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ADDENDUM TO THE BIODIVERSITY CONSERVATION IN SRI LANKA

A Framework for Action

CHAPTER REPORT - 06

IMPACTS ON BIODIVERSITY

Biodiversity Secretariat
Ministry of Environment

Addendum to Biodiversity Conservation in Sri Lanka
A Framework for Action

CHAPTER REPORT ON IMPACTS ON BIODIVERSITY

(Task Force No-05)

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Impacts on Biodiversity in Sri Lanka

1. Background

Economic development of Sri Lanka since gaining Independence in 1948 after almost five centuries of colonial occupation, has centred largely on agriculture, light industry and tourism development. Rapidly increasing population, together with growth in transportation, urbanization, exploitation of forest resources and land-use change have served to impact significantly on natural resources. All these development activities have impacted to a greater or lesser degree on the island's biological and landscape diversity. The social and economical liberalization in Sri Lanka will continue to migration towards the coastal regions and urban centres, significantly increasing pressure on the resources in these areas, with potentially serious environmental implications. Already, human activities have impacted severely on ecosystems on a local scale: if existing trends continue, the impacts could have a much wider reach.

This review seeks to establish a mechanism for the recognition and evaluation of impacts on biodiversity through an appropriate system of monitoring, leading to recommendations for mitigating such impacts. Specifically, it seeks to -

1. identify gaps in the present Framework Action Plan on the adverse impacts (including potential impacts) on the different components of biodiversity;

2. recommend actions to mitigate adverse impacts and to avert potential adverse impacts;

3. managing bio-resources so as to conserve biodiversity while enabling the use of the resources within sustainable limits;

4. analyse the institutional framework and, where needed, propose institutional reforms that will provide an appropriate suite of incentives for conservation and sustainable use of biodiversity resources;

5. build capacity and develop programmes to deliver scientific interventions designed to conserve exploited species and species under threat due to excessive collection;

6. build capacity and develop programmes to research the different components of Sri Lanka's indigenous biodiversity and the processes that affect it;

7. enhance public awareness of biodiversity and encourage public participation in its conservation; and

8. provide inputs into the biodiversity conservation policy-making process.

Constraints

1. Weak implementation plans with respect to national policy directives.
2. Lack of financial commitment.
3. Poor or *ad hoc* planning, especially with respect to developmental activities.
4. Poor understanding among policy makers/scientists/practitioners of cross-cutting issues with respect to CBD and other related international conventions (especially due to identification of focal points for different conventions under different ministries).
5. Absence or non-implementation of management plans in different ecosystems.
6. Absence of mechanisms in monitoring of changes of biodiversity over time, and long term data collection system.
7. Limited availability of (especially genetic diversity) and access to information.
8. No effective actions taken to avoid conversion of land use, and protected area (PA) management.
9. Sustainability of development actions has been not addressed properly in a biological sense.
10. Lack of collaboration among institutions.
11. Inadequate information management systems with respect to impacts on biodiversity and conservation of biodiversity.
12. Lack of capacity building (human resources and institutional) on understanding and estimating impacts of developmental activities on biodiversity.

The threats to biodiversity have underlying causes related to population growth, demographics, trade, political instability, perverse incentives, economic performance, poverty, corruption, lack of law enforcement, poor protection standards, lack of awareness and lack of information.

In addition, new threats are emerging to deal with, which biologists are poorly prepared. The current rate of increase in protected areas and associated improvements in management of biodiversity resources is failing to achieve

conservation objectives. At the same time, new tools and mechanisms to counter the threats to biological diversity have not been used effectively.

2. REVIEW AND GAP ANALYSIS

The ecosystem diversity of Sri Lanka and their extents are given in Table 1. However, biological diversity of the country has been reported to have lost at an unprecedented rate due to land-use change (habitat loss and fragmentation); invasive alien species; over-exploitation/over-harvesting of resources; soil, water and atmospheric pollution; desertification; climate change; industrialization and demand for natural resources.

In addition to these, logging and agricultural expansion, wildlife trade (both legal and illegal), pollution, invasive alien species (Marambe 1999, 2000, 2002; Marambe *et al* 2002), climate change and the potential threats posed by genetically modified organisms (GMOs) are current concerns in the region. The most important issue is to recognize the huge benefits being derived from biodiversity and ecosystem services and develop ways of taxing the main beneficiaries to reward those regions and communities whose actions either enhance or avoid destroying such services. Thus, any adverse impact on biodiversity would affect nature, and as a whole, the well-being of human beings.

Forest and Wildlife Ecosystems

The environmental role of forests in increasing soil water recharge, controlling soil erosion and shaping the climate has long been established under Sri Lankan conditions. The importance of the (rain) forests of the wet zone as the only refuge of an extraordinary proportion of the country's endemic biological wealth has come to be fully appreciated only in recent times (MENR, 2003). Much of the wet zone forests administered by the Forest Department (FD). Appreciation of the unique importance and vulnerability of these forests led to an administrative decision in 1989 to prohibit all future logging of natural forests, leading to the FD being transformed from a primarily forestry-development agency into a biodiversity conservation institution.

A national policy statement on wildlife Conservation was first drafted in 1990, introducing the concept of actively managing national forest assets for conservation (MENR, 2003). This policy, however, was not implemented by the Department of Wildlife Conservation (DWLC). However, with funding available from the Global Environment Facility (GEF), many progressive steps such as amendment of the Fauna and Flora Protection Ordinance were taken in 1993 and for the first time the importance of protected-area buffer zones and refuges was recognized and provision made to establish them. In 2000, a new National Wildlife Policy was approved by the Cabinet of Ministers of the Government of Sri Lanka.

Table 1. Ecosystem diversity and extent

Ecosystem	Provisional Extent (ha)
Forest and related ecosystems	
• Tropical wet evergreen forest (lowland rain forest	141,506
• Tropical most evergreen forest	243,886
• Tropical dry mixed evergreen forest	1,090,981
• Tropical thorn forest	na
• Savannah	na
• Riverine forest	22,435
• Tropical submontane forest	68,616
• Tropical montane forest	3,108
• Grasslands	na
Inland wetland ecosystems	
• Flood plains	na
• Swamps	na
• Streams and rivers	5,913,800
• Reservoirs and ponds	179,790
• Wet villu grasslands	na
• Wet montane grasslands and patnas	na
Coastal and Marine ecosystems	
• Mangrove habitats	12,500
• Soft marches	23,819
• Sand dunes and beaches	19,394
• Mud falts	9,754
• Seagrass beds	na
• Lagoons and basin estuaries	158,017
• Coral reef	na
• Coastal seas	na
Agricultural (Crop) ecosystems	
• Paddy lands	491,129
• Fruit cultivation	97,000
• Small crop holdings or other field crops (pulses, Sesame, etc)	128,000
• Plantation crops	772,000
• Home gardens (cultivated)	367,800
• Chena lands (slash and burn cultivation)	na

Source: SOE (2002). na : not available

The wet zone rain forests are the richest in biodiversity and contain about 75% of the endemic vascular-plant flora (MOFE 1999), and an even higher proportion of vertebrate endemics. Some 80% of the island's endemic birds are forest species unable to utilize non-forest environments (MOFE 1999). Thus, any alteration of the forest environment impacts negatively on biodiversity.

In the past few decades trends in economic development have threatened the nation's unique indigenous biological wealth. Rapid deforestation from a forest cover of 70 per cent in 1900 to less than 24 per cent in 1992 has left only 1.5 million ha of closed-canopy natural forest cover (Mahindapala 2001). The wet evergreen forests of southwest Sri Lanka are particularly rich in biodiversity and endemic species and the region has been recognized as one of the 34 biodiversity hotspots of the world, along with the Western Ghats of India (Mittermeier *et al.*, 2004). The forests are now fragmented and face severe threats from encroachment and overuse.

Logging. Clear cutting, the dominant mode of logging in dry zone forests, can have devastating impacts on a region by removing wildlife habitat, causing loss of nutrient-rich topsoil and destroying aquatic ecosystems by siltation. Clear-cutting not only alters habitats, but retards the potential for the habitat to re-establish following logging disturbance. The disturbance and fragmentation of dry zone forests for human settlements, irrigated agriculture and swidden cultivation have also affected the overall geographic ranges of large mammals such as leopards, elephant and some primates (MOFE 1999). Soil regeneration under these conditions is extremely slow. Mature tree communities, a required habitat of many plant and animal species, can take decades, even centuries to re-establish themselves. Finally, logging roads have fragmented the ecosystem and render it vulnerable to edge effects, including invasive species that flourish in disturbed habitats. The dry zone forests are exploited heavily and illegally to extract timber, thus impacting on biodiversity. Shifting cultivation has also contributed to degradation of genetic diversity in these ecosystems.

The exploitation of forests was common in the past given to the lack of awareness of effects upon forest biodiversity, which have been further exacerbated by recent forestry practices. The lack of adequate investment in silviculture, afforestation and restoration, the maintenance of forest roads, fire protection, and other conservation measures has contributed to the loss and degradation of forest habitats for many plant and animal species. Overexploitation of biological resources has also lead to the degradation and impoverishment of habitats, as well as the risk of extinction of a large number of plant and animal species. Uncontrolled harvesting of medicinal plants, aromatic plants, and plants with industrial value has also taken a significant toll. Forests close to human habitations are particularly at risk. Due to the existing difficult economic conditions and the traditional practices, the rural population depends for its survival on the overexploitation of forests, especially for cooking and heating. The harvesting of shrubs and coastal vegetation has created problems especially for the birds, which use these habitats for nesting.

Legal protection for biological diversity and for safeguarding other environmental resources falls within the purview of FD, DWC and the CEA. However, it is important to note that many forests and other wild areas outside the protected area network are also rich in species and genetic diversity: all need attention. Biodiversity conservation should therefore, not be restricted to the protected areas alone. There is relatively well documented information for some forest areas such as Sinharaja, less so for Knuckles and the KDN complex (BCFAP 1998; CEA 1994). Species diversity has not been assessed for many other areas. Boundary demarcation has been done for most forests, and inventories of faunal and floral biodiversity have been developed for several wetlands and protected areas. Threatened species too, are well-documented (IUCN 2000).

Gaps. The following gaps in the 1999 BCFAP were identified in relation to impacts on biodiversity in forest and wildlife ecosystems:

1. A lack of knowledge of genetic diversity.
2. Impact of environmental pollution.
4. Impact of compliance and enforcement of international conventions and agreements to which Sri Lanka is signatory.
5. Impact of Invasive Alien Species and development of methods to manage them.
6. Lack of awareness of mechanisms for biodiversity valuation.
7. Impact of war on forests and wildlife biodiversity.
8. Impact of encroachment, agricultural practices and land-use change on forest and wildlife biodiversity.
9. Impact of development projects on biodiversity.
10. Lack of scientific capacity in the biodiversity conservation establishment to identify and mitigate impacts.

Urban and Built Environments

High rates of population growth during the past 50 years have accompanied a progressive increase of anthropogenic impacts on biodiversity. Many new towns and villages were constructed, and existing ones enlarged with the enhancement of infrastructure and economic activities. Fragmentation, reduction, and loss of natural habitats have been a direct result of demographic developments and the urbanization process.

The urban population in Sri Lanka has been steadily increasing and it is now believed to make up nearly 30% of the total population of the country (MENR, 2003). Urban centres have been expanding over the last few decades into their surrounding rural areas. Sri Lankan planners and policy makers now face the challenge of creating more

liveable cities by providing employment and economic opportunities, together with basic amenities and services, with the objective of encouraging 60% of the population to live in urban areas by 2025 (ICSC 2004). Although poverty in Sri Lanka is still largely a problem of the countryside, trends indicate that rural poverty is decreasing, while urban poverty is rising (http://netec.mcc.ac.uk/WoPEc/data/Papers/wopwobaps1738.html). It is evident therefore, that the agencies responsible for urban development will face fresh challenges in the future. Environmental standards need to be set prescribing the maximum permissible levels of pollutants that affect the environment and biodiversity. Furthermore, the lower income residents of cities in Sri Lanka are poorly serviced by municipal infrastructure for water, sewerage and solid waste disposal. Unplanned urban population growth has resulted in ecologically important areas including wetlands being encroached upon or otherwise use for house construction (MENR, 2003). Air and water pollution are commonplace, and lush natural vegetation in urban areas has too often been replaced by concrete, thus reducing the biodiversity. This leads to the inevitable conflicts between efforts to conserve biodiversity and the need to accommodate expanding urban populations.

With urban development, in particular with the increased involvement of the private sector, the need for regulatory measures becomes evident to overcome the ever-present danger of environment pollution, thus affecting biological diversity in urban environments. The National Environmental Act, which was passed by the parliament in 1980 and amended in 1988, has made adequate provisions to enforce adoption of pollution control measures by industry. However, environmental standards need to be reviewed in order to implement regulations prescribing maximum permissible levels of polluting substances allowed to be discharged.

The working environment in many small-and medium-scale industries and service facilities has fallen below desirable standards and this adversely affects not only the workers concerned but also the population of the surrounding areas (MENR, 2003). The policy, legal and administrative arrangements regarding this aspect of environmental health needs to be reviewed. In the development of industrial zones, as well as in the setting up of other labour intensive industries, a socio-economic need that has not been sufficiently addressed is the provision of adequate and well-planned housing and other amenities to the workforce.

Gaps. The subject of the urban environment was not treated in the 1999 BCFAP. In particular, the following impacts need to be considered in the planning process:

1. Globalization/global trading systems
2. Urban greening projects/landscaping
3. Invasive alien species
4. Agrochemical usages

5. Industrial development projects
6. Sewage and solid waste management projects

Coastal and Marine Ecosystems

Ecosystem diversity is high in coastal and marine areas in Sri Lanka. The coastal seas are the habitat of 5 species of turtle, 13 sea snakes, and about 1,800 coastal and marine fishes including pelagic species (SOE 2002). It has also been reported that due to human activities in the coastal and marine ecosystems, 400-500 ha of mangrove or mangrove associates (NARA 1995) and 359.5 ha of shrimp ponds (Jayasinghe 1995) have been cleared, thus significantly affecting the biodiversity of the ecosystem.

Coral reef biodiversity has suffered severe negative impacts during recent decades. Human activities that have affected coral degradation include:

- coral mining from marine reefs
- blast fishing
- use of 'moxi' nets
- pollution by boats
- sewage discharge
- sedimentation
- anchoring by recreational boats

Natural impacts include (see Arulpragasam 2003):

- coral bleaching
- predation by crown of thorns starfish
- invasive organisms such as tunicates, algae
- sedimentation due to natural erosion

Harvesting of ornamental marine organisms for export, including fish and invertebrates from reef associated habitats too, has impacted on biodiversity in these ecosystems (SOE 2001). Marine pollution from shipping has sporadically impacted on the marine ecosystem, while the potential for introduction of invasive alien species from ballast water remains unassessed.

Many **estuaries and lagoons in** the country are polluted to different degrees. High population density and impact of human activities due to urbanization have resulted in high levels of pollution resulting in loss of biodiversity (e.g., frequent incidences of fish kill). Encroachment, changes to the salinity regime, destruction of submerged and fringing vegetation, inlet modification and loss of fishery habitats have been identified as the main causes of biodiversity loss in estuaries and lagoons (Coastal 2000).

The biodiversity of mangrove ecosystems of Sri Lanka have also been affected by changes in freshwater recharge, salinity regime and tidal flow patterns, increase in silt load due to refuse dumping, introduction of pollutants, sewage and over-harvesting of resources. Pressures on mangrove ecosystems have also been imposed by tiger prawn farming and associated land filling, and housing and infrastructure development (SOE 2001).

Sea-grass beds in coastal and marine ecosystems are being reported to be affected by physical alterations, excessive sedimentation and siltation, and increasing outflows of nutrients and/or pesticides associated with agriculture. Human activities have also contributed to degradation of bird habitats while seed fish collection sites in **salt marshes** has impacted on the biodiversity of these ecosystems..

Gaps. The following impact assessments omitted in the 1999 BFAP need to be made with regard to marine and coastal biodiversity.

1. Agrochemical usage on fisheries and aquatic biodiversity.
2. Sewage discharge to water bodies.
3. Land based water pollution.
4. Fish culture.
5. Global warming and climate change.
6. Developmental projects

Wetlands

Inland aquatic habitats (wetlands) are integrated ecosystems, which are valuable natural resources. The natural and man-made inland waters of Sri Lanka comprise of a large and important component of national biodiversity (SOE 2002). The state has acknowledged the need for conservation of wetlands. In recent times the inland waters have been subjected to unsustainable human activities. The diversity in inland waters varies depending on the speed of water flow, depth and quality, and the climatic zone they occur in (MOFE 1999).

The diversity of fauna in inland water ranges from zooplankton and invertebrates to a wide variety of macrofauna. Wetlands are also homes for many species of freshwater algae, diatoms, and other phytoplankton, florating plants, rooted aquatics, grasses, sedges, reed bamboo and ferns, and a wide variety of higher plants such as wild rice (MOFE 1999). Inland aquatic resources have been reported to include 104 species of fish belonging to 36 families including brackish water species (Pethiyagoda 1991), and 28 indigenous species that are traditionally considered food fishes (de Silva 1988).

Inland aquatic plants are widely distributed in Sri Lanka. Aquatic plants in the

country include 11 endemics, 90 peninsular species and 7 non-peninsular species (Abeywickrema 1956). All the endemics and some of the peninsular species are found in wet zone. The aquatic flora serve as sources of food, ornamental plants (de Alwis 1992), medicinal plants, water purifiers (Yapa 1992), livestock feed and fertilizers.

The wetlands are valuable but often vulnerable environments. They also have enormous potential for recreational activities based on their rich biodiversity. The threats to wetland biodiversity in Sri Lanka are many. Pollution with pesticides, fertilizers and sewage is becoming a major problem. Dumping of soil and industrial waste, siltation, wetland *deniya* cultivation with paddy or betel (after clearing natural vegetation), and loss of wetland habitats in the face of urbanization are some other major factors impacting on biodiversity of this ecosystem. Over-harvesting of wild

species for export (e.g. *Cryptocoryne and Aponogeton* spp.) has seriously threatened some populations of these species. The freshwater biodiversity is also threatened by the introduction of invasive alien flora and fauna (SOE 2002). There are special problems with rapid expansion of the shrimp industry, such as introduction of new diseases and release of polluted effluents into the ecosystems.

Gaps. The gaps identified in relation to wetland biodiversity include the need to assess the following impacts:

1. invasive alien species
2. recreational activities/encroachment
3. urbanization and built environments
4. pollution
5. aquaculture practices
6. globalization and international trade

Agriculture Ecosystems (crops and livestock)

The traditional farming systems in Sri Lanka have evolved over many centuries as part of an overall system of conservation-oriented management, with farmers manipulating sustainable production systems in harmony with the environment. Conserving the crop and livestock diversity in agricultural lands is now considered extremely important as these gene pools form the basis for genetic improvement of plants and animals to increase national productivity.

Diversity in crop plants (collections) in the island is given in Table 2. The medicinal plants in Sri Lanka include about 1414 species. Among them 50 species are heavily used, 208 are commonly used, and 79 are threatened species (Anon 1996).

Rice (*Oryza sativa*) being the major staple food crop cultivated with a history of two

Table 2. Germplasm collection status by Crop group at the Plant Genetic Resources Centre (PGRC). - *PLEASE SEE ANNEXURE III FOR UPDATED INFORMATION*

Crop Group	No. of species	No. of accessions	% collection
Rice	2	3809	34.0
Other cereals	9	785	7.0
Pulses	14	1907	17.0
Vegetables	52	2927	26.1
Spices & Condiments	9	500	4.5
Fruits	16	363	3.2
Root and 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**	**11,205**	**100**

Thousand years in Sri Lanka, it is reported that there are over 3000 accessions of indigenous rice varieties, containing about 1000 distinct cultivars. Some of them show tolerance to drought, submergence and flash floods, high salinity and other adverse soil conditions, and low temperatures. Some varieties are highly resistant to pests and diseases. Rice fields are associated with rich wetland flora and fauna, including many endemic species (SOE 2002).

The country has a range of cereals such as maize, sorghum and other millets. The pulses comprise of cowpea, green gram, black gram, winged bean and soya bean. Sri Lanka also has 8 indigenous species of *Cinnamomum,* about 500 known selections and 10 wild species of pepper, about 10 wild races of cardamom, several indigenous species of betel, 3 species of nutmeg, 2 species of chilli, 1 species each of ginger and turmeric. Sri Lanka also has an estimated 170 species of plants of ornamental value, of which 174 species are endemic (SOE 2002; NSF 2000).

No quantitative estimates are available with respect to livestock diversity in Sri Lanka. It is recorded that both wild relatives and indigenous species of buffalo, poultry (chicken) and swine are found in Sri Lanka. As in many parts of the world these indigenous farm animal species show low production standards despite the high adaptation for local management and environmental conditions. Hence, the contribution of these species to national livestock production is very low and, the country depends heavily on imported strains to meet the domestic demand. This is a serious threat in maintaining biodiversity among farm animals. The consequences of the present trend of importation of high producing animals may lead to shrinkage of genetic diversity and limit the industry to rely on few species in the future.

One example can be drawn from the poultry (chicken) industry where imported

breeds are popular on a commercial scale and represent around 90% of the chicken population in the country whereas the indigenous populations are limited only to subsistence level farmers (Silva and Himali, 2005). Moreover, none of the genetic characteristics of the Jungle fowl, a progenitor species, has been reported in the imported and improved breeds found at present, which highlights the uniqueness of the germplasm the country possesses. Unfortunately, the local poultry breeds are fast disappearing due to preference towards imported breeds, despite the fact that local breeds have resistance to tropical diseases.

In swine production, it is believed that gene flow is taking place between the wild and village populations. Nevertheless, imported breeds (i.e. large white and land race) are dominating the industry with no efforts being made to increase diversity of populations through breeding programs. Sri Lankan indigenous buffaloes are forming a unique genetic group in the subcontinent. Unlike the other native buffaloes in the region, Sri Lankan indigenous buffalo represents swamp characteristics while resembling the river type genotypically. The wild buffaloes are distinct from the indigenous type and show more swamp-type characters. However, there has been no evaluation done on the Sri Lankan wild buffaloes establish whether or not they belong to the river type.

At present, many species of medicinal and ornamental plants are over exploited. It has been reported that of the 170 species of orchids found in Sri Lanka, 99 are rare, 7 are vulnerable, and 13 are endangered (Sumithraarachchi 1986). Use of high yielding and imported crop varieties and imported livestock breeds in preference to indigenous varieties/breeds continues to pose a threat to the survival of the wide spectrum of indigenous genetic diversity.

Gaps. Gaps identified in the 1999 BCFAP in relation to impacts on biodiversity in agricultural ecosystems (crops, livestock and domestic species) include the need to make the following impact assessments.

1. climate change on the crops and domestic animal Diversity.
2. human dimensions in agricultural biodiversity
3. livestock breeding/improvement programs
4. globalization and international trade
5. traditional and non-traditional farming systems
6. changes in parallel sectors (mechanization in agricultural sector)
7. agrochemical usage (soil-plant-water system)
8. continuous cultivation
9. traditional cultivation systems
10. globalization and international trade
11. invasive alien species
12. introduction/use of GMO/FFP
13. ornamental and exotic-species fishery
14. use of pesticides

3. RECOMMENDED ACTION (PRIORITIES)

Recommended Actions	Gaps to be mitigated (Major subject areas)	Time Frame	Responsible Authorities
Strengthen the scientific capacity of the key institutions responsible for biodiversity, including the DWC, FD and CEA.	• All ecosystems	2004-2006	MENR
Quantitative assessment of the impact of developmental projects on biodiversity, revising the NEA to provide the necessary regulatory framework	• Urban and Built Environments • Wetlands • Fisheries, Aquatic/Marine • Crop and Livestock	Once in two years from 2004	CEA MA&L ME&NR FA/Universities NARA
Review the status of Protected areas and establish a protected area network connecting every possible critical habitat	• Forest and Wildlife • Wetlands • Livestock		DWC, FD
Develop and implement biosafety regulations [*refer to chapter on Biosafety*]	• Forest and Wildlife • Urban and Built Environments • Fisheries, Aquatic/Marine • Crop and Livestock	2004	ME&NR
Establish a regulatory framework to share the benefits of Protected Areas (PA) among buffer zone communities.	• Forest and Wildlife	2004-2006	DWL, FD
Develop a legal framework and implementation to ensure compliance with the international treaties (CBD, IPPC, CITES, etc)	• Forest and Wildlife • Urban and Built Environments • Wetlands • Fisheries, Aquatic/Marine • Crop and Livestock	2004-2005	ME&NR MA&L
Initiate programs to restore degraded critical habitats	• Forest and Wildlife • Wetlands • Crop and Livestock	2004-2005	DWL FD MA&L
Develop a mechanism to regulate and monitor the collection of flora and fauna [*refer to chapter on Sustainable Use*]	• Forest and Wildlife • Urban and Built Environments • Fisheries, Aquatic/Marine • Crop and Livestock		
Ensure the survivability of endangered species through breeding programs and reintroduction	• Crop and Livestock	Continuous (from 2004)	MA&L

Systematic Assessment of urban greening projects	• Urban and Built environment	Once in two years from 2004	UDA ME&NR
Development and implementation of strategies to prevent and mitigate impacts of invasive alien species and restoration of ecosystems	• Forest and Wildlife • Urban and Built Environments • Livestock • Fisheries, Aquatic/Marine • Crop and Livestock	2004-2006	ME&NR MA&L
To ensure long term planning to mitigate the elephant – human conflict.	• Forest and Wildlife • Crop and Livestock	2004-2006	DWL
Develop and implement strategies to promote and enrich home gardens as a vehicle for *ex situ* conservation	• Crop and Livestock	2004-2005	MA&L
Monitor key parameters relating to climate change and natural disasters, and assess their potential impact on biological diversity	• Urban and Built Environments • Wetlands • Fisheries, Aquatic/Marine • Crop and Livestock	2004-2006	ME&NR FA/Universities [revise this list as per the actions]
Quantitatively assess the impact of agrochemicals and pollutants on biodiversity	• Urban and Built Environments • Fisheries, Aquatic/Marine • Crop and Livestock	Once in two years from 2004	MA&L ME&NR FA/Universities NARA CEA
Establish a continuous programme to build public awareness of biodiversity, the risks posed to it, theneed for conservation/sustainable use and the mechanisms to achieve this.	• National	Continuous (from 2004)	MENR DOA Universities

ME&NR - Ministry of Environment and Natural Resources
MAL - Ministry of Agriculture and Livestock
DA - Department of Agriculture
DAPH - Department of Animal Production and Health
NARA - National Aquatic Research Agency
DWL - Department of Wildlife
FD - Forest Department
FA - Faculties of Agriculture

- In 1999, the First National Experts Committee on Biological Diversity of the Ministry of Environment developed a National Invasive Plants (Annexure I). The Second National Experts Committee on Biological Diversity of the Ministry of Forest and Environment is currently in the process of updating the list.

  Being an issue of national and international importance, a National Strategy to prevent and mitigate the impacts of Invasive Alien Species has been considered as a priority by the Ministry of Forest and Environment. A draft Policy and Procedural Synopsis on Invasive Species in Protected Areas has been formulated by the Department of Wildlife Conservation (Annexure II).

4. SELECTED REFERENCES

- Abeywickrema BA 1956. The origin and affinities of the flora of Ceylon. Proc 11th Annual session, Ceylon Ass. Adv. Sci. 2: 99-121.
- Anon 1996. An investment proposal for the conservation and sustainable use of medicinal plants of Sri Lanka. ICUN Sri Lanka Country Office, 59 pp.
- Anonymous 1993. Proceedings of the workshop on Conservation of wet lands in Sri Lanka, Central Environmental Authority, Wetland Conservation Project.
- Anonymous 2000. Statistical compendium on Natural Resource Management of Sri Lanka-2000 for sustainable development, Ministry of Forestry and Environment, Sri Lanka.
- Arulpragasam KD 2000. Coastal and Marine Resources. Natural Resources of Sri Lanka 2000. NSF, Colombo pp167-193.
- CEA 1994. Wetland site report: Walauwatta Waturana Swamp Forest. Central Environment Authority, Colombo
- Coastal 2000. A Resource Management Strategy for Sri Lanka's Coastal Region. Coast Conservation Department, Colombo.
- De Alwis A. 1992. Aquatic ornamental plants of Sri Lanka. Vidurava 14(2): 4-18.
- De Silva, S.S. 1988. Reservoirs of Sri Lanka and their fisheries. FAO Technical Paper 298, 126 pp.
- http://netec.mcc.ac.uk/WoPEc/data/Papers/wopwobaps1738.html
- ICSC 2004. Urban Greening Project Report. International Centre for Sustainable Cities, Canada.
- IUCN 2000. Report of the South and South East Asian Regional Session of the Global Biodiversity Forum 1999, IUCN-Asia Regional Biodiversity Program, Sri Lanka.
- Jayasinghe JMPK 2000. Inland aquatic resources. Natural Resources of Sri Lanka 2000. NSF, Colombo pp195-211.

- Kotagama H.B. Wijesekara and A.Wijesundara D.S.A. (eds) 2001. Sri Lankan Biodiversity Review Dept. of Agriculture Peradeniya, Sri lanka.
- Mahindapala R 2001. Biodiversity Planning in Asia: Chapter 17 Sri Lanka.
- Marambe B. (ed) 1999. The first national work shop on Alien invasive species in Sri Lanka, Ministry of Forestry and Environment Sri Lanka.
- Marambe B. (ed) 2000. Alien invasive species in Sri Lanka: Impacts on Ecosystems and Management, Ministry of Forestry and Environment Sri Lanka & National Agricultural society of Sri Lanka (NASSL).
- Marambe B. 2002. Invasive alien species in insular South-Asia Plenary Lecture. Regional Workshop on Prevention and Management of Invasive Alien Species: Forging Cooperation throughout South and Southeast Asia (Eds. N. Pallewatta, J. K. Reaser, and A. T. Gutierrez), pp 51-54. A joint publication of Government of USA, Royal Thai Government Thai Biodiversity Center, and GISP.
- Marambe, B., Amarasinghe, L and Gamage G. 2002. National Profile Report on Invasive Alien Species in Sri Lanka. Regional Workshop on Prevention and Management of Invasive Alien Species: Forging Cooperation throughout South and Southeast Asia (Eds. N. Pallewatta, J. K. Reaser, and A. T. Gutierrez), pp 91-103. A joint publication of Government of USA, Royal Thai Government Thai Biodiversity Center, and GISP.
- Mittermeier, R. A., P. R. Gil, M. Hoffman, J. Pilgrim, T. Brooks, C. G. Mittermeier, J. Lamoreux & G. A. B. da Fonseca, 2004. Hotspots revisited: Earth's biologically richest and most threatened terrestrial ecoregions. CEMEX, Mexico City and Conservation International, Washington, D. C. Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. da Fonseca & J. Kent, 2000. Biodiversity hotspots for conservation priorities. Nature, 403: 853858.
- MENR 2003. Caring for the Environment 2003-2007: Path to sustainable development. Ministry of Forestry and Natural Resources, Colombo 131 pp.
- MOFE 1999. Biodiversity Conservation in Sri Lanka: A Framework for Action, Ministry of Forestry and Environment, Sri Lanka.
- MOFE 2001. National Environmental Action Plan 1998-2001. Ministry of Environment and Natural Resources of Sri Lanka
- NSF 2000. Natural Resources of Sri Lanka 2000. National Science Foundation of Sri Lanka.
- Pethiyagoda R. 1991. Fresh water fishes of Sri Lanka. Wildlife Heritage Trust Of Sri Lanka. 362 pp.
- Rajasuriya A., De Silva MWRN, & Ohman, MC. 1995. Coral reefs of Sri Lanka: Human Disturbances and Management Issues. Ambio 24 (7-8).
- Silva, GLLP and Himali SMC (Eds) 2005. Status of farm animal genetic resources in Sri Lanka. 54 pp. A Joint Publication of the University of Peradeniya, Sri Lanka and Department of Animal Production and Health, Sri Lanka.

- SOE 2001. State of the Environment in Sri Lanka. UNEP/Ministry of Forestry and Environment, Sri Lanka.
- SOE 2002. State of the Environment in Sri Lanka. National Report Prepared for the South Asian Association for Regional Cooperation, Ministry of Environment and Natural Resources, Sri Lanka.
- Sumitrarachchi B. 1986. A report on steps taken to conserve Orchidaceae in Sri Lanka. Phyta. Journal of the Botanical Society of the University of Peradeniya, 3(1): 26-41.
- Yapa PAJ 1992. Water hyacinth: the silent purifier of nature's water bodies. Vidurava 14(2): 1-3.

ANNEXURE 1

National List of Invasive Alien Plants -1999 (in alphabetical order)

Botanical Name	Status (Distribution)	
Alstonia macrophylla Wall. ex G. Don (Family: Apocynaceae)	Degraded forests and forest edges in moist lowland	Provincial
Annona glabra L. (Family: Annonaceae)	Coastal lagoons, marshes	Provincial
Clidemia hirta (L.) D. Don (Family: Melastomataceae)	Rainforests	Provincial
Clusia rosea Jacq. (Family: Clusiaceae)	Mid country moist open & rocky areas, forest edges	Provincial
Chromolaena odorata (L.) King & Robinson (Family: Asteraceae)	Road sides, waste ground in lowlands	National
Dicranopteris linearis (Burm.) Underw. (Family: Gleicheniaceae)	Wastelands and fallow fields	Provincial
Eichhornia crassipes (Mart.) Solms (Family: Pontederiaceae)	Inland stagnant water bodies	National
Lantana camara L. (Family: Verbenaceae)	Open scrublands, waste ground	National
Mikania cordata (Burm.) Robins. (Family: Asteraceae)	Secondary forests in moist regions up to 1000 m elevation.	Provincial
Miconia calvescens D.C. (Family: Melastomataceae)	Degraded forests in sub montane region	Provincial
Mimosa pigra L. (Family: Mimosaceae)	River banks, reservoir edges and open areas up to 1000 m elevation	Provincial
Panicum maximum Jacq. (Family: Poaceae)	Grasslands, Open areas up to 1000 m elevation	Provincial
Panicum repens L. (Family: Poaceae)	Grasslands, Open areas up to 2000 m elevation	Provincial
Pennisetum polystachyon (L.) Shultes (Family: Poaceae)	Grasslands, Fallow fields road-sides up to 1100 m elevation	Provincial
Pistia stratiotes L. (Family: Araceae)	Water bodies in wet and dry zones	National
Pteridium aquilinum (L.) Kuhn (Family: Dennstaedtiaceae)	Disturbed montane forests, wet grasslands and bare ground	Provincial
Salvinia molesta Mitchell (Family: Salviniaceae)	Inland stagnant water bodies	National
Ulex europaeus L. (Family: Fabaceae)	Montane forests, wet pathana grasslands (Horton Plains)	Provincial
Dillenia suffruticosa (Griff. ex Hook. & Thomson) Martelli (Family: Dilleniaceae)	Marshes, stream banks, riverbanks	Provincial

Note: This list was prepared by the First National Experts Committee on Biological Diversity of the Ministry of Forest and Environment in 1999. The Ministry of Environment is currently in the process of revising this list.

ANNEXURE II

DEPARTMENT OF WILDLIFE CONSERVATION

PROPOSED POLICY AND PROCEDURAL SYNOPSIS ON INVASIVE SPECIES IN PROTECTED AREAS, 2005

(DRAFT)

Introduction and Background

Invasive species, especially those of alien origin, present problems for biodiversity conservation and wildlife management in several protected areas (PAs) in Sri Lanka. A national policy on invasive alien species is lacking, though the Ministry of Environment has prepared a list of problematic invasive alien species. The Ministry is also undertaking biological control trials on two species of alien aquatic weeds outside PAs. The national framework Biodiversity Conservation Action Plan (1998) and its updates and draft addenda currently under preparation (2005), propose formation of a national invasive species specialist group, a national database and research into invasive species control. Sri Lanka's national Wildlife Policy (2000) acknowledges invasive alien species as a threat and seeks to prevent importation.

Similarly, the international Convention on Biological Diversity (CBD), which Sri Lanka has ratified, highlights invasive alien species (IAS) as a major threat to biodiversity, especially on islands, and calls on parties to "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats, or species" (Article 8h). The Global Invasive Species Programme (GISP) is a voluntary partnership, which maintains relevant and useful databases and shares information on invasive alien species administered by three international organizations: IUCN - The World Conservation Union, CAB International, and the Scientific Committee on Problems of the Environment.

The Department of Wildlife Conservation (DWC) has experience in control of IAS plants in PAs. However, an overall conceptual, and policy and procedural framework for these interventions is absent. This document provides an internal DWC policy and procedural synopsis focused on control of IAS plants in its PAs. The policy and procedures document DWC's overview of IAS, determination of priorities and approaches to their management. A separate detailed DWC guideline will augment procedural aspects of IAS control. Other types of species that negatively affect management objectives for key species, habitats and ecosystems are addressed in an addendum. The policy and procedures herein are based on outcomes of a DWC workshop in October 2005.

The DWC Policy

DWC undertakes active management of biological resources in some PAs to achieve certain conservation objectives, which are normally described in a management plan. Several PAs have large areas covered IAS trees and shrubs, which threaten indigenous biodiversity, habitats or ecological processes.

Policy objective: ***where feasible, to control or eradicate invasive alien species that threaten conservation management objectives of protected areas.***

Policy Statement:

1. When available and relevant, national IAS issues and priorities will be taken into account in developing control programs, but DWC may undertake specific programs in PAs that are not otherwise a national priority.

2. Although this policy focuses on IAS (plants), DWC recognizes that IAS animals, including domestic livestock, threaten conservation objectives in several PAs (see addendum). Existing legal instruments will be used to control impacts of IAS domestic animals in PAs. DWC will remain vigilant to other IAS animals, and develop management strategies for those that threaten PA conservation objectives.

3. A standardized surveillance, threat-assessment and information system will be established for IAS in, and those close to PAs that constitute a potential threat.

4. Widespread IAS (trees and shrubs) in several PAs are identified as the highest priority threat to management objectives from invasive species. Such threats are common in PAs when a management objective is established in specific parts of the PA to maintain an early stage in ecological succession to enhance forage and habitat for large mammalian herbivores. Such areas will generally be designated as "focal species zones" within DWC's zoning scheme for national parks.

5. Ecosystems and habitats dominated by IAS have their own indigenous ecological assemblages and biodiversity values. Decisions to exercise control are, therefore, based on conservation objectives and targets for the PA as a whole, as stated in a management plan. Where a management plan is unavailable, control activities are undertaken following an assessment and articulation of clearly defined PA-specific conservation objectives, and in the context of the national PA system.

6. Eradication of IAS (plants) is rarely possible in PAs unless the invasion is recent, or limited to small areas. Re-invasion from surrounding areas is probable in most cases, requiring continued surveillance and action as necessary, following local eradication. Therefore, this policy emphasizes control and containment of IAS.

7. Assessment of feasibility of control for specific IAS in specific PAs will take account of ecological, financial and sociological factors. Ecologically or socially acceptable, or affordable control of some IAS in areas of PAs may not be possible. In such cases, PA management will focus on mitigation of IAS impacts and management of native flora and fauna which benefit from, or are unaffected by, IAS.
8. Control methods comprise:

   a) allowing ecological succession and dominant native Species to replace IAS;
   b) physical removal using human labor and hand tools;
   c) mechanical removal using heavy machinery;
   d) controlled burning to remove and prevent regeneration;
   e) chemical control using herbicides;
   f) biological control using indigenous or alien natural enemies.

9. Control by succession is optimal where maintaining an early stage of succession is not a management objective in the relevant parts of a PA, and where native species will eventually out-compete IAS. Where IAS prevent succession to dominant native plant species other methods of control are required.

10. Where active intervention is necessary, physical and mechanical methods are preferred, with physical control applicable in smaller areas, or less dense infestations of IAS. Controlled burning of defined areas may be used to maintain areas free of IAS, and at early stages of ecological succession following removal of IAS plants.

11. Chemical control will not be used in DWC PAs, unless the chemical agent is highly specific in killing the target IAS, and does not otherwise affect biological, soil and water resources. Biological control using alien natural enemies will not be applied in DWC PAs. Biological control using native species will be subject to extensive research and testing before use in a PA.

12. Wherever practical, the labor force used in control programs will be drawn from local communities adjacent to the PA, to enable financial and employment benefits to those communities.

14. DWC will make every effort to ensure that a control program receives adequate resources throughout its implementation, recognizing that an uncompleted control program is often of no value because of re-growth of, and reinvasion by, remaining IAS.

15. Environmental Impact Assessment will precede large IAS control programs. At minimum, an Initial Environmental Examination will be conducted for smaller or pilot programs, including a monitoring plan and management of the control method to mitigate adverse effects.

16. IAS control plans for a PA will include public education and information aspects to ensure that stakeholders understand the measures undertaken. In particular, reasons for the control program and long-term positive conservation impacts will be stressed, relative to short-term negative impacts, which may result from disturbance.

Procedural Synopsis

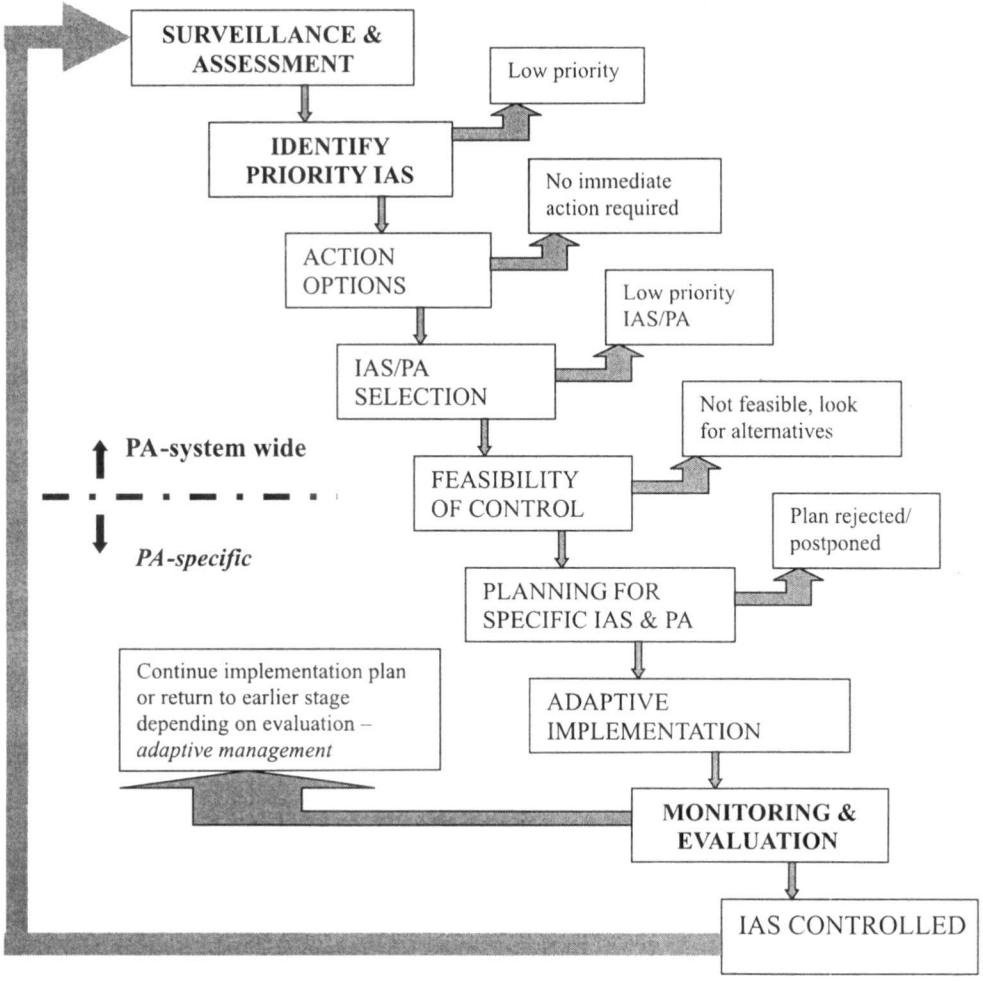
Figure 1 outlines the adaptive IAS control process used by DWC. A detailed guideline for IAS programs providing recommendations for each step illustrated will be developed. The guideline will include options and factors to consider in adaptive decision-making at each step, and standardized reporting formats where appropriate.

1. DWC will rigorously gather **available information on IAS** that pose conservation threats in its PAs before undertaking control programs. Diverse information is available on the worldwide web (including CBD, IUCN and GISP sites), from researchers based in Sri Lanka, and from local traditional knowledge sources. Where key information is lacking, DWC will undertake or commission research on a particular IAS before undertaking a control program in a PA.

2. To enable effective **surveillance,** each DWC PA will provide an annual report on IAS using a standardized reporting format. DWC will compile an annual system-wide **assessment,** which will be used to review and modify existing priorities and control programs as necessary. A **DWC database of IAS** will be assembled and updated annually to inform priority-setting and programmatic decision-making system-wide. The DWC database will contribute to the national database proposed by the Ministry of Environment.

3. The Deputy Director, Natural Resources (as designated in the cabinet approved DWC structure), or equivalent officer, will be responsible for Head Office technical coordination and information management regarding IAS.

Figure 1. Summary of sequential steps and decision points in control of IAS



4. In determining **priorities** for which species are controlled where, DWC will follow a systematic decision-making process, based on available information. Factors considered comprise:
    a) threats to native biodiversity;
    b) PA management objectives;
    c) extent of IAS cover and likelihood of further spread;
    d) ecological impacts of control measures;
    e) impacts of control on PA stakeholders.

5. **Action options comprise:**
    a) no immediate action (beyond annual surveillance and assessment);

b) more rigorous monitoring of IAS status to determine need For future action;
c) eradication from the PA (rarely feasible);
d) Control.

6. In determining **feasibility** of eradication or control, issues Addressed will include:
   a) suitable control methods are available and ecological impacts are acceptable;
   b) control methods are cost effective and affordable in the long term;
   c) impacts of control methods on local communities, PA visitors and other stakeholders;
   d) mitigation of negative impacts;
   e) positive impacts and time scales for PA management and for each interest group (short term disturbance impacts during and after removal; longer term benefits related to Conservation objectives).

   DWC will not initiate control programs unless these issues are resolved. If sufficient information is unavailable, small-scale pilot programs may be undertaken to determine feasibility.

7. The designated PA manager (Warden, where designated, head of Regional Office if no Warden) will submit a comprehensive **multi-year objective-based action plan and budget** when control of an IAS is proposed. The plan will include a justification (in the context of a management plan where available) and an Initial Environmental Examination of the proposed activities, and will follow **adaptive management** principles, incorporating a **monitoring and evaluation plan.** The budget will include public information and education aspects and a contingency amount to enable adaptive response to lessons learned during the control program.

   If DWC Head Office approves the plan, in the light of other priorities, sufficient resources and authority will be provided to the PA manager to implement the plan, and make **adaptive adjustments,** over the number of years specified.

   If the control program does not meet planned objectives and targets according to annual reviews, the program may be suspended, or reassessed by the PA manager, or by DWC Head Office, according to the relevant steps in Figure 1.

8. Following completion of a control plan, annual surveillance and assessment will continue as in item 2 above to detect and control reinvasion, following the same sequence of steps in Figure 1.

Addendum: Other Species of Concern

DWC will remain vigilant to threats in PAs from taxonomic groups other than IAS plants following the same policy and procedures outlined above. In particular annual surveillance and assessment reports will be prepared as necessary for such species. Regarding other **plant species,** the following general levels of priority are provisionally assigned (subject to specific PA management objectives).

	Palatability (large herbivores)		Invasive	Non-invasive
Alien	*Palatable*	***Existing***	**If control needed 2**	**Control/monitoring 3**
		New	**Prevent invasion 2**	
	Unpalatable		**1**	**3**
Native	*Palatable*		**3**	**No issue**
	Unpalatable		**2**	**Under specified circumstances 3**

Priority Level: 1 high; 2 medium; 3 low.

This classification covers IAS, non-invasive alien species, invasive and non-invasive native species, and palatability to large herbivorous mammals. In addition, palatable IAS are split into existing species (already present) and ones which may yet invade (new), such that certain existing alien species may enhance grazing conditions, and thereby not be regarded as a threat, or may need containment, only. The highest priority for control overall is assigned to unpalatable IAS (shaded), which are the focus of this document. Note that under exceptional circumstances, control of native plant species may be undertaken in line with specified PA management objectives. Several **domestic vertebrate species** especially cattle, buffalo (including feral buffalo) and dogs have negative impacts on wildlife in PAs. Existing provisions of the Fauna and Flora Protection Ordinance cover control of these species. Although introduced fish (especially tilapia species, and rainbow in Horton Plains National Park) are present in some PAs, they were introduced deliberately for fishery purposes, and are not addressed by this policy unless in a PA habitat where fishing is prohibited. Other alien fish species kept as ornamentals by aquarists occasionally escape and may pose a threat to native biodiversity in the future.

Definitions

(Based on: IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species. *Prepared by the Species Survival Commission Invasive Species Specialist Group. Approved by the 51st Meeting of the IUCN Council, Gland Switzerland, February 2000.)*

Alien invasive species means an alien species, which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity.

Alien species (non-native, non-indigenous, foreign, exotic) means a species, subspecies, or lower taxon occurring outside of its natural range (past or present) 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.

Containment, a special case of control, means limiting the spread of the (alien invasive) species and to contain its presence within defined geographical boundaries.

Control means the long term reduction in abundance or density of the (alien invasive) species.

Eradication means to completely remove the (alien invasive) species.

Native species (indigenous) means a species, subspecies, or lower taxon, occurring within its natural range (past or present) and dispersal potential (i.e. within the range it occupies naturally or could occupy without direct or indirect introduction or care by humans.)

Supplementary DWC Documents

(*Documents prepared with support of Protected Area Management and Wildlife Conservation Project*)

Strategic Approach to Management of Invasive Species in Protected Areas. Workshop Report, October 2005.

Adaptive Management in Sri Lanka's Protected Areas. A Case with Alien Invasive Plant Species. Concept Note, July 2005. By Steve Dennison.

Management Zonation in Sri Lanka National Parks. Concept Paper, July 2005. TA Team.

Habitat Management Activities Conducted by the Department of Wildlife Conservation, December 2004. By Devaka Weerakoon.

ANNEXURE III

Germplasm collection status by Crop group at the Plant Genetic Resources Centre (PGRC, 2006).

Crop Group	Genus	No. of accessions	% collection		
			Wild species	Landraces/old varieties	Breeding lines/new cultivars
Cereals					
Rice	Oryza	4004	1	75	24
Maize	Zea	697	1	35	64
Millets	Sorghum & other millets	602	1	76	23
Food Legumes					
Cowpea	Vigna	324	1	93	6
Green gram	Vigna	509	1	24	75
Black gram	Vigna	62	6	70	23
Soybean	Glycine	249	-	9	91
Ground nut	Arachis	193	1	14	85
Beans	Phaseolus	225	-	10	9
Other	-	1145	< 1	24	73
Vegetables					
Tomato	Lycopersicon	230	3	30	67
Chilli	Capscicum	546	18	27	55
Pumpkin	Cucurbita	251	2	92	5
Okra	Abelmoschus	296	3	73	24
Bitter gourd	Momordica	108	8	85	7
Onion	Allium	26	-	4	96
Other	-	697	6	80	14
Oil Crops					
Sesame	Sesamum	319	4	52	44
Mustard	Brassica	113	-	-	-
Fruits					
Water melon	Citrullus	36	-	70	30
Melon	Cucumis	38	-	1	2
Banana	Musa	200	2	92	6