands within forests with paddy or betel is also a destructive practice as it involves loss of forest species localized in wetland sites and results in the addition of chemical fertilizer and pesticides to the forest environment.

One of the problems encountered in preventing forest encroachment is the lack of clear and well-defined boundaries. It is necessary that the forests are surveyed, particularly those requiring special protection, and their boundaries established using permanent boundary markers.

The depletion of forest resources is also linked closely in some areas to the demand for forest products such as timber, posts, poles and fuelwood. Fuelwood collection from forests is prevalent in all climatic zones, but is least evident in the wet zone where a good part of the requirement comes from crop plantations. It is estimated that the need for biomass fuel will increase in the future. Besides fuel, certain other wood products like cane and bamboo are collected on a semi-commercial scale, with the highest collection of rattan occurring in wet zone forests for a lucrative rattan based cottage industry.

Forests also provide a multitude of non-wood products such as gums, resins,

Box 6.3

MEDICINAL PLANTS - SRI LANKA'S PRIZED BIODIVERSITY

Historical perspective: Plants and their products have been systematically used in Sri Lanka for treating illnesses for over two thousand years, and a total of 1,414 plant species are listed for their traditional medicinal use. These include several endemic species which are becoming increasingly rare and under threat of extinction. Approximately 200 species of medicinal plants are in common use, and of these, 50 are heavily used in ayurvedic medicinal preparations. In total, 79 species are now considered threatened.

As local supplies can no longer meet the demand for medicinal plants, approximately 60% of Sri Lanka's requirements are now imported, at considerable cost. Dwindling supplies are exacerbated by the rapid depletion of natural habitats, the increased export of a selected number of plant species, and unsustainable exploitation. Equally threatened is the knowledge base on which the traditional medicinal system is based, as only a small portion of the traditional knowledge is documented: the majority remains recorded in ancient, obscure manuscripts scattered around the country or in the memory of elderly practitioners.

Action to Conserve: The Ministry in charge of indigenous medicine, with support from other ministries and technical assistance from IUCN - The World Conservation Union, aims to address these problems through a project for the conservation of medicinal plants. The project will focus on three major areas, namely: increasing populations of medicinal plants in their natural habitat; cultivating and propagating medicinal plants in sites outside their strict natural habitat; and strengthening the knowledge base whilst promoting education and awareness.

The principal activities will include: the establishment of five medicinal plant reserves supported by community based management structures and facilities such as herbal gardens, nurseries, dispensaries, and information centres; formulation of standard products and ayurvedic drugs; training staff; ethnobotanical studies in the villages near the reserves; and introducing regulations necessary for medicinal plant cultivation and conservation, harvesting, marketing and export.

The project will operate for five years and strengthen the capacities of the Department of Ayurveda and the Bandaranaike Memorial Ayurvedic Research Institute.

medicinal plants, bee honey, kitul treacle, jaggery and fermented products and, to a lesser extent, certain materials of plant and animal origin used for socio-cultural practices. A national survey of the traditional uses of forests carried out by the Forest Department and IUCN indicates that kitul tapping is not a harmful activity, provided the processing of the sap is done outside the forest. Collection of food items from forests is also sustainable except when particularly adverse practices, such as cutting down branches to collect fruit, are carried out. Collection of plant material for use in ayurvedic medicine takes place from primary and secondary forests and, on an intensive scale, from the savannah lands of the dry zone. Many species of medicinal plants have become scarce as a result of habitat loss and over-collection.

Complete restriction of the use of forest resources by local people (except in biological sensitive areas) is not only unrealistic but also counter-productive. It is increasingly recognized that there should be an attempt to move towards a participatory management approach which permits local communities to

assume a stakeholder role of conserving and managing forests as a resource useful to them and their children. This has to be promoted through education and awareness creation, and by way of equitable sharing of benefits from the forest. Even under such schemes, the management strategy could break down with the increase of population pressure. A complementary strategy of providing alternative employment opportunities is, therefore, necessary to wean away households dependent on forest resources for their living.

The policy framework in the form of the Forestry Sector Master Plan of 1996 and the current plans and programmes of the Forest Department should provide the base for moving into an active phase of biodiversity conservation in forestry. What is required is for the Department to strengthen its capacity in the scientific and management aspects of biodiversity conservation and sustainable use and in community mobilization, and to secure the necessary resources for implementation. As for wildlife conservation, the Department concerned has in the past focused its attention on regulation and law enforcement, and a change in approach is needed here. In the sphere of medicinal plants, urgent action is required to arrest the decline in populations of many medicinal plant species and to document and preserve the vast store of knowledge on medicinal plants and their uses that is now in the memory of old medical practitioners and in ancient ola manuscripts. The proposed project on medicinal plants is expected to address these issues.

Objectives:

1. To ensure that threatened forest ecosystems and species are given adequate protection.
2. To put in place a system for monitoring forest biodiversity and taking corrective action when necessary.
3. To promote conservation of indigenous forest species both within and outside protected areas.
4. To involve communities living on the fringes of forests in participatory activities for the conservation and sustainable use of biodiversity.
5. To promote mixed cropping with indigenous species in private lands and state lands leased for agroforestry.
6. To increase timber supplies through forest plantations, which will have the effect of reducing the pressure on natural forests for producing timber.
7. To promote public awareness of the environmental benefits of conserving forest biodiversity.

Recommended action:

1. Develop a system for the regular monitoring of forest biodiversity, and take remedial action to rectify any negative trends as and when necessary, including threats from invasive species.
2. Take effective action to stop further encroachments on the wet zone forests (bioregions 4,5 and 6).
3. Take action to prevent the use of high-forest areas and fragile ecosystems for chena cultivation.
4. Complete the preparation of management plans (including surveying and boundary marking) for all protected areas; ensure that such plans continue to recognize the participatory role of communities living in proximity to the areas under protection and adequately address the conservation and sustainable use of biodiversity.
5. Actively implement the conservation-management plans of protected areas, giving due attention to buffer zone activities involving the peripheral communities.
6. The Forest Department and Department of Wildlife Conservation to collaborate to strengthen their capabilities in protected area management.
7. Enhance field staff capability in pest management, protection against unlawful activities, and fire protection.
8. Define, demarcate and establish an optimal protected area system network utilizing scientific and distributional data available from the NCR, paying special attention

to the conservation of endemic species of plants and animals.

9. Ensure that activities in forests outside protected areas are governed by management plans that pay adequate attention to the conservation of biodiversity.

10. Both within and outside protected areas, promote in situ conservation activities that specially target threatened species.

11. Establish a mechanism to continually expand and update the Forest Department's database on faunal and floral species in forests and other natural habitats.

12. Strengthen research capacity and pursue research on the silvics of selected forest species, with a view to promoting natural regeneration of, or actively propagating, these species.

13. Review the issue of deniya permits for cultivation in forests in relation to the impact of this practice on biodiversity.

14. Strengthen research capacity and pursue research to determine sustainable use thresholds for selected forest species.

15. In forest extension work, promote the use of selected indigenous species of timber, medicinal plants, and food and fibre producing plants, targeting home gardens, private woodlots, etc.

16. Promote the conservation and propagation of indigenous medicinal plants.

17. Establish a suitable mechanism for ensuring co-ordination in the management of protected areas and the conservation of biodiversity between the Forest Department and the Department of Wildlife Conservation.

18. Expand programmes for afforestation, reforestation and forest rehabilitation, paying attention to the use of indigenous species as far as possible.

19. Promote the improved utilization of timber and the use of alternative materials in place of timber.

20. Organize skills enhancement and awareness programmes on biodiversity conservation for operational staff, NGO participants, CBO personnel and rural communities.

21. Establish forest plantations on currently non-productive land as entrepreneurial ventures in collaboration with the private sector to cater to the timber and fuelwood demand.

22. Review legal instruments relating to the collection of forest plants and animals, including regulations relating to export, and amend in order to eliminate anomalies and strengthen the law, so as to afford protection to threatened species of indigenous plants and animals.

23. Strictly enforce the laws relating to collection, possession, sale, and export of plants and animals protected by law.

24. Expand and maintain the programme of setting up urban forests, and develop educational and awareness programmes in relation to these forests.

Main state institutions involved in implementing:

FD, DWLC, Survey Department, Department of Ayurveda, Mahaweli Authority, MFE, Ministry in charge of plantations and provincial administration, law enforcement agencies (Police, Customs, Attorney General).

6.2 Wetlands

Identifying the issues:

There is an overall lack of awareness among the general public of the importance of wetlands, and these areas are often considered as wastelands to be cleared and filled for other land uses or to be used as waste dumps. Large sections of these habitats have been lost due to landfill for housing and commercial and industrial development and conversion to agricultural land for growing paddy, vegetables, betel, etc.

There are numerous factors, all of

Box 6.4

MUTHURAJAWELA MARSH - AN URBAN PROTECTED AREA

The Muthurajawela Marsh covers about 3000 ha and is part of a larger complex that stretches up to and includes the Negombo lagoon. It is an important wetland located in the western coast of Sri Lanka that has retained its natural values despite centuries of human activity in the region. It is noted for its biological and ecological diversity, scenic beauty, history and scientific potential, particularly because of its location in a highly urbanised and industrialized area. In recognition of its ecological value, a Master Plan for the marsh-lagoon complex and surrounds was completed In 1991. Proceeding from this, a Conservation Management Plan, directed towards sustainable use of resources in different zones within the complex, was formulated in 1994. The management plan is implemented by DWLC. A participatory approach involving local communities is adopted in the management of the Conservation Zone. This is proving to be successful in effectively harmonising environmental management with economic development.

The Muthurajawela Marsh Conservation Zone was proclaimed a Sanctuary under the Fauna and Flora Protection Ordinance in 1996. It is an important habitat for plant and animal life, and a large number of the animal species found here are endemic, many of which are rare or threatened. Mammals such as the fruit bat, slender loris, otter, fishing cat, and mouse deer are found in this wetland. Among the numerous birds - of which 85 species are residents and 40 species are migrants - one can frequently see cormorants, storks, bee-eaters and kingfishers. Of the reptiles, the saltwater crocodile is seen occasionally while the large monitor lizard and serpents are plentiful. The rich vegetation found in this area includes mangroves, ferns, grasses and sedges. At least 129 plant species were recorded recently, including 44 species with medicinal value.

The marsh is also home to a human population of more than 4000, many from a long line of marsh dwellers who belong to the lowest income category. Since the unsustainable use of resources in the Conservation Zone by local people is directly linked to poverty and unemployment, special emphasis is placed on community development. About 280 encroacher families have been given permanent housing combined with opportunities for improving their living conditions and earning capacity. These communities have also taken an active part in the preparation and implementation of the Master Plan and are highly supportive of managing the marsh as an urban protected area.

them the result of human activities, that pose a threat to the biodiversity of wetlands. Siltation, and pollution resulting in eutrophication and the prolific growth of water hyacinth and other aquatic weeds, have eroded the species diversity of wetlands. For example, it is believed that the snake head (Channa marulius) has become rare due to the influx of agrochemicals into its habitat. Over-fishing and poaching (mainly of birds) and the uncontrolled collection of ornamental freshwater fish for export have placed several endemic species under threat. In addition to the fish, water plants are collected and exported in bulk for the aquarium trade. One of these is Cryptocoryne thwaitesii, an endemic aroid, considered to be under threat. Although it is illegal to do so, fishermen continue to use beach seines to catch fish in some of the larger reservoirs. Exotic species of fish were introduced, without adequate research, for developing inland fisheries, and the prolific multiplication of these species can pose a threat to the indigenous biodiversity in inland aquatic systems.

Today, the state has acknowledged the value of wetlands and the scenario for conservation of wetlands is encouraging. Site

Box 6.5

THREAT TO SRI LANKA'S ENDEMIC ORNAMENTAL FRESHWATER FISH SPECIES

Over exploitation and improper management in the ornamental freshwater fish export trade are having severe repercussions on the icthyofauna of Sri Lanka. About 75% of indigenous freshwater fish species including 21 endemic species, are utilised in the ornamental fish trade, and the fishes are mainly collected from the wild. Among the endemic species, 19 are listed as nationally threatened, and these include two critically threatened species and one endangered species. Endemic species, which are highly prized in the export industry, are the ones most at risk from over exploitation. Many of these have a critical threshold limit to their population, below which the ability to maintain the population is lost even when breeding occurs as usual. This has been observed in several endemics e.g. Puntius nigrofasciatus, P. cumingi, and Rasbora vaterifloris. The survival of ornamental fish is further endangered by the rapid deterioration of their habitats, mostly wet zone streams.

Many of the indigenous fish are exported at very low prices, and the foreign exchange earnings have been negligible. As such, the full potential of the ornamental fish trade as a foreign exchange generator has not been realized. Lack of proper management of the industry contributes to this. Basic requirements of collected fishes, such as adequate space, clean water and oxygen are sadly neglected, resulting in high death rates. In order to compensate for the high death rate during transportation, sensitive and delicate endemics such as Rasbora vaterifloris and Puntius titteya are being exported in huge quantities.

Although the export of live fish is governed by the provisions of the Fauna and Flora Protection Act and the Fisheries Ordinance, it is believed that many protected species continue to be exported by using various ruses to circumvent the provisions of the law. And such operations are not entirely covert, as is evidenced by the fact that a newly found rare endemic which is legally protected, Rasbora wilpita, has been listed (along with its price) in a UK ornamental fish catalogue.

The high demand for Sri Lankan ornamental freshwater fish is mainly due to the development of the aquarium trade, setting up of fishery gene banks, and laboratory experimentation on fresh water fish in developed countries. Today, Sri Lanka's indigenous freshwater fish are exported to over 25 countries, with USA, Japan, Holland, Germany, UK, Singapore and Hongkong accounting for 60% of the trade. Fish exports to Europe has been growing at an annual rate of 10% during the past five years.

Clearly, the trade in Sri Lanka's ornamental fishes, as it now occurs, is a threat to an important component of the country's biodiversity and it has to be addressed as a matter of urgency.

Source: Gunasekera (1996); Gunawardena (1994)

reports and management plans have been prepared for many wetlands under the Wetland Conservation Project of the CEA. Several other sites have been identified for conservation, and a total of 41 wetland sites in Sri Lanka are listed in the Directory of Asian Wetlands as being of critical importance, ecologically. The Forest Department is preparing conservation-management plans for several selected mangrove sites. As for implementation, only the management of Muthurajawela marsh is being fully implemented. Some management activities are being carried out in the Bundala, Minneriya, and Bellanwila-Attidiya wetlands, but only on a marginal scale. The challenge is to move into a full scale implementation of the management plans. An important pre-requisite for the effective management of the wetlands is their surveying and mapping on a suitable scale.

There have been some studies of wetlands by NGOs. The Ceylon Bird Club carries out counts of water birds annually. A few other NGOs have also been active in

carrying out observations and educational projects on wetland avifauna (e.g. the Field Ornithology Group). Some aspects of fisheries and limnological research in freshwater bodies have been carried out, mainly by the universities and the National Aquatic Resources Research and Development Agency. In the wetlands associated with the Puttalam lagoon and the southern lagoon systems, efforts are underway by the Ministry of Fisheries (under the Bay of Bengal Fisheries Programme) to culture sea weeds, molluscs, milk fish, etc. In a few wetlands such as Mi Oya, Tabbowa and Bundala, there have been studies on the human-elephant interactions. There is also a community-based research and management project by an NGO at the Nachchaduwa wetland site. These activities signify only an awakening of interest in the conservation of wetlands and the sustainable use of their rich resources. It is time to establish a system to coordinate these efforts, to identify the areas where investments have to be made, and to mount a robust programme for conserving the biodiversity of wetlands.

An area that requires urgent attention is the development of scientific methods for breeding of ornamental fish in captivity, which is vital for sustaining the freshwater ornamental fish industry while ensuring the survival of rare species in inland waters. At present, some freshwater ornamental fish species are reared by a few private groups engaged in the aquarium trade, but this needs to be scientifically monitored and expanded.

Foremost among the scientific initiatives so far taken in connection with safeguarding the country's wetlands is the assessment of the hydrological value of all the natural forests in the country through the National Conservation Review carried out under the Forestry Sector Development Project of the Forest Department, with technical assistance by IUCN - The World Conservation Union. In terms of soil conservation and hydrology, this study identified a total of 104 forests which are critical to the protection and sustenance of the downstream wetlands.

An impediment to wetland conservation and management is that some wetlands which are important in terms of biodiversity are either wholly or partly under private ownership. With regard to wetlands under state ownership which includes the large bulk of the wetlands, there are no special laws governing wetlands as such in Sri Lanka. Wetlands coming under state ownership are generally governed by the Fauna and Flora Ordinance and the Forest Ordinance. The Urban Development Authority Act, the Land Reclamation Ordinance and the Agrarian Services Act also touch on some aspects of wetland conservation. As regards the agencies in charge of wetlands, many of the natural habitats occur within protected areas managed by the Department of Wildlife Conservation. The Forest Department controls the wetlands falling within the forest areas under its purview. The Forest Department has also taken the responsibility for managing many ecologically sensitive mangrove sites. The protection of wetland wildlife in terms of their collection, sale and export is the responsibility of DWLC. It is important to note that with the devolution of power the provincial administration shares responsibility with other state agencies for the protection of wetlands and their biodiversity.

Due to the complex nature of the ecology and use of wetlands, as well as their situation, the need for collaborative programmes to manage wetland sites is widely recognized. The implementation of management plans for wetlands should take into account the need for inter-agency coordination to minimise environmental impacts and resource use conflicts. Wetlands are often connected to rivers and streams that flow across administrative boundaries and this needs to be recognized in decentralized regional administrative planning.

As it was felt that the absence of specific legislation or of a single responsible agency has been a setback for the proper management of wetland ecosystems in Sri Lanka, the Government, in 1990, granted approval for the establishment of a National Wetlands Steering Committee (NWSC) within the Central Environmental Authority. Because of its function as the central coordinating arm between the different line ministries and other agencies within whose jurisdiction wetlands occur, the NWSC was subsequently re-constituted to

function under the relevant ministry - the Ministry of Transport, Environment and Women's Affairs (now the Ministry of Forestry and Environment) - to ensure that it will function more effectively.

In view of the importance of the wetlands in terms of productivity and the multiple benefits they provide, the NWSC has formulated a National Wetland Policy for the conservation and sustainable use of wetlands. This Policy which is still in the draft stage is expected to complement the goals and objectives of the National Conservation Strategy (of 1988), the National Wildlife Policy (of 1990), the National Forestry Policy (of 1995), and other sectoral policies, including those of fisheries, irrigation, and agriculture. It will also identify action necessary to halt the deterioration of wetland ecosystems and ensure sustained conservation of wetlands through proper management. It will also cover prioritization of major wetlands for conservation, and, where necessary, restoration; development and implementation of an effective research programme to ensure the conservation of wetlands; and the development and implementation of a public awareness programme on wetlands. The overall policy needs to spell out a general strategy for each of the major activity areas identified and require that all interventions undergo the mandatory EIA process.

Objectives:

1. To ensure that both natural and man-made wetlands are properly managed and to conserve and sustainably use wetland biodiversity.
2. To promote the restoration of ecologically important degraded wetlands.
3. To build public awareness of the importance of wetlands and the need for their conservation.

Recommended action:

1. Continue to develop strategies and plans for the management of wetlands.
2. Strengthen and enhance current efforts to identify critically important wetlands in terms of biodiversity, and prepare site reports and management plans where necessary.
3. Prepare suitable maps and implement the management plans for wetlands, taking into account the need for collaboration between the several state institutions concerned, including the provincial administration, and based on participatory management principles.
4. Increase public awareness of the importance of wetlands and their benefits to local communities through the print and electronic media (government departments in collaboration with the private sector, media and NGOs).
5. By prohibiting or strictly regulating collection from the wild and adopting active measures, promote the conservation of aquatic fauna and flora species under threat.
6. Carry out a comprehensive awareness programme to combat disposal of household and industrial refuse into wetlands and enhance capability for law enforcement.
7. Increase the use of wetlands for education and eco-tourism.
8. Strengthen the capability of NARA and other relevant state institutions for regular monitoring of freshwater aquatic-biodiversity, in collaboration with universities and NGOs, and provide guidelines where necessary.
9. Carry out studies on the impact of introduced exotic species of fish, and measures for their control if found to be harmful to indigenous wetland biodiversity.
10. Undertake research programmes to culture threatened freshwater flora and fauna with emphasis on economically important species including those that are commonly exported.
11. Assist those in the aquarium trade to culture organisms for export with stringent monitoring and control by the state sector through a licensing scheme.

12. Increase national funding for wetland associated research, with special emphasis on the ecology and culture of endangered and economically important freshwater species.

13. Ensure that the forests identified as important hydrologically through the NCR study are brought within the protected area system and given strict protection.

14. Enforce the legal provisions for protecting river and stream reservations.

15. Review the legal framework that relates to the conservation of wetlands, identify gaps and rectify as necessary either through strengthening existing laws or enactment of new laws pertaining to wetlands.

16. Examine government policies that may promote adverse activities concerning wetlands (e.g. reclamation of wetlands for urban development), and recommend remedial measures thorough the National Wetlands Steering Committee.

Main state institutions involved in implementing:

NARA, CEA, FD, DWLC, MFE, UDA, the provincial administration, universities

6.3 Coastal and Marine Systems

Identifying the issues:

Fisheries is a major activity affecting marine biodiversity in the coastal waters of Sri Lanka. Fish supply is important in terms of food and income, and it has continued to increase in recent years. As a result, many nearshore waters are now over-fished or at their maximum levels of exploitation. Another development is the increased mechanization and modernization of the fishing industry. The capture techniques adopted include the use of trammel nets and purse seines. There is also the use of explosives to catch fish, and this destroys biodiversity. Bottom-set nets used to catch reef fish destroy the habitat, and nylon gill nets used to catch food fish are death traps to turtles and small marine mammals. Blast fishing in particular affects coral reefs. With the use of large multi-day motorized crafts with insulated fish hold facilities, the catches are much larger than in the past, and there is a much increased catch of marine mammals encountered in the deeper waters. As a result, some species of dolphins are now considered threatened in Sri Lankan waters. Fishing by local and foreign trawlers that use bottom-set nets and long drift nets may also affect biodiversity.

The traditional fishery which uses non-motorized craft such as dugout canoes and catamarans and relatively non-destructive fishing techniques such as angling, gill netting (using natural fibre nets), and beach seining is adversely affected due to the depletion of the nearshore fish resources and the competition from mechanised crafts. Other factors, such as restrictions imposed by hotels on access to sections of the beach, may contribute to a decline in the traditional beach seine fishery, particularly on the southwestern coast.

The lobster resource in the southern coast has been depleted due to indiscriminate harvesting of gravid females and juveniles. While laws are present to prevent such activities, their enforcement has to be strengthened. A study is currently in progress to assess the gravity of this problem so that remedial measures may be taken. At present the export trade in ornamental fish ranks next to that of prawns and lobsters in terms of value, and the current levels of ornamental fish collection for sale and export is widely considered to be unsustainable. Clearly, there is need for more data. The selective harvesting of rare species has caused their depletion, and the high intensity of collection disturbs the equilibrium of the reef ecosystem. The corals themselves are damaged due to the use of moxy-nets for collection of reef fish for the aquarium trade.

Naturally occurring prawn resources in the lagoons of the northwest coast are depleted due to siltation from soil disturbed by agricultural and construction practices and deforestation inland. Silt smothers coral reefs, causes a reduction in the depth of water bodies and has a destructive effect on bottom dwelling species. For example, the pearl oyster beds that supported a lucrative trade up to the 1920s have probably been adversely affected by the silt carried down from rivers. Siltation

Box 6.6

DEALING WITH THE BURGEONING TRADE IN MARINE ORNAMENTAL FISH

The marine ornamental fish industry in Sri Lanka has expanded rapidly over the last 20 years or so. There are between **200 - 300** marine species of fish and invertebrates that are being exported in the aquarium trade today. There is, however, no monitoring or management of the trade at present, and reports of over-exploitation and habitat destruction are common.

The Sri Lanka Marine Ornamental Fishery Project, carried out by the National Aquatic Resources Development Agency (NARA) in collaboration with the Marine Conservation Society (UK), aims to ensure that, in the long term, the marine ornamental fishery is sustainable and that the conservation of marine biodiversity is promoted. The project, which is scheduled to run from 1995 - 1998, includes the following activities:

- surveys of coral reef fish and invertebrate populations to obtain information on abundance, recruitment and distribution patterns. The conditions of the reefs and associated marine habitats will also be noted.
- a socio-economic survey of the user communities.
- preparation of illustrated manuals on important ornamental species to assist divers, fishery field officers and custom officers to identify these species.
- training courses and workshops for those involved in the trade.
- fishery survey and community involvement to increase management options and ensure the conservation of marine biodiversity in the long term.

The project has been progressing quite smoothly, and, up to June 1997, dive surveys of near-shore and off-shore reefs had been carried out at approximately 30 sites along the south and west coasts of Sri Lanka and information gathered on different species in the trade. The socio-economic survey is currently underway and a large number of collectors/divers have been registered with NARA. A handbook on protected marine species in Sri Lanka has been published and two workshops held for those in the ornamental fish trade.

Source: MCS/NARA (1996a,b)

can also be detrimental to fishery that is dependent on clear water. Pollution from unregulated discharge of sewage, untreated water from industries, wastes from ships, and coconut husk retting at some sites along the coast also cause destruction of coastal biodiversity.

Sri Lankan waters have seven species of edible Holothuria (sea cucumber) out of 20 edible species found in the Indian Ocean. While the traditional harvesting of sea cucumber was limited to estuarine environments, the demand for this commodity for export has resulted in large numbers being collected, especially in the Kalpitiya and Batticaloa areas. It is possible that collection may prove to be unsustainable, especially when collection is selective. This is an area where studies are needed.

The fisheries sector has traditionally sought to increase productivity without paying adequate attention to conservation and sustainable use of aquatic resources. However, due to the recent heavy decline of near-shore fish yields, there is now greater awareness of the need to conserve these resources. This has resulted in the new Fisheries and Aquatic Resources Act of 1996 addressing measures for "protection of fish and other aquatic resources" and for increased concern about the

Box 6.7

CORAL MINING

Coral mining has been a traditional occupation for coastal people for generations, mainly along the south and southwestern coastline of Sri Lanka. Corals are extracted mainly for the production of lime for building purposes, through a conversion process of heating fragments of the calcareous corals to produce quicklime and mortar in lime kilns. Corals are mined from inland fossil resources and from coral rubble on the beach, but the additional and illegal extraction of sea coral has been a major threat to the reefs of Sri Lanka. The demand and economic incentive for mining corals is high, and corals supply approximately 90 % of the lime produced. This has created difficulties in attempting to combat the problem, and reef mining continues to cause coastal erosion and the loss of habitat and biodiversity. The Coast Conservation Department has played an important role in addressing this problem through a multitude of strategies covering legislation to prohibit mining, collecting, processing, storing, burning and transporting corals in the coastal zone; education programmes for coral miners; and schemes to provide alternative livelihoods to those dependent on coral mining. These efforts have reduced the sea coral extraction from 7,659 tonnes in 1984 to 4,020 tonnes in 1994, and there was a corresponding increase in the inland extraction during the same period from 10,400 tonnes to 15,800 tonnes. However, reef mining is still a serious problem, and there is need for a vigorous and sustained campaign to eliminate it.

Source: CCD (1996)

sustainable use of aquatic biodiversity in the fishery sector. A sign of the current interest in active management for conservation and sustainable use is the identification of fisheries management areas (e.g. the Negombo lagoon), and the selection of lobster management areas in the southwest followed by the preparation of management plans.

To remedy the paucity of data on off-shore fisheries resources, NARA is currently conducting a Fisheries Resources Survey. NARA has also taken action to promote the survival of lobsters by providing new habitats. A survey of some species of coastal fish is also currently being undertaken by NARA to determine the status of species harvested for the aquarium trade.

For centuries the coastal reefs have been a valuable resource for the people of Sri Lanka, in particular for the coastal communities. More recently, the export of coral reef organisms has contributed substantially to the economy. These reefs are now severely degraded, especially in the southern region, due mainly to coral mining for production of lime. Annually, over 7000 tons of coral and coral debris are removed from a 60 km stretch along the south-west coast, and both coral and shells are collected for the tourist industry. Although the removal, possession and processing of coral is illegal, the destruction of reefs has continued due to poor law enforcement and the profitability of the lime industry. Attempts have been made to provide alternative employment to those involved, but without much success. Conservation and management of coral reefs is also impeded because some of the largest and species rich reefs occur offshore, beyond the coastal zone, and are outside the jurisdiction of the Coast Conservation Department. Coral reefs are also damaged by natural factors such as the proliferation of the coral predator the Crown of Thorns Starfish (Acanthaster planci) and the effect of high wave action. Unless stringent conservation action is taken, it is believed that by the 21st century most near-shore reefs would be adversely affected, and only the reefs in protected areas may survive to provide habitats for important and threatened species of fauna and to check coastal erosion (see Figure 6.1).

Reef destruction is very evident in the marine sanctuary at Hikkaduwa where many

coral reefs are dead or dying. Even after receiving Protected Area status, reef degradation continues due to damage caused by heavily loaded glass bottom boats, pollution from hotels, oil pollution, sedimentation, trampling by divers and collectors of reef organisms, and anchoring of boats.

The action taken hitherto to manage marine biodiversity, establish marine Protected Areas, and prepare management plans for important near-shore and off-shore coral reefs is far from adequate. Some proposals for environmental management and planning of coastal and marine zones in Sri Lanka have been made by UNEP, CCD, the Department of Fisheries and Aquatic Resources (DFAR), and CEA but there has been no implementation. The Inter-Ministerial Committee on Marine Parks and Sanctuaries set up by NARA in 1982 had identified more than 20 coastal sites to be declared as marine parks and sanctuaries, but only two have so far been declared as Protected Areas by statute, and management plans have been prepared for only one.

There are a number of government organizations that should play a role in the conservation and management of coral reefs and the implementation of laws that govern use of marine resources. These include NARA, CCD, CEA, DWLC, and DFAR. While conservation and management of coral reefs is considered an urgent issue, implementation efforts are impaired due to inadequacies as regards institutional cooperation, political commitment and awareness among the public of the importance of this resource.

Most coastal habitats in Sri Lanka are limited in extent and vulnerable to degradation. These habitats include biologically productive mangrove systems, estuaries, lagoons and seagrass beds. Resources within lagoons and estuaries have been over-used for fishery and shrimp culture. There is also uncontrolled use of these sites for anchorages of boats. Sand mining, siltation, as well as dumping urban wastes and chemical pollutants from agricultural farms and industries in estuaries are other major problems. Seagrass beds, which support a rich flora and fauna and are breeding grounds for marine fish, have been damaged due to destructive fish harvesting techniques.

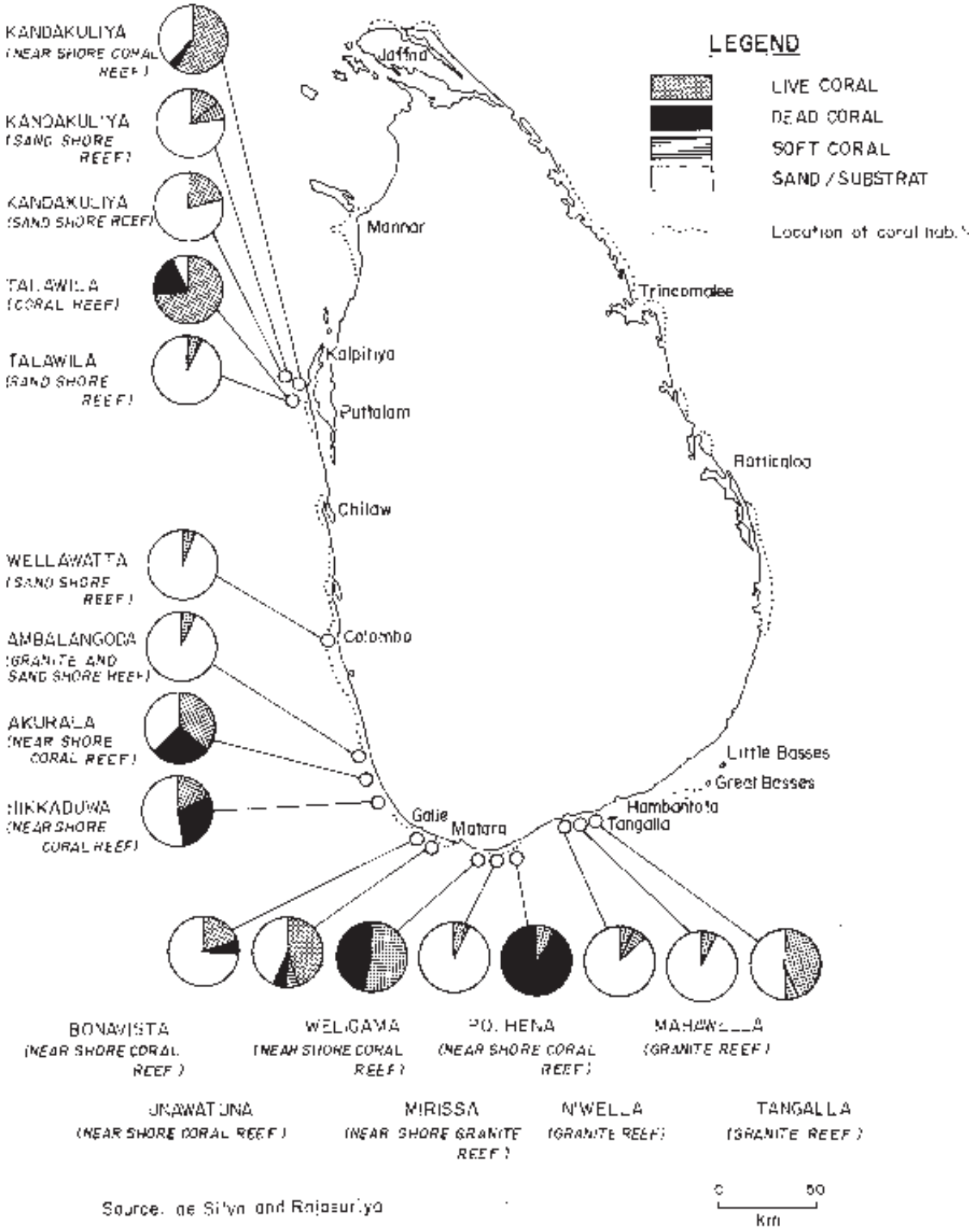
The increased allocation of coastal zone lands, especially in the south and southwest coast, for hotels is also a serious problem. There is also a proliferation of slums and shanties in certain sections of the coast. With the projected increase of urban populations by the 21st century, it is evident that most shorelands of the country will be converted to other uses. Much of the biologically diverse shorelands are state owned, but inadequacies in the law and poor enforcement contribute to habitat loss. Effluents discharged from urban industries near natural water bodies also destroy biodiversity.

Brackish water shrimp culture is an industry that earns over a billion rupees in foreign exchange annually. It has, however, caused considerable loss of coastal wetlands since 1980 due to encroachment and pollution by the establishment of mariculture ponds covering an area of over 2000 ha. Other adverse effects are disruption of nutrient chains and increased salinity of waterways, resulting in biodiversity loss. Abandoned shrimp farms in the form of barren land with no topsoil are an eyesore and may become breeding grounds for disease vectors.

Mangroves are destroyed for expansion of human settlements (much of it as encroachments) and for expansion of aquaculture. Poles and fuelwood for domestic use and twigs for brushpile fishery are also extracted from the mangroves. The mangrove swamps are, therefore, fragmented, heavily exploited by local people, and degraded by water pollution and siltation. It is estimated that the current mangrove habitat will be reduced to half by the year 2001. Despite the efforts taken by NGOs to re-establish mangrove habitats and to create awareness about this resource, little progress was made in the past to conserve mangroves.

Recently, the Forest Department has assumed control of several mangrove areas identified for protection, and management plans are being prepared for them. The management proposals take into consideration socio-economic factors, and, in-keeping with other policy initiatives for coastal resources, promote a participatory approach.

Figure 6.1 Distribution and Condition of Coral Reefs between Tangalle and Kalpitiya



Some of the picturesque sandy beaches of Sri Lanka, with their littoral and sandy shore biodiversity, are being degraded or lost due to extensive coastal erosion which is aggravated by coral mining; non-scientifically erected embankments, rivets and groins; and sand mining along the seashore and in rivers. Although direct removal of sand from the beaches has been curbed by the CCD, sand mining in rivers continues.

Ecotourism has much potential in the coastal areas. Beaches and areas with fringing reefs are favoured sites for tourism. Snorkelling, scuba diving and viewing corals are popular among tourists. The Ceylon Tourist Board has prepared a Master Plan for development of tourism and there are guidelines for hotel developers regarding pollution control. Nevertheless, some of the most uniquely diverse biological habitats in the southern and western coasts have been damaged due to construction of "beach hotels" that do not conform to regulations regarding waste disposal, environmental safeguards, and land use planning to protect vulnerable ecosystems. Tourism is an important economic activity in the country and it is in the interest of the tourist trade to preserve the coastal environment and its biodiversity.

There is also a proliferation of private turtle hatcheries along the southwest coast, some in collaboration with foreign groups. Although the claim is that these hatcheries are set up for conservation purposes, investigations by NARA show that most are profit-motivated and tourist oriented, and that the practices adopted by the hatcheries may be detrimental to the survival of the young.

Several incentives available for economic activities in the coastal and marine region tend to adversely affect biodiversity due to inadequate attention being paid to environmental conservation. These activities include: expansion of shrimp farming, export of marine fauna and flora, environmentally detrimental fishing practices, ad hoc land reclamation, the putting up of unauthorized constructions and other infrastructures, and the proliferation of industries that release effluents.

The ineffectiveness of law enforcement alone as the means of curbing adverse activities in coastal areas has amply demonstrated the need for adopting a participatory approach involving the local communities. The need is also felt for coastal management to proceed simultaneously at the national, provincial, district and local levels, with the collaboration of several state agencies, local entrepreneurs, NGOs and communities. At present, activities at the national level are guided by the CCD with the support of other relevant state agencies. In the future, resource management efforts for coast conservation need to focus on issues within the jurisdiction of the provinces. This will need considerable strengthening of the capacities of provincial and local institutions and the preparation of provincial CZM Plans in consultation with relevant state agencies. The national CZM Plan has not yet been translated into provincial actions, although activities at local level will be the ultimate determinants of the sustainability of coastal resources.

Current policies also require that work by national and provincial agencies at the local level in the coastal zone be planned and managed within geographically distinct sites, through the formulation and implementation of Special Area Management (SAM) Plans. These will make it possible for problems and opportunities to be examined and assessed in a site-specific context. SAM plans focus on effective devolution of resource management to local stakeholders through a participatory process by creating community-based management groups. SAM Plans have already been prepared for Rekawa and Hikkaduwa and implementation has commenced. Twenty other coastal sites have been identified for similar planning and management.

With the multiplicity of organizations involved in different activities within the coastal zone, a strong co-ordinating mechanism becomes necessary. Co-ordination is not effective at present, and there is a clear need for a review of this function which at presents rests with the CCD.

Objectives:

1. To promote the conservation of coastal and marine habitats of the country such

Box 6.8

SAM: Special Area Management in Sri Lanka

Special Area Management can be defined as a collaborative, adaptive and flexible approach to planning resource management within a defined geographic area. It assumes that residents of a local community and the local government have both the incentives and the knowledge of the resources and resource-use problems to act collectively in ways that ensure that resources are used sustainably. A key aspect of the SAM approach is that even during planning, implementation of small projects can proceed.

Two areas have since 1991 been pilot testing sites for SAM planning: Rekawa and Hikkaduwa. The Coastal Resources Management Project (CRMP) has been acting as facilitator in the processes, through emphasis on data collection and analysis and education and organisation of the local communities. The two pilot areas are characterised by a varied set of management issues.

Rekawa is a lagoon area with a low income community, in which 80 percent have earnings below the poverty line (Rs 1,500 per month). The use of natural resources for the livelihood of the local community has surpassed sustainable limits and caused environmental degradation. The Rekawa Special Area Management Coordinating Committee, composed of central and local government officials and also representatives of key community groups, has with the participation of the general Rekawa community defined a set of objectives and developed strategies and action plans with the overall goal of protecting and managing the coastal resources. Some of the most critical issues of concern identified during the management process is the reduced flow of both freshwater and seawater into the Rekawa lagoon, increased sedimentation, unsustainable fishing methods, coral mining, sea turtle egg poaching, and the poverty of the people.

Hikkaduwa and its Marine Sanctuary *i*s the most popular beach resort area in the country. As a consequence of overuse of the coastal resources in the area, resources are degrading rapidly. The community with the assistance of CRMP has established the Hikkaduwa Special Area Management/Marine Sanctuary Coordinating Committee, which coordinates the development and implementation of the SAM plan. Some important management issues are the degradation of the coral reef ecosystem, deterioration of the coastal water quality, lack of alternative forms of income generation for the local people, increasing traffic congestion and noise, and conflicts between economic interests, especially tourism and fisheries.

The SAM concept is strongly advocated in the revised Coastal Zone Management Plan (1996). Five potential sites for future SAM planning have been identified as having high priority: Arugam Bay; Bar Reef; Beruwela/Bentota; Negombo Lagoon and Unawatuna Bay. These new sites have been rated through a set of criteria, covering severity of issues, biodiversity, and economic significance.

Source: CCD (1996); CCD, NARA & MTEWA (1996a,b)

as the coral reefs, sea grass beds, mangroves, lagoons, estuaries, salt marshes.

2. To promote the conservation of threatened marine species (e.g. marine mammals) as well as other species which are subject to exploitation for food, for the aquarium trade, etc.
3. To promote sustainability in the use of coastal and marine bioresources in the fisheries and tourist industries.
4. To strengthen current government initiatives to increase stakeholder participation in the conservation of coastal and marine resources.
5. To increase collaborative participation among stakeholders with regard to policies and programmes that affect coastal and

marine biodiversity and initiatives that support conservation, such as research.

Recommended action:

1. Strengthen and enhance current efforts to conduct a comprehensive fish resource assessment in Sri Lankan marine waters and an assessment of sustainable levels of harvesting for the food fishery.
2. Promote the preparation of management plans for the sustainable use of the fisheries resource, taking into consideration the establishmen of fisheries reserves where necessary and regeneration of the nearshore fishery resource.
3. Promote research programmes to determine the sustainable levels of fish catches.
4. Monitor the extent and sustainability of harvesting coastal resources such as ornamental fish, sea-cucumber, molluscs, sponges, beche-de-mer, and other species with a market demand.
5. Initiate and strengthen research for ex situ cultivation of economically important coastal and marine species and identify alternatives to selectively exploited species where possible; disseminate results to the industrial sector through seminars, workshops and training programmes.
6. Initiate a comprehensive programme to study wild stocks of marine mammals in Sri Lankan waters, the catch estimates and the feasibility of alternative income generation through eco-tourism, and carry out an islandwide awareness campaign to stop the killing and sale of flesh of these species.
7. Preserve seagrass beds and encourage sustainable use of resources via proper in situ culture and harvest practices among local communities and entrepreneurs.
8. Strengthen and enhance current efforts to map the biological resources, including corals, seagrass beds etc. in the coastal waters of Sri Lanka based on Geographical Information Systems.
9. Carry out scientific biodiversity assessment of coral reefs and other important marine systems to identify a minimum network of marine reserves to conserve the totality of marine biodiversity based on principles similar to the National Conservation Review of forests.
10. In collaboration with relevant state agencies, user groups and communities, prepare management plans for identified marine protected areas to conserve biodiversity, and strengthen capabilities for management.
11. Prepare and implement management plans and strengthen capability among stakeholders for conservation and management of mangrove areas using a participatory approach.
12. Examine and monitor effects of fishing methods that may have adverse effects on biodiversity, and take appropriate action.
13. Enforce, strictly, the current laws against the use of explosives, illegal types of fishing gear and harvesting of juvenile and gravid lobsters in the sea.
14. Strengthen capabilities to enforce existing regulations against the slaughter of small cetaceans and turtles (including harvesting of their eggs), and provide better protection for feeding, breeding and nesting grounds of marine species, including licensing and state monitoring of turtle hatcheries.
15. Control the expansion of prawn farms into mangrove areas and salt marshes to prevent excessive biodiversity loss, and preserve all biodiversity rich areas as habitats for aquatic fauna and flora.
16. By prohibition or strict regulation of collection from the wild and other active measures, promote the conservation of coastal and marine species of fauna and flora of species under threat.
17. Increase institutional capability for strict enforcement of laws against sand and coral mining.
18. Promote policy incentives for the use (including the import) of substitutes for coral based lime in the building industry.

19. Carry out research in collaboration with universities and the private sector to produce alternative materials to replace marine coral-based lime for the building industry and to promote designing that obviates the use of lime plaster.

20. Develop capacity among entrepreneurs and guidelines for aquaculture that take into account preservation of the natural environment.

21. Initiate and promote research programmes to determine the effects of sea level rise on marine and coastal habitats.

22. Establish a strong and effective co-ordinating mechanism to secure the collaboration of all the concerned institutions in the effective management of the coastal zone.

23. Initiate action in collaboration with agricultural and irrigation authorities and provincial/regional bodies to prevent siltation of lagoons, estuaries and marine ecosystems due to soil erosion inland.

24. Develop capacity for eco-tourism in selected coastal areas, with the participation of communities and local entrepreneurs, for viewing coral life, watching marine mammals, etc.

25. Enlist support of NGOs and rural communities to establish woodlots in sand dunes adjoining mangroves, with fast growing fuelwood trees such as Casuarina, to ameliorate pressure on mangrove vegetation.

26. Develop and apply feasible methods for waste disposal from industries, tourist hotels and households in the coastal zone, through surveys, research and community projects.

27. Commence awareness programmes for different target groups to mitigate adverse effects of pollution, coral reef damage and over-harvesting of species from coastal and marine ecosystems.

28. Strengthen and expedite the preparation and implementation of the special area management programmes identified in "Coastal 2000" and the CZM Plan of 1996, and extend the programmes to other coastal sites as necessary.

Main state institutions involved in implementing:

CCD, NARA, DFAR, DWLC, FD, CEA NARESA, and the provincial administration

6.4 Agriculture Systems

Identifying the issues:

Much of the agricultural land in the country, mainly the rice paddies, home gardens and some crop plantations, is privately owned. State land has also been given to farmers for cultivation on permits or grants under the Land Development Ordinance.

An aspect of agricultural land use that has a direct bearing on the status of biodiversity, particularly in the non-plantation sector, is that the cultivator is often not the owner or permit holder or grant holder of the land he cultivates. In many such cases, the tenant farmers use the land for one or few seasons on his agreeing to pay a rental in the form of a share of the produce. As a result, the farmer has no long-term interest in the land and will not be encouraged to adopt multi-cropping or to invest in land management practices to ensure sustained productivity.

The Paddy Lands Act of 1958 and the Agrarian Services Law of 1979 were introduced with a view to rectifying this shortcoming by restricting the rights of the landlord to evict tenant farmers, fixing the crop share to be paid by the tenant, and permitting more flexibility for tenants to transfer user rights. These regulations, however, have not had the desired effect of increasing crop productivity. Even today, as much as 11 per cent of farmers are landless and 38.5 per cent possess only home gardens of which the average size is around 0.4 ha. Thus about half the farming community is not in control of sufficient land to produce a marketable surplus, let alone engage in multi-cropping to enhance biodiversity. In would be difficult,

therefore, to induce these resource-poor farmers to adopt sustainable agricultural practices to protect ecosystems and biodiversity.

A positive factor is that about five per cent of the holdings are around 2.8 ha each. These holdings total 283,000 ha. Increasing the biodiversity of such farms through multicropping may be feasible. On the other hand, in the plantation sector where tea, rubber, coconut and sugarcane are grown, mono-cropping is the accepted practice, and this does not promote the maintenance of biodiversity. However, it is encouraging to note that some plantations have recently turned to multi-cropping.

With the Land Reform Law setting a ceiling on the size of an individual's land holding, the Land Reform Commission acquired over 400,000 ha or nearly 30 per cent of the arable land in the country. This brought in its wake several problems such as reduction in soil fertility through neglect and fragmentation of agricultural land for other uses. A common problem in the agriculture sector is the occurrence of disputes over inheritance of private land among small holders, particularly in the wet zone. As a result, a high proportion of land in these areas remains uncultivated or neglected.

The area under plantation crops has gradually declined during the last decade primarily due to the use of agricultural lands for settlements and infrastructural development. The current policies and trends, however, favour increased production, both through increasing productivity and by increasing the area under cultivation. The incentives for expanding the tea areas in the low country would certainly result in a move to convert forest land in the southwest to tea, and this would exert pressure on the already vulnerable wet zone forests.

Inadequate management of tea lands and vegetable gardens in the hill country has also brought in its wake soil erosion and land degradation. The loss of top soil and the absence of organic matter coupled with excessive use of agro-chemicals have made some of the tea soils almost barren of soil fauna, resulting in an imbalance in the faunal diversity in those areas. By and large, the adoption of resource conservation practices in the plantation sector has been neglected in the past due to fluctuating commodity prices and low profitability, particularly in tea and rubber.

The agriculture sector is largely serviced by the Department of Agriculture (DOA). This department was established in 1912 primarily to develop peasant agriculture, but it has focused its attention on domestic food production since 1940. The broad objectives of the DOA today are to increase agricultural productivity and farming incomes, to generate employment and to promote the conservation of the resource base.

To date, considerable work has been carried out on varietal improvement of rice. As a result, the national average yields have increased five-fold from 0.65 tonnes per hectare in the 1940s when only the traditional varieties were grown to 3.5 tonnes in the 1980s due to the use of new improved varieties. Since then rice yields have remained virtually static despite the release of more versatile breeds of rice. As a result of the switch over to high yielding varieties, there has been a sharp drop in the cultivation of traditional varieties.

Indigenous varieties exhibit a wide range of genetic characteristics among which are resistance or tolerance to biotic and abiotic stresses and to varying agro-ecological conditions. While strengthening efforts to conserve this germplasm, the farmers must be informed of how they could access the seed material for cultivation.

The traditional homegardens have been the repository of germplasm of numerous species used as food items, spices and medicinal plants over the ages. In recent years, the homegarden system suffered a set back due to land fragmentation and population increase. These gardens play a vital role in the in situ conservation of germplasm selected by farmers over generations, and every effort must be made to encourage and sustain the multi-cropping practices in homegardens.

Research in the agricultural sector is funded mainly through individual departmental

budgets. Some funding is also provided through the Council for Agricultural Research Policy and the Natural Resources, Energy and Science Authority. Notable deficiencies in the research sector are inadequacy of research on captive breeding of important domesticated animals, ex situ conservation of traditional cultivars of crops, and mixed cropping.

The application of plant tissue culture for the conservation and improvement of germplasm of tea, rubber, coconut and sugar cane is being carried out by the respective research institutes. However, these programmes are constrained by limitations of funds and facilities, and they warrant support and strengthening.

The agricultural sector is also responsible for another important aspect of biodiversity conservation, namely, the prevention of the entry of alien species to the country. The Plant Protection Ordinance makes provision for preventing the introduction of weeds, pests and diseases which would pose a threat to plants in Sri Lanka, particularly the crop species. All imported plants and animals, or their parts, have to be declared at the point of entry to the country and be subject to quarantine regulations. Imported seed has to be certified by the Seed Certification and Quarantine Division prior to release or use within the country. The Plant Protection Ordinance does not specifically cover the import of living modified organisms (LMOs), and the law has to be amended to remedy this. The Animal Diseases Act and the Fauna and Flora Ordinance should also be reviewed in the context of the import of LMOs.

During recent years, the government's policies, for good reasons, have been directed towards increasing exports which include traditional agricultural exports as well as newly developed agriculture based products. Export-oriented enterprises involving live plants and animals include the export of ornamental plants and fish. This is an aspect requiring very close scrutiny and stringent controls as there is a direct threat to biodiversity through the unchecked collection of organisms from their natural habitats. Such activities would undoubtedly endanger the survival of wild stocks.

Objectives:

1. To adopt policies and programmes for the conservation of Sri Lanka's agricultural biodiversity.
2. To adopt agricultural and crop plantation practices that will enhance the conservation of biodiversity.
3. To promote among farmers and other land owners practices for the conservation of biodiversity.

Recommended action:

1. Promote the leasing of suitable state land for agroforestry and mixed cropping on the traditional home garden pattern.
2. Improve co-ordination and provision of institutional support for home-gardens, which would include credit and technical assistance.
3. Facilitate access (by farmers) to seed material of indigenous varieties.
4. Secure ownership of the land for farmers and leaseholders who demonstrate their commitment to conservation of biodiversity in their landholdings.
5. Provide economic incentives for the popularization of conservation farming; these could include fiscal measures, provision of services, improvements in land and tree tenure, training and awareness creation, etc.
6. Provide incentives and technical and other assistance for integrated farming in coconut, and support research on such activities under rubber and tea.

Main state institutions involved in implementing:

DOA, DEA, FD, Department of Animal Production and Health, Mahaweli Authority, TRI, CRI, RRI, MAL, Tea Small Holdings Development Authority, Rubber Development Authority, Coconut Cultivation Board.

6.5 Priority Action for Selected Bioregions

Identifying the issues:

Given the situation that the resources available in Sri Lanka for biodiversity conservation, as for other socio-economic development activities, will continue to be limited in the foreseeable future, it was considered necessary to develop a scheme that will provide a basis for prioritizing action. A conceptual framework for dividing the country, including its coastal and marine areas, into bioregions and for prioritizing the regions in terms of the need to take biodiversity conservation action was developed. For prioritizing, an integrative approach was adopted that recognizes both the ecological sensitivity of the region and the pressures they are subject to from human activities. Fifteen bioregions were recognized, and it is recommended that bioregions 4,5 and 6 inland and 11, 13 and 14 in the coastal and marine region be accorded high priority for biodiversity conservation action.

Objective:

To ensure that the bioregions requiring the most urgent attention for biodiversity conservation are accorded high priority in the conservation programmes.

Recommended action:

1. The National Steering Committee, Task Forces, and the Biodiversity Secretariat (see Chapter 8) to place special emphasis on plans and programmes for biodiversity conservation in the high priority bioregions (4, 5, 6, 11, 13 and 14), and ensure that they are adequately resourced.
2. All government organizations to accord high priority to biodiversity programmes targeting the conservation and sustainable use of biodiversity in the high priority bioregions.

Main state institutions involved in implementing:

MFE, FD, DWLC, Department of Ayurveda, CEA, CCD, MAL, Mahaweli Authority, provincial administration

6.6 Ex situ Conservation

Identifying the issues:

The conservation of biodiversity has to be done mainly within natural habitats, i.e. in situ . However, ex situ conservation, or conservation outside the natural habitat, is also considered important. In today's context, despite efforts at in situ conservation, species may still be lost in the wild, and ex situ collections may turn out to be the only surviving germplasm of the species. Also, unpredictable events could occur resulting in the destruction of natural habitats and the extinction of rare species. Ex situ conservation, however, should not be considered as a substitute for in situ conservation, but as a complementary strategy.

Ex situ conservation is carried out only in a very limited way in Sri Lanka. The Plant Genetic Resources Centre at Peradeniya is the only institution with facilities for the cryo-preservation of germplasm, and, as at present, only a fraction of the range of the agricultural germplasm found in the country is stored at this center. (See Table 3.3). The three botanical gardens at Peradeniya, Hakgala and Henarathgoda house 4800, 100 and 500 species of plants, of which 99, 60 and 38 respectively are endemics, 81, 20 and 10 are orchid species, and 300, 40 and 60 are medicinal plants. The National Zoological Garden houses 103 species of mammals of which three species are endemic; 119 species of birds of which three are endemic; 37 species of reptiles of which three are endemic; 34 species of freshwater fish of which 11 are endemic; and ten species of butterflies of which two are endemic.

The Department of Animal Production and Health and its research arm the Veterinary Research Institute, though mandated to improve and ensure the proper utilization of domesticated animals such as cattle, pigs and poultry, do not have organized programmes for germplasm conservation.

Through the medicinal plant gardens coming under its purview, the Department of Ayurveda carries out the ex situ conservation of some species of medicinal plants. Some Provincial Councils also maintain herb gardens affiliated to their ayurvedic hospitals. The

Department of Town and Country Planning, under its Urban Park Development Project, maintains a medicinal plants garden at Kataragama, and the NGO Ritigala Community-Based Development and Environmental Management Foundation, at Ritigala, carries out the cultivation of medicinal plants.

As regards indigenous wild fauna, the role of the National Zoological Gardens for the ex situ conservation of germplasm is very limited. There are no scientifically managed captive breeding programmes for threatened animals, though captive breeding has been found to be successful with certain species like the elephant and leopard.

Regarding aquatic biodiversity, the National Aquatic Resources Research and Development Agency (NARA) has conducted successfully some programmes on the ex situ cultivation of corals and the breeding of some indigenous varieties of ornamental fish in captivity. There have also been a few other attempts at ex situ conservation of endangered species. Out of some 70 species of Holothuria (sea cucumber) found in the Indian Ocean, about 20 are edible, and out of those, seven species are known to be found in the Sri Lankan marine waters. The NARA Regional Center at Kalpitiya, in its efforts to save the species Holothuria spinifera which is selectively and intensively harvested in the northwestern coast, has demonstrated that all seven species available in these waters are of comparable quality, and that there is no necessity to harvest exclusively only one species. Scathophagus argus and Monodactylus argentium are two wild species of brackish water ornamental fish, currently in demand for export. The NARA Regional Research Center at Kadolkele, Negombo, has recently commenced scientific research on captive breeding of these two threatened species of brackish water fish in order to ensure their sustenance and survival. These efforts, though commendable, fall far short of what is required in terms of ex situ conservation and sustainable use of Sri Lanka's aquatic fauna.

In discussions held with Departments of Agriculture, Export Agriculture, and Animal Production and Health, and the research institutes dealing with plantation crops, the need to establish and sustain wide germplasms of the species they are responsible for was emphasized. The Department of Animal Production and Health was concerned about the absence of accurate, scientific characterization of local breeds of domesticated animals. It also showed its interest in the cryo-preservation of animal germplasm.

Currently, all the research institutes maintain field collections of the varieties, cultivars and clones that are being used, but strengthening their capabilities, particularly to apply modern biotechnological methods for germplasm conservation, is warranted. The Department of Export Agriculture showed an interest in characterizing its crop species and preparing plant descriptors under the guidelines of the International Plant Genetic Resources Institute. With regard to medicinal plants, the current efforts at ex situ conservation are grossly inadequate in the context of the diminishing habitats of these species. It is expected that the field conservation of germplasm will be greatly expanded once the proposed medicinal plants project is implemented.

The expansion of field gene banks is constrained by the shortage of personnel and funds. The maintenance of live gene banks or field collections of some of these crops (particularly those susceptible to cross pollination) is complicated by the necessity for artificial selfing, emasculation, and other techniques to prevent cross-breeding which will result in the dilution and genetic mixing of pure lines. This warrants the use of trained field personnel and the placing of the field gene banks under the supervision of mandated, competent institutions.

To alleviate the problem of resource limitations, it should be possible to adopt innovative approaches for ex situ conservation. For example, gardens of chilli plants (which may have over 50 cultivars), coconut cultivar gardens, or root tuber crop cultivar gardens can be set up to make them attractive to tourists and so bring in revenue. Such gardens would also serve for education and for stimulating public awareness. NGOs showing

an interest in such activities could provide support to the government institutions concerned.

A number of animal species indigenous to Sri Lanka, including certain endemic species, are threatened with extinction. The ornamental fish trade has recently made significant demands on tropical species which are harvested and exported indiscriminately. It has therefore become necessary to launch a programme of ex situ conservation, including captive breeding to protect certain species of animals. The Zoological Gardens, though mandated to perform this function, faces several limitations to implement such a programme. It is recommended that the Zoological Gardens be provided with additional personnel, facilities and funds to formulate and launch a captive breeding programme for endangered species of animals. In drawing up such a programme, expertise should be obtained from the universities, NARA and the Department of Wildlife Conservation, and from competent persons located in Sri Lanka and abroad. The functions of the Zoological Gardens should be expanded to act as a repository of genetic material from wild, indigenous species of animals.

There is no centralized repository for microbial germplasm conservation, and a few research groups attached to universities and certain research institutes maintain their own culture collections. There is, therefore, an urgent need to have a centralized repository for the vast array of useful microorganisms that are used in medicine, agriculture, food processing and industry, particularly in view of their extensive application in modern biotechnology.

Overall, it is evident that the important role that ex situ conservation has to play in safeguarding Sri Lanka's biodiversity, though understood by the implementing institutions, is not recognized adequately at higher policy making levels. Consequently, except for the setting up of the Plant Genetic Resources Centre (which is the only institution with facilities for the cryo-preservation of germplasm in Sri Lanka) as a "one off" exercise, all other measures for ex situ conservation are left to the institutions to manage as best as they can with the limited resources at their disposal. An umbrella scientific organization like NARESA is well placed to take on the role of stimulating interest at the policy level for promoting the allocation of resources for addressing ex situ conservation in a meaningful way.

Objectives:

1. To develop a national policy on ex situ germplasm conservation.
2. To develop and implement programmes for the ex situ preservation of the germplasm of indigenous species of useful plants, animals and microorganisms, and identified species under severe threat.

Recommended action:

1. Formulate and implement a national policy for germplasm conservation.
2. Strengthen the capacity and scope of the Plant Genetic Resources Centre as a national centre for germplasm conservation.
3. Strengthen the facilities of the three botanic gardens to enable them to expand their ex situ conservation activities.
4. Improve the facilities available at the National Zoological Gardens so that it will serve as a repository of genetic material for all indigenous wild animal species.
5. Improve facilities at NARA for the ex situ conservation of indigenous ornamental fish species.
6. Establish a gene bank for all indigenous domesticated animal species at the Veterinary Research Institute.
7. Initiate scientifically managed captive breeding programmes for endemic and threatened animal species.
8. Survey and collect germplasm of local fruit trees and medicinal plants and establish arboreta.
9. Compile a directory of all institutionally

and privately held collections of species.

10. Monitor and support local community and NGO efforts to establish and maintain seed banks.
11. Monitor and support the efforts of private establishments to propagate commercially important indigenous threatened plant species, utilizing biotechnology.
12. Identify suitable centres and provide adequate resources for the conservation of microbial germplasm.
13. Establish urban and rural parks and field gene banks of selected species and, where possible, develop these as centres for promoting education and creating awareness among the public.

Main state institutions involved in implementing :

DOA, DEA, Department of Animal Production and Health, TRI, RRI, CRI, RRI, VRI, Botanical gardens, Zoological gardens, NARA, NARESA

6.7 Research

Identifying the issues:

Most of the government organizations that deal with the conservation and use of biodiversity have a section within their institutions devoted to research. These include the Forest Department, Department of Agriculture, Department of Export Agriculture, Department of Animal Production and Health, Department of Ayurveda, and the NARA. Notably, however, the Department of Wildlife Conservation does not have a research section. Some state organizations are exclusively devoted to research activities such as the TRI, CRI and RRI. The universities too play a significant role in the national research efforts on biodiversity, and many of their research projects are being carried out in collaboration with foreign scientific institutions. NARESA supports research on biodiversity by providing grants.

The Forest Department's research section was created over 60 years ago, and in the early days its activities were focused on silvicultural and timber utilization research. From the 1960s, with the department's reforestation programme expanding sharply, the resources provided for research (trained manpower and funds) began to decline. The low priority given to research continued until recent times. In recent efforts to resuscitate the research division of the Department, several measures were adopted, among which was the setting up of a National Forestry Research Committee, with the Conservator of Forests as Chairman, and with members from other organizations including the universities. This initiative must be accompanied by a strengthening of the research capacity of the department to build within it a core of researchers on different aspects of forest science. Even with the additional strengthening, the department should always recognize, as it does now, that a great deal of forestry research should continue to be done at the universities, and this must be given every encouragement.

As regards research on biodiversity, the Forest Department has, through its National Conservation Review, gathered valuable data on biodiversity in the natural forests of the country in relation to plants (woody species) and animals (vertebrates, molluscs and butterflies). The Department, through its normal research programme, is also carrying out some research on the regeneration of indigenous woody species. Research projects on forest biodiversity have been carried out by some members of the teaching staff of the universities in areas of particular interest to them, and these are mostly related to the distribution of plant species and animal species of selected taxa. Subjects such as conservation and reproductive biology, which are important in the context of sustainable use of biodiversity, are poorly researched. All the current research on biodiversity does not add up to the level of research that is necessary to support an effective programme for the conservation and sustainable use of forest biodiversity and is, at any rate, quite inadequate for a country with such a wealth of biodiversity and endemism among its indigenous fauna and flora. Further research in biodiversity should therefore be promoted. Collaboration with centres of excellence abroad should be encouraged in order to strengthen national research capabilities;

but in so doing adequate safeguards should be taken to ensure that access to Sri Lanka's genetic resources and related information is provided only on binding conditions that will ensure that any benefits derived from the use of such resources or information are equitably shared with this country.

Research on bioactive substances obtained from diverse bioresources, including medicinal plants, is being conducted by researchers in the universities, the Medical Research Institute and the Ceylon Institute of Scientific and Industrial Research. This, together with other areas of biodiversity research, would have to be strengthened in the context of the provisions of the Convention on Biological Diversity regarding access to genetic resources, access to and transfer of technology, and technical and scientific cooperation.

On aquatic fauna, research in biodiversity overall is inadequate. NARA has been carrying out research on some marine and brackish water species, and there have been a few research projects carried out by university staff. A great deal more has to be done to provide the scientific information for the conservation of aquatic fauna, particularly of threatened species.

An interesting study was carried out by IUCN Sri Lanka in collaboration with WCMC on Investments on Biodiversity Conservation in Sri Lanka in the period 1991 to 1994. This study revealed that, for biodiversity conservation work, over 90 per cent of the funds come from external agencies, mainly through bilateral arrangements. With regard to biodiversity conservation research, many small to medium scale projects were undertaken by researchers in the universities. The total funds received by the universities for research on biodiversity conservation was, however, less than a tenth of the total funding received for all aspects of biodiversity conservation work in the country from external as well as from internal sources. The study also revealed that, with respect to research, the main focus was on systematics and inventory and on basic studies relating to species and ecosystems. Biodiversity research on flora received much more attention than on fauna, and scant attention was accorded to the in situ management of threatened faunal species. There was no research on captive breeding with the aim of subsequent re-introduction to the wild.

Objectives:

1. To evolve mechanisms for coordination and consolidation of research efforts in biodiversity conservation and its sustainable use.
2. To promote research on subjects relevant to the conservation and sustainable use of indigenous species of fauna and flora, particularly those under threat.
3. To establish and support programmes to collect, collate and document scientific data on Sri Lanka's biodiversity.

Recommended action:

1. Institutionalize and strengthen current programmes of research on biodiversity and document qualitative, quantitative and distributional data on animals, plants and microorganisms of Sri Lanka.
2. Review all on-going and past research on biodiversity conservation and sustainable use, and identify gaps, institutions and scientific resources for future research.
3. Provide financial resources for research on identified high priority areas pertaining to the conservation and sustainable use of components of biodiversity, particularly digenous species under threat and those of potential economic value.
4. Extend the NCR to cover gaps in knowledge on the existence and distribution of non-vascular plants, invertebrates and microorganisms
5. Mobilize resources and expertise for biodiversity research in Sri Lanka.
6. Develop and introduce regulations to ensure that, if access to Sri Lanka's genetic resources and related information is granted through collaborative research arrangements to non-national organizations or individuals, adequate safeguards are

taken to ensure that any benefits derived from such resources or information are shared equitably with this country.

7. Promote collaborative research aimed at strengthening Sri Lanka's research capability in biodiversity related work, with adequate safeguards as specified under 6 above.

Main state institutions involved in implementing:

NARESA, CARP, FD, MFE, NM and universities

6.8 Education and Awareness

Identifying the issues:

In the sphere of education, biodiversity conservation rarely figures as a subject by itself and is often included as a part of environmental curricula. This is not surprising as, in the current context, concern for the loss of biodiversity is still an emerging issue. In the school curriculum of the national education system, environmental education is included from the primary grades. At secondary school level, aspects of environmental education are included in the subjects science, social studies and health studies. At pre-university level, aspects of biodiversity are included in the subjects botany, zoology and geography.

The National Institute of Education is the main institution concerned with curriculum development within the school system. Although sound curricula have been developed, there are, as the Institute itself acknowledges, several deficiencies in the imparting of environmental education. This is mainly because the teachers, for the most part, use only conventional classroom lectures to teach environmental subjects, and they lack the motivation and technical capacity for effective teaching of the relevant subject components. Teachers are particularly weak in promoting environmental consciousness among students. While some teachers are decidedly innovative, they form a small minority. The constraints identified by teachers as barring effective teaching of environmental topics were: lack of access to current literature on topical matters; lack of training in effective teaching methods; shortage of equipment and teaching aids; social constraints to the introduction of practical aspects of environmental education; the examination oriented teaching practices expected of teachers by senior school administrators, students and parents; and the lack of support from school administrators for departing from the conventional approach to environmental education.

A few organizations have attempted to address the problem of resource constraints faced by teachers. March for Conservation (MfC), a national NGO which specializes in environmental education, prepared a set of innovative environmental education aids for years six, seven and eight, and tested them among teachers and students from about 100 schools in selected districts. The teachers responsible for environmental education in these schools were also trained to supplement their class room teaching with these teaching aids, using novel teaching techniques. Several other NGOs carry out programmes related to strengthening awareness on biodiversity among school children. These include Worldview and the Wildlife and Nature Protection Society.

NARESA carried out a project in collaboration with MfC to carry out training programmes for teachers in field sites and to produce supplementary reading material and posters (tropical rain forests and coral reefs) for secondary schools. It is at present engaged in producing a set of scientific pictorial books on mammals, birds, the Sinharaja forest, medicinal plants and coastal resources. Posters and other educational material on aspects of biodiversity are being produced by other government organizations too, e.g. the Forest Department, MFE, Coast Conservation Department, CEA, DWLC and NARA, and these organizations also conduct seminars for school children and the public. All these activities by both the governmental and non-governmental organizations are insufficient by themselves to make a significant national impact on improving the standard of teaching of biodiversity and its conservation at the school level. A concerted national effort is needed to

give appropriate training to the teachers and to provide the necessary teaching aids.

At the university level, biodiversity is covered in many undergraduate courses in the biological sciences, but is absent in the veterinary science degree course. At the postgraduate level, for masters degrees by course work, biodiversity is included in the relevant curricula at the Universities of Colombo, Peradeniya and Sri Jayewardenepura, and at the Open University. A significant gap at the postgraduate level is that only a few students opt to specialize in taxonomy which is essential for biodiversity survey and assessment.

Many of the activities which deal with education and awareness relating to biodiversity conservation are carried out by NGOs.

At present there are over 360 NGOs involved in such activities, from the national level right down to the village community level. Many of these activities are being managed on "shoe string" budgets. The Wildlife and Nature Protection Society, an NGO of over 100 years standing, is coordinating and assisting the activities of a network of nature clubs covering 300 schools in the Island. Many other NGOs are spreading the message of biodiversity conservation through seminars, workshops, and the radio and print media.

Notwithstanding the many activities that are being carried out to promote awareness among school children and the general public of the importance of conserving biodiversity and using it sustainably, they are slow to make an impact. One reason is that these activities target only small sections of the population. Another is that they are very poorly funded, which means that they are severely restricted in term of materials and manpower.

A serious deficiency in implementing biodiversity conservation measures is the non-availability of the requisite information needed by professionals. For example, law enforcement agencies like the Customs and the Police do not have access to information on identifying plant and animal species commonly smuggled out of the country. Indeed, a good general understanding of biodiversity is required in all sectors of government to ensure that biodiversity concerns are recognized in the course of implementing development projects. NARESA has initiated a programme to address this need; such programmes should be expanded and replicated. In the private sector too a knowledge of biodiversity is necessary in sectors like trade, commerce and building construction.

A project for enhancing biodiversity skills among professionals in both the governmental and non-governmental sectors was started in 1995 by MfC in collaboration with MFE and IUCN Sri Lanka. There is every reason to justify the continuation of this project and to upgrade it into a continuing programme.

Objectives:

1. To enhance knowledge, skills, attitudes and values relating to biodiversity and its conservation and sustainable use, through formal and non-formal education.
2. To enhance knowledge on biodiversity and the need to conserve it, among professionals in the governmental and non-governmental sectors.
3. To increase awareness and concern among the public of the need to conserve Sri Lanka's biodiversity.
4. To increase resources for education, training and awareness activities in relation to biodiversity.

Recommended action:

1. Improve the quality of school curricula to make the learning and teaching of biodiversity more effective.
2. Review, select and make available in adequate numbers supplementary educational materials that have already been developed, for use in primary and secondary schools.
3. Produce new educational material on biodiversity issues not adequately covered at present and, in the nature of case studies, on new emerging conditions relating to biodiversity.
4. Organize training courses for teachers on the use of practical and field oriented methods of teaching biodiversity, with an

emphasis on different location-specific situations, giving due recognition to the proposals and recommendations made by teachers at various fora.

5. Formulate a scheme for nominating motivated school teachers to follow overseas courses in biodiversity teaching methods and to serve as master teachers on their return.

6. Activate the existing field centres (at Horana, Palabaddala, Kurulukele, etc.) for practical work related to biodiversity, and open more centres where appropriate, ensuring that the bioregions are adequately represented.

7. Introduce aspects of biodiversity into undergraduate courses in agriculture, veterinary science, engineering, architecture, commerce and the social sciences.

8. Promote, by offering grants and by other means, postgraduate specialization in biodiversity fields, e.g. taxonomy of plants and animals.

9. Increase support for NGOs with demonstrated capability, to carry out awareness programmes on biodiversity.

10. Support the production of biodiversity oriented feature films; such videos could be marketed locally and internationally.

11. Formulate a comprehensive countrywide awareness programme through the print and audio-visual media, and seek private support for the programme.

12. Institutionalize the Biodiversity Skills Enhancement Project, and secure funding for its continuation; replicate such programmes.

13. Increase media capability by organizing short training courses on the production of audio-visual programmes which promote biodiversity conservation (documentaries, discussions, news clippings, etc.).

14. Mobilize funding for education and awareness creation activities on biodiversity conservation.

15. Publish a low-cost newsletter particularly for use by teachers and media personnel regarding biodiversity issues of topical interest.

16. Promote the publication of biodiversity information in established newspapers that target the school going population.

Main state institutions involved in implementing:

NIE, UGC, CEA, FD, CCD, NARESA, MFE, Ministry of Education and Higher Education

6.9 Biodiversity Information

Identifying the issues:

Although there is a sizeable volume of information on Sri Lanka's biodiversity - in the form of bibliographic collections, specimen lists, maps, reports, GIS holdings, and digital databases - much of it is scattered in governmental, semi-governmental, non-governmental, project, and academic institutions, or is in the custody of individual scientists. Its existence, however, remains largely unknown to would-be users, including policy makers. A good deal of information on Sri Lanka's species is also found in institutions abroad where types specimens are lodged and where the scientific papers are published. Among local scientists, only a few have the means of getting access to this information. A user's inability to obtain specific information may either be due to its non-existence or to difficulties of access, the latter because of the lack of established measures to classify and provide information to different categories of users which is a constraint that is applicable mainly to state institutions.

A national survey of biodiversity information was conducted in 1996 as part of the BCAP preparation process. The primary purpose of the survey was to develop a "metadatabase" (defined as data that describe other data) of biodiversity related information. Evidence from the survey suggests that information managers were well trained, but in fields that do not prepare them to take advantage of modern technology. For instance,

about a quarter of the "information management specialists" have post graduate training, but very few have had any training in computer hardware maintenance, analysis of computerized spatial data, or systems analysis. By contrast, library science is the most common area of training within this group.

About 80 per cent of biodiversity information management institutions regularly use Database and Graphics software, but less than 15 per cent use GIS software. State institutions had the best equipment for information management, but it was little used for this purpose.

Although nearly 50 per cent of information management institutions have access to e-mail, of these, less than half have access to full Internet facilities such as the File Transfer Protocol, Worldwide Web, Gopher, etc. Academic institutions constitute the group that is best served with full Internet connections, while government institutions are the least.

Among biodiversity information data-sets, information concerning gene banks on plants, animals and micro-organisms were poorly represented. While a large number of data-sets had information on ecosystems, there were relatively few on protected areas. Although a fair number included socio-economic information, few had information on legal issues or land tenure and property rights. Nearly all data-sets have English as one of their operational languages, but only about a quarter are operational in Sinhala and about six per cent in Tamil.

In the course of BCAP preparation, several working groups were set up to identify the issues and the actions needed for improving the status of biodiversity information in Sri Lanka and providing better access to it. Their findings are briefly reported below.

There is much information on forests, including protected areas, but this is not readily accessible to those who need it. In part, this is because the institutions and individuals concerned do not make widely known the published and unpublished information they possess. Often, the unpublished information remains in files as raw data and may eventually be lost. Some information is found in scientific papers published abroad, and few people in Sri Lanka other than the authors know of the existence of these publications. Clearly there is a need for collation of the biodiversity related information, and this should be done as a continuation of the exercise which has already commenced at MFE in compiling a metadatabase.

An important data-set that has contributed immensely to the information base on forest biodiversity has been developed through the NCR. However, this information is restricted to woody plants among the flora and to vertebrates, molluscs and butterflies among the fauna. Information on herbaceous flora has not been collected in this survey. Another area where forestry information is inadequate is on the characterization of medicinal plants and of different ecotypes of useful species. On non-timber uses of forests, the recently carried out survey on traditional uses of forests provides very useful basic information, but this has to be followed up by more detailed studies. A related area is the human-forest relationship, where much of the available information is anecdotal.

Several important data-sets are available on coastal and marine resources, but are not readily accessible to researchers and planners. Examples are data on mangroves, coral mining, fishery practices, ornamental fish exports, etc. Information on habitats and ecosystems in the coastal and marine areas is sparse. The wetland site reports provide a nucleus of information and they could be used as a model where rapid collection of data on biodiversity is necessary. On marine invertebrates, identification and characterization is inadequate, particularly in the context of the growing economic importance of these species for export. With regard to water quality, apart from NARA's surveys and reports of some years back and limited monitoring by the National Water Supply and Drainage Board and the University of Sri Jayewardenepura, there are no other sources of information.

In the area of agriculture, biotechnology and genetics, many institutions possess specialised data-sets on focused topics, but the custodians of the information do not readily make it known that such information is available.

On faunal species, much information is available but is difficult to access. Many faunal species, especially invertebrates, collected in Sri Lanka have been identified and characterized outside the country, and few people in Sri Lanka have access to this information. Data on animal husbandry are notably sparse. On micro-organisms, Sri Lanka has no institutionalized database, and, given the commercial significance of micro-organisms today, this is considered a serious deficiency. There is also a marked absence of information on biosafety measures.

An important information resource in Sri Lanka is the indigenous knowledge on biodiversity and its use in farming, ayurvedic medicine, home remedies, etc. Some of the information on medicine is documented in ola leaves, but much of the information is in the memory of old medical practitioners, farmers, priests, and village elders, and this information is passed down through an oral tradition from one generation to the next. This information must be compiled, documented and archived. In so doing, it is important to see that this traditional knowledge is adequately safeguarded, and that it is made accessible only if measures are taken to ensure that any benefits derived from its use are equitably shared by this country.

Objectives:

1. To ensure that the sources of all the information on Sri Lanka's biodiversity are centrally documented.
2. To formalize and regulate access to information on biodiversity.
3. To strengthen the information base on biodiversity, and to ensure that major gaps in biodiversity information are identified and addressed through targeted investments.
4. To archive indigenous knowledge and legalize mechanisms to protect it.

Recommended action:

1. Formulate a national policy on information management that includes the identification of criteria for collection, management and storage of biodiversity information and guidelines to assist custodial institutions to formulate individual information access policies for in-country and external would-be users.
2. Establish mechanisms at MFE for regularly maintaining and updating the meta-databases on biodiversity now being established, and for setting up of a meta-database on indigenous biodiversity information held outside Sri Lanka.
3. Identify a state institution to deal with biodiversity information management and access issues and to facilitate the continued maintenance of biodiveristy meta-databases.
4. Increase capacity of individual custodial institutions to collate and analyse biodiversity data using current computer technology and software through training and review of staff requirements; and increase capacity for the operational language of databases to be expanded to cover Sinhala and Tamil where relevant.
5. Promote measures to enhance technical capacity for information exchange and establish mechanisms for the collation of information on Sri Lanka's biodiversity available within and outside the country and store such data in the relevant custodial institutions.
6. Extend the coverage of biodiversity data collection to include non-woody and non-vascular flora, invertebrate fauna, micro-organisms and marine fauna and flora, and store such information in the custodial institutions.
7. Strengthen information collection in the following areas: uses of forest resources other than timber and fuelwood, functional aspects and dynamics of ecosystems and habitats, and human-resource relationships.
8. Collate data on hydrology and water quality and store data in relevant custodial institutions.
9. Strengthen the database relating to the characterization of indigenous plant species in use for medicine and food.
10. Gather information on the benefits as

well as risks associated with the application of modern biotechnology in the conservation and use of biodiversity.

11. Launch a special programme for the collection and archiving of data on indigenous knowledge pertaining to biodiversity and institutionalize the process giving due regard to the need for controlling and regulating access to this information.

12. Identify and provide support to selected "centres of excellence" for collating and managing data sets on aspects of biodiversity.

13. Provide support to identified NGOs for assisting in research and collection of field data on biodiversity.

Main state institutions involved in implementing:

MFE, MAL, Ministry in charge of ayurvedic medicine, Ayurveda Department, DOA, DWLC, FD, NARA, NARESA, CEA, universities.

6.10 Legal Measures

Identifying the issues:

In Sri Lanka, the different laws in force today relating to environmental protection, many of which directly or indirectly relate to the conservation of species and ecosystems, add up to around 80. The most often cited ones are the Forest Ordinance, the Fauna and Flora Protection Ordinance, National Environmental Act, National Heritage Wilderness Areas Act, Felling of Trees (Control) Act, Botanic Gardens Ordinance, National Aquatic Resources Research and Development Agency Act, Fisheries and Aquatic Resources Act, Plant Protection Ordinance, Animal Diseases Act, and the Customs Ordinance.

Despite this large body of statutes, it could be said that there are many activities taking place today which are seriously eroding the biodiversity resources of the country. One clear reason for this is poor law enforcement, since even with the existing laws, despite deficiencies, much more could be done to arrest the adverse trends in biodiversity loss. Another reason, and a major one at that, is that the provisions available in the existing laws for protecting the biodiversity of the country are defective in certain respects and inadequate for fulfilling their purpose. For example, there is now a lucrative export trade in the export of live ornamental fish and plants, and collection in the wild and export in large numbers poses a serious threat to many indigenous species. The laws relating to these activities must be reviewed and revised.

In certain statutes there is overlap and sometimes, conflict. What is strictly regulated and controlled by one Act may be permitted more freely under another. A notable case is the Fauna and Flora Protection Ordinance and the Fisheries and Aquatic Resources Act in respect of the import and export of fish and other aquatic organisms.

As regards the management of protected areas and other state forests, the statutes covering this activity are generally replete with acts that are prohibited and the penalties for infringement - the command and control concept. There is very little room for participation of stakeholders in the management of these areas. The rights that communities living adjacent to forests have enjoyed for generations is not duly recognized in these ordinances. With regard to the state's obligations, except for the Coast Conservation Act and the National Wilderness Areas Act, there is no direction to the implementing agencies as to their responsibility for the proper management of the areas under their jurisdiction.

The Plant Protection Ordinance and the Animal Diseases Act, dealing with the import of plant and animal species respectively, are intended to prevent the introduction of pests, diseases and invasive organisms. However, with changing perceptions in science where micro-organisms are not considered to belong either to the plant or the animal kingdom, and with advances in science and technology bringing into being a new breed of organisms, namely, living modified organisms, the statutes must be amended and updated to recognize these changes. At present, when micro organisms are to be imported to Sri

Lanka, it is not clear whether it is the Department of Agriculture or the Department of Animal Production and Health that has to grant the relevant authority, or whether any approval at all is necessary.

The Convention on Biological Diversity (CBD) is the major international legal instrument for the conservation of the world's biodiversity. It has been ratified by over 165 countries as of March 1997. Sri Lanka ratified the Convention in March 1994. Besides the CBD there are other international conventions dealing with biodiversity, and notable among these are the Ramsar Convention on wetlands and the CITES Convention on trade in endangered species.

The CBD has introduced many new areas of concern in international relations regarding the conservation of biological diversity. These include the transfer of genetic material from one country to another, the use of traditional knowledge of one country for technological development in another, the equitable sharing of benefits derived from the use of genetic resources, and collaboration in research between developed and developing countries. These concerns are strongly voiced in developing countries which are richly endowed with genetic resources but are often relatively weak in their science and technology capacity. These countries are also heirs to a rich store of germplasm selected through centuries for particular desirable characters and cultivated in situ, and of traditional knowledge in the use of biological diversity for food and medicine. The countries are concerned that the developed countries may, through provisions in the CBD, gain access to these resources and use their superior technological skills for product development, while not compensating the country from where the resource originally came. Many developing countries do not have the legal mechanisms in place to safeguard their genetic resources from such exploitation. This is precisely where Sri Lanka is placed.

Legislative or quasi-legislative measures, as appropriate, must be adopted in the context of the CBD to safeguard Sri Lanka's interests regarding the conservation and use of its biodiversity. Sovereign rights of the state over its biological diversity have to be recognized by law. Laws and regulations should be enacted to control access to the country's genetic resources and traditional knowledge and to ensure that there is equitable sharing of benefits from the use of these resources. Action must be taken to incorporate "prior informed consent" and "mutually agreed terms" in agreements covering the export of germplasm, the sharing of traditional knowledge, and the carrying out of joint research .

Objectives:

1. To develop sound legislation to ensure the conservation and sustainable use of the country's indigenous biological diversity, particularly the components under threat.
2. To enforce the legislation pertaining to the conservation of biodiversity.
3. To provide for the fair and equitable sharing of benefits by resource owners and users arising from the utilization of genetic resources and indigenous specialized knowledge.

Recommended action:

1. Provide legal recognition to the sovereign right of the state over its biological resources, including genetic resources.
2. Establish a legal framework for the control and regulation of access to genetic resources, collaborative research using indigenous biodiversity, and bio-prospecting.
3. Establish a legal framework and regulatory mechanism for controlling research in, and the release of, genetically modified organisms.
4. Review the legislation pertaining to the import and export of living organisms (including genetic resources) and amend, as necessary, to remove anomalies and strengthen where necessary, so as to provide adequate protection to indigenous biodiversity.
5. Clarify legal issues relating to the import of a all organisms, including microorganisms and living modified organisms.

Box 6.9

VALUATION OF BIODIVERSITY

The economic values attributed to biodiversity may be categorized according to different types of uses as follows.

Direct Use This might be the use of a forest, wetland or other ecosystem for timber extraction, collecting non-timber products, fishing, and so on.

Indirect Use This refers to the benefits deriving from ecosystem functions such as flood control, storm protection, soil conservation, water recharge, nutrient recycling, carbon storage, etc.

Option Value This a potential use in the future i.e. based on opting to conserve biodiversity with the hope that in the future it could be used directly or indirectly e.g. as a source of genetic material, for pharmaceuticals, etc.

Bequest value This measures the benefit accruing to any individual from the knowledge that others might benefit from the conserved resource in the future.

Existence value This is the value placed on biodiversity purely based on its continued existence, irrespective of whether or not it will ever be used.

Source: Pearce and Moran (1994)

6. Control and regulate the export of all organisms, particularly threatened organisms.
7. Provide a legal framework for the recognition and protection of indigenous knowledge of the country by petty patents or such other similar systems irrespective of time limitations.
8. Provide a legal framework to enable the implementation of the CITES convention with regard to the protection of endangered species.
9. Take remedial measures for the protection of species that are presently being subject to illegal trade.
10. Draft regulations in terms of section 38, of the Fauna and Flora Protection Ordinance regulating the release of mammals, birds, reptiles, amphibians, fish or invertebrates.
11. Draft regulations in terms of section 24, of the Forest Ordinance, as amended by the Forest (amendment) Act, No. 3 of 1995 for the import and export of timber and seeds of forest tree species and other forest produce.
12. Draft legally binding regulations to ensure that research on any component of indigenous biodiversity carried out by non-nationals of Sri Lanka is only done on the basis of an agreement with a local institution and in close collaboration with Sri Lankan scientists, and that the outcome of such research, including information that is generated, is made available to Sri Lankan scientists and institutions.

Main state institutions involved in implementing:

MFE, MAL, Legal Draftsman, AG's department, FD, DWLC, Department of Ayurveda, Registrar of Patents and Trademarks

6.11 Institutional Support

Identifying the issues:

A survey of the institutions in both state and non-state sectors revealed that there are numerous organizations which are stakeholders in biodiversity conservation. Among these, there are several lead organizations whose activities will determine the successful implementation of the Biodiversity Conservation

Action Plan (BCAP). These organizations need to be proactive to BCAP challenges. They will have to lead and enthuse other organizations and chart the future course of the BCAP. Capacity building efforts should be directed primarily towards these institutions in the expectation that such efforts would have the desired multiplier effect on other relevant institutions. In addition, there are also many state organizations which are important users of bioresources as well as a large number of institutions, both in the state and private sector, whose activities can have an adverse impact on biodiversity. The activities of some research institutions, universities, NGOs and private entrepreneurs can also exert a considerable influence on the biodiversity of the country. Efforts focused on promoting conservation and sustainable use of biological resources should be directed towards these organizations and institutions.

A survey on institutional capabilities has revealed a variety of organizational, managerial and structural deficiencies in addition to a gross shortfall in physical, financial, and human resources that would be needed for the effective implementation of the Biodiversity Conservation Action Plan.

The biological resources of the country are administered by many state institutions - under the purview of the central government and the provincial administrations. Natural forests come under the jurisdiction of several state agencies, chiefly the Forest Department and the Department of Wildlife Conservation. Other institutions that have a role in the conservation and management of biological resources are the Department of Coast Conservation; the National Aquatic Resources Research and Development Agency; the Zoological Gardens; the National Botanical Gardens; the research institutes under the Ministry of Plantation Industry; the Natural Resources, Energy and Science Authority; the Central Environmental Authority; and the Mahaweli Authority. In addition, the provincial ministries of the environment should have a responsibility for biodiversity conservation at the regional level. There are several other government organizations whose activities involve the consumptive use of biological diversity. These are, notably, the Departments of Agriculture, Fisheries, and Ayurveda. The Forest Department falls into this category also, as timber and other forest products are harvested from the forests under its charge. The universities are engaged, to varying degrees, in carrying out research which provides basic data for the conservation and management of biodiversity.

Many non-governmental organizations play a significant role in the conservation of Sri Lanka's biodiversity, both at national and grass roots level. The key NGOs concerned with biodiversity are regularly consulted by the relevant government organizations on research and management activities, formulation of environmental policy, and promotion of environmental education both at school and community level.

At the national policy level, the ministries in charge of the subjects of environment, agriculture, lands, forests, plantations, fisheries, livestock, indigenous medicine, science and technology, education and defence, and the Provincial Councils have a vital role to play in the conservation and sustainable use of biodiversity.

In order to co-ordinate activities related to biodiversity conservation, MTEWA set up a Biodiversity Co-ordinating Group with representatives from ministries, departments, corporations and the NGO sector. In addition, the ministry has set up an Experts Committee on biodiversity whose main function is to advise the ministry on matters relating to the implementation of the Convention on Biological Diversity. Besides the above two bodies, the ministry has set up networks of organizations involved in the use or conservation of biodiversity or whose activities have an impact on biodiversity. The formation of these bodies are useful first steps in enthusing the "constituency" as a whole to recognize the importance of conserving biological diversity and using it sustainably. But to work effectively, bodies created by the ministry in charge of the environment must be adequately resourced in terms of skilled manpower and funds. This is what is lacking now and it must be remedied as soon as possible.

The principal state organizations mandated for environmental protection and biodiversity conservation have developed plans such as the Forestry Sector Master Plan, the National Environmental Action Plan, and the Coastal Conservation Master Plan. Within the

umbrella of these sectoral plans, several action plans have been prepared. Notable amongst those concerned with biodiversity conservation is the dozen or so management plans for conservation forests and the plan for the Peak Wilderness Sanctuary. If these sectoral and departmental plans are implemented, they would make a huge impact on the conservation of the nation's biodiversity. But here again, the resource constraint is the impediment, and progress in implementation is slow at best.

Much has been done to awaken government organizations and the general public (many for which the concept of biodiversity as now understood was entirely novel) to a realization that the country's biodiversity is a national treasure that had to be conserved. This has been done primarily through the efforts of the ministry in charge of the environment and other organizations including NGOs. The time is now ripe to declare a national policy on biodiversity, the adoption of which will give an impetus to the implementation of biodiversity conservation programmes.

Objectives:

1. To develop an effective system to coordinate and monitor activities for the conservation and sustainable use of biodiversity.
2. To ensure that institutional arrangements are in place, with adequate resources and manpower, in all the government organizations concerned for the conservation and sustainable use of biological diversity.
3. To ensure that all government organizations that have an impact on biological diversity recognize the need to conserve this resource and take appropriate action to do so.

Recommended action:

1. Provide the needed resources to the departments in charge of biodiversity conservation for capacity building - staff recruitment and training and infrastructural support.
2. Provide the needed resources to the Department of Ayurveda whose main function relates to the use of biodiversity.
3. Catalyze international collaboration in relevant areas of research on biodiversity and biotechnology where local expertise and facilities are limited.
4. Develop plans for international projects on marine biodiversity in collaboration with NARA and the universities.
5. Take adequate steps to strengthen the research capabilities of universities, research institutes and the botanical and zoological gardens, particularly in modern techniques of biotechnology for taxonomy and germplasm conservation.
6. Take steps to modernize the storage and maintenance capacity of "custodial institutions of information on biodiversity" to ensure confidentiality and efficiency.
7. Enhance the knowledge of law enforcement and preventive officers (including the police, customs and quarantine) and provide the necessary material to enable them efficiently to stem unauthorized transactions in biodiversity.
8. Provide manpower training and facilities to implement recommended actions.

Main state institutions involved in implementing:

Ministry in charge of wildlife, Ministry of Finance, MFE, MAL, FD, DWLC, DFAR, Department of Ayurveda, Botanical and Zoological Gardens, CEA, NARA, NARESA, research institutes, universities, provincial administration, police, customs and quarantine.

6.12 Valuation of Biodiversity

Identifying the Issues:

Biodiversity and the manifold processes that go with it form the basis of life in the biosphere. Biological diversity, therefore, has immense value because of its ecological functions.. It also has social, ethical and cultural values, and this has been recognized from the earliest days of human history. With mankind's survival and well-being so heavily dependent on it, biodiversity must certainly

also have considerable economic value. However, conventional principles of economic analysis demand that a resource be used for it to acquire value. In other words, a standing tree can only be valued in terms of the price it would fetch in the market place as timber. New approaches to economic assessment are required in order to ensure that economic values incorporate both monetary and non-monetary expressions of preference. Assigning these qualitative and quantitative values could provide justification for increased action in conserving biodiversity.

In Sri Lanka, calculations of the contribution of the forestry sector to the GDP take into account only the marketed timber and fuelwood. In the case of fuelwood, a good part of what comes from the forest is in fact not marketed. The numerous biodiversity values, which could be several times the value of the marketed wood, are not taken into account. The very presence of the biodiversity rich forests in the wet zone, situated as they are on the mountain slopes, serve a critically important hydrological function. By regulating water discharge, they provide benefits to agricultural systems, hydropower schemes, and the living environment. There are other benefits that are easier to quantify, but still not adequately recognized in assessing the value of the country's biodiversity. These are the multitude of non-timber products which the forests provide such as fuelwood (the large quantities collected directly from the forest by rural house-holds), medicinal plants, food items, cane, rattan, etc. A country's biodiversity also serves as a gene pool of considerable potential value. Wild species, or genetic material derived from them, have from time to time yielded benefits of immense value in the spheres of food and medicine. Here, in Sri Lanka, a case in point is the development of cultivated varieties of rice which are resistant to certain pests and diseases by crossing with wild varieties that are naturally resistant. Wild species, particularly wild relatives of cultivated plants, are a resource of considerable potential economic value, but the value of this resource cannot be estimated until it is used. Finally, an important value of biodiversity that goes unrecognized as such in national accounting is its aesthetic value.

The methodologies for valuing biodiversity are still evolving, but studies have been made elsewhere in the world on how biodiversity values can be incorporated into the process of decision making on investment projects. In Sri Lanka, there is currently a lack of expertise to carry out environmental valuation, and the relevant expertise must be developed. This is a matter that should receive the urgent attention of MFE (as the focal point for biodiversity and the environment), the ministry in charge of policy planning, and academia.

In carrying out valuation studies, it is necessary to emphasize the importance of adopting appropriate criteria and methodologies and focusing on values that are of relevance to Sri Lanka. Grant funding should be made available to encourage researchers to take to this field of study. Failure to address this issue will mean that biodiversity will continue to be undervalued, and public investments on biodiversity will continue to be disproportionately low.

Objectives:

1. To develop methodologies and expertise for the proper valuation of the country's biodiversity.
2. To develop mechanisms to incorporate biodiversity values into national accounting and decision making at different levels.

Recommended Actions:

1. Undertake policy studies on the general impacts of economic policy on biodiversity.
2. Develop appropriate methodologies and apply them for carrying out studies to make realistic valuations of Sri Lanka's biodiversity, and apply the results in national planning, national accounting, and decision making at different levels.
3. Gather information on indigenous knowledge on the use of plants for medicine, and carry out vertical integration in biodiversity prospecting, i.e. take the utilization of bioresources for ayurvedic medicine beyond the basic level of direct use to the preparation of the marketable finished products.

Main state sector institutions involved in implementing:

MFE, Ministry in charge of planning, Ministry of Finance, Ministry in charge of Ayurveda, academia.

Integrating National Efforts for Biodiversity Conservation

7.1 The Role of Government

The stakeholders of Sri Lanka's biodiversity are many. The State, as the custodian and trustee of the major portion of the land, is the most important stakeholder. The government, through its departments and other institutions, carries out many activities which have a significant impact on biodiversity. There are three key departments whose mandates are heavily weighted towards the conservation of biodiversity. They are the Forest Department, the Department of Wildlife Conservation, and the Department of Coast Conservation. The policies and programmes of these three departments are crucial to the conservation and sustainable use of biological diversity. Besides these, there are a large number of departments and other statutory bodies whose activities affect biodiversity. They can be broadly classified into those that use, protect, or whose activities have an impact on, biodiversity.

National and sectoral planning policies and strategies provide the environment within which the national planning process is initiated and carried out. Down the line, this process involves several types of studies, some of which constitute situation analysis reports, project reports, evaluation studies, etc. These studies provide the basic data and information to guide the divisional or departmental planning officials in preparing their programmes, projects and budgets, which is done through supportive consultations involving decision makers on the one hand, and those responsible for implementation on the other.

Where national policies have been followed up with strategies or action plans, the planning process proceeds to incorporate relevant components of such strategies and plans in the national development plan and the national investment programmes. The national development plan generally covers a period of four to six years, and is often subjected to annual review and revision.

In relation to biodiversity conservation, there are a number of policies and plans that have a bearing on national planning. These include the following.

- The relevant provisions of the Constitution of the Republic of Sri Lanka, and the policies of the government.
- The National Conservation Strategy and the National Environmental Action Plan.
- The Food and Nutrition Strategy, and the group of policies relating to self sufficiency in food and productivity and profitability of agricultural production systems.
- The National Policy Framework for Agriculture and the National Agricultural Research Plan.
- The group of policies on land use and the proposed action plan on land use in the agricultural sector.
- The National Forestry Policy and the Sri Lanka Forestry Sector Master Plan, including the recently formulated Five-Year Implementation Programme in Forestry.
- The National Wildlife Policy.
- Coastal 2000 - The Resource ManagementStrategy for Sri Lanka's coastal region and Coastal Zone Management Plan.
- Policies and plans on the conservation of wetlands.

Besides the above, there are the statutory provisions and the policies relating to the devolution of power to the provincial governments.

Action for integrating biodiversity considerations into national planning could be said to have started with the preparation of the National Report for the United Nations Conference on

Environment and Development in 1992. Following the ratification of the Convention on Biological Diversity by Sri Lanka in 1994, the ministry in charge of the subject of environment carried out several activities to promote the implementation of the Convention, culminating in the current exercise of preparing the national Biodiversity Conservation Action Plan.

The BCAP is expected to lead to an integration of biodiversity conservation considerations into national development planning. Since national planning adopts a sectoral approach, a convenient pathway for integration is through the sectoral plans and projects. In the implementation of projects, it is important to ensure that biodiversity considerations are duly recognized. This could be addressed through the "initial environmental examination report" or the "environmental impact assessment report" which, according to the current environmental law, has to be prepared in respect of certain categories of projects before approval is granted for their implementation. The project approving agencies should pay special attention to see that proposed projects avoid causing serious adverse impacts on biodiversity. MFE and its implementation arm the CEA have a special responsibility to ensure that these conditions are observed.

The government is the trustee of the nation's biodiversity and hence holds the ultimate responsibility for its conservation. While ensuring that policies, plans and programmes will recognize the need to protect and nurture this important national heritage, the government should provide sufficient financial resources in the annual budgets of the relevant institutions to enable them to take measures for the conservation of biodiversity.

7.2 Community-based Resource Management

Among direct users of biological diversity, the communities living within or on the fringes of critical ecosystems constitute the most conspicuous interest group. It is important to involve these communities in the management of the ecosystems, and the principle of community-based resource management (CBRM) is now widely accepted. However, there is no simple prescription for practising CBRM, and a model found successful in one region may not necessarily succeed in another, even within the same country.

As a pre-requisite for any community based resource management project, a proper assessment of the biodiversity resource has to be carried out paying special attention to its dynamics (degradation or improvement), in order to determine sustainable harvest levels. Based on data on the demography and cultural and economic features, the community stakeholders have to be categorized and their corresponding roles in the management process identified. Enabling institutional and legal frameworks have to be established for co-management, user rights, tenureship, etc. A harmonious relationship between community development and long term resource management has to be established. Above all, the organization and the mobilization of the community is of vital importance.

Initial access to local communities is best mediated through village elders who command respect, such as temple head priests and other clergy, native physicians, senior school teachers, social workers, etc. It is advisable to avoid politically affiliated individuals and government officials. The community should recognize the importance of bio-resources in relation to the common problems encountered by the community, e.g. water shortage due to denudation of forests; siltation of reservoirs as a result of soil erosion. Through processes of dialogue and discussion, the community should be motivated to conserve biodiversity. During these initial activities, individuals with leadership potential should be identified and gradually nurtured to take over responsibilities. Throughout this exercise, due care should be taken to let the community nominate organizers voluntarily. Very often the first attempt may not capture the best leader and sometimes it may not be successful even after second or third attempts. Patience and forbearance is required in large measure during these formative steps. The selected leaders should be provided with basic management training relevant to the projects at hand, together with basic knowledge of maintaining records, book keeping and banking (if handling of funds is required). It is important, as an initial exercise, to give basic training on biodiversity skills to village based officials such as Grama Niladharis and agriculture, veterinary and fisheries extension personnel.

Disbursement of funds as hand outs should be avoided, as this becomes a negative inducement for motivated participation in the long run. Provision of funds (when necessary) has to be done as "seed money" or "soft loans" that would enable the initiation of a project which could eventually generate its own funds. Participants in community-based projects should be made stakeholders so that they may develop a sense of ownership of the resource they help to conserve.

In order to prevent the protected bioresources turning into marketable tourist products, community based conservation projects for "eco-tourism" have to be developed and managed with due care. If such products enter the market, adequate measures for ex-situ propagation should be taken to ensure the conservation of the original resources.

Once a community is well organized and its confidence has been won over for a particular biodiversity conservation activity, technical and other assistance should be made available through public sector agencies and NGOs.

7.3 The Role of Non-governmental Organizations

One of the major problems in involving non-governmental organizations (NGOs) in biodiversity conservation and other similar activities is inadequate institutional capability. Although it is widely recognized that NGO participation can substantially enhance natural resources management, unless their institutional capability is strengthened and they are provided with more resources they would not be able to realize their full potential. NGOs should play both a complementary as well as a supportive role, and in order to do so effectively their activities should be supported with clear policy initiatives and legal back up.

Possible roles for NGOs (including community based organizations often referred to as CBOs) include (i) mobilization of village communities and organizing community action groups, (ii) awareness creation and skills development, (iii) establishment of forest plantations and nurseries, (iv) promoting the conservation of coastal and marine biodiversity, (v) providing know-how and material support for the cultivation of medicinal plants, (vi) assisting in establishing small to medium scale industries, (vii) assisting in obtaining credit facilities, (viii) assisting in marketing of agricultural and industrial products, (ix) assuming leadership and guiding community based rural development activities, (x) acting as link agencies between the communities and the key interest groups (including state agencies), (xi) carrying out operational research in collaboration with relevant state agencies, (xii) collecting data and information for the purpose of evaluating and monitoring of activities, and (xiii) assisting and co-operating in law enforcement in protected areas and sites such as multiple use natural forests.

7.4 The Role of the Private Sector

Through dialogue and dissemination of information, the private sector should be made aware of the fact that biodiversity conservation should be a matter of concern to them and that contributing towards achieving conservation objectives is in their long term interest. A policy framework has to be formulated to promote their participation, for example by providing incentives for investment on conservation programmes. On the subject of biotechnology, while accepting the beneficial aspects of its application, awareness should be created among the private sector of the dangers of indiscriminate use of genetically modified organisms, or living modified organisms (LMOs) which have not been adequately tested and authenticated. This should apply to organisms as well as their products such as live vaccines.

In consultation with the private sector, schemes have to be worked out for bio-prospecting combined with ex situ conservation (including the use of tissue culture and captive breeding) for indigenous bioresources having a good export market.

Enabling legislative and leasehold mechanisms should be formulated to attract private sector participation in eco-tourism, establishment of biofuel forests and multiple use wood lots, etc.

Tax concessions and other incentives should be given to obtain private sector participation in sponsoring biodiversity conservation oriented activities, such as awareness programmes, skills enhancement, mass media events and TV programmes.

Where private sector organizations are involved in collecting fauna and flora from the wild for commercial purposes, and if such an activity is allowable in the context of biodiversity conservation, regulations should be formulated to ensure that the state which is the custodian of the nation's biodiversity is adequately compensated. A part of these funds could be channeled to NARA, the universities, the botanical and zoological gardens, etc. for research programmes on biotechnology, tissue culture, aquaculture and captive breeding.

It is necessary to establish a system whereby the relevant government organizations and the provincial authorities are empowered to charge in advance the estimated cost of ecological restoration prior to the issuing of permits for timber extraction, gemming and prawn culture.

The following actions are recommended to bring in the private sector as active partners in biodiversity conservation.

1. Develop a policy and legal framework to facilitate the active involvement of the private sector in biodiversity conservation.

2. Provide enabling mechanisms (e.g. tax rebates) for plantation companies to engage in (i) protection of river catchment areas and clusters of existing forests, (ii) establishment of plantation forests, (iii) adoption of multiple cropping, (iv) establishment of field gene banks preferably including indigenous and traditional species, (v) minimal use of toxic agro-chemicals, and (vi) setting examples to others through demonstrations and models in the use of environment friendly technologies in agriculture (e.g. the SALT technology).

3. Prepare (or amend), in consultation with national experts, regulations and guidelines for controlling and regulating (i) inward and outward flow of biological material, (ii) standards and certification of planting material, (iii) use of biotechnology in developing genetically engineered organisms, (iv) import and distribution of transgenic biological material (including viruses, bacteria and other microorganisms), (v) reformulation and distribution of agro-chemicals not certified by the Department of Agriculture, and (vi) imports and exports of indigenous and threatened species.

4. Provide enabling policy and legislative mechanisms to support leasehold forestry systems.

5. Provide tenurial rights, planting material and other resources to sustain home gardens.

6. Support and make provision for awareness creation in the trade and commerce sector as well as in the construction industry, on the significance of, and measures for, biodiversity conservation (e.g. the Biodiversity Skills Enhancement Project undertaken by MfC).

Implementation

The overall responsibility for implementing the BCAP will devolve on the Ministry in charge of the subject of environment (ME), which is the national focal point for the Convention on Biological Diversity. Once the BCAP is accepted by the Cabinet of Ministers, it is recommended that the government issues a policy statement on the conservation and sustainable use of biological diversity in Sri Lanka. ME will then initiate action for implementing the BCAP, and the following institutional arrangements are proposed to enable it to take on the overall responsibility for ensuring that the BCAP is implemented.

Biodiversity Secretariat:

It is necessary to establish a Biodiversity Secretariat in ME, mandated to coordinate and promote the implementation of all projects and programmes under the BCAP. It is recommended that the present "Biodiversity Cell" of ME be elevated to a "Biodiversity Secretariat" with enlarged functions and additional staff. In order to avoid duplication of work and to use the existing institutional structures[1], the Biodiversity Secretariat will be placed in the Environment Division of the Ministry under the **Director, Natural Resources.** The core staff in this unit include an already functioning **Deputy Director** and an **Assistant Director** who will be appointed in 1998. The Biodiversity Secretariat will have support staff from the Environment Division. As the Secretariat develops its activities, staff may be appropriately increased.

The Secretariat's main functions are to:

- Liaise with sectoral agencies for identifying priorities and developing mechanisms to incorporate the recommended actions in BCAP into their implementation plans;
- Liaise with governmental organizations and the provincial administration in the preparation of project proposals under the BCAP;
- Monitor the implementation of recommendations in the BCAP, and take appropriate corrective action where necessary;
- Initiate action on cross sectoral activities identified in the BCAP;
- Organize meetings of the National Steering Committee (NSC) and the Task Forces (TF);
- Prepare documents for, and maintain records of, all meetings of NSC and TFs; and
- Attend to the day- to-day administration of all activities of ME dealing with biodiversity.

The Secretariat should also be the body to liaise with the Secretariat to the Convention on Biological Diversity and be responsible for preparing documentation in connection with Sri Lanka's participation at meetings of the Conference of the Parties (CoP) and other Convention-related meetings.

The Biodiversity Secretariat will thus be the implementation arm of the ME that will ensure that the Ministry fulfills all its functions, obligations and responsibilities as the focal point of the Government of Sri Lanka on the conservation and sustainable utilization of biodiversity. In carrying out its functions, the Secretariat will be guided by the National Steering Committee and the Task Forces. The recommended organizational framework for implementation and co-ordination of activities under the BCAP is depicted in Fig. 8.1.

The Biodiversity Secretariat must become fully operational within six months of a proposed **two-year inception phase** for the implementation of the BCAP. It should initiate action leading up to the early setting up of

the National Steering Committee and the Task Forces.

The Secretariat should also complete the following activities on a priority basis, within the first year of its operation:

- set up a biodiversity information management system, including conditions for access and exchange;
- complete the setting up of the meta-database on biodiversity;
- draw up terms and conditions for access to genetic resources;
- develop modalities for scientific and technical cooperation including terms and conditions for sharing results of research and development in a fair and equitable manner; and
- develop modalities for effective participation in biotechnological research including establishment of national guidelines and regulations for safe transfer, handling and use of LMOs.

National Steering Committee on Biological Diversity:

It is proposed that the highest level of coordination be exercised by a National Steering Committee (NSC) on Biological Diversity, appointed by the Minister in charge of the subject of environment, and chaired by the Secretary of the Ministry. This committee will be the apex body for policy formulation and policy decisions on the overall implementation of the BCAP.

It is recommended that the NSC be composed of 14 members, as follows.

- Secretary of the Ministry in charge of the subject of environment (Chair)
- Eight Secretaries chosen to represent the following key sectors: Finance and National Planning; Agriculture, including plantations and livestock; Forests, Wildlife, Zoological Gardens and Botanical Gardens; Fisheries and Aquatic Resources, Coast Conservation and Tourism; Science and Technology, and Education; Lands; Power, Energy and Irrigation; Indigenous Medicine
- Three experts on biodiversity-related areas
- One representative from the NGO community
- One representative from the private sector

The suggested Terms of Reference for the National Steering Committee are as follows.

(a) Provide policy guidelines to the ME for translating the recommendations of the BCAP into an implementation programme, and coordination of such activities at the national level

(b) Provide policy guidelines to the ME on the Convention on Biological Diversity, Conferences of the Parties, Subsidiary Body for Scientific, Technical and Technological device, and the Global Biodiversity Forum

(c) Identify priority areas in the BCAP requiring the attention of the government

(d) Provide guidance and advice to the ME, and through it to the Biodiversity Secretariat, for overall coordination of biodiversity conservation activities identified in the BCAP

(e) Periodically review the biodiversity implementation plan

The Director, Natural Resources of the Environment Division shall function as the Convenor/Secretary of the NSC.

This committee will meet at least twice a year; once primarily to finalize and decide on plans and programmes to be implemented and the financial requirements which can be incorporated into the budget estimates of the corresponding ministries, and again to review progress and make necessary adjustments.

Task Forces:

Many of the recommendations for action in the BCAP will involve a co-ordinated effort by several government agencies including provincial councils, non-governmental organizations, and the private sector. The

Biodiversity Secretariat would require expert guidance to translate the recommendations in the BCAP into implementation programmes, and it is proposed that this be achieved through the appointment of Task Forces for identified key areas. The Task Forces will consist of representatives of the main implementing agencies and other experts in the respective fields. The number of Task Forces, the activity areas to be covered by each, and the personnel to be included will be decided by the Secretary of the ministry in charge of environment and will be subject to ratification by the Minister.

To ensure effective coordination with the devolved administration of the provinces, it is proposed that the Task Forces also include representatives of the Provincial Councils, especially those Councils within whose jurisdiction the high priority bioregions fall.

The basic function of the Task Forces will be as follows.

(a) Study the BCAP recommendations for action

(b) Evaluate the current related activities in relation to these recommendations

(c) Identify priority areas for action, and to work out a programme of action assigning responsibilities for implementation

(d) Provide expert advice to the NSC on matters of relevance to their subject areas, as and when necessary

(e) Critically examine papers and recommendations prepared by experts in relation to identified issues, for the National Steering Committee

(f) Regularly monitor and review performance in relation to implementation

(g) Undertake any other activities specified by the NSC

The roles of the current committees :

The Coordination Group on Biological Resources and the Experts' Committee on Biodiversity will have to be evaluated in the context of the new implementation and monitoring structure that would be put in place, and if one or both are considered redundant they should be dissolved.

Time Frames for Achievement of Results:

For the implementation strategy to be effective, it is necessary to set time frames for achieving results. The following time frames have been worked out on the presumption that the Biodiversity Secretariat together with the allied entities will be in place as stipulated and would have completed its initial tasks within the two-year inception phase. The targeted time frames have been worked out from the end of the inception phase.

It is expected that, within five years of completing the inception phase, Sri Lanka should have:

- a more complete inventory of its bioresources, and a Metadatabase on Biodiversity;
- well formulated, forest management plans being implemented with the active participation of stakeholder groups and communities;
- local communities more amenable and motivated to protect and rehabilitate forests, wetlands and coastal and marine habitats;
- some eco-tourism activities that strengthen the conservation of forests, wetlands and coastal and marine ecosystems;
- significant reduction in illegal activities such as unauthorized logging, gemming, coral and sand mining, collection of protected species of fish and other fauna for trade, slaughter of small cetaceans and turtles, and use of illegal fishing gear and poaching;
- protective and rehabilitation programmes being actively implemented in the six prioritized biodiversity regions;
- some operational units set up under NARA for the ex situ conservation of marine bioresources;
- wetlands, salt marshes and mangroves protected from unauthorized expansion of prawn farming;

- strengthened "field gene banks" of selected crops;
- institutionalized botanical, zoological and microbial surveys;
- an institution conducting biodiversity skills enhancement programmes;
- more research activities on biodiversity related issues;
- well formulated, effective legislation for protecting biodiversity; archiving and safeguarding indigenous knowledge; regulating the import and export of GMOs, LMOs and their products; implementing articles of CITES; incorporating of EIA procedures for recognizing biodiveristy concerns;
- enabling legislation for land alienation for home gardens and conservation farming; active participation of NGOs, CBOs, communities and the private sector in the management of biodiversity and natural habitats; and providing fiscal, financial and other incentives for biodiversity conservation and sustainable use;
- strengthened capabilities among officers engaged in the prevention of illegal transactions in biodiversity; and
- a proper basis for the government to make budgetary provision of funds for biodiversity conservation and related activities.

It is expected that, ten years after the inception phase, Sri Lanka should have:

- a well established protected area network system of forests and wetlands, having adequate representation of the diverse range of biodiversity found in the country;
- well managed and rehabilitated wetlands, protected from urban development activities, and free of industrial pollution and urban solid waste;
- a comprehensive database on the status and distribution of forest biodiversity and its utilization;
- alternative sources of fuelwood including cultivated woodlots that could minimize the pressure on natural ecosystems for this resource;
- well developed education and eco-tourism enterprises such as wetland and coastal and marine parks; arboreta; forest gardens; biodiversity conservation centres; and crop, horticultural and flower gardens that would strengthen the biodiversity conservation efforts;
- alternative sources for coral lime that could mitigate the destruction of this bioresource;
- marine and coastal conservation areas managed with the participation of local communities;
- a better understanding of the status of marine bioresources that would enable the development of more sustainable harvesting strategies;
- well established programmes for the ex situ conservation of endangered freshwater and marine flora and fauna;
- well maintained biodiverse home gardens having a multitude of indigenous plant species;
- significant replacement of chena cultivation by eco-friendly conservation farming systems;
- a higher level of multi-cropping in the perennial plantation sector, particularly under coconut;
- well formulated ex-situ biodiversity conservation programmes such as animal germplasm conservation, and captive breeding, and the widespread application of modern biotechnology (including tissue culture) for conservation and propagation;
- comprehensive surveys providing valuable data on bioresources and facilities for preservation and storage of useful germplasm including microorganisms;
- biodiversity included in the primary and secondary school curricula and taught in university undergraduate courses in agriculture, veterinary science, architecture, engineering, management studies and

social sciences;

- postgraduate courses oriented towards specialized training in ecology and environmental management, including conservation of biodiversity;
- well organized research programmes, including programmes on the application of modern biotechnology in the conservation and sustainable use of biodiversity;
- a high percentage of the population aware of the value and importance of biodiversity and concerned about its conservation for the benefit of future generations;
- a high level of involvement of NGOs, CBOs, communities and the private sector in biodiversity conservation efforts, working in close collaboration with state sector agencies;
- a private sector playing an active role in conservation and rehabilitation efforts and in the use of biodiversity in a sustainable manner; and
- a government that is aware of the true value of the country's biodiversity, which would therefore allocate a proportional quantum of funding for the conservation of this valuable resource.

Resource Needs:

Manpower training. Specialized training of selected personnel will be necessary in certain areas such as underwater and marine research, modern biotechnology, bio-safety procedures, etc. Due to economic constraints such training will have to be sought through bilateral and international programmes. On the other hand, universities and certain research institutes in the country do have some trained staff and their expertise should be utilized to a maximum. Obtaining locally available expertise should be given priority over the commissioning of foreign consultants.

Taxonomy is a vital scientific discipline in biodiversity and its related activities. However, it has been noted that increasingly lesser numbers enter this field of tertiary education because of the lack of appropriate employment opportunities. It has been claimed that even in institutions such as the botanical gardens, where a knowledge of taxonomy should be at a premium, there is no provision to give preference to graduates specialized in taxonomy in the recruitment procedures for curators. Action must be taken at the highest levels to rectify this anomalous situation.

Funds. The National Steering Committee should formulate a clear policy and a strategy to raise funds, both local and foreign, for biodiversity-related activities. The possible areas for fund raising include: licensing fee for exports and imports, income generation through eco-tourism, biodiversity centres, nature films, etc. Fund generation from the private sector should be promoted through tax rebates for contributions to biodiversity conservation activities.

Where international funding is involved, care should be exercised to prevent exploitation of biological resources contrary to the provisions in the Convention on Biological Diversity.

In order to reflect the commitment of the country and its people to biodiversity conservation, it is recommended that the government provides a line item in its budget estimates to ME for biodiversity related activities.

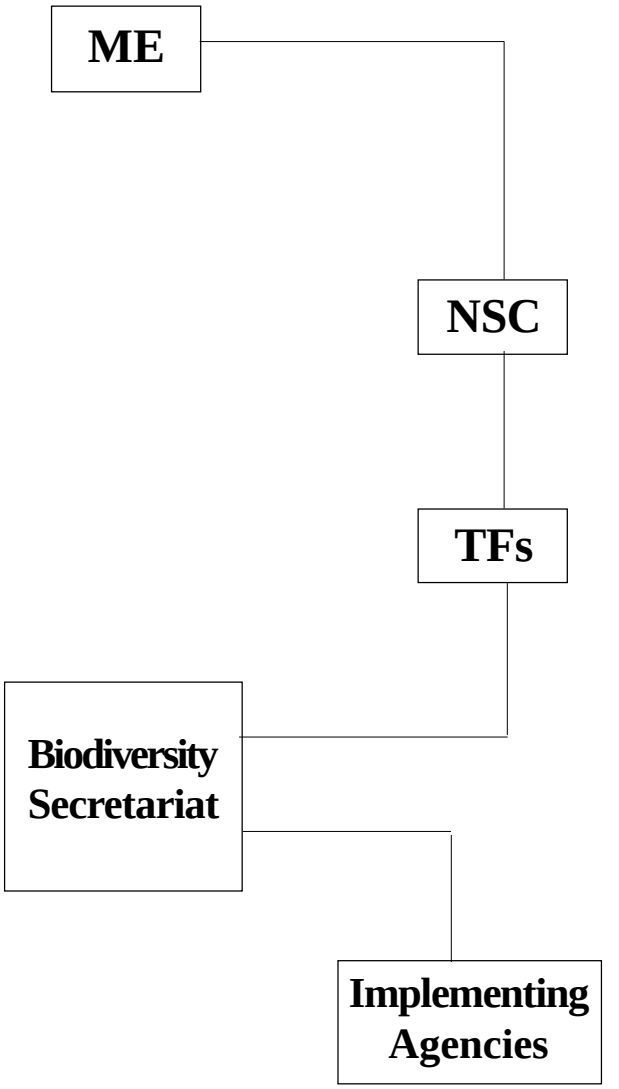
International collaboration. This should be sought particularly in areas where there is a dearth of national expertise, facilities and equipment. Regional cooperation with countries having similar biodiversity would be a profitable approach. International funding earmarked for such regional cooperative efforts should be explored. Bilateral and international funding should be solicited through the Department of External Resources, from countries and agencies committed to environmental protection and nature conservation. Universities and research institutes would have to be given all the encouragement, information and support to prepare good research proposals and compete for international research funding.

In organizing collaborative programmes with foreign organizations, due care has to be taken to ensure that there is "prior informed

consent" and "mutually agreed terms" for receiving an equitable share of benefits derived from the use of the country's biodiversity and traditional knowledge.

Monitoring of progress. The Task Forces, with the assistance of the Biodiversity Secretariat, should develop a set of indices for the continual monitoring of the progress of plan implementation using the targeted time frames as guidelines.

Fig. 8.1 Organizational Structure for Implementing BCAP



The BCAP Preparatory Process

The BCAP preparatory process commenced with the assembling of a consultancy team made up of several subject matter specialists (some as part time consultants) in various fields concerned with biodiversity conservation

The consultancy team comprised:
Prof. S A Kulasooriya (Team Leader), Mr M A T de Silva (Asst. Team Leader), Ms J D S Dela (Biodiversity Plans and Programmes), Mr H A Weerasinghe (Resource use), Dr A L Herath (Socio economic impacts), Prof. C V S Gunatilleke (In situ conservation), Dr S Miththapala (Ex situ conservation), Mr A Nanayakkara (Legal aspects), Dr D Wesumperuma (Institutional and Manpower Development), Ms S Blok (Education and awareness).

Prof. M U Jayasekera functioned as Team Leader in November and December 1996, during the absence of Prof. S A Kulasooriya. The Natural Resources and Environmental Policy Project of the MTEWA carried out the consultancy on biodiversity information management and valuation of biodiversity. The BCAP preparatory process received inputs from IUCN consultants Mr Jeremy Carew-Reid and Mr Jeffrey McNeely during short-term international consultancies. Ms Nagis Umagiliya assisted with data collation on Education. The Ministry of Environment provided guidelines for the framework in Chapter 8.

The members of the consultancy team met with a large number of stakeholders (including NGOs) representing a broad spectrum of interests and incorporated their views in their respective thematic reports. Ms J D S Dela of the IUCN staff prepared a thematic report on education. The reports submitted by the consultants, and other additional information collated during discussions were consolidated into a comprehensive report by Prof. S A Kulasooriya and Mr M A T de Silva. This included recommendations and a draft implementation plan.

Based on the consolidated report, and with additional inputs, the BCAP was prepared by Mr L C A de S Wijesinghe and Ms J D S Dela, supported by Ms C Wickramasinghe. The document was edited by Mr L C A de S Wijesinghe.

The preparation of the BCAP was monitored by a Management Committee Chaired by Ms Chandra Amerasekera (Addl. Secretary, MTEWA), and comprising Mr S Sapukotana (Senior Consultant, NAREPP), Mr Gamini Gamage (Deputy Director, MTEWA), Prof. S A Kulasooriya (BCAP Team Leader), Mr M A T de Silva (BCAP Asst.Team Leader), Mr L C A de S Wijesinghe (Country Representative, IUCN Sri Lanka), Mr Kapila Fernando (Director Programme, IUCN Sri Lanka), Ms J D S Dela (Programme Officer, IUCN Sri Lanka and team member), and Dr Sumith Pilapitiya (World Bank Representative). MTEWA's link with the BCAP preparation was maintained through representation in the management team.

In order to make the BCAP preparation a widely participatory process, a large number of stakeholders, including state institutions and NGOs representing a broad spectrum of interests, were consulted through round-table discussions, brain-storming sessions, seminars, workshops and discussion groups. Individuals with specialized knowledge on different aspects of biodiversity conservation were also consulted. Meetings were held with key personnel in selected government departments and institutions that are directly involved in biodiversity related activities. The preparatory process benefitted from these meetings in clarifying issues, identifying solutions, and arriving at a consensus regarding outputs and activities. Table A 1.1 sets out the different meetings that were held during the preparatory stage, the participants, and the specific purpose of each meeting. Table A 1.2 sets out meetings that were held to review and refine the BCAP.

The BCAP preparatory process and review of drafts benefitted from the inputs of the following, either as representatives of their organisations or in their individual capacity.

Dr A S Abeyratne (Director, DAPH); Mr S D Abeywardena (FD); Prof. B A Abeywickrama (Univ. of Colombo); Dr S L Amarasiri (Director General, DOA); Ms Chandra Amerasekera (Addl. Secretary, MTEWA); Prof. F P Amerasinghe (Univ. Of Peradeniya); Dr U S Amerasinghe (Univ. of Kelaniya); Dr A R Attapattu (Director, DFAR): Mr P R Attygalle (MASL); Dr K D Arudpragasam (NEC); Mr H M Bandaratilleke (Conservator of Forests); Ms Hestor Basnayake (UDA); Mr Gamini Batuwitage (IIMI); Prof. Uma Coomaraswamy (OUSL); Prof. M D Dassanayake; Dr Pauline Dayaratne (NARA); Mr Philip J DeCosse (NAREPP); Mr G W S K De Silva (Ministry of Public Administration, Home Affairs Plantation Industries and Parliamentary Affairs); Mr Gunaratne De Silva (Ayurveda Department); Dr Jayanthi de Silva (Univ. of Colombo); Dr M P Dhanapala (Director, RRDI); Mr A M U Dissanayake (Director, Agricultural Statistics Division, Dept. of Census and Statistics); Mr N W Dissanayake (Director, DWLC) Dr S U K Ekaratne (Univ. of Colombo); Dr S Epitawatta (USJ); Dr M H J P Fernando (Director, Seed Certification and Plant Protection, Department of Agriculture); Mr Sarath Fernando (FD); Mr Gamini Gamage (MTEWA); Prof. I A U N Gunatilleke (Univ. of Peradeniya); Mr Nalaka Gunawardena (Free lance Journalist); Mr H S Hathurusinghe

(Wildlife and Nature Potection Society); Mr H M B C Herath (DWLC); Mr J P Herath (NIE); Mr T Hewage (Director, FSDD); Mr Lal Hewapathirana (Worldview Sri Lanka); Mr J Jayasinghe (Head, Land Use Planning and Policy Division); Dr J M P Jayasinghe (NARA); Dr A H M Jayasuriya (Director, PGRC); Mr Avanti Jayatilleke (USAID); Dr G Jayawardena (Director, HORDI); Prof. J Jinadasa (USJ); Mr A W Kalupahana (VRI) ; Dr S K Kathirgamathaiyah (Director, DEA); Dr D Kirthisinghe (Executive Director, CARP); Dr A O Kodituwakku (Deputy Director, DAPH); Dr H B Kotagama (Univ. of Peradeniya); Mr C Kudagamage (HORDI); Kaushallya Kurukulasuriya (Sri Lanka Environmental Journalists Foundation); Harsha Liyanage (Sarvodaya Foundation); Dr M Liyanage (Director, CRI); Mr Sunil Liyanage (FD); Dr R Mahindapala (Executive Director, CARP); Dr H Manthrithillake (MASL); Mr S Medawewa (FDED); Dr W Modder (Director, TRI); Ms N Mohottala (MTEWA); Ms Madhivi Obaddage (Univ. of Colombo); Dr U K G K Padmalal (OUSL); Mr Alex Perera (National NGO Council); Mr A R Perera (Ministry of Foreign Affairs); Dr U Pilapitiya (Director BMARI); Mr S P Premadasa (ORDE); Mr W R A K J S Rajapaksha (VRI); Mr Arjan Rajasuriya (NARA); Dr Hemantha Ranasinghe (USJ); Dr S S E Ranawana (VRI); Dr S Ratnaweera (Acting Director, SRI) ; Dr P K Samarajeewa (PGRC); Dr Jayampathy Samarakoon (Consultant, WCP); Mr R A D B Samaranayake (CCD); Prof. V K Samaranayake (Director,Institute of Computer Technology); Mr S Sapukotuna (MTEWA); Prof. Y D A Senanayake (Director, PGIA) ; Ms Iranganee Serasinghe (Ruk Rekaganno); Dr Palitha Serasinghe (Univ. of Colombo); Dr B M P Singhakumara (USJ); Mr K P Sri Bharathie; Mr D B Sumithraarchchi (Director, National Botanical Gardens); Ms Manel Tampoe (Neo synthesis Research Centre) ; Prof. Rohana Ulluvishewa (USJ); Mr S I Vitarana (TR); Mr Hemantha Vithanage (Environmental Foundation Ltd); Ms Kamini Vitharana (Ruk Rekaganno); Mr M Watson (NARESA); Dr R H Wickremasinghe (International Tropical - Environment Society); Mr Harsha Wijayawardena (Univ. of Colombo); and Dr N Yogaratnam (RRI).

Contributions were made by the following NGOs, through their representatives, during group meetings and work-shops or by a review of sections of the drafts:

Agriculture & Environmental Development Foundation (Mr S G Siriwardena); Arunodhaya Environmentalists (Mr T R Stanley); Bambaragama Environmental Conservation Board (Mr D K Piyasena Senadheera); Biyagama Environmental Protection Organisation (Mr L Somapala); C T B Organisation (Mr P P Siriwardena); Diyawannaoya Farmers Environmental Society (Mr G D T Wijesinghe); Environment and Natural Resources Protection Organization, Matale (Mr G A B Dissanayake); Environmental Foundation Ltd (Mr Ravi Algama, Ms Mihiri Gunawardena, Mr Hemantha Vithanage); EMACE Foundation of Sri Lanka (Mr E M Abeyratne); Gal lena Vihara Environmental Foundation (Mr U G N M Wimalasiri); Gampaha Environmental Foundation (Mr S A M A R D Senaratne); Gemiseva Sevana, Galaha (Mr L D Samaranayake); Indigenous Medicinal Plants & Environmental Conservation Society (Dr P J Withana); Integrated Development Society, Kandy (Mr S Wanigadeva); Kandurata Sobadaham Rakshitha Hawula (Mr J Ekanayake); Keethigama Vegetable & Fruit Producing Committee (Mr E M Chandrasekera); March for Conservation (Dr Nirmalee Pallewatte); Nation Builders Association (Mr M B Adikaram, Mr M Weerakoon) : NATMACO, Waikkal (Mr S M Fernando); Nature Conservation Group (Mr S S S Jasinghe); Neo synthesis Research Centre (Ms Manel Tampoe); Pavana Environmental Organisation (Mr H W Wijesinghe); RITICOE (Mr P Gunetillake); Ruhunu UNESCO Organisation (Mr C A Samaradivakara); Ruk Rekaganno (Ms Iranganee Serasinghe); Sama Sevaya (Mr S Jayasinghe); Sarvodaya Foundation (Mr Harsha Liyanage); Sarvodaya Women Movement (Ms K U De Silva); Saviya Development Foundation (Mr C Seneviratne); Seethawaka Environmentalists (Mr K P Yasapala); Sevashrama Environmental Circle(Mr D N Welikala); Social Development Association, Panadura (Mr P M K De Silva); Social Development Society (Mr D A D N C Wimalaratne); Society for Environment & Social Protection (Mr G A Gunawardene); Sri Bodhirajasthama Society (Ven. K Wimaladhamma Thero); Sri Lanka Environmental Congress (Mr S Gunasekera); Sri Lanka Environmental Journalists Forum (Mr Piyal Parakrama); Sri Lanka Environmental Protection Society (Mr M Gunaratne) Sri Lanka Youth Exploration Society (Mr L Senadheera); Tharuna Sithivili Samajaya (Mr G B R Hurikaduwa); The League of Swans (M N Gunasiri); Vayamba Udanaya (Mr W M T Bandara); Veerya Seva Movement (Ms N Kumar); Wildlife and Nature Protection Society (Dr Ranjen Fernando, Mr H S Hathurusinghe); and Worldview Sri Lanka (Mr Lal Hewapathirana)

In addition to those mentioned earlier, the following members of the IUCN staff made contributions as indicated against their names. Mr Kapila Fernando (review of drafts); Dr Ranjith Mahindapala (review of drafts), Ms Sonali Senaratne and Mr Torben Berner (text boxes on coastal and marine issues); and Ms Padmi Meegoda (word processing and formatting).

Table A 1.1 Special meetings organised by IUCN with stakeholders during the BCAP preparation process

Meeting/activity	Participants
Round table meeting with representatives of national NGOs 8 Aug 1996	Representatives of WNPS, NSRC, EFL, Ruk Rekaganno, ITES with some BCAP consultants and Senior IUCN staff
A brainstorming workshop to identify key issues to be addressed in the BCAP 15 Aug 1996	Members of the National Experts Committee on Biodiversity, relevant government officials, NGO invitees, selected subject specialists, MTEWA officials and BCAP consultants
Meeting to identify sectoral issues and options with regard to animal production and health 11 Oct 1996	The Director of DAPH, Deputy Director - Research VRI and other officials of the DAPH with BCAP consultants
Meeting to identify issues and recommendations for the Agricultural sector 21 Oct 1996	The Directors of HORDI, RRDI, PGRC and Botanical Gardens with Team Leader and other consultants
Meeting with the Standing Committee on Science of the UGC to apprise them of the BCAP 24 Oct 1996	Members of the Standing Committee on Science, the BCAP Team Leader, and Asst. Team Leader
Meeting to identify issues and needs to be addressed in the plantation research sector 31 Oct 1996	Directors of TRI, RRI, SRI and Director General Plantation Industries Division, Ministry of Plantation Industries, and consultants
Meeting to identify specific issues and options to enhance BDC in export crops 1 Nov 1996	Director and relevant officials of the Dept. of Export Agriculture with BCAP consultants
Brainstorming workshop for grassroot level NGOs to review issues identified by BCAP consultants on BD impacts and users; research; in situ and ex situ conservantion, information and valuation 4 Nov 1996	Country-wide representatives of NGO organizations (43), subject specialists, MTEWA officials and BCAP consultants
Meeting to identify issues and identification of specific needs for BDC in the coastal sector 20 Nov. 1996	Manager Coast Conservation Project of the CCD programme and BCAP consultants
Meeting to identify current initiatives and issues connected with marine and inland aquatic biodiversity 20 Nov. 1996	Scientific staff of NARA and BCAP consultant.
Meeting to identify issues and options to be addressed in the Forestry Sector 27 Nov 1996	Addl. Conservator of Forests (Research) Deputy Conservator of Forests (Research), Asst. Conservator of Forests (Environment Management), and BCAP consultants
Meeting to discuss current initiatives for land use planning and mapping 27 Nov 1996	Head, Land Use Planning and Policy Div. of MALF, and BCAP consultants
National seminar on biodiversity information 3 Dec 1996	Representatives of key state institutions dealing with BDC, subject area specialists NGO representatives, MTEWA officials, NAREPP officials and BCAP consultants
Meeting to discuss current programmes and future directions and needs in the wildlife sector, with emphasis on protected area management	Director and Deputy Director of DWLC with BCAP consultants
Meeting to discuss the legal aspects to be addressed in the BCAP 27 Feb 1997	Chairman and two members of EFL and BCAP consultants
Meeting to discuss past and present initiatives for education and awareness on BDC 28 Feb 1997	General Coordinator MfC and BCAP consultants

Table A 1.2 Meetings held to review and refine draft BCAP

Meeting/activity	Participants
Meeting with representatives of key state institutions concerned with BDC to review first draft 10 April 1997	Officials from FD, CCD, DFAR, NIE, MTEWA, Addl. Secretary MTEWA, IUCN Country Representative, IUCN Director Programme, and consultants
Meeting with representatives of key state institutions concerned with BDC and subject matter specialists to examine and review second draft 16 May 1997	State officials and scientific persons whose work is related to aspects of biodiversity conservation, Addl. Secretary MTEWA, IUCN Country Representative, IUCN Director Programme, and consultants
Meeting with represenatives of national NGOs to examine and review third draft 3 June 1997	NGO representatives, Addl. Secretary MTEWA, IUCN Country Representative, IUCN Director Programme, and consultants
Meeting with National Experts Committee on Biodiversity to review third draft 10 June 1997	Members of the National Experts Committee, IUCN Country Representative

Provisional List of Threatened Species of Vascular Plants in Sri Lanka[1]

(The names of endemic species are denoted by#)

PTERIDOPHYTES

Equisetaceae
Equisetum debile

Isoetaceae
Isoetes coromandelina

Lycopodiaceae
Lycopodium carolinianum
L. ceylanicum #
L. clavatum
L. hamiltonii
L. phlegmaria
L. phyllanthum
L. pinifolium
L. pulcherrimum
L. serratum
L. squarrosum
L. wightianum

Psilotaceae
Psilotum nudum

Selaginellaceae
Selaginella calostachya #
S. cochleata #
S. praetermissa #
S. wightii

Adiantaceae
Actiniopteris radiata
Cheilanthes thwaitesii
Idiopteris hookeriana
Pellaea boivini
P. falcata
Pteris argyrea
P. confusa #
P. gongalensis #
P. praetermissa #
P. reptans #

Aspleniaceae
Asplenium disjunctum #
A. longipes #
A. nitidum
A. obscurum
A. pellucidum

Cyatheaceae
Cyathea hookeri #
C. sinuata #

Dennstaedtiaceae
Microlepia majuscula #
Lindsaea repens var. pectinata

Dryopteridaceae
Deparia polyrhizon #
Diplazium cognatum #
D. paradoxum #
D. zeylanicum #
Polystichum anomalum #
Pteridrys syrmatica
P. zeylanica
Tectaria thwaitesii #

Grammitidaceae
Ctenopteris glandulosa #
C. repandula #
C. thwaitesii #
Grammitis wallii #
Scleroglossum sulcatum
Xiphopteris cornigera #

Hymenophyllaceae
Trichomanes exiguum
T. intramarginale
T. motleyi
T. nitidulum
T. pallidum
T. saxifragoides
T. wallii #

Lomariopsidaceae
Bolbitis appendiculata
Teratophyllum aculeatum

Marattiaceae
Marattia fraxinea

Ophioglossaceae
Botrychium daucifolium
B. lanuginosum
Helminthostachys zeylanica
Ophioglossum costatum
O. gramineum
O. nudicaule
O. pendulum
O. petiolatum
O. reticulatum

Osmundaceae
Osmunda collina

Polypodiaceae
Belvisia mucronata
Leptochilus wallii #
Microsorium dilatatum
Pleopeltis macrocarpa

Schizaeaceae
Schizaea digitata

Thelypteridaceae
Amauropelta hakgalensis #
Ampelopteris prolifera
Christella meeboldii
C. subpubescens
C. zeylanica
Pronephrium gardneri #
Sphaerostephanos subtruncatus
Thelypteris confluens
Trigonospora angustifrons
T. calcarata
T. ciliata
T. glandulosa #
T. obtusiloba
T. zeylanica #

GYMNOSPERMS

Cycadaceae
Cycas circinalis

ANGIOSPERMS

Acanthaceae
Andrographis macrobotrys
Barleria nitida
Gymnostachyum thwaitesii #
Strobilanthes caudata
S. gardnerana #
S. nigrescens #
S. nockii #
S. punctata #
S. rhytisperma #
S. stenodon #
S. thwaitesii #
S. zeylanica #
Synnema uliginosum

Amaranthaceae
Achyranthes bidentata
A. diandra #
Centrostachys aquatica
Cyathula ceylanica #

Anacardiaceae
Semecarpus moonii #
S. obovata #
S. parvifolia #

Annonaceae
Alphonsea hortensis #
A zeylanica #
Anaxagorea luzonensis
Artabotrys hexapetalus
Goniothalamus thomsonii
Miliusa zeylanica
Orophea polycarpa
Phoenicanthus coriacea #
Polyalthia moonii #
P. persicaefolia
Uvaria cordata

U. semecarpifolia #
Xylopia nigricans #

Apocynaceae
Anodendron rhinosporum
Hunteria zeylanica
Rauvolfia serpentina
Vallaris solanacea
Willughbeia cirrhifera
Wrightia flavido-rosea

Apostasiaceae
Apostasia wallichii

Araceae
Arisaema constrictum #
Cryptocoryne spiralis
C. thwaitesii #
Rhaphidophora decursiva
R. pertusa
Typhonium flagelliforme

Araliaceae
Polyscias acuminata

Asclepiadaceae
Bidaria cuspidata #
Brachystelma lankana #
Caralluma adscendens
C. umbellata
Ceropegia candelabrum
C. elegans var. gardneri
C. parviflora #
C. taprobanica #
C. thwaitesii
Cosmostigma racemosum
Cynanchum alatum
Dischidia nummularia
Gymnema rotundatum #
Heterostemma tanjorense
Hoya ovalifolia
H. pauciflora
Marsdenia tenacissima
Oxystelma esculentum
Taxocarpus kleinii
Tylophora fasciculata
T. multiflora
T. pauciflora
T. zeylanica

Balanophoraceae
Balanophora fungosa

Balsaminaceae
Impatiens janthina #
leucantha #
I. repens #
I. subcordata #
I. taprobanica #
I. walkeri #

Begoniaceae
R Begonia dipetala
B. subpeltata
B. tenera #

Bombacaceae
(Adansonia digitata, introduced to Sri Lanka, but needs protection for historical reasons)

Boraginaceae
Cordia subcordata
Heliotropium supinum
Rotula aquatica

Burmanniaceae
Burmannia championii
Thismia gardnerana #

Campanulaceae
Campanula canescens
C. fulgens

Capparidaceae
Cadaba fruticosa
Capparis divaricata
C. floribunda
C. tenera
Cleome chelidonii

Caryophyllaceae
Stellaria pauciflora

Celastraceae
Celastrus paniculatus
Euonymus thwaitesii #
Glyptopetalum zeylanicum
Kokoona zeylanica
Maytenus fructicosa #

Combretaceae
Lumnitzera littorea

Commelinaceae
Cyanotis obtusa #

Compositae
Adenostemma angustifolium
Anaphalis fruticosa #
A. pelliculata #
A. thwaitesii #
Blepharispermum petiolare
Blumea angustifolia #
B. aurita
B. barbata
B. crinita #
B. lanceolaria
Glossogyne bidens
Gynura hispida #
G. zeylanica #
Notonia grandiflora
N. walkeri
Senecio gardneri #
Sphaeranthus amaranthoides
Vernonia anceps #
V. pectiniformis
V. thwaitesii #
Xanthium indicum

Connaraceae
Ellipanthus unifoliatus

Convolvulaceae
Argyreia choisyana
A. hancorniifolia #
A. pomacea
A. splendens
Bonamia semidigyna
Ipomoea coptica
I. jucunda #
I. staphylina
I. wightii

Crassulaceae
Kalanchoe laciniata

Cucurbitaceae
Kedrostis rostrata
Melothria leiosperma

Cyperaceae
Baeothryon subcapitatum
Carex breviscapa
C. taprobanensis #
Cyperus articulatus
C. cephalotes
Eleocharis confervoides
E. lankana #
Fimbristylis zeylanica #
F. monticola
Hypolytrum longirostre #
Mapania immersa #
M. zeylanica
Mariscus compactus
Pycreus stramineus
Rhynchospora gracillima
Scirpodendron ghaeri
Scleria pilosa #
Tricostularia undulata

Dilleniaceae
Acrotrema dissectum #
A. lyratum #
A. thwaitesii #

Dioscoreaceae
Dioscorea trimenii #

Dipterocarpaceae
Cotylelobium scabriusculum #
Hopea cordifolia #
Shorea disticha #
S. ovalifolia #
Stemonoporus affinis #
S. bullatus #
S. lanceolatus #
S. moonii #
S. nitidus #
S. oblongifolius #
S. petiolaris #
S. reticulatus #
S. rigidus #
Vatica obscura #

Ebenaceae
Diospyros acuta #
D. albiflora #
D. atrata #
D. attenuata #
D. chaetocarpa #
D. ebenoides #
D. koenigii #

D. moonii #
D. opaca #
D. oppositifolia #
D. quaesita

Elaeocarpaceae
Elaeocarpus ceylanicus #
E. montanus #

Eriocaulaceae
Eriocaulon fluviatile #
E. longicuspis #
E. luzulifolium
E. philippo-coburgi
E. walkeri #

Euphorbiaceae
Antidesma thwaitesianum #
Bridelia stipularis (= B. scandens)
Chaetocarpus pubescens #
Chrozophora rottleri
Cleidion javanicum
C. nitidum
Cleistanthus collinus
Croton moonii #
Dalechampia indica
Drypetes lanceolata #
Euphorbia cristata
Glochidion nemorale #
Mallotus distans
Phyllanthus affinis #
P. anabaptizatus #
P. hakgalensis #
P. longiflorus
P. rotundifolius
Putranjiva zeylanica #
Sauropus assimilis #
S. retroversus #
Trigonostemon diplopetalus #

Flacourtiaceae
Hydnocarpus octandra #

Gentianaceae
Exacum sessile
Crawfurdia championii

Geraniaceae
Geranium nepalense

Gesneriaceae
Aeschynanthus ceylanica
Chirita moonii #
C. walkeri #
Didymocarpus floccosus #
D. zeylanicus #
Epithema carnosum

Goodeniaceae
Scaevola plumieri

Guttiferae (= Clusiaceae)
Calophyllum cordato-oblongum #
C. cuneifolium #
C. trapezifolium #
Mesua stylosa

Haloragidaceae
Laurembergia indica #
L. zeylanica

Hippocrateaceae
Hippocratea arnottiana
H. macrantha

Hydrocharitaceae
Nechamandra alternifolia

Icacinaceae
Pyrenacantha volubilis

Labiatae (= Lamiaceae)
Anisochilus paniculatus
Coleus elongatus
Leucas longifolia
Plectranthus capillipes #
P. glabratus
P. subincisus
Scutellaria robusta #

Lauraceae
Actinodaphne albifrons #
Cassytha capillaris
Cinnamomum capparu coronde #
C. citriodorum #
C. litseifolium
Cryptocarya membranacea #
Litsea nemoralis #
L. undulata #

Leguminosae (= Fabaceae)
Acacia ferruginea
Adenanthera bicolor
Albizia amara
Alyssicarpus longifolius

Bauhinia scandens
Cassia italica
C. senna
Caesalpinia crista
C. digyna
C. hymenocarpa
C. major
Crotalaria berteroana
C. linifolia
C. montana
C. mysorensis
C. triquetra
C. wightiana
C. willdenowiana
Crudia zeylanica #
Cynometra ripa
Desmodium gangeticum
D. jucundum #
D. zonatum
Dioclea javanica
Dunbaria ferruginea
Eleiotis monophylla
Eriosema chinense
Galactia striata
Indigofera constricta
I. glabra
I. parviflora
I. trifoliata
I. wightii
Mucuna gigantea
M. monosperma
Pericopsis mooniana
Rhynchosia acutissima
R. densiflora
R. nummularia
R. suaveolens
Sesbania sericea
Smithia conferta
Sophora violacea #
S. zeylanica #
Strongylodon siderospermus
Tephrosia hookerana
T. senticosa
T. spinosa

Lemnaceae
Lemna gibba

Lentibulariaceae
Utricularia scandens (= U. capillacea)

Liliaceae
Chlorophytum heyneanum
Dipcadi montanum
Urginea rupicola

Loranthaceae (See also Viscaceae)
Barathranthus mabaeoides
Dendrophthoe lonchiphyllus
Helixanthera ensifolia
Macrosolen barlowii
Tolypanthus gardneri

Malvaceae
Abutilon pannosum (= A. muticum)
Dicellostyles axillaris #
Julostylis angustifolia #
Pavonia patens (= P.glechomifolia)
Thespesia lampas

Melastomaceae
Medinilla cuneata #
M. maculata #
Memecylon ellipticum #
M. gracillimum #
M. grande
M. leucanthum #
M. macrocarpum #
M. orbiculare #
M. ovoideum #
M. phyllanthifolium #
M. revolutum #
M. rotundatum
Sonerila brunonis
S. cordifolia #
S. firma #
S. gardneri #
S. lanceolata #
S. pilosula #
S. robusta #
S. tomentella #
S. wightiana #

Menispermaceae
Coscinium fenestratum

Menyanthaceae
Nymphoides aurantiaca

Moraceae
Broussonetia zeylanica #
Dorstenia indica
Ficus costata
F. trimenii
Maclura cochinchinensis

Myrtaceae
Eugenia amoena #
E. cotinifolia #
E. fulva #
E. glabra #
E. mabaeoides #
E. rivulorum #
E. rufofulva #
E. terpnophylla #
Syzygium lewisii #

Ochnaceae
Ochna rufescens

Olacaceae
Ximenia americana

Oleaceae
Jasminum bignoniaceum
Olea paniculata

Orchidaceae
Agrostophyllum zeylanicum #
Bulbophyllum crassifolium #
B. purpureum #
B. tricarinatum #
Coelogyne zeylanica #
Corymborchis veratrifolia
Dendrobium maccarthiae #
Diplocentrum recurvum
Eria tricolor #
Galeola javanica
Gastrodia zeylanica #
Goodyera fumata
Habenaria virens
Liparis barbata #
L. brachyglottis #
Malaxis densiflora
M. lancifolia #
M. purpurea
Oberonia claviloba #
O. dolabrata #
O. fornicata #
O. quadrilatera #
O. recurva
O. scyllae #
O. wallie silvae #
O. weragamensis #
Peristylus plantagineus
Phaius luridus #
Phreatia elegans
Pteroceras viridiflorum
Rhynchostylis retusa
Robiquetia gracilis
Sirhookera latifolia
Taeniophyllum gilimalense #
Vanda thwaitesii #

Orobanchaceae
Aeginetia pendunculata
Cambellia aurantiaca #
Christisonia thwaitesii #

Palmae
Areca concinna #
Nypa fruticans

Piperaceae
Peperomia wightiana

Podostemaceae
Dicraea stylosa

Polygalaceae
Polygala leptalea

Portulacaceae
Portulaca wightiana

Proteaceae
Helicia ceylanica #

Rhizophoraceae
Ceriops decandra

Rosaceae
Alchemilla indica
Rubus glomeratus
Sanguisorba indicum #

Roxburghiaceae
Stemona minor

Rubiaceae
Byrsophyllum ellipticum
Canthium macrocarpum #
Dichilanthe zeylanica #
Gardenia turgida

Hedyotis cyanescens #
H. cymosa #
H. evenia #
H. gardneri #
H. inamoena #
H. quinquenervia #
H. rhinophylla #
Lasianthus rhinophyllus #
L. thwaitesii #
Nargedia macrocarpa #
Neurocalyx gardneri #
Oldenlandia trinervia
Ophiorrhiza pallida #
Psychotria glandulifera #
P. longipetiolata #
P. moonii #
P. plurivenia #
P. stenophylla #
Saprosma indicum
S. scabridum #
Scyphiphora hydrophyllacea
Scyphostachys pedunculatus #
Tricalysia erythrospora #

Rutaceae
Atalantia racemosa
Glycosmis cyanocarpa
Naringi crenulata
Zanthophyllum caudatum

Sapindaceae
Cardiospermum corindum
Euphoria gardneri #
Thraulococcus simplicifolius #

Sapotaceae
Madhuca clavata #
M. moonii #
Palaquium canaliculatum #
P. thwaitesii #

Scrophulariaceae
Adenosma subrepens #
Lindernia viscosa
Verbascum chinense

Simaroubaceae
Suriana maritima

Sonneratiaceae
Sonneratia apetala

Sterculiaceae
Pentapetes phoenicea
Pterygota thwaitesii #
Sterculia guttata

Stylidiaceae
Stylidium uliginosum

Symplocaceae
Symplocos diversifolia
S. elegans #
S. kurgensis

Symphoremaceae
Symphorema involucratum

Taccaceae
Tacca leontopetaloides

Theaceae
Gordonia speciosa #

Thymelaeaceae
Phaleria capitata

Tiliaceae
Corchorus tridens
Grewia asiatica
G. hirsuta
Triumfetta glabra #

Triuridaceae
Hyalisma janthina
Sciaphila erubescens #
S. inornata #
S. secundiflora #

Umbelliferae
Peucedanum ceylanicum
Sanicula elata

Urticaceae
Elatostema acuminatum
E. walkerae #
Lecanthus peduncularis

Vahliaceae
Vahlia dichotoma

Verbenaceae
Premna divaricata

P. purpurascens #
P. thwaitesii #
Priva cordifolia
Svensonia hyderabadensis

Violaceae
Hybanthus ramosissimus #

Viscaceae
Ginalloa spathulifolia #
Korthalsella japonica
Notothixos floccosus #
Viscum ramosissimum

Zingiberaceae
Alpinia fax #
A. rufescens #
Amomum acuminatum #
A. benthamianum #
A. graminifolium #
A. hypoleucum
A. trichostachyum #
Curcuma albiflora #

Provisional List of Threatened Animal Species in Sri Lanka

(The names of endemic species are denoted by #
The species denoted by * are those that are included
in the 1996 IUCN Red List of Threatened Animals)

INSECTS

Lepidoptera

Atrophaneura jophon # *	- The Sri Lanka rose
Troides helena	- The common bird wing
Papilio polymnestor	- The blue mormon
P. helenus	- The red helen
P. crino	- The banded peacock
Graphium antiphates	- The five bar swordtail
G. nomius	- The spot swordtail
Hasora badra	- The Ceylon awl
Bibasia sena	- The orange tail awl
B. oedipodea	- The banded orange awlet
Choaspes benjaminii	- The Indian awl king
Gangara thyrsis	- The giant redeye
G. lebadea	- The banded red eye

Tagiades japetus	- The Ceylon snow flat
Tapena thwaitesi	- The black angle
Gomalia elma	- The African marbled skipper
Caprona alida	- The Ceylon golden angle
Pratapa deva	- The white royal
Suastus minuta	- The Ceylon palm bob
Udaspes folus #	- The grass demon
Halpe decorata #	- The decorated ace
H. homolea	- The rare ace
Baoris farri	- The paint brush swift
Potanthus pseudomaesa	- The common dart
Tajuria jehana	- The plains blue royal
Horaga albimacula	- The brown onyx
Catapaecilma major	- The common tinsel
Rapala iarbus	- The Indian red flash
R. lankana	- The malabar flash
Jamides coruscans #	- The Ceylon cerulean
J. lacteata #	- The milky cerulean
Celastrina singalensis	- The Sinhalese hedge blue
C. akasa	- The white hedge blue
C. lilacea	- Hampson's hedge blue
C. lanka #	- The Ceylon hedge blue
Spindasis nubilus	- The clouded silverline
Azanus ubaldus	- The bright babul blue
Nacaduba ollvetti	- Woodhouse's four lineblue
N. calauria	- The dark Ceylon six lineblue
N. noreia	- The white tipped lineblue
Iraota timoleon	- The silver streak blue
Arhopala abseus	- The aberrent bushblue
A. ormistoni #	- Ormiston's oakblue
Virachola perse	- The large guava blue
V. isocrates	- The common guava blue
Hypolycaena nilgirica	- The nilgiri tit
Bindahara phocides	- The plane
Tarucus sylvia	- The striped pierrot
Euthalia lubentina	- The gaudy baron
E. evelina	- The red spot duke
E. nais	- The baronet
Parthenos sylvia	- The clipper
Neptis hordonia	- The common lascar
Hypolimnas bolina	- The great eggfly
H. misippus	- The danaid eggfly
Precis lintingensis	- The yellow pansy
Vanessa indica	- The Indian red admiral
V. canace	- The blue admiral
Charaxes polyxena	- The tawny rajah

C. solon	- The black rajah
Murwareda athamas	- The common nawab
Limenitis procris	- The commander
Vindula erota	- The cruiser
Phalanta alcippe	- The small leopard
Byblia ilithyia	- The joker
Cethosia nietneri	- The tamil lace wing
Doleschallia bisaltide	- The autumn leaf
Libythea lepita	- The beak
L. myrrha	- The club beak
Discophora lepida	- The southern duffer
Idea lynceus	- The Ceylon tree nymph
Danaus fumata # (= Parantica taprobana)	- The Ceylon tiger
Euploea phaenareta	- The great crow
Kallima philarchus	- The blue oak leaf
Lethe dynsate	- The Ceylon forester
L. daretis	- The Ceylon tree brown
Mycalesis rama #	- The Cingalese bushbrown
Elymnias singala	- The Ceylon palmfly
Huphina nadina	- The lesser gull
Appias indra	- The plain puffin
Prioneris sita	- The painted saw tooth

Hymenoptera

Aneuretus simoni #	- Sri Lankan relict ant

SPIDERS

Arachnida

Chilbrachys nitelinus
Plesiophrictus tenuipes
Poecilotheria bara
P. faciata
P. uniformis
P. ornata
P. subfusa
Scalidognathus oreophilus
S. radialis
Plagiobothrus semilunaris
Aprusia strenuus
Obrimona tennenti
Phricotelus stelliger
Atimiosa quinquemucronata

CRUSTACEANS

Cladocera

Ghardaqlaia ambigua
Stenocypris fernandoi
Chrissa ceylonica
C. halyi
Centrocypris viridis
Darwinuka lundi

Decapoda

Caridina singalensis #
C. pristis #
C. fernandoi #
C. zeylanica #
C. costai #
Macrobrachium srilankanse #
Ceylonthelphusa rugosa #
C. soror #
C. inflatissima #
Oziothelphusa minneriyensis #

Hymenocera elegans	- Painted shrimp
Stenopus hispidus	- Boxing shrimp
Lysmatha debelius	- Asoka/Scarlet shrimp
L. amboinensis	- Peppermint shrimp
Panulirus versicolor	- Painted spiny lobster
P. homarus	- Scalloped spiny lobster
P. longipes	- Long legged spiny lobster
P. ornatus	- Ornate spiny lobster
P. pencilliatus	- Prong horned spiny lobster
P. polyphagus	- Mud spiny lobster

MOLLUSCS
(Land and freshwater molluscs)

Acavus haemastoma #
A. phoenix #
A. prosperus #
A. fastosus #
A. roseolabiatus #
A. superbus #
Oligospira waltoni #
O. skinneri #
Rachis adumbratus #
Aulopoma grande #
A. helicinum #
Ratnadvipia edgariana #
R. irridians #
Beddomea albizonatus #
B. ceylanicus #
B. intermedius #
Corilla adamsi #
C. beddomeae #
C. carabinata #
C. colletti #
C. erronea #
C. fryae #
C. gudei #
C. humberti #

Cryptozona ceraria #
C. novella #
Cyclophorus ceylanicus #
Digoniaxis cingalensis #
Ena panos #
E. proletaria #
E. stalix #
Euplecta binoyaensis #
E. colletti #
E. concavospira #
E. gardneri #
E. hyphasma #
E. isabellina #
E. laevis #
E. layardi #
E. prestoni #
E. rosamonda #
E. trimeni #
E. turritella #
E. verrucula #
Eurychlamys regulata #
Glessula ceylanica #
G. collettae #
G. fulgens #
G. inornata #
G. lankana #
G. layardi #
G. nitens #
G. pachycheila #
G. prestoni #
G. punctogallana #
G. reynelli #
G. serena #
G. sinhila #
G. veruina #
Hemiplecta chenui #
H. juliana #
Japonia binoyae #
J. occulta #
J. vesca #
Kaliella colletti #
K. delectabilis #
K. leithiana #
K. salicensis #
Leptopoma apicatum #
L. taprobanensis #
Leptopomoides conulus #
L. orophilus #
Macrochlamys kandiensis #
M. nepas #
M. perfucata #
M. tratanensis #
M. umbrina #
Microcystina bintennensis #
M. lita #
Nicida ceylanica #
N. lankaensis #
N. pedronis #
Opeas layardi #
O. mariae #
O. prestoni #
O. pussilus #
O. sykesi #
Phaedusa ceylanica #
Philalanka circumsculpta #
P. depressa #
P. lamcabensis #
P. liratula #
P. mononema #
P. secessa #
P. sinhila #
P. thwaitesi #
P. trifilosa #
Pterocyclus bifrons #
P cingalensis #
Pupisoma longstaffae #
P. miccyla #
Pyramidula halyi #
Ruthvenia biciliata #
R. caliginosa #
R. clathratula #
Satiella membranacea #
Scabrina brounae #
Sitala operiens #
S. phyllophila #
S. pyramidalis #
Streptaxis cingalensis #
S. gracilis #
S. layardinaus #
Cyathopoma ceylanicum #
C. leptopornita #
C. ogdeniamum #
C. perconoideum #
C. serendibense #
C. uvaense #
C. turbinatum #

Theobaldius bairdi #
T. liliputianus #
T. cadiscus #
T. parapsis #
T. thwaitesi #
T. loxostoma #
T. annulatus #
Thysanota elegans #
T. eumita #
T. eumita #
Tortulosa aurea #
T. austeniana #
T. blanfordi #
T. cumingi #
T. decora #
T. pyramidata #
T. recurvata #
T. templemani #
T. rugosa #
T. greeni #
T. congener #
T. connectens #
T. eurytrema #
T. haemastoma #
T. marginata #
T. nietneri #
T. sykesi #
T. unicolor #
Trochomorpha galerus #
T. hyptiocyclos #
Truncatella ceylanica #
Viginulus maculautus #
V. templetoni #
Ravana politissima #
Bulimus inconspicua #
Paludomus chilinoides #
P. sulcatus #
P. regalis #
P. tanschauricus #
P. palustris #
P. bicinctus #
P. loricatus #
P. decussatus #
P. nigricans #
P. neritoides #
P. solidus #

(Marine molluscs)

Charonia tritonis - Triton's trumpet
Chicoreus ramosa
C. palmarosa
Murex ternispina
Cypracassis rufa - Helmet shell
*L*ambis scorpius
L. chiragra
L. crocata
L. lambis
Tibia delicatula
Conus textile - Textile cone
C. geographus
C. aulicus
C. litteratus
C. episcopas
Tridacna squamosa
Cypraea tigris - Tiger cowry
C. talpa
C. argus
C. nivosa
Exabranchus sanguinea - Spanish dancer

ECHINODERMS

Protoreaster linki
Fromia elegans
F. monilis
Heterocentrotus mammaliatus - Slate pencil urchin
Toxopneustes pileolus
Asthenosoma varium

FISHES
(Freshwater fishes)

Cypriniformes

Puntius titteya # - Cherry barb
P. cumingii # - Cuming's barb
P. nigrofasciatus # - Black ruby barb
P. srilankensis # [3] - Blotched filamented barb
P. pleurotaenia # - Black lined barb
P. bimaculatus # - Redside barb
P. asoka # - Asoka barb
P. bandula # * - Bandula barb
P. martenstyni # * - Martenstyn's barb
Rasbora vaterifloris # - Golden rasbora
R. wilpita # * - Wilpita rasbora
Labeo fisheri # * - Green labeo
L. lankae # *
Garra ceylonensis - Stone sucker
G. phillipsi # - Phillip's garra
Schistura notostigma # - Banded mountain loach
Acanthocobitis urophthalmus # - Tiger loach
Horadandia atukorali # - Green carplet
Lepidocephalichthys jonklaasi # * - Jonklaas' loach/spotted loach
Danio pathirana # * - Barred danio

Perciformes

Sicyopus jonklaasi # - Lipstick goby
Schismatogobius deraniyagalai # - Redneck goby
Sicyopterus griseus
S. halei # - Red tailed goby
Kuhlia marginata - Spotted flagtail
Malpulutta kretseri # - Ornate paradise fish
Belontia signata # - Combtail

Channiformes

Channa orientalis # - Smooth-breasted snakehead

Cyprinodontiformes

Aplocheilus dayi # - Day's killifish
A. werneri # - Werner's killifish

Siluriformes

Heteropneustes microps # * - Stinging catfish

(Marine fishes)[4]

Perciformes

Acanthurus leucosternon	- Powder-blue surgeon-fish
Paracanthurus hepatus	- Wedge-tailed blue tang
Chaetodon falcula	- Saddle back butterfly-fish
C. lunula	- Racoon butterfly-fish
C. auriga	- Thread fin butterfly-fish
C. citrinellus	- Speckled butterfly-fish
C. collare	- Collare butterfly-fish
C. triangulum	- Triangular butterfly-fish
C. madagascariensis	- Madagascar butterfly-fish
C. meyeri	- Meyer's butterfly-fish
C. ornatissimus	- Ornate butterfly-fish
C. oxycephalus	- Spot-naped butterfly-fish
C. octofasciatus	- Eight banded butterfly-fish
C. plebeius	- Blue-spot butterfly-fish
C. unimaculatus	- Tear drop butterfly-fish
C. xanthocephalus	- Yellow-head butterfly-fish
C. ephippium	- Saddled butterfly-fish
C. rafflesi	- Latticed butterfly-fish
C. guttatissimus	- Spotted butterfly-fish
C. semeion	- Dotted butterfly-fish
C. benneti	- Bennett's butterfly-fish
Cheilinus undulatus *	- Humphead wrasse
Thunnus maccoyii *	- Southern bluefin tuna
T. obesus *	- Bigeye tuna
Pseudochromis pesi *	
Anthias evensi	
Forcipiger flavissimus	- Long nosed butterfly-fish
Parachaetodon ocellatus	- Ocellate coral-fish
Hemitauricththys zoster	- Black pyramid butterfly-fish
H. pleurotania	- Indian banner-fish
Oxycirrhites typus	- Long snouted hawk-fish
Paracirrhitus arcuatus	- Hawk fish
Nemateleotris menateleotris	- Fire blenny
Plectorhynchus obscurus	
Gaterin albovittatus	
Labroides bicolor	- Bi-coloured cleaner wrasse
L. dimidiatus	- Cleaner wrasse
Coris formosa	- Queen rainbow-fish
Bodianus diana	- Diana's hog-fish
Lutjanus sebae	- Emperor snapper
Pomacanthus annularis	- Blue-ringed angel-fish
P. semicirculatus	- Koran angel-fish

P. imperator - Emperor angel-fish
Centropyge eibli - Eibl's pigmy angel-fish
Apolomichthys trimaculatus - Three spot angel-fish
Amphiprion clarkii - Clark's anemone-fish
A. nigrepes - Maldive clown-fish
Pterois volitans - Red turkey-fish
P. antennata
P. radiata - Clear fin turkey-fish
Dendrochirus zebra - Dwarf lion-fish
D. brachypterus - Short fin turkey-fish
D. biocellatus
Epinephelus flavocaeruleus - Blue grouper
E. lanceolatus * - Giant grouper
Plectropomus laevis - Black saddled coral trout
Variola louti - Lunar tailed grouper
Zanclus cornutus - Moorish idol

Tetradontiformes

Oxymonocanthus longirostris - Beaked leatherjacket
Paraluteres prianurus
Balistoides conspicillum - Clown trigger-fish
Pseudobalistes fuscus - Jigsaw trigger-fish
Canthigaster benneti - Bennett's puffer
C. valentini - Black saddled puffer
Ostracion cubicum - Blue-spotted box-fish
Lactoria cornuta - Long horned cow-fish
L. fornasini - Ceylon cow-fish
Diodon hystrix - Porcupine puffer fish

Lophiiformes

Histrio histrio - Sargassum fish

Anguilliformes

Echidna nebulosa - Starry moray eel
E. zebra - Zebra moray eel
Rhinomuraena quaesita - Ribbon moray eel
Myrichthys maculosus - Spotted snake eel
M. colubrinus - Striped snake eel

Cypriniformes

Plotosus lineatus - Striped catfish

Syngnathiformes

Hippocampus aimei *
H. borbonensis *
H. brachyrhynchus *
H. camelopardalis *
H. coronatus *
H. erinaceus *
H. fuscus *
H. histrix *

H. horai *
H. japonicus *
H. jayakari *
H. kuda * - Spotted sea horse
H. longirostris *
H. novaehebudorum *
H. planifrons *
H. raji *
H. sindonis *
H. spinosissimus *
H. taeniops *
H. takakurae *
H. trimaculatus * - Three-spotted sea horse

Gasterosteiformes
Pegasus laternarius *

Hexanchiformes
Hexanchus griseus * - Bluntnose sixgill shark

Lamniformes
Carcharias taurus * - Sand tiger shark
Carcharodon carcharias * - Great white shark
Lamna nasus * - Probeagle

Carchariniformes
Carcharhinus limbatus * - Blacktip shark
C. obscurus * - Dusky shark
C. plumbeus * - Sandbar shark

Squaliformes
Dalatias licha * - Kitefin shark

Pristiformes
Pristis pectinata * - Smalltooth sawfish

AMPHIBIANS

Anura
Bufo kelaarti # - Torrent toad
B. atukoralei # - Atukorale's dwarf toad
Rana greenii # (=Limnonectes greeni) - Sri Lanka reed frog
R. corrugata # (=L. corrugata) - Wrinkled frog
Rana gracilis # - Slender wood frog
R. aurantiaca # - Lesser wood frog
Nannophrys guentheri # - Guenther's cliff frog
N. ceylonensis # - Sri Lanka cliff frog
N. marmorata # - Marbled cliff frog
Tomopterna breviceps #
T. rolandae #
Polypedates cruciger # - Greater hourglass tree frog

P. eques #	- Montane hourglass tree frog
P. longinasus #	- Sharp nosed tree frog
Philautus nasutus #	- Lesser sharp nosed bush frog
P. hypomelas #	
P. temporalis #	
Theloderma schmarda #	- Wrinkled tree frog
Ramanella palmata #	- Montane ramanella
R. obscura #	- Red ramanella
Microhyla zeylanica #	- Montane narrow mouthed frog
Rhacophorus cavirostris #	
R. fergusonianus #	
R. macropus #	
R. reticulatus #	
R. microtympanum #	- Small-eared tree frog

Apoda

Ichthyophis glutinosus #	- Lesser yellow banded caecilian
I. pseudangularis #	- Yellow banded caecilian
I. orthoplicatus #	- Brown caecilian

REPTILES

Testudinata

Dermochelys coriacea *	- Leathery turtle
Lepidochelys olivacea *	- Olive-backed ridley turtle
Caretta caretta *	- Loggerhead turtle
Eretmochelys imbricata *	- Hawksbill turtle
Chelonia mydas *	- Green turtle
Melanochelys trijuga	- Hard-shelled terrapin
Lissemys punctata	- Soft-shelled terrapin
Testudo elegans	- Star tortoise

Crocodylia

Crocodylus porosus	- Estuarine crocodile
C. palustris *	- Marsh crocodile

Squamata

Cnemaspis podihuna #	- Lesser diurnal gecko
C. jerdoni #	
Gymnodactylus frenatus #	- Jungle gecko
Geckoella triedrus #	- Devil gecko
G. yakhuna #	- Devil gecko
Hemidactylus depressus #	- Jungle gecko
H. triedus	
Calodactylodes illingworthi #	- Great rock gecko
Calotes liocephalus # *	
C. ceylonensis #	- Sri Lanka lizard
C. liolepis #	
C. nigrilabris #	- Black-lipped lizard

C. calotes	- Green garden lizard
Otocryptis wiegmanni #	- Earless lizard
Cophotis ceylanica #	- Pigmy tree lizard
Ceratophora stoddarti #	- Rhino-horned lizard
C. tennentii # *	- Tennent's leaf-nosed lizard
C. aspera #	- Rough-nose horned lizard
Lyriocephalus scutatus #	- Hump-nose horned lizard
Chamaeleo zeylanicus	- Chamaeleon
Mabuya macularia #	- Spotted skink
M. bibroni	
Dasia haliana	- Haly's skink
Sphenomorphus megalops #	
S. striatopunctatus #	
S. dorsicatenatus #	
Lankascincus taprobanensis #	- Smooth skink
L. deignani #	
L. fallax #	- Brown skink
L. taylori #	
L. deraniyagalae #	
L. gansi #	
Riopa singha #	
Chalcidoceps thwaitesi #	- Four-toed snake skink
Nessia burtoni #	- Three-toed snake skink
N. didactyla #	- Two-toed snake skink
Evesia monodactyla #	- Toeless snake skink
Bipodes sarasinorum #	- Sarasin's snake skink
B. smithi #	- Smith's snake skink
Anguinicephalus deraniyagalae #	- Deraniyagala's snake skink
A. layardi #	- Layard's snake skink
A. hikanala #	- Shark-headed snake skink
Cabrita jerdoni	- Lesser grass lizard
C. leschenaulti	- Grass lizard
Typhlops mirus #	
T. ceylonicus #	
T. malcolmi #	
T. violaceus #	All the Typhlops species
T. lankaensis #	and Typhlina bramina
T. veddae	are referred to as
T. tenebrarum #	blind snakes
T. porrectus	
T. leucomelas #	- Pied typhlops
Typhlina bramina	
Uropeltis melanogaster #	
U. phillipsi #	
U. ruhunae #	
Pseudotyphlops philippinus #	- Large shield-tail snake

Rhinophis blythi #
R. drummondhayi #
R. porrectus #
R. punctatus #
R. philippinus #
R. oxyrhynchus #
R. trevelyanus #
R. dorsimaculatus #
R. tricolorata #
Platyplectrurus madurensis

All Uropeltis
Rhinophis, Pseudotyphlops and
Platiplectrurus species
are referred to as rough-tails or
shield-tails

Cylindrophis maculatus # - Sri Lankan pipe snake
Oligodon sublineatus # - Dumeril's kukri snake
O. calamarius # - Kukri snake
O. taeniolatus - Variegated kukri snake
Lycodon osmanhilli # - Taylor's wolf snake
Dendrelaphis oliveri # - Oliver's bronze back
D. caudolineatus - Gunther's bronze back
Macropisthoden plumbicolor - Green keelback
Leopeltis calamaria - Reed snake
Dryocalamus nympha - Bridal snake
D. gracilis - Scarce bridal snake
Cercaspis carinatus # - Sri Lanka wolf snake
Balanophis ceylonensis # - Blossom krait
Aspidura copei # - Cope's roughside
A. trachyprocta # - The common roughside
A. drummondhayi # - Drummond-Hay's roughside
A. brachyorrhus b # - Boie's roughside
A. guentheri # - Guenther's roughside
A. deraniyagalae #
Haplocerus ceylonensis # - The black spined snake
Chrysopelea taprobanica #
C. ornata - Gold and black tree snake
Dryophis pulverulentus - Brown speckled whip snake
Boiga barnesi # - Barne's cat snake
Xenochrophis asperrimus # - The common pond snake
Gerarda prevostiana - Gerard's water snake
Bungarus ceylonicus # - Sri Lanka krait
Hypnale hypnale - Merrem's hump-nosed viper
H. nepa # - Montane hump-nosed viper
H. walli # - Gloyd's hump-nosed viper
Trimeresurus trigonocephalus # - Green pit viper
Calliophis melanurus - Slender coral snake
Acrochordus granulatus - Wart snake
Python molurus - Rock python
Eryx conicus - Sand boa

BIRDS

Pelecaniformes

Phalacrocorax carbo	- Indian comorant
Pelecanus philippensis *	- Spot-billed pelican

Ciconiiformes

Egretta gularis schistacea	- Indian reef heron
Ephippiorhynchus asiaticus	- Black-necked stork
Plegadis falcinellus	- Glossy ibis
Leptoptilos javanicus *	- Lesser adjutant

Anseriformes

Sarkidiornis melanotos	- Comb duck

Falconiformes

Aviceda jerdoni	- Legge's bazza
Spizaetus nipalensis	- Mountain hawk eagle
Hieraaetus kienerii	- Rufous-bellied hawk eagle
Ictinaetus malayensis	- Black eagle
Falco peregrinus	- Peregrine falcon
F. tinnunculus	- Indian kestral
Pernis ptilorhynchus	- Crested honey buzzard

Galliformes

Francolinus pictus	- Painted partridge
Galloperdix bicalcarata #	- Sri Lanka spurfowl
Gallus lafayettii #	- Jungle fowl

Gruiformes

Rallus striatus	- Blue-breasted banded rail
Porzana fusca	- Ruddy crake

Charadriiformes

Dromas ardeola	- Crab plover
Cursorius coromandelicus	- Indian courser
Vanellus gregarius *	- Sociable lapwing
Rostratula benghalensis	- Painted snipe
Eurynorhynchus pygmeus *	- Spoon-billed sandpiper

Columbiformes

Treron phoenicoptera	- Yellow-legged green pigeon
Columba torringtoni # *	- Sri Lanka wood pigeon

Cuculiformes

Phaenicophaeus pyrrhocephalus *	- Red-faced malkoha
Centropus chlororhynchus # *	- Green-billed coucal

Strigiformes

Tyto alba	- Barn owl
Phodilus badius	- Bay owl
Otus scops	- Little scops owl
Bubo nipalensis	- Forest eagle owl
Glaucidium cuculoides #	- Chestnut-backed owlet

Caprimulgiformes

Batrachostomus moniliger - Frogmouth

Trogoniformes

Harpactes fasciatus - Ceylon trogon

Coraciiformes

Alcedo meninting - Blue-eared kingfisher
Ceyx erithacus - Three-toed kingfisher
Halcyon pileata - Black-capped purple kingfisher
Eurystomus orientalis - Broad-billed roller
Ocyceros gingalensis # - Ceylon grey hornbill

Piciformes

Chrysocolaptes festivus - Black-backed woodpecker
Picus xanthopygaeus - Scaly-bellied green woodpecker
Xantholaema rubricapilla - Ceylon small barbet

Passeriformes

Sturnus senex # - Sri Lanka white-headed starling
Gracula ptilogenys # - Sri Lanka hill mynah
Cissa ornata # - Sri Lanka blue magpie
Irena puella - Fairy blue bird
Pycnonotus penicillatus # - Yellow-eared bulbul
Turdoides rufescens # - Sri Lanka rufous babbler
Garrulax cinereifrons # * - Ashy-headed laughing thrush
Muscicapa sordida # - Dusky-blue fly catcher
Bradypterus palliseri # - Sri Lanka warbler
Ficedula subrubra * - Kashmir flycatcher
Myiophonus blighi # * - Arrenga/Ceylon whistling thrush
Zoothera wardii - Pied ground thrush
Z. spiloptera # - Spotted-winged ground thrush
Z. dauma - Sri Lanka scaly thrush
Dicaeum vincens # - Legge's flower pecker
Lonchura kelaarti - Hill munia

MAMMALS

Insectivora

Feroculus feroculus # * - Kelaart's long-clawed shrew
Suncus zeylanicus # * - Ceylon jungle shrew
Suncus etruscus *[5] - Sri Lanka pygmy shrew
S. murinus *[6] - Sri Lanka highland shrew
Crocidura miya # * - Ceylon long-tailed shrew
Solisorex pearsoni # * - Pearson's long-clawed shrew

Chiroptera

Kerivoula picta	- Painted bat
K. hardwickei	- Malpas bat
Hipposideros galeritus	- Dekhan leaf-nosed bat
Myotis hasselti	- Van Hasselt's bat
Murina cyclotis	- Ceylon tube-nosed bat
Tadarida aegyptiaca	- Indian wrinkled-lipped bat

Primata

Loris tardigradus *	- Slender loris
Trachypithecus vetulus # *	- Purple-faced leaf monkey

Rodentia

Petaurista petaurista	- Large flying squirrel
Petinomys fuscocapillus	- Small flying squirrel
Funambulus layardi	- Flame-striped jungle squirrel
F. sublineatus	- Ceylon dusky-striped jungle squirrel
Mus fernandoni #	- The Ceylon spiny-mouse
Rattus montanus # *	- Nillu rat
Coelomys mayori #	- Bicoloured spiny-rat
Srilankamys ohiensis #	- Ceylon bicoloured spiny-rat
Vandeleuria nolthenii # *	- Ceylon highland long-tailed tree mouse
Ratufa macroura *	- Sri Lanka giant squirrel

Cetacea

Balaenoptera musculus *	- Great blue whale
B. borealis *	- Sei whale
B. physalus *	- Fin whale
B. edeni	- Bryde's whale
Megaptera novaeangliae *	- Hump-backed whale
Physeter catodon *	- Sperm whale cachalot
Stenella longirostris	- Spinner dolphin

Carnivora

Lutra lutra nair	- Ceylon otter
Melursus ursinus *	- Sloth bear
Paradoxurus zeylonensis #	- Golden palm-civet
Herpestes vitticollis	- Striped-necked mongoose
Felis rubiginosa	- Rusty Spotted cat
F. chaus	- Jungle cat
F. viverrina	- Fishing cat
Panthera pardus	- Leopard

Proboscidea

Elephas maximus *	- Elephant

Sirenia

Dugong dugon *	- Dugong

Artiodactyla

Tragulus meminna	- Mouse-deer
Cervus porcinus	- Indian hog-deer

Glossary

accession A sample of crop variety collected at a specific location and time; may be of any size.

avifauna The birds which live naturally in a certain area.

alien species (Non-native, non-indigenous, foreign, exotic) is a species, subspecies, or lower taxon occurring outside of its natural range and dispersal potential (i.e. - outside the range it occupies naturally or could not occupy without direct or indirect introduction or care by humans) and includes any part, gametes or propagule of such species that might survive and subsequently reproduce.

biodiversity (= biological diversity) The definition given by Article 2 of the Biodiversity Convention is "The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". A simpler definition is the total range of the variety of life on earth or any given part of it.

Biodiversity Convention See Convention on Biological Diversity.

biodiversity hotspot A term introduced to describe a location that features an exceptional concentration of species with exceptional levels of endemism and faces exceptional degrees of threat.

biogeography The scientific study of the geographic distribution of organisms.

bioregion A territory defined by a combination of biological, social and geographic criteria, rather than geopolitical considerations; generally, a system of related, interconnected ecosystems.

bioresources (= biological resources) Those components of biodiversity of direct, indirect, or potential use to humanity.

Biosphere Reserve An area of terrestrial or coastal/marine ecosystem, or a combination thereof, which is internationally recognised within the framework of UNESCO's programme on Man and the Biosphere (MAB).

buffer zone The region bordering a protected area where restrictions are placed upon resource use or special development measures are undertaken to enhance the conservation value of the protected area.

chena (= shifting cultivation) Probably the oldest form of agricultural practice in Sri Lanka, widespread in the country until recently, but now confined largely to the dry zone. This involves clearing of a forest area for cultivation which may continue for two to three years after which it is abandoned for a new site.

climax vegetation The plant community which would finally develop in an area in the absence of human intervention.

conservation of biodiversity This covers human actions ranging from totally preserving any component of biodiversity to using biological resources provided that such use is within sustainable limits and does not cause erosion of biological diversity. In the Convention on Biological Diversity and in the BCAP, the expression "conservation and sustainable use of biological diversity" is frequently used to give emphasis to the aspect of conservation that includes the wise and sustainable use of the components of biodiversity.

continental shelf Sri Lanka is surrounded by a seaward extension of the adjacent continent, from the shoreline to the line called the shelf edge beyond which there is a marked increase of slope. The continental shelf surrounding Sri Lanka is on average 20km in width and 20-65m in depth.

Convention on Biological Diversity This Convention was signed by over 150 countries at the Earth Summit (The United Nations Conference on Environment and Development) in Rio in 1992. The objectives of the Convention are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.

cryo-preservation A method of preserving living tissue by freeze-drying.

demographic Pertaining to the science of vital and social statistics as of the births, deaths, marriages, etc. in human populations.

deniya Water-logged valley bottoms situated in the wet zone.

dunes Wind blown accumulations of sand distinct from adjacent land forms such as beaches or salt marshes; found along portions of the northern, southern and northwestern coasts of Sri Lanka.

ecosystem A community of interdependent organisms and the environment they inhabit.

ecotourism As defined by IUCN's ecotourism programme: "Environmentally responsible travel and visitation to relatively undisturbed natural areas, in order to enjoy and appreciate nature that promotes conservation, has low visitor impact and provides for beneficially active socio-economic involvement of local populations.

edaphic Environmental conditions that are determined by the physical, chemical and biological characteristics of the soil.

EIA This refers to an environmental impact assessment of the possible effects of development projects on the environment.

endemic Restricted to a specific locality, or country.

estuaries A semi-closed coastal body of water which has a free connection with the sea, and within which sea water is immeasurably diluted by freshwater derived from land drainage.

ethnobotany The study of the relationships between people and plants in the broadest sense. It requires a multidisciplinary approach, incorporating anthropology and ethnology, botany, linguistic, and in some cases economics, pharmacology, medicine and agronomy.

Exclusive Economic Zone (EEZ) Part of the offshore area of a country where the country has exclusive rights in respect of all economic resources of the water column, underlying seabed and subsoil.

eutrophication Enrichment of water by nutrients which results in the production of very large populations of plant life that rapidly die and deplete oxygen during their putrefaction.

ex situ conservation Keeping components of biodiversity alive outside of their original habitat or natural environment.

fen A wetland of high nutrient status resulting from inputs via flowing water.

flash floods A sudden and destructive rush of water down a narrow gully or over a sloping surface.

flood plains A nearly flat plain along the course of a stream or river that is naturally subject to flooding.

fossorial Digging or burrowing.

gene bank A facility established for the ex situ conservation of individuals (seeds), tissues, or reproductive cells of plants or animals.

genome The set of chromosomes found in each nucleus of a given species.

genotype The genetic constitution of an organism.

germplasm The protoplasm of germcells containing the units of hereditary, the chromosomes and genes.

Global Environment Facility A fund set up in 1992 and managed by the World Bank, UNDP and UNEP to assist developing countries to address issues relating to the conservation of biodiversity, climatic change, ozone depletion and international waters.

habitat The natural dwelling place of an individual or group of organisms.

home gardens A traditional system of perennial cropping that uses a range of economically valuable plant species producing fruits, spices, medicinal products, timber, etc. It offers a highly diversified and economically viable form of land use found around a house.

***in situ* conservation** The conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

kalle korales Forest officers, who in former times were appointed by kings, whose duties included prevention of poaching and protection of forests and trees set aside by royal decree.

***kitul* tapping** An important traditional activity of the rural communities of Sri Lanka. The phloem sap obtained by the tapping of the young inflorescence of the *kitul* palm *(*Caryota urens) is used to produce treacle, jaggery (a locally used sweetener) and an alcoholic beverage.

lagoon Coastal bodies of water containing brackish water, which are permanently separated from the sea, or connected to the sea only during part of the year.

lewaya A depression in the coastal sand belt, with highly saline soil.

liana A woody climbing plant.

littoral zone Shallow water region with light penetrating to the bottom, typically occupied by rooted plants.

Mahawansa Chronicle of Sri Lanka's history covering the period 6th century BC to 4th century AD.

mangroves Salt-tolerant, woody, seed-bearing plants ranging in size from small shrubs to tall trees.

meta-data Data about data. A second level of information about other data sources. Thus, a dictionary of all those who hold datasets on different aspects of biodiversity would be called a meta-database.

montane Mountainous area.

National Conservation Review (NCR) A sample survey of biodiversity covering woody plants, vertebrates, butterflies and molluscs, and a hydrological assessment of the natural forests of Sri Lanka, carried out for designing an optimum protected areas system for the country's natural forests.

National Park In Sri Lanka, a category of protected area, designated under the Fauna and Flora Protection Ordinance. It falls within the IUCN Protected Area Management Category II - a natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area, and (c) provide a foundation for spiritual, scientific, educational and visitor opportunities, all of which must be environmentally and culturally compatible.

patanas A local term used for the montane grasslands.

phylogenetic Pertaining to the evolutionary history of a particular group of organisms.

protected area An area of land (and/or sea) especially dedicated to the protection and maintenance of biological diversity, and of natural and cultural resources, and managed through legal or other effective means.

Ramsar site A site designated as a wetland of international importance under the Convention of Wetlands of International Importance Especially as Waterfowl Habitat.

Red Data Books Catalogues published by IUCN the World Conservation Union, or by national authorities listing species which are rare or in danger of becoming extinct globally or nationally.

Sanctuary A category of protected area in Sri Lanka, that may contain both state and private land.

salt marshes Marshy area subject to frequent inundation by sea water and containing herbaceous, salt-resistant plants.

seagrass beds Composed of rooted, seed-bearing marine plants that occur as submerged meadows within estuaries and lagoons and near-shore coastal waters which are sheltered from highwave energy.

seed bank A facility designed for ex situ conservation of individual plant species and varieties through seed preservation and storage.

slash and burn See chena.

sustainable development Development that meets the needs and aspirations of the current generation without compromising the ability of future generations to meet their needs.

taxa The classification units to which individuals, or sets of species, are assigned.

The Earth Summit The United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992.

villu Wet grassland in the dry zone.

World Heritage Site. A site designated under the 1972 Convention on the Protection of the World Cultural and Natural Heritage.

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Abbreviations

AG	Attorney General
BCAP	Biodiversity Conservation Action Plan
BD	Biodiversity
BDC	Biodiversity Conservation
BMARI	Bandaranaiyake Memorial Ayurvedic Research Institute
CARP	Council for Agricultural Research Policy
CBD	Convention on Biological Diversity
CBO	Community-Based Organization
CBRM	Community-Based Resource Management
CCD	Coast Conservation Department
CEA	Central Environmental Authority
CISIR	Ceylon Institute of Scientific and Industrial Research
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CRI	Coconut Research Institute of Sri Lanka
CZMP	Coastal Zone Management Plan
CZM	Coastal Zone Management
DEA	Department of Export Agriculture
DOA	Department of Agriculture
DAPH	Department of Animal Production and Health
DFAR	Department of Fisheries and Aquatic Resources
DWLC	Department of Wildlife Conservation
EEZ	Exclusive Economic Zone
EFL	Environmental Foundation Limited
EIA	Environmental Impact Assessment
FD	Forest Department
FDED	Forestry Development and Environmental Division
FSDD	Forestry Sector Development Division
GIS	Geographical Information System
GNP	Gross National Product
GMO	Genetically Modified Organism
HORDI	Horticultural Crops Research and Development Institute
IIMI	International Irrigation Management Institute
ITES	Institute of Tropical Environmental Studies
IUCN	International Union for the Conservation of Nature and Natural Resources - The World Conservation Union
KDN	Kanneliya-Dediyagala-Nakiyadeniya
LMO	Living Modified Organism
MAL	Ministry of Agriculture and Lands, functioning as such from 10 June 1997
MALF	Ministry of Agriculture, Lands and Forests; functioned as such until 9 June 1997. Since then subjects have been reallocated to the Ministry of Agriculture and Lands (MAL) and Ministry of Forestry and Environment (MFE)
MASL	Mahaweli Authority of Sri Lanka
MCS	Marine Conservation Society
ME	Ministry in charge of the subject of Environment. Up to 9 June 1997, this was MTEWA or the Ministry of Transport, Environment and Womens Affairs; from 10 June 1997 it has bee istry of Forestry and Environment (MFE)

MfC	March for Conservation
MFE	Ministry of Forestry and Environment, functioning as such from 10 June 1997.
MTEWA	Ministry of Transport, Environment and Women's Affairs; functioned as such until 9 June 1997.
NARA	National Aquatic Resources Research and Development Agency
NAREPP	Natural Resources and Environmental Policy Project
NARESA	Natural Resources, Energy and Science Authority of Sri Lanka
NCR	National Conservation Review
NCS	National Conservation Strategy
NEAP	National Environmental Action Plan
NEC	National Education Commission
NGO	Non Governmental Organization
NIE	National Institute of Education
NM	National Museum
NSC	National Steering Committee
NSRC	Neo-synthesis Research Centre
NWP	National Wetland Policy
NWSC	National Wetlands Steering Committee
OUSL	Open University of Sri Lanka
PGIA	Postgraduate Institute of Agriculture
PGRC	Plant Genetic Resources Centre
RITICOE	Ritigala Community based Development and Environmental Management Foundation
RRDI	Rice Research and Development Institute
RRI	Rubber Research Institute of Sri Lanka
SALT	Sloping Area Land Technology
SAM	Special Area Management
SRI	Sugarcane Research Institute of Sri Lanka
TF	Task Force
TRI	Tea Research Institute of Sri Lanka
UDA	Urban Development Authority
UGC	University Grants Commission
UNEP	United Nations Environmental Programme
USAID	United States Agency for International Development
USJ	University of Sri Jayewardenepura
VRI	Veterinary Research Institute
WCMC	World Conservation Monitoring Centre
WCP	Wetland Conservation Project
WNPS	Wildlife and Nature Protection Society