DRAFT CODE OF CONDUCT FOR THE SUSTAINABLE MANAGEMENT OF MANGROVE ECOSYSTEMS

World Bank, ISME, cenTER Aarhus (2003). *Draft Code of Conduct for the Sustainable Management of Mangrove Ecosystems*.

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Front Cover

Pristine Mangrove, Sematan, Sarawak, Eastern Malaysia. Photo by: Donald J. Macintosh, cenTER Aarhus

Degraded mangrove, Ca Mau Province, Lower Mekong Delta, Vietnam. Photo by: Thomas Nielsen, cenTER Aarhus

Woman carrying mangrove fuelwood in Ghana. Photo by: Donald J. Macintosh, cenTER Aarhus

A coastal shrimp farm in Ceará, Brazil. Photo by: Donald J. Macintosh, cenTER Aarhus

*** WORK IN PROGRESS**

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Based on consultations in South and Southeast Asia (21-23 October, 2002), Africa (17-19 February, 2003) and Central and South America (17-19 March, 2003).

TABLE OF CONTENTS

PREFACE

The term "mangrove" refers to a tidally influenced wetland ecosystem within tropical and subtropical latitudes. Mangroves can also occur in areas without a tidal regime e.g. in some choked coastal lagoons and in the supralittoral zone. Mangrove also designates the marine tidal forest that includes trees, shrubs, palms, epiphytes and ferns (Tomlinson, 1986). Mangrove ecosystems are estimated to cover 181,000 km^2 worldwide (Spalding *et al*., 1997). The best developed mangroves grow along humid sheltered tropical coastlines; for example, in the delta systems formed by major rivers like the Ganges-Brahmaputra, Irrawaddy and Niger, and on coastlines protected by large land masses for example, the Malacca Straits, Borneo and Madagascar. Such areas are often strategic sites for dense human settlements and receive high population pressure. Conversely, there are some open coastlines with extensive mangrove cover and very few people, for example in the state of Maranhao, Brazil.

For much of history many people have regarded mangroves as wastelands, but the scale of human impact on mangroves has increased dramatically in recent years, with many countries showing losses of 50-80% or more, compared to the mangrove forest cover that still existed even 50 years ago. For example the Philippines has lost 75% of the mangrove area that existed in the 1950s (Primavera, 2000). Mangrove ecosystems have been degraded or converted into agriculture, aquaculture, industrial or urban development. Aquaculture has been one of the major causes of mangrove loss and resulted in loss of 90% mangrove cover in some parts of Ecuador (e.g. Chone River estuary). The livelihoods of the local coastal communities have been diminished/or totally lost by the destruction or degradation of mangroves.

Recently however, society has begun to appreciate the benefits of mangroves and there is a growing awareness of their values such as coastal protection, coastal subsistence of coastal dwellers and commercial fisheries. There are also increasing efforts by governments, NGOs and local communities around the world to conserve, rehabilitate and manage mangroves sustainably, but the literature and success stories are still limited.

Recognising the importance of conserving mangrove forest ecosystems worldwide, the World Bank commissioned a desk review "Mainstreaming Conservation of Coastal Biodiversity through Formulation of a Code of Conduct for Sustainable Management of Mangrove Forest Ecosystems". This review builds on the findings from an on-going "Shrimp Farming and the Environment" collaborative program supported by the Bank-Netherlands Partnership Program with, the Worldwide Fund for Nature (WWF), the Food and Agriculture Organisation of the United Nations (FAO) and the Network of Aquaculture Centres in Asia-Pacific (NACA). This program included "A Thematic Review of Coastal Wetlands and Shrimp Culture".

Formulation of the Code of Conduct is based on existing knowledge, experience and concepts. The Code identifies key linkages and co-ordination needs among government departments, NGOs, nearby communities and entrepreneurs who have an interest in the conservation of mangrove ecosystems and sustainable use of mangrove resources. It recommends key legislation and enforcement mechanisms (e.g., governmental and/or community-based) required for the effective conservation, protection and sustainable use of mangroves.

The long-term objective is to arrest the recent and rapid destruction of mangrove ecosystems, to improve their management, and to conserve biodiversity in these critical natural habitats.

The specific objective of the Code of Conduct is to provide a tool for the effective management of mangrove ecosystems for local and national governments, resource managers, NGOs, traditional authorities and communities, donors and development agencies, and conservation groups.

ACKNOWLEDGEMENTS

This generic Code of Conduct for the Sustainable Management of Mangrove Ecosystems (the Code) was commissioned by the World Bank and prepared under a contract with the International Society for Mangrove Ecosystems (ISME) Okinawa, Japan in association with the Centre for Tropical Ecosystems Research (cenTER), University of Aarhus, Denmark.

This draft Code is the product of consultations with many people across the world and in the forum of three regional workshops: a South and Southeast Asia Regional Workshop held, at the Asian Institute of Technology, Bangkok, Thailand, October 2002; an Africa Regional Workshop, held at the Centre for African Wetlands, University of Ghana, Ghana, February 2003; and a Central and South American Regional Workshop, held at Labomar, Fortaleza, Brazil, March 2003. We would especially like to mention the people who helped organise the regional workshops: in Thailand Ms. Arlene Nietes-Satapornvanit, in Ghana Professor Christopher Gordon and Mr. Jesse Ayivor and in Brazil Professor Luiz Drude de Lacerda, Professor Carlos Artur Sobreira Rocha and Mr. Ariel Vaisman.

We wish to thank all those who have contributed to the material in the draft Code and to the supporting country case studies under preparation; they are as follows (by country): Bangladesh: Dr. Neaz Siddiqi (Bangladesh Forest Research Institute, Chittagong), Mr. Dipak Kamal (Fisheries and Marine Resource Technology Discipline, Khulna University), Dr. Rafiqul Islam (Integrated Coastal Zone Management Project, Ministry of Water Resources), Dr. Junaid Choudhury (Sundarbans Biodiversity Conservation Project, IUCN); Benin: Mr. Liamidi Akambi (Direction des Pêches, Cotonou; Department of Fisheries); Brazil: Professor Luiz Drude de Lacerada (Instituto de Ciências do Mar, Universidade Federal do Ceará), Enox Maia (Technical Director The Brazilian Shrimp Farmers Association), Raúl Madrid (Federal Environmental Agency, Fortaleza), Ariel Vaisman (Instituto de Ciências do Mar, Universidade Federal do Ceará); Cambodia: Mr. Vann Monyneath (Ministry of Environment, Phnom Penh); Colombia: Mr. Ricardo Alvarez-Leon (Environmental consultant, Conservation International, Bogota) and Dr. Julian Chara (Post-graduate student, University of Stirling); Ecuador: Alejandro Bodero (Director Grupo Majagual), Roberto Retamales (Universidad Técnica Manabí), Byron Vasconez (Clirsen), Mireya Pozo (Ministry of the Environment); Ghana: Professor Chris Gordon (Centre for African Wetlands, Accra), Mr. Jesse Ayivor (Centre for African Wetlands, Accra), Mr. Stephen Osei Amakye (Ghana Environmental Protection Agency, Accra) and Mr. Edward Obiaw (Ghana Forestry Commission, Kumasi); India: Dr. Arvind Untawale (Sagar Society, Goa) and Mr. E. V. Muley (Ministry of Environment and Forests, New Delhi); Kenya: Dr. James Gitundu Kairo (Kenya Marine and Fisheries Institute, Mombasa) and Dr. Farid Dahdouh-Guebas (Mangrove Management Group, Free University Brussels, Belgium); Malaysia: Mr. Murugadas T. Loganathan (Wetlands International- Malaysia, Petaling Jaya) and Mr. Thai See Kiam (Malaysia Forestry Department, Kuala Lumpur); Nigeria: Mrs. Catherine Ekaete Ekut-Isebor (Nigerian Institute for Oceanography and Marine Studies, Lagos); Philippines: Dr. Jurgenne Primavera (SEAFDEC AQD, Iloilo), Mr. Rodolfo Ungson (Department Environment and Natural Resources, Quezon City); Senegal: Dr. Amadou Tahirou Diaw (Department of Geography, Cheika Anta Diop University, Dakar-Fann) and Mr. Abdoulaye Diame (Coordinator of NGO WAAME West African Association for Marine Environment, Dakar); Thailand: Professor Sanit Aksornkoae (Faculty of Forestry, Kasetsart University, Bangkok), Dr. Sonjai Havanond (Director Mangrove and Wetland Management Division, Bangkok); Vietnam: Dr. Mai Sy Tuan, Professor Phan Nguyen Hong, Dr. Phan Thi Anh Dao and Ms. Quan Thi Quynh Dao (Mangrove Ecosystems Research Division, Hanoi).

We are especially grateful to Dr. Marta Vannucci for her knowledge and companionship on a trip to India and Bangladesh with Dr. E Ashton and her numerous helpful comments on earlier versions of this document. Many others have also given valuable comments and suggestions; they include Francois Blasco (Université Paul Sabatier, Toulouse, France), Margarita Astralaga (Ramsar, Netherlands) and Ebbe Schiøler (retired Danida adviser, Denmark).

Special thanks are due to Dr. Ronald Zweig, World Bank, Washington and Dr. Shigeyuki Baba (ISME) for arranging the contract for this study, and for all their encouragement during preparation of the draft Code.

Mr. Thomas Nielsen, Centre for Tropical Ecosystems Research, University of Aarhus, Denmark, kindly formatted this document and prepared it for circulation.

INTRODUCTION

Traditionally, local communities in mangrove ecosystems collected fuelwood, harvested fish and other natural resources. However, in recent decades many coastal areas have come under intense pressure from rapid urban and industrial development, compounded by a lack of governance or power among environmental institutions. Mangroves have been overexploited or converted to various other forms of land use, including agriculture, aquaculture, salt ponds, terrestrial forestry, urban and industrial development and for the construction of roads and embankments. Mangroves can be affected by several different activities simultaneously, or over time as land use patterns change. Table 0.1 provides a summary of the main threats to mangroves by region of the world. The threat is estimated to be from low to high and whether it is deemed to be increasing or decreasing.

Over and above the chronic loss of mangrove area worldwide, mangrove habitats have also declines in terms of their biological diversity, forest structure and economic value.

Table 0.1: A summary table of the main threats to mangroves, by region

Threat	South and Southeast Asia	Africa	Central and South America
Natural disasters	Low-High *Increasing*	Medium *Increasing*	Low *Increasing*
Population pressure	High *Increasing*	High *Increasing*	Low-Medium *Increasing*
Over-exploitation by traditional users	High *Increasing*	High *Increasing*	Low *Stable-Decreasing*
Forestry	High *Stable*	Medium *Increasing*	Low *Stable*
Agriculture	High *Decreasing*	High *Increasing*	Low *Stable-Decreasing*
Aquaculture	High *Increasing*	Low *Increasing*	Medium-High *Increasing*
Salt Production	High *Decreasing*	High *Stable*	Low-Medium *Decreasing*
Mining	Low-Medium *Decreasing*	Medium *Increasing*	Low *Decreasing*
Urban and industrial development	High *Increasing*	Medium *Increasing*	Medium-High *Increasing*
Tourism	Low-Medium *Increasing*	Low *Increasing*	Low-Medium *Increasing*
Hydrological diversions e.g. dams	Medium-High *Increasing*	Medium-High *Increasing*	Low-High *Increasing*
Coastal pollution	Medium-High *Increasing*	Medium-High *Increasing*	Medium-High *Increasing*
Management shortcomings	Medium-High *Decreasing*	High *Stable*	Low-High *Stable*

Over and above loss of mangrove area, mangrove habitats have also declined in terms of biological diversity, forest structure and economic value, due to excessive harvesting of the most valuable trees. This

has caused a shift in the forest composition towards smaller trees and secondary growth as the larger trees were removed. The main factor leading to the loss of mangrove biodiversity is habitat loss caused by conversion or progressive degradation of the forest, water pollution and withdrawal. Even off-site activities can lead to mangrove degradation through siltation and changes in water flow and water quality, especially salinity change and changes due to pollution. Contaminants may be directly toxic to some marine organisms and their effects may be instantaneous or cumulative. Introduction of exotic species can also cause loss of habitat and biodiversity through competition with native species. It is also recognised that climate change now poses additional threats to mangrove ecosystems as mangroves occupy marginal land areas that would shrink significantly under the influence of projected sea level rise (UNEP, 1992). Many of the problems and causes of mangrove loss stem from failures in policy, management and enforcement of protection measures. These need to be dealt with urgently.

Recognition of the environmental, social and economic impacts associated with the decline and degradation of mangroves are now being addressed through legislative, management, conservation and rehabilitation efforts aimed at mitigating the negative impacts of development on mangrove ecosystems. These include the introduction of new legislation and new governing bodies with clearer administrative or advisory roles on environmental issues; stronger conservation status for some mangrove areas of outstanding value (e.g. as Biosphere Reserves); and more emphasis on public awareness raising and education. However, many of the current management policies adopted are still sectoral in nature, which frequently leads to conflict of interests, and to continuing unsustainable exploitation of mangrove resources. An integrated approach to coastal area and riverbasin/watershed management through coherent policy development and concerted action is increasingly being regarded as the best way to achieve conservation and sustainable use of mangrove and other coastal resources.

The development of a Code of Conduct for sustainable management of mangrove forest ecosystems is thought necessary to guide States[1] and mangrove managers as to the best measures. This Code is designed to assist as a tool for mangrove management. The Code is global in scope and is directed towards all persons concerned with the conservation and sustainable management of mangrove biodiversity resources, such as foresters, fishers, those engaged in processing and marketing of mangrove products, local, national, regional and global organizations, whether governmental or non-governmental, and local communities. The Code provides principles, guidelines and recommended practices applicable to the conservation and management of all mangrove ecosystems, supported by examples of management experiences from different countries. It also covers the integration of mangrove management within coastal zone and river basin management.

It is also recognized that there are already certain programmes and initiatives currently in existence supported through various National, International and State Agencies that already address some of the issues related to conservation and sustainable utilisation of mangrove resources. The Code is to be interpreted and applied in accordance with other applicable rules of international law, including the respective obligations of States pursuant to international agreements to which they are party, and in the light of the 1992 Rio Declaration on Environment and Development and Agenda 21 adopted by the United Nations Conference on Environment and Development (UNCED), and the more recent World Summit on Sustainable Development in Johannesburg, 2002. Together with other relevant declarations and international instruments/agreements, such as the Ramsar Convention on Wetlands of International Importance and in particular Resolution VIII 32 “Conservation, integrated management, and sustainable use of mangrove ecosystems and their resources”, the Convention on Biodiversity (CBD), Jakarta Mandate, the International Tropical Timber Organization Mangrove Workplan (2002-2006), Food and Agricultural Organization Mangrove Forest Management Guidelines, CITES, WHC, UNFCCC, CMS, UNCLOS, CCD (see acronyms and glossary for details). This Code of Conduct is designed to provide

[1] The term ‘States’ is used to refer to the authority responsible for mangrove management, be it Federal, Central, Regional, Provincial or Local Government and their departments and agencies, and traditional institutional structures (e.g. Chiefdoms, Village Councils).

support to such on-going activities and guidance for pipeline activities, e.g. the Africa Process and NEPAD (New Partnership for African Development).

Figure 0.1: The Food and Agricultural Organisation (FAO) Code of Conduct for Responsible Fisheries and the International Tropical Timber Organisation (ITTO) Mangrove Workplan 2002-2006 (Photo by Elizabeth Ashton, cenTER).

This Code of Conduct is intended to guide and assist in the creation of mechanisms for adequate legislation and the development, implementation and monitoring of coordinated policies for the protection of mangrove resources. The main themes that the Code of Conduct addresses concern measures to improve Mangrove Conservation through Policy, People and Productivity (Table 0.2). Conservation policies cannot succeed unless there is also help with the problems of people and production. Mangrove restoration and conservation policies must increase livelihood options for local communities and together with the introduction of best practices (ownership and sustainability) result in sustainable conservation of mangrove biodiversity.

Table 0.2: Logical Framework Analysis: Objectives of the Code of Conduct for Mangroves

OBJECTIVES	INTERVENTIONS (Activities Required)
Development Objective • **Conservation** To arrest the recent and rapid destruction of coastal mangrove ecosystems, to improve their management, and to conserve biodiversity in these critical natural habitats	▪ Directly protect pristine mangrove areas* ▪ Protect mangroves from destruction, degradation and other significant human impacts ▪ Promote natural regeneration where mangrove ecosystems have the capacity for self-renewal ▪ Rehabilitate degraded mangrove ecosystems ▪ Protect and enforce mangrove buffer zones ▪ Protect and enhance cultural and social values ▪ Promote and improve sustainable traditional management techniques ▪ Support co-management with local communities
Immediate Objectives **1. Policy** Innovate and disseminate appropriate policies and strategies for management and conservation of mangrove resources and ecosystems and have them adopted and implemented in focal regions and countries	▪ Improve and reform Governance structures for management and conservation ▪ Adopt policy reforms for sustainable management and conservation (from research and experience) ▪ Strengthen and harmonise regulations enabling the sustainable harvest of mangrove resources ▪ Restructure property right regimes to protect mangrove resources and ecosystems ▪ Promote use of economic incentives by governments and the private sector ▪ Disseminate information for better policy decisions ▪ Empower local people and promote participation in management of coastal resources ▪ Safeguard the use of traditional knowledge ▪ Promote research on mangrove ecosystems, species and genetics
2. People Improve food security, livelihoods and quality of life of those people dependent on mangrove resources and ecosystems	▪ Increase livelihood opportunities ▪ Strengthen capacity of stakeholders ▪ Identify and resolve ownership issues ▪ Promote sustainability of livelihoods ▪ Provide Communication, Education and Public Awareness support ▪ Be sensitive to equity and gender issues ▪ Promote fair trade of mangrove products
3. Productivity Increase and sustain the productivity of mangrove resources such as timber, fuel wood, fish, molluscs and crustaceans	▪ Identify and improve the use of best management practices for mangrove ecosystems through research, education and incentives for compliance by resource users ▪ Increase productivity from mangrove resources for commercial use, while protecting the livelihood of subsistence users ▪ Identify and promote alternative sustainable uses of the resources

* It should be noted that some countries already have legislation protecting all mangroves e.g. Brazil.

ARTICLE 1 MANGROVE MANAGEMENT OBJECTIVES

The fundamental objective of mangrove management is to promote conservation, rehabilitation and sustainable utilisation of mangrove ecosystems to benefit the global population.

1.1 The fundamental objective of mangrove management is to promote conservation, rehabilitation and sustainable utilisation of mangrove ecosystems. States and stakeholders can achieve this objective by:

1.1a Taking the precautionary approach to the management of mangrove ecosystems.

1.1b Adopting the ecosystem approach to the conservation of mangroves and associated watersheds and coastal ecosystems, including transboundary areas.

1.1c Identifying and protecting biodiversity hot spots and endangered species and habitats associated with mangrove ecosystems.

1.1d Recognising and supporting the special needs of traditional mangrove communities and other mangrove resource users.

1.1e Mitigating adverse environmental impacts on mangrove ecosystems caused by human activities and natural phenomena.

1.1f Rehabilitating or restoring areas of destroyed or degraded mangroves through natural regeneration, assisted if necessary by active intervention, including restoring the hydrological regime and/or planting mangroves.

Figure 1.1: A 100 ha area in Gazi Bay, Kenya was clear-cut in the 1970s to provide fuelwood for the chalk industry. In 1994, 7 ha were replanted with *Rhizophora mucronata*. Five years later in 1999 the trees had reached a height of 4 m and survival was greater than 80% (Photos by James Kairo, KMFRI, Kenya).

Figure 1.2: Destroyed mangrove in Los Micos, at the northeastern region of Ciénaga Grande de Santa Marta, close to Sevillano, on the Colombian Caribbean coast (Photo by Francisco Pinto-Nolla, Colombia).

Figure 1.3: The Majagual mangroves in Ecuador contain the tallest mangrove trees in the world (up to 65 m high). A mangrove forest area of 200 ha is totally protected as part of a larger 50,000 ha State level "Ecological Reserve" called the Cayapas-Mataje. (Photo by Alejandro Bodero, Esmeraldas, Ecuador).

1.2 States and all those engaged in mangrove management should adopt measures for the sustainable use of mangrove resources based on sound knowledge, supported by appropriate policy, legal and institutional frameworks.

1.3 Conservation and other management measures at all levels should take into account traditional knowledge and cultural values, together with the best available scientific information. Such measures should be designed to ensure the long-term sustainability of mangrove resources.

Short term considerations should not compromise this goal.

1.4 The following general actions are recommended to strengthen mangrove management:

1.4a Sates should establish, within their respective competence and capacity, effective mechanisms to conduct mangrove assessments (i.e. inventories and monitoring) and establish a mangrove management plan based on the resource assessment process.

1.4b Give due recognition, publicity and effective dissemination to government legislation, as well as local community guidelines/laws/traditions, protecting mangrove ecosystems.

1.4c Explain the purpose of conservation measures to the users of mangrove resources (transparency) to facilitate their compliance and thus gain increased support for the effective implementation of such measures.

1.4d Promulgate local ordinances and exercise political will to ensure enforcement of the legal framework for mangroves.

1.4e Institute Communication Education and Public Awareness (CEPA) programmes to develop awareness among the different sectors/stakeholders (in particular local decision makers) regarding the value of mangrove goods and services. Media and education programmes should be used to promote wider and deeper understanding of the importance of mangrove ecosystems.

1.4f Promote greater cooperation and action agreements (e.g. partnerships, stewardships) between States, NGOs, the private sector and community-based organizations, to enhance public awareness of policy issues and site-specific conservation problems, and to support government actions. It should be noted that local organisations and NGOs can work effectively with schools and colleges, and with the general public, through campaigns and media events.

1.4g Before committing funds for development projects e.g. roads, dams and irrigation systems, National Agencies and international organisations (e.g. development banks) should consider carefully the full value of mangroves and their ecological sensitivity relative to the direct and indirect impacts of the proposed development. Participatory and Independent Environmental Impact Assessments should be carried out before any proposed development is approved.

Figure 1.4: Examples of Information, Education and Public Awareness activities supporting the sustainable management of mangroves (Photo by Elizabeth Ashton).

In many countries throughout the world schoolchildren have produced paintings of mangroves, which have been compiled into books e.g. for Vietnam and into calendars e.g. by the Mangrove Action Project. In Vietnam the "Big Book" is used to teach communities about the importance of mangroves for protecting seadykes. In Colombia the Ministry of Environment and ITTO have published five booklets to educate the public about mangrove ecology, management and conservation. One is a general booklet "Salvemos Nuestros Manglares" and the others are specific booklets about the Pacific coast and Caribbean coast mangroves.

ARTICLE 2 PRECAUTIONARY APPROACH TO MANAGEMENT

The overall approach to mangrove management should be a precautionary one, but a lack of scientific information should not be used as an argument for postponing, or failing to implement mangrove conservation and sustainable management measures.

2.1 States should apply the precautionary approach to the conservation and sustainable management of mangrove ecosystems. Management should include consideration of the traditional knowledge, beliefs and customs of local communities.

BOX 2A: Precautionary Approach: Definition and Application

A decision to take action, based on the possibility of significant environmental damage, even before there is conclusive, scientific evidence, that the damage will occur (European Commission, 1999. Integrating environmental concerns into development and economic cooperation. Brussels).

Principle 15 of the Rio Declaration on Environment and Development states that:

"In order to protect the environment, the precautionary approach shall be widely applied by the States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." (Jakarta Mandate, 1995).

2.2 Identify existing mangrove areas for preservation, conservation or sustainable utilisation based on their location, ecological characteristics and values (see Tables 2.1 and 2.2).

2.2a Where pristine or near pristine mangroves still exist, immediately adopt protection and conservation management measures. Such efforts should remain in force until there are sufficient data to allow a comprehensive assessment of the impact of alternative forms of management (e.g. via an independent Environmental Impact Assessment).

2.2b Protect critical mangrove areas for biodiversity conservation, to maintain all endemic and rare species, including their habitats. The IUCN Red List of Threatened Species defines and lists all critically endangered, endangered, vulnerable and near threatened species.

BOX 2B: Examples of endangered mangrove-associated animal species

The Sundarbans Tiger in India and Bangladesh, and the Proboscis monkey in Borneo, are endangered mangrove species.

Manatees and Dugongs are vulnerable throughout tropical regions. In some areas they have become extinct due to overhunting (the meat is much appreciated by local people and the hide used for local weapons and musical instruments, the very soft hide was also used for parts of delicate instruments such as barometers and max and min thermometers) and accidental death in fishing nets. Loss of mangrove and seagrass habitats has been another major cause for the serious decline in the populations of these sea mammals. In South America two species of Manatee are endangered, *Trichechus manatus* (Caribbean) and *T. inunguis* (Amazonian Rivers) (Alvarez, 2001). In the Saloum Delta, Senegal there is a local campaign by NGOs to increase awareness about the need to protect manatees.

Figure 2.2: Bengal Tiger, Sundarbans, India (Photo by B. Roychowdhury, Forest Department, India).

Figure 2.3: Manatee in the Saloum Delta, Senegal (Photo by Abdoulaye Diame, WAAME, Senegal).

2.2c States should control and carefully regulate the introduction of alien/exotic species and genetically modified organisms into mangrove ecosystems. The Convention on Biological Diversity (CBD) guidelines on alien/exotic species (see Box 2C) should be used for guidance. (See also Article 10.9 alien/exotic species introductions for aquaculture).

BOX 2C: Convention on Biological Diversity (CBD) Guidelines on Alien/Exotic species

Article 8h CBD
Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species (CBD, 1992).

Invasive alien species are species introduced deliberately or accidentally outside their natural habitats where they have the ability to establish themselves, invade, out compete natives and take over the new environments. Intentional introductions include species for aquaculture or forestry; accidental introductions such as organisms accompanying those introduced for economic purposes (viruses, parasites); escapees from aquaria, zoos and other scientific facilities or through fouling of ship hulls or ballast waters. The threat to biodiversity due to introduction of alien species is considered second only to that of habitat loss (http://www.biodiv.org/programmes/cross-cutting/alien).

BOX 2D: Examples of alien/exotic introductions into mangrove ecosystems

Nypa fruticans (nipa palm), a mangrove species native to Southeast Asia, was brought from Singapore to Nigeria in 1906. It was introduced along the coasts of Calabar and Oron in eastern Nigeria to control erosion. However, the nipa palm spread westwards to the State of Ondo, where it invaded extensive areas and displaced valuable indigenous mangrove species, such as *Rhizophora* and an important palm, *Raphia*. It also posed other serious ecological and socio-economic threats by invading fish nursery and feeding grounds. (Contrary to the situation in Southeast Asia, nipa palm is not utilised by the local people of Nigeria). The Federal Ministry of Environment has developed an intervention, the "Nypa Palm Control Programme" to control the spread of this invasive species. Under this programme, the nipa palm is being removed and areas rehabilitated with native mangrove species. Local people should also instructed on the many uses of the valuable palm (thatching material, sugar, vinegar and alcohol).

Tilapias introduced to Asia from Africa for aquaculture purposes (various introductions were made from 1946 on) have now colonized extensive brackishwater areas with mangroves even though it is a freshwater group of fishes. Similarly, in Colombia two freshwater fish species were introduced: the Red Tilapia *(Oreochromis* sp*.)* from Africa for cage aquaculture and the snake skin gourami *(Trichogaster pectoralis)* from Asia for ornamental aquaria, but they escaped and have now colonised the Magdalene River and lagoon near Bogota replacing native fish species. Today, both the tilapia and gourami have become dominant species in the local fishery.

2.2d In areas designated for forest utilisation e.g. production forest, adopt a precautionary approach, especially where information/experience on sustainable forestry practices is not available or is limited.

2.2e Adopt stringent precautions (such as EIAs, environmental audits, environmental management plans) where other economic development activities in mangrove ecosystems are planned, especially those involving loss of mangrove habitat e.g. industry, urban development, agriculture and aquaculture. The potential impact from tourism should not be overlooked.

2.2f Adopt strict protection and conservation management measures for mangroves (e.g. greenbelt/buffer zones) where natural phenomena (such as typhoons/tidal surges/cyclones), have a significant adverse impact on the coastline. Mangrove forests mitigate the effects of storms, by absorbing wind and wave forces, thereby reducing the risks of disasters. Similarly, erosion-prone coastlines and riverbanks should be protected with legally designated mangrove green belts.

Figure 2.4: Mangrove protection belt (1 km wide) of *Kandelia candel* planted in the Red River Delta, Vietnam (Photo by Don Macintosh).

A mangrove protection belt in association with coastal sea dykes in the Red River Delta, Vietnam has greatly improved coastal protection against typhoons. Engineers estimate that an earthen sea dyke with rock facing (revetment) will last about 5 years before it requires repair due to wave damage; however the same sea dyke with a 100m wide protective belt of mangroves in front, will last up to 50 years!

Vietnam has also enacted a 500-1000 m wide green belt (Full Protection Zone) along the Mekong Delta coastline for storm and flood protection (see details Box 3B).

The Philippines has a forestry code specifying a 20 m wide mangrove buffer zone along all shorelines, and 50 m wide in typhoon-prone areas.

2.3 States should continuously adjust, refine and where possible enhance, the precautionary approach to mangrove management as knowledge and experience are gained.

Table 2.1: Conservation management priorities for critical mangrove forest areas in Southeast Asia, classified by habitat and community type

Category	Management Priorities
Mangrove forests which are primary/pristine	Regardless of location, pristine mangrove forest should be preserved or declared as forest reserves because such areas are important in maintaining ecological balance in the coastal ecosystem and for educational and research purposes and as genetic reservoirs.
Mangrove areas subjected to significant environmental hazards for example storms, erosion, floods, water withdrawal and seasonal drought	A minimum protective zone of mangrove forest should be left untouched. The following are examples of the minimum width for mangroves specified in some Southeast Asian countries: > 100 m on open coast > 25 m on river banks and lagoons > 10 m on inland banks, creeks and channels
Mangrove areas near or adjacent to known habitats important as fish, molluscan and crustacean nurseries and/or fishing grounds	Considering the importance of mangroves as nursery grounds for aquatic species, mangroves near or adjacent to known areas abundant for fish, molluscan and crustacean fry and/or fishing grounds should not be alienated or released for development.
Mangrove areas near populated areas/urban centres	Some mangrove areas in urban areas should be conserved exclusively for sustainable utilisation, coastal protection, tourism, education and recreation purposes by the local people who should be involved in any reforestation and maintenance efforts.
Mangroves on small islands	These mangroves serve as a major ecological component of the island ecosystem and should in no case be disturbed.
Mangroves in estuarine areas	To maintain the ecological balance of estuarine areas there should be protection zone areas of mangroves preserved on the banks of the mouth of the river fronting the sea.
Mangroves with abundant mature trees producing seeds and propagules (mother trees)	Mother trees are vital for restoration and rehabilitation as sources of seed and propagules for planting. They are also the means for mangroves to self sustain.

Modified from: National Mangrove Committee of the Philippines.

Table 2.2: Management priorities for mangrove forest areas in South America, classified by physiographic type and indicator species

Category	Indicator Species	**Management priorities** (applying to all categories)
Overwash Forest	*Rhizophora, Anadara, Ucides, Crassostrea*	Conservation of biodiversity specific for each physiographic type Protect a physiographic type of mangrove when the pressure for a resource in that area is high Protect areas where ecological processes/services e.g. energy flow are important for ecological functioning of the mangrove ecosystem and related systems Restrict activities which promote the deterioration of the environment e.g. the positioning of shrimp farms and agriculture activities in predominantly basin forests
Fringe Forest	*Rhizophora, Avicennia, Ucides, Anadara, Iguana, Uca*	
Riverine Forest	*Laguncularia, Rhizophora, Cardisoma*	
Basin Forest	*Avicennia, Conocarpus, Melamphus, Cardisoma, Uca*	
Hammock Forest	*Rhizophora, Avicennia*	
Scrub Forest	*Rhizophora, Avicennia*	

The six physiographic types are modified from Lugo and Snedaker (1974) and Odum et al. (1982).

ARTICLE 3 LEGAL FRAMEWORK

National and international legal frameworks are required to provide overall guidance for the conservation and sustainable use of mangrove resources and to ensure protection for mangrove-associated biodiversity.

3.1 States should ensure that effective policy, legal, institutional and administrative frameworks are developed at the local, national and transboundary levels, as appropriate, to support mangrove management.

3.2 The legal and institutional framework for mangroves is often complex and poorly understood at all levels. The regulatory authority should review the legal status of mangroves at national level, then consolidate and summarize the key points into a form that can be easily understood by stakeholders; e.g. as a pamphlet in the local language with illustrations.

3.3 Clear agency responsibilities for mangrove management are needed, but the lead agency concerned must support effective cooperation mechanisms with other concerned agencies and all stakeholders.

3.4 It is desirable to have clear targets for mangrove conservation and rehabilitation. The overall goal should be to protect and sustainably manage all remaining mangrove ecosystems. It is especially important to avoid further fragmentation of mangrove habitat.

3.5 Physical zoning of mangroves can be a valuable, practical means to help implement conservation and other management objectives. Mangrove areas should be clearly zoned, with the function and conservation status of each zone clearly identified and legally defined.

3.6 Engineering works such as sea walls, embankments and roads, which may affect the normal tidal flow and sediment deposition along mangrove-fringed coastal belts, should not be permitted without a prior study of their impact on the hydrological regime as part of a full, independent EIA and approval by the governmental authorities responsible for mangroves.

BOX 3A: Examples of the legal framework for mangroves

Policy

- Thailand currently (2002) has about 170,000 hectares of mangrove forest. The national policy is to increase this area to 200,000 ha by 2006. There is a recently assigned Office of Mangrove Conservation under the Department of Marine and Coastal Resources, which is a department under the new Ministry of Natural Resources and Environment.

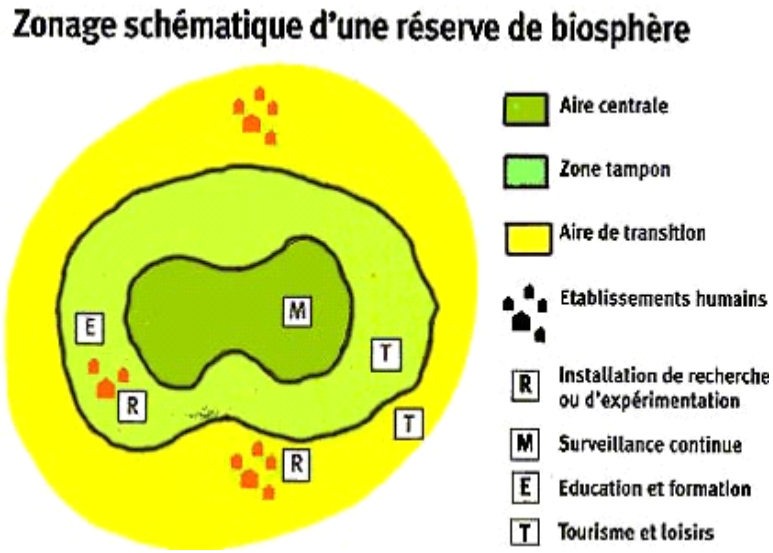
Regulations

- The Philippines has a law prohibiting the cutting of any mangrove forest, whether natural or plantation forest.
- In Brazil, it has been illegal to cut mangroves since 1926 and the legislation was amended in 1965 to make it even more restrictive. Some exceptions are permitted, e.g. to allow for important public utilities, such as bridges and electricity lines. Environmental legislation was further strengthened by the law on environmental crime in 1998.

BOX 3B: Examples of land use zoning involving mangroves

- Vietnam has enacted a zoning plan for the Lower Mekong Delta featuring a Full Protection Zone (FPZ) for coastal protection, a Buffer Zone for controlled economic activities (40% by area), but retaining 60% forest cover, and an Economic Zone where there are no forest conservation restrictions. The FPZ is to be demarcated with clear signs using both symbolic and written information.

- The National Mangrove Plan for Ecuador has strategies for zonation that were accepted in 1990. The zonation plans for each province (Esmeraldas, Manabi, Guayas and Guayaquil) are implemented depending on the user groups. Reserve mangrove areas and community areas are identified within the designated mangrove zone.
- Saloum Biosphere Reserve, Senegal has a zoning plan (with IUCN support) with core, buffer and transition zones. The central area is strictly protected and is a national park, it is clearly marked and understood by the local people and the government. However, the buffer zone for sustainable development and the transition zone for multiple use are not clearly marked and understood both by the local people and government.



3.7 In view of the multiple uses of the coastal zone, States should ensure that representatives of all the different sectors/stakeholders are consulted in the decision-making process in development and management planning, and in environmental protection activities for mangroves.

3.7a The best multiple use systems for coastal areas involving mangroves need to be determined by careful assessment of the environmental and socio-economic conditions affecting local stakeholders and with all stakeholders participating in the assessment process.

3.7b Non-destructive uses of mangrove ecosystems should be encouraged over activities that involve destroying mangroves and/or altering their hydrological conditions.

3.7c All decisions on development activities in mangrove ecosystems should be well founded from a wide base of knowledge, including resource assessments, research studies and stakeholder consultations.

3.7d States should provide the financial and economic conditions for coastal cities to have adequate sewage and landfill treatment systems. Mangroves can be used to treat sewage on a small scale but not for large cities.

BOX 3C: Examples of inter-agency consultations on mangrove management issues

Inter-agency stakeholder consultation and licensing practices have been established for the Matang Mangrove Forest Reserve in Peninsular Malaysia. The licensing of charcoal kilns and wood harvesting is done by the Forestry Department and fish cage licensing by the Fisheries Department. Preservation of a bird sanctuary and archaeological sites were also agreed after consultation with the wildlife department and national museum, respectively. In Malaysia it is standard practice to have State and District level committees dealing with all administrative and operational issues. The District level committee, chaired by the District Officer is where real on the ground issues can be discussed and resolved among the different agencies concerned. The District committee also includes community leaders such as the local member of parliament and or state legislative council members of the District concerned.

Songor Ramsar site, Ghana has a committee that works in consultation with government agencies. The Ghana Wildlife Division at the national level constituted the National Advisory and Oversight Committee with representations from the District Assembly, Wildlife Office, District Planning Office, Traditional Council, Traditional Authorities, Women's groups, Fisherfolks, Farmers, Canoe fishermen and farmers associations, Co-operative salt winners associations and the local media.

3.8 States and mangrove managers should ensure that the laws and regulations protecting mangroves provide for effective penalties against violations, which are adequate in severity to be effective, including withdrawal, refusal or suspension of user authorizations in the event of non-compliance.

3.9 The following measures are recommended to promote compliance with the appropriate laws and regulations:

- Licensing systems to legalize the activities of legitimate mangrove users.
- Designated mangrove forest areas set aside to help meet the subsistence fuelwood and timber needs of very poor mangrove dwellers.
- Penalties for violations should reflect the severity of the mal-practices concerned.
- Speedy disposition of cases involving violations of laws and regulations are strongly urged to protect mangrove resources, and as a deterrent to would-be violators.
- Education of all stakeholders in key aspects of mangrove legislation (see also Article 3.1a)
- Develop actions to promote the organisation of local communities in order to ensure supervision and the full respect of the law and local planning

BOX 3D: Examples of measures to promote compliance with the legal framework for mangroves

Example of an appropriate level of enforcement - In Peam Krasop Wildlife Sanctuary (Koh Kong Cambodia), illegal charcoal kilns were destroyed from 1995 by the Department of Environment, as they were the cause of large-scale cutting of some of Cambodia's best mangroves. The DoE operated with the support of an inter-agency committee set up by the Provincial Authority against charcoal production activities. This action was also backed by existing legislation (Decree 33, dated 1987) prohibiting the cutting of mangrove wood for charcoal production, and a Royal Decree on Protected Areas Management in Cambodia. To further strengthen its fight against charcoal production, in 1999 the Provincial Authority (DoE) declared the buying or selling of mangrove charcoal to be illegal, thereby targeting the powerful middlemen in the charcoal trade for the first time, as well as the producers.

Strict penalties are applied in Ecuador to those destroying mangroves illegally, namely a fine of USD 7000/ha; in addition, violators have to replant the affected area.

In Kenya, to be allowed into the mangrove forest to harvest mangrove wood products, a cutting license (cheti cha ukataji) is required from the Forest Department. The cheti designates the cutting areas and number of mangrove poles permitted to be extracted from the forest. The cutting permit is revised annually at a cost of USD 135 for poles and USD 40 for firewood. After cutting the poles are all brought to a landing site and piled into their respective size classes. The royalty paid to the government depends on the quantity and utilisation class removed (e.g. twenty poles of diameter size 11.5 cm to 13.5 cm is charged a revenue of USD 1.5). There is no tax charged to cutters for harvesting poles for domestic use.

3.10 In conformity with their national legislation, States should implement effective assessment, monitoring, surveillance and law enforcement measures to protect their mangroves.

3.10a Surveillance and law enforcement are most effective when supported by self-regulation by the local communities themselves.

3.10b Monitoring/assessment of mangroves must be simple and inexpensive, but reliable. Two levels of assessment are desirable (a) routine, low level monitoring by local people; (b) more intensive, periodic monitoring by governmental agencies, NGO's and researchers. (See Article 5 for recommended methodology).

3.10c States should encourage studies and research which supports the legal actions and the establishment of the maximum sustainable extraction quantities for fish, molluscs and crustaceans

BOX 3E: Examples of Community self-regulation – The concept of Sacred Forest

In Ghana, although many coastal wetlands are regarded as the abode of Gods, and therefore are well revered and protected, access to mangrove sites are not restricted because most of the coastal communities continue to depend on the mangroves for domestic fuelwood. As they have done traditionally, tribal elders still influence the allocation of mangrove resources to families in their communities.

3.11 States should identify and adopt mechanisms by which mangrove conservation activities can be financed, so that much of the cost of conservation, management and supporting research and education can be recovered. Mangrove Forest Development Funds (MFDFs) or Environmental/Ecological Trust Funds are recommended as good potential mechanisms for financing mangrove conservation activities. A percentage of the royalty is charged on mangrove products (e.g. timber, aquaculture products); this levy is placed in the MFDF exclusively to support mangrove conservation and rehabilitation.

BOX 3F: Examples of Forest or Trust Funds used to support mangrove conservation

- In Malaysia, the Forest Development Fund (FDF) is established by the State Forest Departments in accordance with Section 56 of the National Forestry Act (1984). The FDF is established through an existing financial procedure known as the financial instrument. This specifies the type of expenditure allowed, e.g. for enrichment planting, silvicultural treatments and rehabilitation, or forest inventory, which are directly related to forest development or forest rehabilitation. The FDF is administered by the Forest Department, which reports to the State committee chaired by the State Secretary, with the State Financial Officer and the Director of Forestry included as committee members. A yearly expenditure and income statement is submitted to the committee for approval, together with annual auditing by the government auditor-general. The FDF covers forest development in general for the whole state, including mangrove and freshwater swamp forests.
- In the Philippines, 25 years leases are provide to local communities as Community Based Mangrove Forest Management Agreements (CBMFMA); 10% of the harvest value of mangrove wood is set aside to support mangrove reforestation costs.
- In Nigeria, there are Ecological Trust funds generated as one percent of the revenue from oil. The trust funds are used to address environmental problems e.g. coastal erosion and could be made available for mangrove conservation projects.

ARTICLE 4 IMPLEMENTATION

There is a general weakness in the implementation of the legal framework for mangroves and lack of consultation between the management agencies and the various mangrove stakeholders.

4.1 Mangroves should be managed using the Ecosystem Approach, taking due account of activities and impacts both upstream of the mangrove ecosystem and in adjacent coastal areas. Mangrove management should also take into account previous management measures already established and applied in the region.

BOX 4A: Examples of upstream and other indirect activities affecting mangroves

In India, water and sediments from the Ganges River have been diverted through a barrage (dam) at Farakka since 1974. This has adversely affected agriculture, navigation, irrigation, fisheries, forestry and industrial activities, and increased salinity intrusion of coastal rivers, groundwater, riverbed aggradations, sediment influx, coastal erosion and submergence in Bangladesh. Together with agricultural and industrial activities upstream polluting the remaining water, it has caused a number of negative impacts for the Sundarbans mangrove ecosystem. The stress of the system is thought to be one reason for the top-dying of the Sundari trees (*Heritiera fomes*) (Gorai River Restoration Project EIA, 2001).

In Ghana, the construction in 1964 and 1983 of Akosombo and Kpong dams, respectively, has reduced the rate of seawater intrusion into the River Volta, thereby limiting the mangrove habitat along the banks of the river to about 10km of the coast.

In the Jaguaribe Estuary, Brazil, a dam constructed upriver of the mangrove ecosystem has reduced the deposition of alluvial sediments along the estuary, leading to die-off some of the mangrove forest near the estuary mouth (Lacerda, 2001).

4.2 Management objectives should be translated into specific actions by developing implementable management plans within the legal framework for mangroves. Based on the management plan, realistic operational plans should be developed that are suitable for local implementation, simple, practical and transparent.

4.3 The management of the mangrove ecosystem as a whole should include clear management objectives for each of its individual resources. Management plans should be reviewed and adjusted periodically, so that each resource can be managed optimally.

4.4 States should harmonise institutional arrangements for mangrove management to clearly define responsibilities and to minimize duplication and overlapping of efforts and funding among the various agencies/departments concerned.

4.5 States should promote and coordinate cross-sectoral planning and implementation, which includes the private, scientific and NGO sectors and, in particular, takes account of the needs and rights of local people. For this purpose a national coordinating body for mangrove management is strongly recommended (e.g. a National Mangrove Committee; see Box 4B).

BOX 4B: Examples of national coordinating bodies for mangroves

National Mangrove Committees (NATMANCOMs) were set up in many Asian countries with assistance from the UNESCO/UNDP Regional Project RAS/79/002: Research and Training Pilot Programme on Mangrove Ecosystems. UNESCO requested each participating country to constitute a NATMANCOM, both to act as an advisory body on mangroves for the country concerned, and to participate at regional level in the project activities as a member of the Regional Task Force for mangroves. The NATMANCOMs operated well through the project period up to 1989 and continued to work effectively in several countries after the project.

The Indian National Committee on Mangroves and Coral Reefs in the Ministry of Environment and Forests includes members from the Coast Guard, Ministry of Defence; Department of Ocean Development; Central Marine Fisheries Research Institute; Botanical Survey of India; Zoological Survey of India; National Institute of Oceanography; Calcutta University and Annamalai University. The Committee was formed under the Government of India in 1978-9 and meets twice a year. For implementation the information discussed at the National Committee is disseminated to the State Level Steering Committees. Information also passes in the opposite direction. Implementation of Management Action Plans is through the State Forest Departments (one in each State of India). There are also Research Sub-committees on Conservation and Management of Mangroves and Coral Reefs. NGOs such as the Mangrove Society of India are encouraged to create awareness among the people and work on major mangrove projects associated with local communities.

4.6 Mangrove biodiversity conservation should be strengthened by assigning protected area status to appropriate locations, especially those that also have important ecological, cultural or historical significance. Such areas should be legally protected through governmental legislation. Countries can also nominate a protected area for international recognition if it conforms to one of the existing international conventions (see Table 4.1).

Table 4.1: Examples of Protected Areas involving mangroves

IUCN Protected Area Category by purpose	Mangrove Site	National Status*	International Status*
Ia: Strict Nature Reserve	Majagual, Esmeraldas, Ecuador	Ecological Reserve	Ramsar Site
Ib: Wilderness Area	Sundarbans, India and Bangladesh	Wildlife Sanctuary, Reserved Forest, Sundarbans Tiger Reserve	World Heritage Site Biosphere Reserve Ramsar Site
II: National Park	Superagui National Park, Paraná, Brazil	National Park	World Heritage Site
III: Natural Monument	CanGio, Vietnam	Special use forest	Biosphere Reserve
IV: Habitat/Species Management Area	Xuan Thuy, Vietnam	Special use forest	Ramsar Site
V: Protected Landscape/Seascape	Peam Krasop Wildlife Sanctuary, Cambodia	Wildlife Sanctuary	Includes a Ramsar Site
VI: Managed Resource Protection Area	Somone Lagoon Community Protected Area, Senegal	Conservation forest	Biosphere Reserve

* It is possible for a mangrove conservation area to be granted both legal status nationally as a protected area and international recognition at a number of levels. Classifications include National Parks and Nature Reserves (terminology used varies, see Glossary for details of The World Conservation Union (IUCN) categories in Table above). Other designations can also recognise areas of special natural or cultural significance. For example, countries can nominate areas to be accepted as internationally important through different conventions – World Heritage Sites, Biosphere Reserves and Ramsar Wetlands.

ARTICLE 5 MANGROVE INVENTORY FOR MANAGEMENT

Mangrove survey, inventory and monitoring data are required to support sustainable management.

5.1 There is a severe lack of current baseline information for management. As a first step, States should undertake a survey and inventory of all mangrove areas using standard methodologies (see Box 5A for guidelines).

BOX 5A: Guidelines for Mangrove Survey and Inventory

Basic information required:

Biophysical features

- Location, Area and Demarcation (defined by maps, satellite imagery and GPS)
- Climate (major features e.g. rainfall and temperature)
- Tidal/Hydrological regime
- Dominant Soil Type (colour, organic matter content and texture)
- Water chemistry (salinity, pH, colour, transparency and nutrients)
- Type of forest (primary, secondary, degraded)
- Structure of the forest (density of forest, height of trees, basal area of trees).
- Species inventories (flora and fauna and note special features including rare/endangered species)

Management features

- Existing or proposed land zoning system
- Land/water use and Ownership
- Local knowledge/Traditional uses
- Ecosystem products, functions and attributes
- Pressures and threats on the area
- Potential areas available for rehabilitation/restoration

Key References on Methodologies:

1. Ramsar Framework for Wetland Inventory (8th Meeting of the COP Spain, November 2002). The Framework provides guidance on a standard approach to designing a wetland inventory program from site based to provincial, national and regional levels. It includes information on determining appropriate remote sensing techniques to apply, existing standardised inventory methods, and recommends standards for core data field and data recording.

2. Conservation International methodology for rapid assessment of aquatic systems (AquaRAP) (see http://www.biodiversityscience.org/xp/CABS/research/rap/method). Small teams of expert biologists (international and national) conduct rapid assessments of the biological value of selected areas over a short time period (3-4 weeks) to aid in protecting areas.

3. Survey Manual of Tropical Marine Resources (English *et al*., 1997). Provides detailed methods on mangrove surveys, including measuring forest structure and environmental parameters.

4. A Manual for an inventory of Asian Wetlands (Finlayson *et al*., 2002). Provides a detailed protocol on the assessment, evaluation and monitoring of wetlands in Asia. Similar to Ramsar Framework for Wetland Inventory but with more detailed information on core data collection.

5. Marine Protected Areas (Gubbay, 1995). Provides principles and techniques for management (selection, legislation, making a management plan, techniques for zoning, enforcement, involving the community and education and interpretation).

6. Manual for Investigation of Hydrological Processes in Mangrove Ecosystems (Kjerfve, 1990).

7. The mangrove ecosystem: research methods (Snedaker and Snedaker, 1984).

8. World Mangrove Atlas (Spalding *et al*., 1997). Provides maps and areas of mangrove cover for each country of the world.

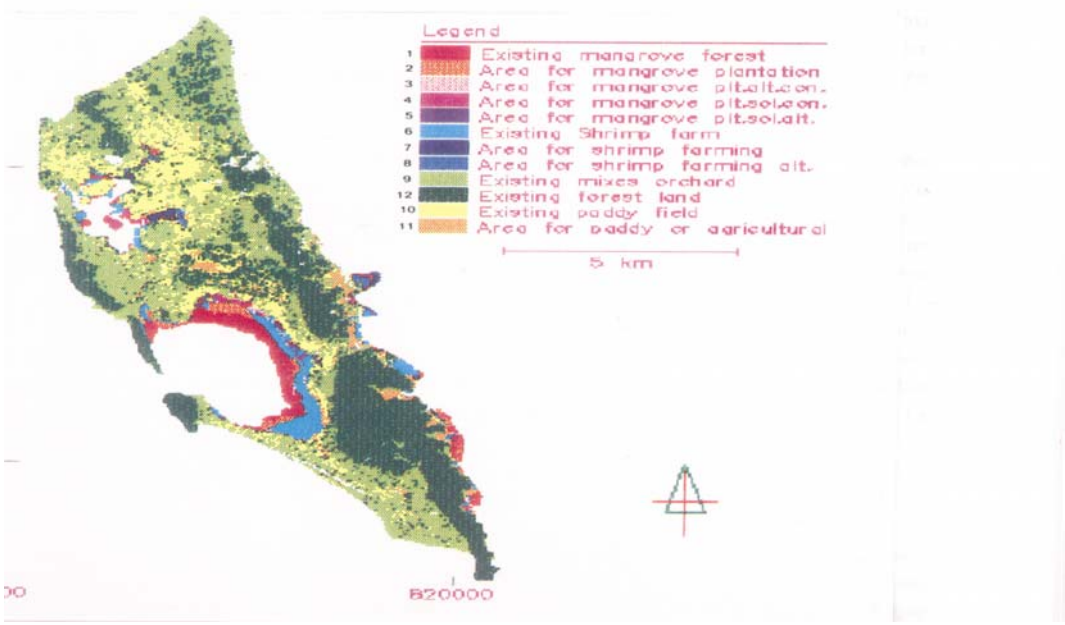
9. Mangrove Forestry in Bangladesh (Siddiqi, 2001). Describes the Sundarbans and Chokoria Sundarbans management, silviculture, nursery techniques and planting on accretion areas.

5.1.a States should integrate baseline data with remote sensing and GIS to directly address priority management issues.

BOX 5B: Examples of remote sensing as a tool for mangrove management

In Thailand a mangrove forest database has been installed on the TYDAC-SPANS GIS of the Remote Sensing Center. A correlation analysis between physical factors (soil, geomorphology, tidal amplitude and latitude, water salinity) and mangrove forest properties was performed to determine the actual potential of this area for mangrove forest development. A "site potential map" was then produced. The site potential map was combined with a land cover map drawn through remotely sensed data, resulting in a land use coastal planning map.

Figure 5.1: Land use coastal planning map of Khungkraben, Thailand



In Bangladesh, hydro-dynamic model studies have been applied to predict impact on mangrove stand due to salinity level changes because of reduced fresh water flow.

5.1.b States should develop and adopt simple indicators as a tool to monitor environmental changes in mangrove ecosystems that can be understood by local managers and communities and used by them to record the impacts of management interventions. For example:

- Number of damaged trees (high = negative indicator)
- Viable fruiting on mangrove trees (high = positive indicator)
- Abundance and diversity of birds (high = positive indicator)
- Soil stability (high erosion rate = negative indicator)
- Crab abundance and diversity (high = positive indicator)

5.2 States should integrate all mangrove baseline data/inventory information into a national database and update this regularly as a tool for management decision-making and made available to all stakeholders. States should strengthen and develop existing institutions and information systems and establish standardized regional databases and procedures for collection, collation, retrieval and dissemination of information related to mangroves. Establish a Database Network and

websites and organize regular meetings and workshops for database managers to update the information. Establish programmes for interpretation and extension so that the results of research and technical reports are rapidly accessible to the community and decision makers.

5.3 States should promote regional and international co-operation in mangrove information gathering and exchange, research collaboration and the sharing of management experiences. (See Article 14 on mangrove research and information exchange for further details of research support for mangrove management).

BOX 5C: Examples of mangrove databases operating at different geographical scales

National

The Kenya mangrove database was set up by the Eastern Africa Coastal Resources Database and Atlas Project under the UNEP Regional Seas Program in 1994. The database is maintained by the Kenya Marine and Fisheries Research Institute (KMFRI), and contains ArcInfo 3.4.2 coverage of all mangrove areas along the Kenya coast. Details of mangrove species composition, type classes, stem density as well as average volume in cubic meters per hectare are included in the database. The database is compatible with GIS ArcView software. The database is constantly consulted by the Government agencies interested in mangrove management such as the Forest Department, the Fisheries Department and the Kenya Wildlife Service.

Senegal started a database on its protected areas including mangroves in 2000. WAAME an NGO in Senegal in partnership with ADG (Belgium) and Department of National Parks are compiling a mangrove database funded by EU, 2003. The database is for scientists, NGOs, Universities at national and international levels working on mangroves in Senegal. The database will be held in WAAME's resource centre in Foundiougne.

Regional

The Centre for African Wetlands (CAW) was commissioned in 2001 at the University of Ghana to contribute to the preservation of the global, regional, national and local values of West African wetlands for the benefit of society as a whole. CAW has initially focused on twelve countries: Benin, Burkina Faso, Cameroon, Cape Verde, Côte d'Ivoire, Ghana, Guinea-Bissau, Liberia, Mali, Mauritania, Nigeria and Senegal, for the partnership development and the subsequent establishment of the CAW network and focal points. It serves therefore as a reference point for information on West African wetlands.

International

The Global Mangrove Database and Information System (GLOMIS) was started in 1996. It is a searchable database (http://www.glomis.com) of scientific literature relating to mangroves, institutions and scientists working on all aspects of mangroves, as well as regional projects and programmes related to mangroves. GLOMIS is based at the International Society of Mangrove Ecosystems (ISME) Secretariat in Okinawa, Japan, and is supported by four Regional Centres located in Brazil, Fiji, Ghana and India. The ISME Regional Centre for Central and South America (located in Fortaleza, Brazil) provides copies of mangrove references from the GLOMIS database on request and exchanges information with other libraries in South America.

ARTICLE 6 SOCIO-ECONOMIC CONSIDERATIONS

Mangroves provide important socio-economic benefits to poor coastal communities worldwide and the sustainable management of mangrove resources is necessary to maintain and improve their livelihoods.

6.1 All proposed development projects that may impact on mangroves both directly or indirectly should have an EIA which encompasses socio-economic valuations (e.g. cost-effectiveness and social impact) that reflect the true social, economic and cultural costs and benefits of the planned development.

6.2 When deciding on the use, conservation and management of mangrove resources, due recognition should be given, as appropriate, in accordance with national laws and regulations, to the traditional practices, needs and interests of indigenous people and other local communities who are highly dependent on mangrove resources for their livelihood.

6.3 States should adopt policy measures (e.g. education, licenses, enforcement) to ensure that the levels of extraction of natural resources (e.g. forest cutting, fish, crustacean and molluscan harvesting and aquaculture) are kept within permitted and sustainable levels.

6.4 In mangrove ecosystems where natural resource utilisation already exceeds sustainable levels States should introduce mitigation measures in consultation with the user groups. Mechanisms should be established to reduce exploitation to a sustainable level and to monitor and enforce this effectively (see Box 6A).

BOX 6A: Examples of protection systems used in mangrove ecosystems

In the mangroves in Ecuador there are user groups for crabs (involving both male and female collectors), mussels (female collectors only), charcoal production (men only) and other user groups e.g. tourist guides (both men and women). Each group nominates a representative for the "National Coordination for mangrove protection" committee which co-ordinates with the State. Many NGOs (e.g. Fundecol, Greenpeace, Ecological action and FEPP) support the committee with funds for reforestation, policing/protection of the resources and education in mangrove values. Photos and videos are available illustrating the workings of this committee for education and dissemination to other interested parties.

Mangrove planting for coastal protection against typhoons has been supported by Red Cross funded projects in nine provinces of the Red River Delta region of northern Vietnam (Fig. 2.4). Poor households selected by each commune were paid to plant *Kandelia candel*, propagules. *Rhizophora stylosa* propagules and *Sonneratia casseolaris* seedlings were also interplanted with *Kandelia* at some sites. The coastal communes involved with mangrove planting were also helped to establish a mangrove protection system, with guards (paid initially by the projects, then later by the communes themselves), guard posts and in some cases patrol boats. Each commune has also erected notice boards explaining the benefits of the mangroves, but also setting out community regulations regarding their unlawful exploitation, based on an agreed punishment and reward system. An example from Thai Thuy District in Thai Binh Province is shown in Table 6.1

Table 6.1: Community regulations for mangrove protection in Thai Binh Province, Vietnam

Regulations	Penalities and Rewards
1. All people have responsibility for protecting mangrove forests	For cutting trees or grazing animals – VND 50,000 For cutting mangrove branches VND 20,000 For catching aquatic products in newly planted areas – VND 5,000 A reward of 50% of the fine paid is given to the persons informing the guard team about violators of the regulations
2. Planters have to fulfill their contract duties	
3. Cutting, catching aquatic species and grazing by domestic animals is not allowed	
4. People using boats must use the designated corridors	

Note: VND 15,000 = USD1.00 approximately.

6.5 Sustainable livelihood options for local communities dependent on mangroves should be identified and encouraged within prescribed limits. Potential livelihood activities include indigenous fish cage culture and mollusc culture, apiculture and agro-forestry plantations on the adjoining community lands. States should encourage local communities and NGOs with good experiences/practices of sustainable livelihood practices to document them.

6.6 States should encourage energy plantations in adjoining areas of mangroves so as to discourage their cutting for fuel wood consumption and encourage development of fodder depots so as to reduce pressure of livestock grazing in mangrove areas.

BOX 6B: Examples of mangrove plantations for fodder and/or fuelwood provision

In India there is a 50% centrally sponsored scheme Area Orientated Fuel wood and Fodder Plantation Project (AOFFP). This scheme aims at supplying fuel and fodder to the local population so that pressure caused by illicit felling of Government forests becomes reduced and, at the same time, the people benefit from employment. For example, 100,000 ha of *Acacia auriculiformis* a fast-growing timber tree, were planted outside the Sundarbans forestry area to reduce the pressure on the mangroves for fuelwood and fodder.

Mangrove leaves are used extensively as fodder in some arid regions (Pakistan, Egypt and Eritrea). *Avicennia marina* is the preferred species, but *Rhizophora mucronata* also provides good fodder for camels, goats and cattle. Browsing can be very intensive, therefore mangrove plantations have been established in some areas to provide the necessary fodder and reduce the grazing pressure on natural mangrove areas.

6.7 Pollution from human activities, such as waste disposal, garbage, sewage, oil, effluents, solid and toxic wastes dumped or discharged in the coastal areas or adjacent river basins should be regulated. This requires that appropriate practices to eliminate, minimize or mitigate the impacts of pollution should be enforced.

BOX 6C: Examples of regulations to control pollution in coastal areas

Specific environmental regulations for shrimp farming in Thailand have been formulated by the Department of Fisheries (the governmental department responsible for shrimp farming):

a) Shrimp farms and hatcheries must be registered.

b) The biological oxygen demand (BOD) of effluent water must be below 10mg/l; and the Secchi disc transparency measure greater than 60 cm.

c) On farms larger than 50 rai (approx. 8 ha), effluent water must be treated in settlement ponds prior to being discharged into canals, etc.

d) Release of salt water into freshwater bodies, and the discharge of silt and sediment into public bodies or onto public land, are forbidden.

(See Thailand country case study in "Country Case Study Report" , or Smith (1999), for further details.)

In Nigeria, the Federal Environmental Protection Agency Act, 1988 determines the allowable levels of pollution and effluent discharge to water bodies and the Harmful Waste Act 1990 Cap165 prohibits dumping of toxic wastes.

In Ghana, the Environmental Protection Act 490 (1994) specifies waste management along the coast. Under schedule 5 of the Environmental Impact Regulations, 1999 (L.I. 1652) the areas that are listed to be very sensitive with respect to general construction and the service sector are the following mangrove areas:

a) Areas with primary pristine dense growth,

b) Areas adjourning the mouths of major river systems,

c) Areas near or adjacent to traditional fishing grounds

d) Areas that act as natural buffers against shore erosion, strong storms or storm surges.

The Brazilian Association of Shrimp Farmers has recently (2002) introduced regulations for monitoring effluents, solid wastes and use of chemicals from aquaculture (ABCC, 2001).

In Colombia there are regulations to restrict/control pollutants from all activities that occur in the coastal zone (Resolution 1594/94).

6.8 States should ensure that mangrove ecosystems adversely affected by human activities are restored or rehabilitated. Mangrove rehabilitation projects should seek to restore maximum benefits in terms of habitat recovery and ecological functioning at the minimum cost socially and economically.

6.9 The raising of funds is a key factor in determining the success of biodiversity conservation management, including rehabilitation. Income generation for the recognized/established management body and traditional resource users is essential to viability and sustainability. Identify and quantify appropriate charges that can be levied on interest groups, especially commercial entities, benefiting from facilities, amenities and natural resources. Income derived should be used for operational and mitigation costs in the protected area.

The following are recommended options to promote socio-economic benefits based on sustainable use of mangrove ecosystems:

- Incentives for local industries that implement pollution preventative measures.
- Favourable loans for environment friendly projects.
- Grants for environmental commitments and protection of critical areas.
- Financial support of scientific studies, training and capacity building in mangrove sustainable management and conservation.
- Incentives for the private sector to support research on mangrove diversity management.
- Ensuring fair market prices are paid for mangrove resources and their services.
- Charging levies on those who pollute the mangrove ecosystem on a "polluter-pays" basis.
- Support local communities to act as wardens of mangrove protected areas.

ARTICLE 7 CULTURAL AND COMMUNITY ISSUES

Mangrove ecosystems are associated with unique human traditions and knowledge, but they are also under severe pressure from some traditional and non-traditional forms of exploitation.

7.1 States should ensure that cultural/historical and other traditional associations with mangroves are respected. Such values should be protected and well integrated into the conservation and sustainable management plans for mangrove ecosystems.

7.1a States should officially recognize and promote sustainable management practices involving local communities.

7.1b The values and potential applications of traditional knowledge related to mangroves should be high-lighted, for example use of traditional medicines. In support of this objective local people should be encouraged to document their traditional knowledge and cultural associations with mangroves.

BOX 7A: Examples of important cultural/historical associations with mangroves

- Sea gypsies (Chao Le) are a traditional ethnic minority group who have lived in the Ranong mangrove system in Thailand for about 200 years but without government recognition. Their staple diet and income come from mangrove oyster gathering and fishing.
- Spirit houses used to protect mangroves are a common sight in Southeast Asia, especially in Cambodia and Thailand, while temples associated with mangroves can be found in India and Myanmar.
- The Historical and Cultural Park in Can Gio Biosphere Reserve, Vietnam records the importance of the Can Gio mangrove forest historically. The Can Gio mangroves were destroyed by herbicides during the American War but were replanted by the Vietnamese people from 1978 onwards.
- Everyone entering the Sundarbans in both Bangladesh and India requests the permission and protection of the local deity, Banobibi for the Muslims and Vanodevi for the Hindus, before engaging in their work, whether wax and honey collecting, fishing or gathering fuelwood. Shrines are built to the deity at the entry points into the mangrove forest.
- A negative example of a traditional use of mangroves is as fuelwood for salt extraction. In both West and East Africa mangroves are heavily exploited as a fuel source to boil brackishwater in clay bowls over a fire to produce salt for cooking. This process is very unsustainable.
- The black slaves from Africa that escaped and lived in the mangroves of Central and South America have left a legacy over the past 500 years, which is kept alive today in poems and dances. The African word “Palenque” describes one of these groups of people.

Figure 7.1: A historical and Cultural Park in the Can Gio Biosphere Reserve, Vietnam showing the underground shelters in the mangroves where the north Vietnamese soldiers hid during the American War (Photo by Elizabeth Ashton, cenTER).

Figure 7.2: A spirit house in Peam Krasop Wildlife Sanctuary, Koh Kong, Cambodia to protect a large *Lumnitzera littorea* tree from being felled. (Photo by Elizabeth Ashton, cenTER).

BOX 7B: Examples of the value and potential uses of traditional knowledge about mangroves

Throughout its range of distribution, the mangrove species *Excoecaria agallocha* has been used to treat leprosy. Alkaloids in the latex of *Excoecaria* (Family Euphorbiaceae) may have been efficient in alleviating the pain of lepers bathing in water containing the latex (Vannucci, 1991, 1992).

Other traditional uses of mangroves for medicines (Bandaranayake, 1998) include: *Acanthus ilicifolius* (aphrodisiac, asthma, diabetes, skin diseases, snake bites, stomach ache); *Acrostichum aureum* (boils and wounds); *Avicennia marina* (rheumatism, small pox, ulcers); *Bruguiera gymnorhiza* (eye diseases); *Ceriops tagal* (stops haemorrhages); *Excoecaria agallocha* (leprosy and toothache); *Heretiera littoralis* (diarrhoea); *Rhizophora apiculata* (hepatitis, typhoid); *Xylocarpus granatum* (cholera, fever, malaria). Research into these and other medicinal mangrove plants is of high potential value in the medical field.

In Nigeria, fishing nets are dyed using tannins from the red mangrove *Rhizophora racemosa* to prevent crab attack. A similar method has also been recorded by indigenous people in other parts of Africa, Arabia and South America.

In Ecuador, the local people prepare an energising liquor from the pneumatophores of *Avicennia germinans*.

7.2 States should minimize the negative impacts of population pressure on mangroves and associated coastal ecosystems. Migration/resettlement into already overexploited coastal areas should be avoided.

7.3 States and NGOs should develop alternative livelihood opportunities for the members of communities whose existing activities result in unsustainable utilisation of mangroves and related ecosystems. Alternative livelihoods and income generating activities should include basic training programmes on environmental topics, sustainable resource use, household finance and community organisation.

Figure 7.3: Poor families living in huts in the mangrove Full Protection Zone (left) have been moved to new homes built for them in the Buffer Zone (right) under a coastal resettlement programme in the Lower Mekong Delta, Vietnam (see details Box 7C) (Photo by Donald Macintosh, cenTER).

BOX 7C: Examples of improved livelihood opportunities for mangrove dwellers

The Coastal Wetlands Protection and Development Project in the Lower Mekong Delta, Vietnam is helping the Government of Vietnam to resettle people from the mangrove Full Protection Zone to the more landward Buffer Zone and prevent others from migrating into the protected zone. The resettled people act as local forest guards to protect the mangroves. Training is also being given in engine mechanics, tailoring, aquaculture and agriculture to improve their livelihood prospects and make them less dependent on mangrove resources.

In Koh Kong Province, Cambodia, mangrove charcoal kilns were destroyed to protect the remaining mangrove forest (see Box 3D), so alternative livelihoods were supported by the Ministry of Environment and external donors; for example, animal husbandry and home gardens, mangrove plantations. A model village was also developed to relocate former charcoal producing families.

7.4 Promote and strengthen the contributions of women to the conservation, rehabilitation and sustainable management of mangroves.

Figure 7.4: In the Jaguaribe River estuary, Ceará, Brazil, about 30 women (wives of local fishermen) are engaged in a project to rear mangrove oysters (*Crassostraea rhizophorae*) using non-destructive methods. (Photo credit to be added).

Instead of collecting wild oysters by cutting them off mangrove roots (the traditional practice), the women now use artificial oyster collectors made from plastic water bottles to obtain spat. The oysters are then transferred to rearing in trays suspended from a fixed frame made from pvc pipe and concrete. Oysters with a meat weight of 1-2g are reared in this way until they can be harvested and sold with a meat weight of 5-7g. The oyster project has been funded by Ceará State Science foundation (FUNCAP) and supported with applied research from the Federal University of Ceará. As well as receiving technical and financial assistance, the women's group has representation in the local municipal administration. Currently, the women can produce 100 dozen oysters weekly, which is sufficient to supplement their basic subsistence income by about 25%. In addition to plans to expand production, the group also needs help to market the oysters more profitably.

BOX 7D: Examples of contributions by women to mangrove management

The women of each household in the Sundarbans, India automatically become joint members of Forest Protection Committees (FPCs) and Eco-Development Committees (EDCs). However, in some FPCs women are primary members. Some FPCs comprise of women members only or are controlled by womens groups (e.g. CARE-INDIA), and with the positive participation of women it has been observed that the FPCs function better. Self help groups have been formed among the members of FPCs to take up various vocational and income generation activities utilising funds from their own savings as well as bank loans where necessary and available. These activities (e.g. sewing, orchards) are particularly inspiring for women as they are able to earn or supplement the livelihood of their families (West Bengal State Forest Report 2001).

In Ghana, the Ada-Azizakpe Womens Group carried out mangrove rehabilitation within the swamps of their island settlement with the support of Heifer International, an international NGO that aims at serving poor people and caring for the earth to alleviate hunger and poverty. The NGO supported the women by sharing livestock among the group members, who in turn were encouraged to replant degraded mangrove areas around the settlement with Rhizophora racemosa.

The gathering of oysters provides supplementary income for the women of the islands of Sine-Saloum in Senegal and constitutes an appreciable contribution of protein to their diet. Therefore, it is necessary to safeguard the oyster stock by practices which respect the mangrove. This is the reason it was necessary to develop alternate solutions to the gathering of oysters such as the culture of the exploited species *Crassostrea gasar*. This motivated WAAME an NGO to choose three sites (Bassoul, Diogane and Ngadiore), villages among the islands of Saloum in order to test the raising of oysters. This study began in February 2001 and the monitoring is done by the women's groups they have formed.

7.5 States and NGOs should increase community awareness at all levels regarding the cultural, social, economic and ecological importance of mangroves and their associated ecosystems. Mechanisms to promote community awareness include seminars, workshops, field visits, youth camps and use of the media for information dissemination. (See detailed recommendations at Article 8: Capacity Development).

7.6 States should promote the exchange of community experiences in mangrove rehabilitation and conservation. Participating together in workshops and site visits are good mechanisms to help different communities to achieve this (see examples in Box 7E).

BOX 7E: Examples of inter-community cooperation to promote mangrove rehabilitation

In the Visayas, **Philippines**, there is good inter-community communication involving community leaders from neighbouring islands visiting a successful mangrove planting project (using *Nypa* and *Rhizophora* species) at Buswang, in Aklan Province, the Visayas. The Department of Environment and Natural Resources organises such visits to promote similar community projects elsewhere.

In northern **Vietnam**, the Red Cross started a pilot project to rehabilitate mangroves (by planting *Kandelia candel* and *Sonneratia caseolaris*) in Thai Thuy District of Thai Binh Province. Community leaders from neighbouring Nam Dinh Province, and other coastal provinces, were then invited by the Red Cross to observe the results and expand the project to other districts. Mangrove planting with support of the Red Cross has now been carried out in nine typhoon prone provinces of the Red River Delta regions of Vietnam.

The Gulf of **Guinea** large marine ecosystem (GOGLME) project involved six West African countries (Nigeria, Ghana, Benin, Cote D'Ivoire, Togo and Cameroon). It was a NGO and community project and allowed for exchange of ideas, greater public awareness and demonstration of mangrove rehabilitation projects.

In **Senegal**, a programme promoted by the National Parks integrates scientists, NGOs, women, youth camps and technical services in the management and rehabilitation of mangroves so that they can exchange experiences. The NGO WAAME is presently working with 50 villages, women's groups and schools in reforesting mangroves. WAAME is also providing exchanges of experiences in fish smoking, oyster farming through community exchanges and local technical training.

In **Ecuador**, there is communication and links between the different communities and user groups for example between North and South Esmeraldas, and between other provinces, and with the National coordination committee for mangrove protection. This system has been operating since about 1992 with effective results in promoting sustainable mangrove management in Ecuador.

In 1999 the Mangrove Action Project (MAP), working closely with the Yadfon Association in **Thailand** and the Small Fishers Federation of Sri Lanka, helped launch the program "In The Hands Of The Fishers" (IHOF) which is a series of workshops bringing together grassroots NGOs and fisherfolk from two or three developing nations containing mangroves. These workshops offer an innovative format for information and skill sharing among local stakeholders, while also offering a toolkit of working alternatives to help enhance Community Based Coastal Resource Management. In addition to the workshops, follow-up projects are undertaken at the participating villages, and these then serve as sites or nodes for modelling sustainable, low-intensity development alternatives for example at the eighth IHOF workshop in Koh Kong, Cambodia August 2003 improved nipa palm sugar stoves will be discussed.

ARTICLE 8 CAPACITY DEVELOPMENT

Capacity development for mangrove management and awareness raising about mangroves is needed at all levels from decision makers in government, to community leaders and educational institutions (teachers, students and school children).

8.1 To develop their capacity for mangrove management, States should establish and strengthen coordination and networking among different institutions, government agencies, private sectors, local communities and other mangrove stakeholders.

8.2 States should develop curricula/teaching modules and supporting teaching materials on mangroves suitable for adoption into national environmental education programmes for (a) primary and secondary schools; and (b) institutions of higher education.

BOX 8A: Examples of existing educational programmes on mangroves

In **Thailand**, students of Bangtaboon School which is situated in the mangrove forest of Petchaburi Province, the students receive practical teaching in mangrove research, rehabilitation and protection, with the active support of the Ministry of Education.

In the Red River Delta, **Vietnam**, the teachers use a "Big book" developed by NGOs illustrating the role of mangroves for coastal protection (see Box 1B). School children also participate in innovative learning activities, such as, theatre, puppets, dance, art, school, competitions, video and CD ROM to promote the conservation and sustainable use of mangroves and related ecosystems.

Khulna University in **Bangladesh** offers several courses directly related to mangroves, such as Mangrove Ecology and Coastal Afforestation, Mangrove Resource Utilisation and Management.

In 1996, **Ghana** introduced environmental studies into primary schools and ecological studies into secondary schools, including coverage of forestry and wetlands. The Centre for African Wetlands based at the University of Ghana supports studies on wetlands for MPhil Environmental Science students.

In **Nigeria**, integrated science is taught in primary and secondary schools and at University level there are postgraduate studies on mangroves offered in the coastal Universities.

In **Senegal**, there is a first year PhD course on coastal areas and islands at the Department of Geography of the University of Dakar which is supported by UNESCO.

In **Ecuador**, ESPOL (Escuela Superior Politecnica Del Litoral "Polytechnic Superior School of the Littoral") University degree courses are taught on coastal resource management, including mangroves.

The Mangrove Action Project (MAP is a non-profit organisation based in the **USA** see glossary for details) has released a Mangrove Educational Curricula which was developed at the Cayman Islands for school children from kindergarten to ninth grade and is taking it to other parts of the world, modifying it for local regions and translating it into local languages.

8.2 States should develop and implement practical in-country training courses and seminars targeting especially community leaders and teachers, using local dialects and techniques to promote conservation and sustainable management of mangrove ecosystems. Without such assistance, local communities may not understand or fully appreciate the value of mangroves. Similarly, research findings should be interpreted so that local stakeholders can understand them. They may also need guidance on how to restore mangroves and how to develop more sustainable livelihood activities.

Figure 8.1: Traditional leaders in Ghana attending a training course on wetlands ecology and management for World Wetlands Day (February 2nd) (Photo by Jesse Ayivor, Centre for African Wetlands, Ghana).

Figure 8.2: Community awareness training course on mangrove forests for famers in Ca Mau, Lower Mekong Delta, Vietnam (Photo by Donald Macintosh, cenTER).

Figure 8.3: A community workshop for the Eperara-Siapidara Amerindians, at Laguna Santa Bárbara, the Colombian Pacific coast (Photo by Hernando Bravo, Colombia).

BOX 8B: Examples of community training in mangrove resource management

In Vietnam, training courses are conducted regularly for farmers in Ca Mau, Lower Mekong Delta by the Division of Forestry, Department of Agriculture and Rural Development (DARD). The farmers are from both the State managed Forest and Fishery Enterprises (FFEs) and from private farms. The planting and maintenance techniques that they learn are put in to practice on their farms with good success (see Figure 8.2).

In Thailand, the community of Pled Nai Village in Trad Province have been trained in mangrove rehabilitation, maintenance and protection. These activities have been possible through the strong commitment of a local NGO, Yad Fon, which has helped to mobilise governmental and public support for this poor coastal community (Yad Fon Association).

In the central Philippines, the New Buswang, Kalibo, Mangrove Plantation is an example of a successful 70-ha reforestation project due, among other factors, to the people's association KASAMA (Kalibo Save the Mangroves Association), a community-based organization initially comprising 27 families and a local NGO called USWAG. KASAMA families planted a total 50 ha of *Rhizophora* species and *Nypa fruticans,* each family was assigned an average area of 1.7 ha. Aside from site preparation and planting, activities included regular maintenance (removal of debris, pruning of damaged branches and stands, replacement of dead plants), protection and record keeping for 3 years. The local community leaders were also trained in basic law and organization by the local NGO.

In Senegal, there are training programmes in the Saloum Biosphere Reserve on how to develop sustainable livelihoods, planting of mangroves, managing finances and organising women's groups. These programmes held by a local NGO WAAME focus on mangrove management and planting and oyster farming and fish smoking.

In Nigeria, the NGOs Nigeria Conservation Foundation and CCDI provide training on utilisation and management of mangrove resources, especially the *Nypa* palm which they are trying to help the local people to utilise (e.g. to make thatch for houses, straw hats, and to use the sap) so that the numbers of *Nypa* are controlled (this mangrove palm is regarded as a weed in Nigeria).

8.3 States should develop regional capacity for training of trainers in mangrove ecology and management by establishing appropriate training and resource centres, or by strengthening existing centres with regional capabilities.

BOX 8C: Examples of Regional and International training opportunities on mangroves

The Aquaculture Department of the Southeast Asian Fisheries Development and Education Centre (SEAFDEC) offers regional training courses in Coastal Resources Management

APEC (Asia Pacific Economic Cooperation) Programme is offering training programs on mangroves for teachers and students from 21 countries.

The Centre of Advanced Studies in Marine Biology, Annamalai University, Parangipettai, India conducts a United Nations University International Course on Biodiversity in Mangrove Ecosystems. This is a two week course offered annually to train trainers, young professionals from Asian country Universities or other institutions that can replicate the work in their own country on their return after training.

The Centre for African Wetlands (CAW) based at the University of Ghana is a regional body for Africa that was commissioned in 2001 to offer training programmes to African institutions on the sustainable management, legal issues, policy framework, networking and research of wetlands, including mangroves.

8.4 States and NGOs should provide information and technical training to assist people at the site management and community levels to monitor and assess mangrove resources, including rapid resources assessment using simple, standardized and operational protocols (see also Article 5: Mangrove Inventory for Management).

8.5 States and donor agencies should establish training programmes for managers and researchers at all levels including exchange programmes, scholarships, fellowships and grants for on-the-job training in community development.

8.6 States and NGOs should promote awareness programmes on mangroves in a manner suitable for politicians, land use planners and developers, other decision-makers and lawyers to understand the values of mangrove ecosystems.

8.7 States and NGOs should develop educational facilities, which include walkways and information centres at strategic mangrove sites to provide convenient access and knowledge for local communities, school children, tourists and other interested groups.

8.8 Information on mangroves should be provided appropriately for the different interested groups including translation into local languages and simplified versions for school children. Illustrated information boards, posters and brochures are excellent and inexpensive formats for visitor information.

Figure 8.4: School children visiting the Ranong Biosphere Reserve, Thailand, which has a well-designed walkway through the mangroves and informative signboards for visitors on mangrove biology and ecology in Thai and English. (Photo by Donald Macintosh, cenTER).

Figure 8.5: The museum at Can Gio Biosphere Reserve, Vietnam with botanical and zoological specimens of different mangrove species. (Photo by Elizabeth Ashton, cenTER).

BOX 8D: Examples of information centres for mangroves

In Senegal, a museum in the Saloum Biosphere Reserve has a library of information on mangroves and a biological station through a National Park and IUCN project, which is due to completion in 2003/4. The NGO WAAME resources Centre in the Saloum BR has a mangrove interpretation centre for children, local communities and tourists to visit.

In Brazil, the Labomar institute (Arquivos de Ciencias do Mar) of the Federal University of Ceará (Universidade Federal do Ceará) in Fortaleza provides an interpretation centre on mangroves and other marine environments for school children. Labomar also houses the Central and South America regional centre for ISME/GLOMIS. The Federal University of Ceará co-manages a mangrove wetland park together with the municipality authority of Fortaleza City.

8.9 States should strengthen the capacity to interpret and understand policies and legislation on the conservation and sustainable management of mangroves, including community level laws/regulations (see Article 3.1). Illustrated posters are strongly recommended for information

dissemination, as these can be displayed prominently (e.g. in government offices, schools and village meeting places) to reach a wide audience.

Figure 8.6: A crab poster published by Ceará State, Brazil to emphasise the preservation of crabs by protecting berried females and young crabs. (Photo by Donald Macintosh, cenTER).
The poster teaches " If you know how to collect the Uçá crab there will be no scarcity"

BOX 8E: Examples of information dissemination on mangrove management policies to local stakeholders

In the Lower Mekong Delta of Vietnam, leaflets have been distributed explaining the allowable and non-allowable activities in the two coastal land zones involving mangroves (Full Protection Zone and Buffer Zone).

In Ecuador, the Ministry of Environment (MoE) receives information from local stakeholders and University research before deciding policies. The MoE and the action group within the government PMRC (Management Programme on Coastal Resources) provides posters and leaflets on coastal resources utilisation, including mangroves. There are visits made by PMRC to explain environmental policies to local stakeholders in more detail and to seek their agreement on local implementation.

ARTICLE 9 FORESTRY/SILVICULTURE MANAGEMENT

Mangrove forestry/silviculture objectives may have an economic, environmental or aesthetic basis, or a combination of these. The specific objectives for forest management include timber and fuelwood production, shoreline and river channel stabilisation, landfill and waste management, fisheries and wildlife support, storm and flood protection, ecological and biodiversity restoration and land-scaping.

9.1 The primary objectives for mangrove forest management should be defined clearly and prioritised (e.g. is it for wood products, shore protection, waste management or biodiversity conservation?). The history of a site and the activities that have led to the present forest conditions there should be taken into consideration for management planning. Table 9.1 gives good examples of successful sustainable management systems to meet specific objectives. **However, wherever possible, multiple-use management should be the ultimate goal of mangrove forest management.**

9.2 States should provide a clear framework for the operation and implementation of forest management/silviculture such as a working plan for wood production. The framework should be based on past experiences, research and other knowledge of the area.

9.3 Even in locations where pristine mangrove areas no longer exist, the priority should be to protect any stands of mature mangroves that are still reproductively viable. Even in disturbed areas, reproductively active trees and shrubs are valuable because many mangrove species have good dispersal mechanisms (floating, saltwater tolerant fruits or propagules). This is an important prerequisite to support sustainable forest management and mangrove rehabilitation efforts.

9.4 States should identify degraded or destroyed mangrove areas for rehabilitation. Allow natural regeneration wherever possible, but if this is inadequate assist with active interventions involving restoring the natural hydrological regime and mangrove planting.

9.5 A careful technical assessment should be made for all sites being considered for mangrove planting. If mangrove planting is deemed necessary to rehabilitate a site, use local mangrove species as far as possible (see Annex 1 for planting guidelines from Asia).

BOX 9A: Oil impacted mangroves; e.g. Caribbean coast of Panama, bays in Southeastern Brazil, Lake Maracaibo, Venezuela

Converted/destroyed mangrove:

Abandoned shrimp farms; e.g. in the Gulf of Guayaquil, Ecuador

Abandoned resort areas; e.g. in southeastern Brazil

Abandoned silviculture areas; e.g. along the San Juan River, in Venezuela

Abandoned salt pans; e.g. along the northeastern Brazilian coast.

Strongly impacted/degraded mangroves:

Oil impacted mangroves; e.g. Caribbean coast of Panama, Southeastern Brazil bays; Lake Maracaibo, Venezuela

Industrialized areas; e.g. Protected coastal areas along the southeastern coast of Brazil; Cartagena Bay, Colombia *(Lacerda L.D. and Kjerfve, B.J. 1999).*

9.6 Mudflats provide important feeding grounds at low and high tide for e.g. waterbirds and fish but can also be used for planting mangroves if the intertidal level, currents and soil conditions are suitable. Plant mangroves on open mudflats only if there were mangroves present previously,

mangroves are likely to colonise naturally on newly accreted lands but require some assistance, or if coastal protection is a top priority e.g. due to storm risks.

9.7 **DO NOT** plant mangroves on sea grass beds or coral reefs as these are important ecosystems in their own right.

9.8 Mangrove planting on public or community lands should involve local people at all stages: nursery preparation of mangrove seedlings, planting out of rehabilitation sites, and the maintenance and protection of plantation forests.

Table 9.1: Practical examples of Mangrove Forest Management to meet specific objectives

Management Objective	Working example
Wood production The Matang Mangrove Forest Reserve in Peninsular Malaysia, has been managed sustainably for the production of charcoal for over 100 years. Forest management is based on a Silvicultural Operation and Working Plan.	The silvicultural operation in Matang runs on a 30 year rotation with thinnings at 15 and 20 years. The forest is divided into blocks of a few hectares, which are allocated to charcoal companies. Each block is clear-felled, leaving a 3 metre strip on the shoreward side to prevent erosion of the bank and to provide mother trees for propagules. The timber is cut into logs of standard length, which are transported by boat to the charcoal kilns at a nearby village. Due to the way the blocks are allocated for clear-felling, they are always surrounded by a mature forest so repopulation with mangrove propagules occurs rapidly. The debris (branches and bark) resulting from the clearing takes about two years to decompose. After one year the site is inspected and, if less than 90% of the area is covered by natural regeneration, repopulation is assisted by artificial planting. Local villagers are contracted to rear suitable seedlings in small nurseries for this purpose. *Rhizophora apiculata* is the preferred species for charcoal and is planted at 1.2 m intervals. Any weeds, for example the mangrove fern *Acrostichum* spp., are destroyed by hand or using chemical weed-killers. After 15 years the young trees are thinned to a distance of 1.2 m (4 feet) to prevent overcrowding and the timber removed is used for fishing poles. After 20 years the stand is again thinned to a distance of 1.8 m (6 feet) and the resulting timber used for the construction of village houses. Finally, after 30 years the block is clear-felled for charcoal production, except for a 3 metre buffer zone along the bank.
Figure 9.1: Transporting logs in Matang Mangrove Forest Reserve, Peninsular Malaysia and a signboard for compartment 17 with mangrove trees aged six years old (Photos by Elizabeth Ashton, cenTER).	 
Coastal protection	In India there is a total ban on cutting mangroves to protect villages and agricultural lands from storm surges. In northern Vietnam the mangroves are planted very close together (0.5 m x 0.5 m) as a coastal protection belt at least 100 m wide in front of the sea dyke. In Bangladesh accretion areas, hundreds of ha of mudflats have been planted with mangrove seedlings in prograding delta areas for coastal protection. The mudflats are, and can be consolidated into new islands by

	planting mangroves.
Research	In Bangladesh, Malaysia, Thailand, Vietnam and the Philippines trials have been conducted in nurseries to improve the cultivation of mangrove seedlings for transplanting. Seedling survival and growth has been compared under different conditions e.g. soil salinity and nutrient status, fertilization, pest control.
Figure 9.2: Royal Forest Department Mangrove Nursery, Phuket, Thailand (Photo by Donald Macintosh, cenTER)	
Biodiversity Conservation	Mixed planting of two, three or four species has shown more positive results than planting only one species as a monoculture. Good examples described in the country case studies include *Kandelia c*andel (main species) plus inter planting of *Sonneratia caseolaris* and *Rhizophor*a *stylosa* in the Red River Delta, Vietnam; mixed planting of *Rhizophora mucronata*, *R. apiculata, Bruguiera cylindrica* and *Ceriops tagal* in Ranong, Thailand; mixed planting of *Nypa* or *Rhizophora*, *Heritiera* and *Xylocarpus* in India (see Box 13F)
Rehabilitation of degraded mangroves	During the 1997-98 El-Niño event in Kenya, 30% of 54,000ha of mangroves found in Kenya died as a result of siltation and water logging. Natural rehabilitation of the affected areas proved to be slow to restore the forest because of the lack of mother trees. In 2000, a project to rehabilitate degraded mangrove areas as a result of El Niño weather was initiated at Gazi bay, Kenya. Some 10,000 trees of mostly *Rhizophora mucronata* and *Ceriops tagal* were replanted in 2.0 ha plots. The survival rate two years later was 75%, the majority being *Rhizophora*.
Shrimp ponds and tin mining areas	Abandoned shrimp ponds and tin mining sites have been rehabilitated with mangrove species in Ranong, Thailand with some success (Macintosh *et al*., 2002).

ARTICLE 10 FISHERIES AND AQUACULTURE

Mangrove associated fisheries and aquaculture have worldwide importance in providing subsistence food and income, as well as commercial benefits, for a wide range of stakeholders, from very poor fisher communities and coastal farmers, to major companies that have invested in aquaculture and seafood processing. Thus, the importance of effective management in relation to mangrove fisheries and aquaculture development cannot be overestimated. It should also be recognised that lack of enforcement of existing fisheries regulations to protect mangrove nursery sites is one of the major causes of unsustainable fishing. Similarly, many of the problems associated with mangroves and coastal aquaculture stem from poor aquaculture management practices and/or lack of enforcement of environmental regulations.

10.1 States should follow the general guidelines that already exist for responsible fisheries and aquaculture. These include: the FAO Code of Conduct for Responsible Fisheries (1995), FAO Code of Conduct for Responsible Aquaculture Development (1997), the SEAFDEC Regional guidelines for Responsible Fisheries in Southeast Asia-Responsible Aquaculture (2001), the Global Aquaculture Alliance (GAA) Guidelines for Sustainable Shrimp Farming (2001) the Ramsar Resolution VIII.32 (2002) on conservation, integrated management and sustainable use of mangrove ecosystems and their resources and the WB/NACA/FAO consortium on Shrimp Farming and the Environment (2002). The following articles relate more specifically to fisheries (including subsistence collecting of aquatic resources by hand) and aquaculture in and adjacent to mangrove ecosystems.

10.2 States should protect mangrove nurseries and breeding habitats of fish, crustacean and molluscan species important to subsistence and/or commercial fisheries (See Table 2.1 and 2.2). The most effective measures for habitat protection are likely to be (a) where fishing is prohibited within clearly defined areas; or (b) where local communities are given management responsibilities for specific fishery sites under a stewardship arrangement, or similar community-based agreement, which includes appropriate fishery conservation measures.

10.3 States should clearly demarcate mangrove areas where free access for non-destructive fishing activities is permitted for local communities. The great importance of open access areas for subsistence hand collecting of mangrove fish, crustaceans and molluscs by poor fishers should be recognised by all stakeholders.

BOX 10A: Examples of mangrove habitat protection to conserve fishery stocks

In Brazil, the legal framework making it illegal to destroy any mangroves was established to protect their fisheries support functions.

In Vietnam, there is a large totally protected area of shallow coastal waters ("Bai Boi") to conserve the breeding habitat of fish, shrimp and mud crabs. The mangrove Full Protection Zone of the lower intertidal belt also features strict rules, which limit fishing to hand collecting (use of boats, nets and other fishing gear is not permitted).

10.4 Destructive fishing methods in mangrove ecosystems should be banned, or if this is not possible for socio-economic reasons, they should be very carefully regulated with the voluntary agreement and full participation of the local fisher communities.

Figure 10.1: Women and children collect shrimp larvae using very fine nets as a livelihood in Bangladesh (Photo by Dipak Kamal, Khulna University, Bangladesh).

BOX 10B: Examples of destructive fishing methods in mangrove ecosystems

Mangrove associated penaeid shrimp species (e.g. *Penaeus monodon*, *P. merguiensis*) are collected heavily for broodstock and seed (postlarvae and juveniles), especially in Bangladesh (see Fig 10.1). There is a high mortality of other shrimp/fish species as by-catch from the shrimp seed fisheries. Catching seed (for grow out ponds) need not be banned, but should be regulated, and the use of captive broodstock from hatcheries should be promoted as an alternative source of seed production.

In Benin, the vegetation behind mangroves is burned in order to capture land crabs (*Cardisoma* species), but the mangroves also sometimes catch fire.

10.5 States should be aware that many millions of people depend on traditional fishing activities in mangrove ecosystems for food and income generation. Great care should be taken to support the livelihoods of mangrove fishers, to promote awareness of the fisheries importance of mangrove ecosystems, and to help local communities to adopt more sustainable fishing and/or aquaculture practices. (The Acadja system of West Africa is a particularly good example of a traditional mangrove fishery showing how better local management and awareness can improve sustainability; see Box 10C).

Figure 10.2: Floating Fish cage culture in Matang mangrove Forest Reserve, Peninsular Malaysia, which also serves as a tourist attraction (Photo by Donald Macintosh, cenTER).

Figure 10.3: The Tar jal fishermen fish in creeks in the Eastern Sundarbans, Bangladesh with the aid of pet otters. This traditional fishing method is very effective compared to other types of fishing and is not harmful to the environment. However, the method is slowly dying out as new fishing techniques are introduced. This unique, interesting and traditional method should be supported for future generations and as a tourist attraction (Photo by Dipak Kamal, Khulna University, Bangladesh).

BOX 10C: Examples of how better management can lead to more sustainable fishing and fish trading practices in mangrove ecosystems

The 'a*cadja'* or brush park system of **West Africa** is a traditional method of fishing, which involves setting up artificial habitats in the middle of lagoons using tree branches. Many tree branches are pushed into the bottom of the lagoon to form a sanctuary for fish. The *acadjas* are fished about six months after the branches are put in position. There are examples of both sustainable (Benin) and unsustainable (Nigeria) uses of mangroves to construct *acadjas*. The *amatong*, a variation of the brush park system using rocks as well as branches is practised in Negros and other islands in the Philippines and if used sustainably is a good additional source of income.

In **Senegal**, the project "Rehabilitation and integrated management of the resources of wetland communities in the Ramsar site of Saloum Delta" financed by the Dutch Committee for IUCN was a test initiative for equitable shrimp trade. It consisted in supporting the small-scale fishermen from eight villages with equipment adapted to sustainable fishing concerning the renewal of stocks and the safety and security of the small-scale fishermen. Nets (with the lawful mesh size), life jackets, ropes etc. were provided with the objective to improve and upgrade the utilisation of techniques and machines for sustainable fishing to safeguard the resource. A private company, which is partner to this initiative, buys the production and sets up the means of collecting and transporting the production to its manufacturing unit based at Mbour. It pays the factory price to the producer, which is different to the prices that the intermediaries practice. However, standards of quality are required, as a rigorous selectivity is in force. So the fishermen group together and each village grouping can measure its performance on the environmental level which is cheap. In summer, a working capital is released for each village grouping in order to reinforce the capacities of the small shrimp producers and to prepare direct access to the market avoiding the middlemen. The marketing of the village productions inspires of the system of equitable trade (fair trade) worldwide and tends to improve the pay back chain to the profit of the small producers. The income generated after elimination of the middlemen (intermediaries) returns to the villages in the form of community cash, which contributes to financing some small development projects at the end of the fishing season. This monetary income will also contribute to the regeneration of the mangrove ecosystem, as the buying of improved ovens will reduce the consumption of mangrove wood for smoking fish. The first trends of this initiative test of equitable trade are still favourable on two essential points: (1) the fishermen understood that the mature shrimp are more expensive than the juveniles and consequently the question related to the selectivity of the fishing gears is selected and regulated; (2) community organisation pays them more money, which enables them to choose periods of rest for them and the resources also.

10.6 States should recognise that mangroves are not the most suitable sites for aquaculture pond construction and that responsible aquaculture development in mangrove ecosystems should not destroy mangroves any further.

10.7 All commercial aquaculture developments in and around mangroves should be preceded by a full and independent EIA, which includes assessment of (a) the impact of the planned development on the mangrove ecosystem; (b) potential negative impacts on the livelihoods of local communities (e.g. by causing pollution/degradation of fishing areas, or preventing access to them, reducing or contaminating freshwater supplies).

10.8 States should recognise that, by retaining or promoting significant areas of mangrove habitat, the ecological conditions for sustainable aquaculture can be safeguarded. In theory, the "ecological footprint" concept is a valuable guide to aquaculture sustainability. In practice, mangrove buffer zones in front of aquaculture development areas can help to support the vital ecological functions that mangroves provide.

Figure 10.4: A large sustainably managed shrimp farm in Ceará, Brazil on the site of a former salt works. Naturally colonising mangrove forest can be seen along the water canal on the right. A voluntary code of practice is followed by shrimp producers in Ceará, see Box 10E (Photo by Elizabeth Ashton, cenTER).

BOX 10D: Ecological Footprint: definition and application to aquaculture

One way of identifying human demands for natural resources and ecosystems services is to estimate the ecosystem area - the Ecological Footprint – functionally required to support human activities. This tool can be applied to track human demand on nature at the global, national, regional, organisational or individual level and is very useful in illuminating the non-priced and often unperceived work of nature that forms the basis for economic activities such as aquaculture.

A study in Colombia estimated the spatial ecosystem support or "footprint" of a $1m^2$ semi-intensive shrimp farm in a coastal mangrove area. The area required to produce food inputs, nursery areas and clean water, as well as to process wastes was 35-190 times the surface area of the farm. The mangrove nursery area required to produce shrimp larvae to stock the pond was the largest support system (160 times pond area). The mangrove area: to supply natural food inputs was at least 4.2 m^2 per m^2 shrimp pond; to absorb polluting nutrients in farm effluents was 2-22 m^2 per m^2 shrimp pond; to catch the fish used in feed pellet manufacturing was 14.5 m^2, plus an additional $0.5m^2$ of agricultural area for the vegetable ingredients in the feed and 7.2 m^2 for providing clean water to the ponds; and to sequester the CO_2 of fossil fuel at the farm the farmer should replant a forest area of 0.8-2.5 m^2 per m^2 shrimp pond area. The size of the footprints will change with the intensity of farming.

(Larsson *et al*., 1994; Kautsky *et al.* 1997)

10.9 In line with the precautionary approach (see Article 2), States should take steps to ban or strictly regulate exotic/alien species introductions for aquaculture. Mangrove ecosystems are open systems with high levels of water exchange and animal movements between adjacent freshwater and marine habitats. Consequently, exotic/alien species, which escape from coastal aquaculture facilities, are likely to disperse very rapidly into and through mangrove waterways, with unpredictable consequences (see Box 2D).

10.10 States should take effective action to ban or regulate the use of chemicals and drugs (especially antibiotics) in aquaculture, as mangrove ecosystems will often be the first point of entry for chemical/drug residues from coastal aquaculture.

10.11 States should encourage the development of local Codes of Conduct for aquaculture, which will allow local shrimp farmer associations to set their own standards of environmental practices based on international standards (See Box 10F).

BOX 10E: Local Codes of Conduct for aquaculture

In Brazil the government does not allow the use of two antibiotics (Nitrofuran and Chloramphenicol) in aquaculture and their sale is also prohibited. The association of shrimp producers of Ceará State recommends no use of antibiotics at all in its Code of Practice for Shrimp Farming.

The Philippine Code of Practice for Sustainable Shrimp Farming (2000) supports the protection of mangroves from adverse aquaculture impacts and mandates the development of wastewater discharge systems not detrimental to mangroves.

10.12 Abandoned or under-utilised shrimp/fish ponds should be rehabilitated back to mangroves by restoring the natural hydrology to promote mangrove recolonisation and/or by planting mangroves. Funds for such rehabilitation and other environmental mitigation measures should be identified, for example by increasing land use fees charged to aquaculture farms.

10.13 States should promote the development and adoption of integrated mangrove aquaculture systems, which are both environmentally sustainable and suitable (socio-economically viable) to support the livelihoods of poor fisher and farmer communities. Examples of successful systems are:

- Mudcrab fattening or growout in mangrove pens and cages (Malaysia, Kenya)
- Fish cage/bivalve and seaweed culture in mangrove waterways (Thailand)
- Mixed shrimp-mangrove-crab-cockle systems (Vietnam)
- Integrated mangrove fish or shrimp farms, silvofisheries or tambaks (Indonesia).
- Oyster rearing (Brazil) (see Fig. 7.4).

Within the mangrove ecosystem in Kenya, one of the crustacean species most exploited by the local communities is the mud crab, *Scylla.* Most of the captured crabs are sold to tourist hotels, and the rest consumed locally. Local fishermen indiscriminately catch the crabs irrespective of size, or whether it is a breeding population; and this has a great bearing on the future stocks of the species. It is therefore imperative that the community is educated on alternative methods of exploiting crabs without interfering with the adult population and the future stocks of the species. One of the ways of doing this is by introducing crab cultures in mangrove areas, where gravid females are collected from the wild, induced to spawn, and introduced to culture pens after a certain stage of their growth. Crab farming has net benefits to the local community through direct employment, as well as a source of income through the sale of the adults.

Figure 10.5: Crab pen culture in the mangroves of Mtwapa, Kenya (Photo courtesy of KMFRI, Kenya)

BOX 10F: Examples of sustainable integrated mangrove aquaculture systems

Integrated mangrove-aquaculture systems, or silvo-fisheries, have a long tradition dating back many centuries to mangrove fishponds known as "tambaks" in Indonesia. Different forms of silvo-fisheries continue to operate on a large scale today in many countries, especially in Indonesia, Philippines and Vietnam. Some of the culture systems in operation are still based on traditional methods, others feature significant advances in design and operation. A well known, traditional example is the Empang Parit model from Indonesia (Fizgerald, 1997). This model features a pond with a raised central platform planted with mangroves, surrounded by a deeper canal usually 3-5m wide that provides the permanent culture area for fish, shrimp and crabs. The central platform is flooded intermittently as the pond water level changes with the tidal cycle, giving the mangroves trees alternative periods of inundation and exposure to air. When inundated, the mangrove platform also provides valuable additional habitat for the cultured stock; mangrove crabs in particular like to use the platform in this manner. Performance of the model can be varied to meet local conditions and production needs by varying the ratio of mangrove forest to pond area, or by adjusting the density of trees (which in turn affects many processes in the pond e.g. light penetration and algal productivity, litter production and water circulation).

10.14 Wherever possible, States should mitigate against potential harmful impacts on mangrove biodiversity from aquaculture. In summary, these are:

- Mangrove habitat loss
- Mangrove-associated species destroyed as by-catch in shrimp seed fisheries
- Mangrove-associated species caught for use as fish feed in aquaculture
- Escape of farmed aquatic animals, including in some cases exotic/alien species, into mangrove ecosystems
- Disease organisms transferred from farmed aquatic animals to wild species populations

BOX 10G: Examples of impacts from aquaculture development in mangrove areas

Negative impact from aquaculture development in India – local fishermen have been adversely affected by shrimp farms in Nellore, because this aquaculture development has restricted their access to traditional fishing areas and increased pollution in coastal waters.

Positive impact from aquaculture development in Malaysia – the cockle farming industry at Kuala Selangor (a mangrove fringed estuary with extensive intertidal and subtidal mudflats) has helped to promote awareness of the need for sound environmental management along the Selangor coast, as the quality of the cockles, e.g. their growth rate, condition factor and level of *E. coli* contamination, are very sensitive indicators of environmental change.

ARTICLE 11 AGRICULTURE, SALT PRODUCTION AND MINING

The conversion of mangroves to other forms of land use, including agriculture and salt pans has been a major cause of wetland habitat loss in many countries. Mining has also caused significant localized damage to mangrove ecosystems, especially in Africa and parts of Asia.

11.1 States should not sanction further conversion of mangroves for agriculture or mining. Agriculture is generally unsustainable due to the potential acid sulphate soil conditions prevalent in mangrove areas.

11.2 Salt pans should be sited behind the mangrove forest zone and where possible integrated into existing land use systems (e.g. shrimp or *Artemia salina* (brine shrimp), culture with salt production in the same ponds).

11.3 Coastal agriculture, salt production or mining should only proceed after full and independent EIAs have been prepared, including their expected impacts on mangroves and other wetlands downstream of the proposed activities.

11.4 As a guiding principle, all developments of this type should be designed to (a) minimise changes of the hydrological conditions in surrounding wetlands; and (b) have built–in safeguards against pollution, such as adequate waste treatment systems, monitoring of effluents and salt.

11.5 States should implement the principle of zero pollution from agricultural and salt production areas and mining sites (including effluent discharge). The "polluter pays" principle should also be adopted.

Figure 11.1: An abandoned dredge at a tin mining site in Ranong, Thailand (Photo by Donald Macintosh, cenTER).

Figure 11.2: Coastal erosion due to sand mining at the mouth of the Volta River Delta, Ghana has had serious consequences for the villages around Keta and is threatening the mangroves in the Keta Lagoon. (Photo by Donald Macintosh, cenTER).

BOX 11A: Examples of mining damage to mangrove ecosystems

In Africa the main impacts on mangroves from mining involve sand mining, titanium mining (in sites adjacent to mangroves) and oil drilling. The negative impacts from mining include increased turbidity and siltation in mangrove waterways, direct smothering of mangroves by mined sediments and indirect impacts from pollution (e.g. from oil exploration). The effects of oil pollution can last for many years.

ARTICLE 12 TOURISM, RECREATION AND EDUCATION

Tourism is the World's largest and fastest growing sector of the global economy. Mangrove ecosystems are no exception; their unique habitat and biodiversity provide ecotourists with many potential opportunities, including recreational fishing, bird watching, viewing wildlife and scenic boat trips.

12.1 States should recognise the potential value of sustainable tourism in mangrove ecosystems (see definition Box 12A), but also be aware of the dangers of allowing tourism to develop in an unplanned/unregulated manner.

12.2 It is important that mangrove tourism development is linked to conservation so that both can be sustainable. States should ensure that some of the revenue from tourism is used to pay for conservation efforts in mangrove ecosystems.

BOX 12A: Definition of sustainable tourism

"All forms of tourism development, management and activity, which maintain the environmental, social and economic integrity and well being of natural, built and cultural resources in perpetuity" (Federation of Nature and National Parks of Europe, 1993).

12.3 States should develop guidelines and legislation for the sustainable management of mangrove tourism, taking account of the environmental carrying capacity of mangrove ecosystems (see definition in glossary). To minimise potential negative environmental impacts from tourism on mangroves, tourists should be restricted to clearly marked paths/board walks and approved boat transportation.

12.4 To support ecotourism, States should provide visitor centres with well prepared displays (e.g. maps, photos, species descriptions) that teach visitors about the natural, cultural and historical features of the protected mangrove area.

12.5 The management of tourist activities associated with mangroves should be developed jointly with the stakeholder groups and must never exclude the local community.

12.6 States should create opportunities for local communities to benefit directly from tourism activities associated with mangroves. Local people should be selected and trained as tourist guides by giving them basic training in mangrove ecology and conservation practices.

12.7 Mangrove tourism should be promoted in tourist hotels, newspapers and other forms of media to promote awareness. Promote attractions with selling points e.g. the state of Esmeraldas in Ecuador features the largest mangrove trees in the world.

Figure 12.1: The Majagual mangroves in Esmeraldas, Ecuador can reach 65m tall and are 100-150 years old. Twelve local tourist guides have been trained and they can take 10 people at a time through the mangroves on the walkway. About 2000-3000 tourists visit this site annually (mainly nationals). Esmeraldas students have to visit the mangroves as an educational requirement (Photo by Alejandro Bodero, Majagual, Ecuador).

BOX 12B: Examples of management issues affecting tourism sites involving mangroves

Kuala Selangor Nature Park in Peninsular Malaysia includes 300 hectares of mangrove forest. The objectives of the Park are conservation, education, scientific research, tourism and park management in relation to the local community. The carrying capacity for day visitors and chalet occupants was set at a very modest level to protect the natural environment. Conservation projects have included construction of a lake system as additional habitat for birds and fish, nesting platforms for birds, breeding programs and other research on endangered species (e.g. milky stork and mangrove-associated fireflies). School children and teachers can visit the park for nature study and university staff and students can apply to undertake their own research projects.

Kampong Kuantan is another well-known mangrove ecotourism site near Kuala Selangor featuring fireflies, which inhabit the mangroves along part of the Selangor River estuary. This mangrove attraction generates a turnover of MYR 11 million a year (almost USD 3 million). However, none of the tourist income is used to protect the *Sonneratia* mangrove trees, which support the fireflies and this ecotourism site. The number of trees supporting fireflies has decreased drastically in the past 10 years as river pollution and riverbank disturbance have increased.

Wasini Island in Kenya features a mangrove and fossilised coral garden site with a traditional fishing community. The Women's Group organise tourism (mainly foreign tourists) and act as guides; a boardwalk is maintained and the mangroves are well protected because of the local communities involvement in this tourist activity.

Figure 12.2: The entrance ticket to Can Gio museum and nature park, Vietnam (Photo by Donald Macintosh, cenTER).

Figure 12.3: Visitor information boards at Ranong Biosphere Reserve visitor center, Thailand (Photo by Donald Macintosh, cenTER).

Figure 12.4: An otter watches tourists setting out on a boat trip in the Ranong mangrove ecosystem, Thailand (Photo by Donald Macintosh, cenTER).

ARTICLE 13 MANGROVE PRODUCTS AND RESPONSIBLE TRADE

Sustainably produced mangrove products should be promoted by "green labelling" and they should be traded following the principles of fair-trading and benefit sharing.

13.1 States and trade organisations should ensure that the trade in mangrove-associated products (timber, non-timber and fishery/aquaculture products) does not compromise the sustainable development and responsible utilisation of mangrove resources.

13.2 All mangrove products should be produced and sold following the principles of fair-trading. In particular, traditional and sustainably produced mangrove goods should be promoted under fair-trading practices.

13.3 States and trade organisations should promote "green" labelling of mangrove products, based on sustainable production methods. States should ensure that the increased financial benefits from green label products are passed back to the local producers.

13.4 States should promote research and development into new or improved products from mangroves that can be produced on a sustainable basis (see Box 13B and Fig 13.2).

13.5 The Convention on Biological Diversity (CBD) guidelines on benefit-sharing should be followed wherever possible (see Box 13A, 13C and also Ramsar Convention on fair trade of wetland products).

BOX 13A: Key articles of the CBD on fair trade and benefit-sharing

CBD Article 15.7
Take legislative, administrative or policy measures, as appropriate… with the aim of sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilization of genetic resources with the Contracting Party providing such resources. Such sharing is to be on mutually agreed terms.

CBD Article 8(j)

Promote the wider application of the knowledge, innovations and practices of indigenous peoples and local communities with their approval and involvement and encourage the equitable sharing of the benefits arising from the utilization of the knowledge, innovations and practices of indigenous and local communities.

Figure 13.1: A mudcrab farmer in the Red River Delta, Vietnam. Juvenile crabs caught in the mangrove protection belt by poor fishers are sold to crab farmers for rearing in ponds to a marketable size of 200-300 g (Photo by Lynne Overton, cenTER).

BOX 13B: Examples of research on the sustainable use of mangrove products

In Vietnam, mud crabs and mudskippers have been collected traditionally for food. Mud crab and mudskipper farming in mangrove ponds is now developing rapidly, particularly among poor farmers. Research leading to the breeding of mudcrab and mudskipper in hatcheries and nurseries is now underway. Successful production of mudcrab and mudskipper fry would greatly enhance the potential to culture these mangrove-associated species.

See also Fig 7.2 sustainable oyster rearing in Ceará, Brazil.

BOX 13C: Examples of the potential to promote "green labelling" of mangrove products

Mangrove charcoal from the Matang Mangrove Forest Reserve is marketed in Japan as a product from "sustainably managed forests".

"Kapi" is a type of shrimp paste produced by poor villagers in Ranong, Thailand from *Acetes* shrimp caught in mangrove waterways, which is then dried and salted. This is a sustainably produced, traditional product, which the producers sell very cheaply to local middlemen. With assistance from the management of the Ranong Biosphere Reserve where the villagers live, it has been recommended that this mangrove product should be better packaged and promoted with a "green" label to generate higher income to the villagers concerned (e.g. via direct marketing to local hotels, shops and other retail outlets).

Figure 13.2: Mangrove products being sold at a local market in Ranong, Thailand. Shrimp paste, *kapi*, is shown at the front right and if better packaged and given a green label could generate a higher income for the local villagers. (Photo by Elizabeth Ashton, cenTER).

ARTICLE 14 MANGROVE RESEARCH AND INFORMATION EXCHANGE

Poor understanding of the functions and values of mangrove ecosystems continues to hamper efforts to conserve and manage mangrove resources sustainably. However, there are considerable skills, information and opportunities worldwide to use research knowledge more effectively to improve management.

14.1 States should promote further development of scientific knowledge on mangrove ecology and the economic, social and cultural values of the mangrove ecosystem. Scientific knowledge should also be utilized more effectively to assist decision-making on the wise allocation and use of mangrove resources.

BOX 14A: Examples of multidisciplinary research on mangrove ecosystems

The Centre for African Wetlands (CAW) at the University of Ghana has made an inventory of the research needs for West African wetlands, including mangroves. CAW promotes the development of knowledge on wetlands by providing capacity for research, training and networking.

"Projet de Formulation de la Reserve du Saloum" - a multidisciplinary 3 year project to formulate the Saloum Biosphere Reserve, was very strongly local community orientated, involving the National Parks and supported by the Netherlands through IUCN and UNESCO (see Box 3B).

The values of Philippine Coastal Resources: Why Protection and Management are Critical. White and Cruz-Trinidad, 1998. Coastal Resource Management Project, Cebu City, Philippines, 96 pp.

UNDP/UNESCO The Integrated Multidisciplinary Study of the Ranong Mangrove Ecosystem, Thailand (Macintosh *et al*., 1991).

14.2 Opportunities should be provided for greater interaction between local communities, scientists, managers and policy makers to foster valuable interdisciplinary exchange of ideas on the management of mangrove ecosystems. This can be achieved by field visits, consultations, workshops, symposia, newsletters and use of the Internet. A list of mangrove web sites is provided at the end of the references.

BOX 14B: Examples of current exchange mechanisms for information on mangroves

Mangrove Database:

GLOMIS (Global Mangrove database Information System) has a directory of mangrove experts and references on mangroves to help exchange knowledge between different countries of the world.

Email Discussion Groups:

Mangrove e-mail discussion lists provide a global forum for the exchange of information for those interested in mangroves. For example, (http://possum.murdoch.edu.au/~mangrove/submang.htm). To subscribe to this list send an e-mail message to majordomo@essun1.murdoch.edu.au with the subject and message body reading "subscribe mangrove".

14.3 States should register research institutions and researchers performing studies on mangrove ecosystems, in order to encourage the exchange of information and prevent the duplication of research work.

14.4 Research is most needed on the following topics related to mangroves: ecological functions and productivity of mangrove ecosystems; links and interactions between mangroves and other ecosystems; taxonomy and genetics of mangrove species; socio-economic valuation of mangrove

ecosystems; traditional knowledge and appropriate technologies for sustainable management; and mangrove rehabilitation techniques.

14.4a The following are some specific research needs in mangrove ecology:

- The critical size of mangrove habitats that must be retained to maintain their ecological functions.
- Understanding the aquatic nursery functions of mangroves and other mangrove-fisheries interactions
- Fate/pathways for nutrients/particulates in the mangrove ecosystem, including nutrients generated from mangrove-friendly aquaculture
- The importance of mangroves as habitat for biodiversity/wildlife.
- The value of mangroves as an important feature of coastal protection.
- The role of mangroves as carbon sinks.
- Productivity studies on mangroves
- The impacts on mangrove ecosystems from global climate change

14.4b Promote taxonomic research on mangrove organisms. Increase the number and capacity of taxonomists and assistance and coordination with experts. Record local knowledge of species identification and species habits.

BOX 14C: Examples of recent taxonomic research on mangrove species

Research even on common mangrove groups, e.g., sesarmid crabs continues to generate descriptions of new species and taxonomic revisions (Tan and Ng, 1994).

The mangrove mudcrab, genus *Scylla* is another example. Only a single species, *Scylla serrata*, was recognised until recently. Keenan *et al*. (1998) revised the genus, identifying four closely related species, *Scylla olivacea, Scylla paramamosain* and *Scylla tranquebarica.* The distribution and biology of the three additional species described is still poorly known, but new studies on these species are now underway.

Figure 14.1: A poster produced by Clive Keenan and David Mann, Bribie Island Aquaculture Research Centre, Austrlia, gives the names and descriptions of the four mudcrab species now recognized by Keenan *et al*. (1998) - *Scylla serrata, Scylla olivacea, Scylla paramamosain* and *Scylla tranquebarica.*

14.4c There is limited information on mangrove genetic diversity and hence there is an urgent need for genetic studies with modern molecular tools like DNA profiles. This can be supported by establishing regional and in some cases national level mangrove genetic resource centres (MGRC) with reference specimens housed in herbaria and zoological museums.

BOX 14D: Example of a mangrove genetic resource centre

In India there are national and state level centres where specimens of mangrove plants have been preserved. The Botanical Survey of India is the leading Government Organisation for this purpose. A number of mangrove genetic programmes have been initiated in some national laboratories. The National Mangrove Committee of India identified one island Kalibhanj-Dia of Bhitarkanika Sanctuary, in the delta of the Mahandi River in Orissa, to be protected for a National Mangrove Genetic Resource Centre (NMGRC) because within the 2,000 ha area of the estuarine island there are about 64 mangrove species. During 2000-2001 the NMGRC was established.

14.4d Research on the direct and indirect use values of mangroves (benefits derived from their ecological and cultural functions) is crucial to fully incorporate the environmental costs ssociated with management actions (Bandaranayake, 1998; Ewel et al., 1998).

14.4e Research on traditional knowledge of mangroves is needed but such research should proceed with due respect for, and acknowledgement of, the rights and ownership of indigenous/local people. Local people should be encouraged to document their knowledge for future generations. See Box 14E for specific recommendations.

14.4f Promote research on appropriate technologies (e.g. GIS, See Article 5.1a), based on forestry experiences, for natural regeneration and plantation mangroves, selection of species, tree density, identification of suitable mangrove areas and criteria for healthy growth of mangroves. Investigate restoration, rehabilitation and mitigation of degraded habitats such as abandoned shrimp ponds, salt pans, areas heavily cleared for firewood and oil spills.

Table 14.1: The application of economic valuation to mangroves

		Location of Goods and Services	
		On-site	**Off-site**
Valuation of Goods and Services	**Marketed**	Usually included in economic analysis, e.g., poles, charcoal, woodchips, and crabs.	May be included in economic analysis, e.g. fish, crustaceans and molluscs caught in adjacent waters.
	Non-marketed	Seldom included in economic analysis, e.g., local subsistence collecting of mangrove crustaceans and molluscs for food, medicinal uses, bioturbation activities by mangrove animals e.g. crabs, fish nursery areas, feeding grounds for estuarine fish, crustaceans and molluscs, wildlife sanctuaries, biodiversity attributes, educational and research uses.	Usually ignored, e.g., nutrients flow down estuaries, buffer against storm damage, erosion control.

Modified from Hamilton and Snedaker (1984) and Dixon (1991).

BOX 14E: Mangrove traditional knowledge: priority research topics

Investigate ownership and right of use of mangrove traditional knowledge.

Research on social and economic aspects of mangrove resource use.

Document and evaluate traditional management systems for mangroves

Figure 14.2: In the Sundarbans there are many positive examples of restorative planting involving several mangrove species. On embankments of ponds in Binodpur village, 24 Parganas South, India *Nypa* or *Rhizophora* are planted at the lower levels and *Xylocarpus granatum* higher up on the banks. Still higher, *Heritiera fomes* followed by coconut (*Cocos nucifera*) are planted (Photo by Elizabeth Ashton, cenTER).

BOX 14F: Examples of mangrove rehabilitation at selected sites

Place	Objectives	Species	Comments
Bangladesh Ganges-Brahmaputra Delta	Planting newly formed mud islands for land consolidation and coastal protection	*Sonneratia apetala, S. caseolaris Avicennia* spp., *Excoecaria agallocha, Heritiera fomes, Xylocarpus* spp., *Bruguiera sexangula, Ceriops decandra* and *Nypa fruticans*	Forestry Department initiated afforestation programme in 1966. Seeds are directly planted or seedlings are raised in nurseries. 170,000 ha have been planted (Siddiqi, 2001).
Thailand Ranong Biosphere Reserve	Rehabilitate abandoned shrimp ponds and tin mining sites	*Rhizophora apiculata, R. mucronata, Ceriops tagal, Bruguiera parviflora*	Private sector and Local community groups did the planting under the supervision of the Royal Forest Department.
Benin Lake Nokoué, Porto Novo Lagoon, Ouémé Delta	Restore ecological function as fish nurseries	*Rhizophora racemosa, Avicennia africana*	Fishing in Lagoons Project started restoration programme 15 years ago with the cooperation of the local people.
Ghana Ada	Rehabilitate over-exploited areas to protect fish ponds	*Rhizophora racemosa*	Volta Basin Research Project for Aquaculture Development
Senegal Saloum Biosphere Reserve	Restore degraded areas ecological function as wildlife habitat	*Rhizophora racemosa, R. harrisonii, R. mangle*	Local NGO and local community participated in planting

14.4g Promote research on the sustainable use of mangrove resources, such as oysters, cockles, clams, gastropods, crabs and shrimps. These products are often a very important resource for local communities, but are often overlooked in fisheries statistics. Moreover mangrove crustacean and molluscan products are easily depleted by over collecting (see Box 7D).

14.5 States should coordinate research and development programmes to avoid duplication of effort and to promote more effective use of the information already available from research on mangroves.

14.6 States should seek assistance from national and international agencies (e.g. ISME) to help fill gaps in their knowledge base for mangroves and to help standardise methods of research.

14.7 A comprehensive mangrove information database is recommended in each country to help monitor the status of mangrove biological diversity, realise its economic potential and areas of application, and is essential toward adequate protection in the management of and access to these resources. Such a database should include mangrove characterization (covering geomorphology, hydrology, climate and export rates) and biodiversity (genetic and species resources, biological community structure, ecosystem processes and functions, and social and economic values) and be updated regularly. The data collected will assist the state Governments in better understanding their natural resources and developing policies integrating economics and the environment and assist in decision-making processes. See Box 5C for examples.

ARTICLE 15 INTEGRATION OF MANGROVE MANAGEMENT INTO COASTAL ZONE AND RIVER BASIN MANAGEMENT

Mangrove ecosystem management is an integral part of the coastal zone and river basin area management. Strong coordination is required at all levels between the authorities concerned with mangroves and other coastal and riverine ecosystems and resources.

15.1 States with neighbouring coastal areas or connecting water sources should cooperate together at the sub-regional and regional levels to facilitate the sustainable use of their common resources and to conserve the environment. States should also seek wide support in order to improve integrated coastal area and river basin management, including drawing on the wide experience of regional and international initiatives.

Figure 15.1: The mountainous watershed catchment area above the Ranong mangroves in Southern Thailand (Photo by Donald Macintosh, CenTER).

BOX 15A: Examples of regional cooperation mechanisms for mangrove management

The African Ministerial Conference on the Environment (AMCEN) and the African Ministerial conference on Water (AMCOW) rationalise approaches on environment and water use. These committees can be used to raise mangrove issues at regional level.

15.2 States should establish interministerial committees to promote cooperation and coordination among national authorities involved in the planning, development, conservation and management of coastal ecosystems and river basins.

BOX 15B: Examples of interministerial committees for implementation of national policies affecting mangroves

In Bangladesh there is interministerial Steering and Technical committees for integrated coastal zone management. The Program Development Office-Integrated Coastal Zone Management is in the Water Resources Planning Organization (WARPO) of the Ministry of Water Resources, Bangladesh but is composed of representatives from all relevant Ministries and Departments involved in coastal zone management.

15.3 States should ensure that the authority (or authorities) managing mangrove ecosystems in the coastal management process have the appropriate expertise and are provided with adequate financial resources and mandates to carry out their responsibilities. Existing sources of financial, technical and human resources should be reviewed in order to make their full potential available for the conservation and sustainable management of mangroves.

15.4 States should identify implementing agencies for mangrove management at the national level. Reconstitute or create National Level Committees with representatives from government, mangrove experts of all related fields, representatives of stakeholders and NGOs actively involved in all matters relating to mangroves for development, implementation and monitoring of

sustainable management action plans for mangrove ecosystems. (See reference to NATMANCOM in Box 4B).

15.5 States should develop strategic plans (preferably country wide and in line with ICZM framework) to provide for the conservation and sustainable use of mangroves and establish criteria and guidelines that must be addressed in preparing and considering predictive Environmental Impact Assessment.

15.6 States should develop Mangrove Management Plans so as to provide coordinated, cross-sectoral actions to implement the National Action Plan. The Mangrove Management Plan should involve the following:

- Stakeholder participation at all stages of planning and implementation.
- Assessment of the status of mangroves and the success of management initiatives in the respective areas and progress reporting
- Local academic and research institutions with appropriate expertise of implementation, monitoring and evaluation of mangrove ecosystems.
- Performance criteria on the effectiveness of implementation repeated at least once every 3 to 5 years.

15.7 States should ensure that all proposed development projects that may directly or indirectly affect mangroves both upstream and in the coastal area should be evaluated before approval (and later monitored) as part of an established Environmental Impact Assessment process.

15.8 States should control mangrove conversion for agriculture or salt production, housing, industries and mining, infrastructure (e.g. ports, roads, canals) or coastal aquaculture and ensure that coastal engineering and construction practices are environmentally sound.

15.9 States should recognise the importance of mangroves as a component of disaster preparedness to help mitigate natural and human induced disasters, especially catastrophic events such as cyclones, hurricanes, tidal and storm surges and oil pollution such as oil spills.

Figure 15.2: In Kenya mangroves were rehabilitated in Gazi Bay after environmental damage caused by the El Niño event of 1997/8 through the El-Niño Rehabilitation Program. (Photo courtesy of KMFRI, Kenya).

BOX 15C: Examples of mangroves used for disaster preparedness

In Vietnam mangroves have been planted to provide a protection zone against storms and flooding in both the Red River Delta and Mekong Delta regions. See Fig 2.4 and Box 3B.

15.10 States should promote multidisciplinary research on mangroves in support of integrated coastal area management, in particular studies which integrate environmental, economic, social, legal and institutional aspects of sustainable mangrove management.

15.11 Ultimately, sustainable management of mangrove ecosystems will depend on governmental bodies at all levels, and NGOs, donor agencies and local stakeholders working together towards a common goal. To achieve this, States should promote integration of the various approaches and tools for management provided in articles 1-14 of this Code of Conduct.

GLOSSARY

Afforestation

The conversion of bare or cultivated land into forest. The establishment of a forest, stand or tree crop on an area not previously forested, or on land from which forest cover has very long been absent (IUFRO Silva term database. http://iufro.boku.ac.at/)

Agenda 21

A comprehensive set of programmes of action to promote sustainable development into the 21st century. Adopted, Rio, June, 1992.

Alien species

A species occurring in an area outside of its historically known natural range as a result of intentional or accidental dispersal by human activities (also known as exotic or introduced species) (UNEP-WCMC glossary).

Assessment

The identification of the status of, and threats to, wetlands/mangroves as a basis for the collection of more specific information through monitoring activities (Ramsar definition).

Biodiversity

A condensed form of biological diversity means "the variability among living organisms from all sources including, *inter alia* terrestrial, marine and aquatic systems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (United Nations Environment Programme, 1992, p.27).

Biosphere Reserve

Biosphere Reserves (BRs) were established under UNESCO's Man in the Biosphere (MAB) Program in 1970. Biosphere Reserves are areas of terrestrial and coastal/marine ecosystems or a combination thereof and are a series of protected areas linked through a global network. Each reserve is through appropriate zoning patterns and management mechanisms intended to fulfil three complementary functions:

- A conservation function (to preserve genetic resources, species, ecosystems and landscapes);
- A development function (to foster sustainable economic and human development); and
- A logistic function (to support demonstration projects, environmental education and training, and research and monitoring related to local, national and global issues of conservation and sustainable development.

To carry out the complementary activities of nature conservation and use of natural resources, Biosphere Reserves are organized into three interrelated zones:

- A core area that should be legally established and sufficiently large to meet the conservation objectives.
- A buffer zone which is clearly delineated and which surrounds the core area. Activities do not hinder core area conservation but help to protect it for example through research.
- A transition zone is the area of co-operation that extends outwards, and which may contain a variety of agricultural activities, human settlements and other uses.

Benefit sharing

Refers to the sharing of results of bioprospecting activity and benefits arising from the utilization or commercialisation of the biological or genetic resources fairly and equitably with the indigenous cultural community/local community/protected area/private landowner concerned and the national government by the Principal/Collector. Among the results and benefits that may be shared are payment for access to specimens, royalties, data, technology, capacity building, training, joint research.

Bioprospecting

Refers to the research, collection and utilization of biological and genetic resources, for purposes of applying the

knowledge derived therefrom for scientific and/or commercial purposes.

Buffer zones

Areas on the edge of protected areas that have land use controls and allow only activities compatible with protection of the core area, such as research, environmental education, recreation and tourism (UNEP-WCMC).

Capacity Building

Improving and building the technical and managerial skills and resources within an organization (World Bank. Glossary of Municipal Solid Waste Management Terms)

Carrying capacity

It is the maximum number of individuals of a defined species that a given environment can support over the long term, or it is the ability of an environment to sustain the resource demands of a species or a community without losing its ability to regenerate the resource. The carrying capacity of a given area for a certain type of use can be defined as the capacity to provide space, resources and environmental conditions in a sustainable manner. IUCN, UNEP and WWF define it as the "capacity of an ecosystem to support healthy organisms while maintaining its productivity, adaptability, and capability of renewal".

Co-management

The sharing of authority, responsibility, and benefits between government and local communities in the management of natural resources (UNEP-WCMC glossary).

Conservation

Protection from change, loss or damage or protection of valued resources through the protection, management and care of natural and cultural resources (Encarta, 1999).

Convention on Biological Diversity (CBD)

Adopted in Rio de Janeiro, Brazil, June 1992 and came into force December 1993. Signed by over 150 countries. Legally binding agreement with the three key objectives:

- Biodiversity Conservation
- Sustainable use of biodiversity
- Fair and equitable sharing of the resulting benefits

This Convention is the first global, comprehensive binding agreement to address all aspects of biological diversity: genetic resources, species and ecosystems. It requires countries to develop and implement strategies for sustainable use and protection of biodiversity and provides a forum for continuing dialogue on biodiversity related issues through the annual Conference Of the Parties (COP).

Convention on International Trade in Endangered Species of wild flora and fauna (CITES)

Adopted in Washington D.C. March 1973 and came into force July 1975 in response to the growing concern over large scale exploitation of wildlife for international trade which was threatening species with extinction. Aims to regulate international trade of wildlife (animals and plants dead or alive or any recognizable parts or derivatives of) threatened or endangered in the wild through a system of permits and controls.

Direct use value

The productive or consumptive values derived from direct use or interaction with a biological resource which may be marketed or non-marketed.

Ecosystem

A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (Article 2 on the Convention of Biological Diversity).

Ecosystem Approach

It is a strategy for the integrated management of land, water and living resources that promotes conservation and

sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organisation, which encompasses the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems.

Adopted by the Conference of the Parties of the CBD, at its Fifth Meeting in Nairobi, 2000, as the primary framework for action under the Convention (V/6). Recommended the application of 12 principles on the Ecosystem Approach.

Principle 1: The objectives of management of land, water and living resources are a matter of societal choices.

Principle 2: Management should be decentralized to the lowest appropriate level.

Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

Principle 4: Recognising potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem management programme should:

a) Reduce those market distortions that adversely affect biological diversity
b) Align incentives to promote biodiversity conservation and sustainable use
c) Internalise costs and benefits in the given ecosystem to the extent feasible

Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.

Principle 6: Ecosystem must be managed within the limits of their functioning

Principle 7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

Principle 8: Recognising the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.

Principle 9: Management must recognize that change is inevitable.

Principle 10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

Principle 11: The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.

Principle 12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

Ecosystem Diversity

The variety of habitats, biotic communities and ecological processes in terrestrial, marine and other aquatic environments in a particular area, together with the processes and interactions that take place within and between these systems.

Ecosystem functions

The processes of production and dynamics of resources (organic matter, nutrients, biomass, elements) and energy through systems. A set of ecological processes responsible for providing an environmental good or service (Gilbert and Janssen, 1998).

Ecosystem resilience or resistance

Determines the persistence of relationships within a system, and is a measure of the ability of these systems to absorb changes in species composition and abundance and still persist without drastically changing the ecosystem performance.

Economic value

The value of a good or service placed by an individual or society through his willingness to pay using market price or other indicators.

Economic valuation

Measuring the preferences of people or society for a good or service or against economic activity.

Endangered species

A technical definition used for classification in the United States referring to a species that is in danger of extinction throughout all or a significant portion of its range. IUCN The World Conservation Union (1994) definition, defines species as endangered if the factors causing their vulnerability or decline continue to operate UNEP-WCMC glossary).

Endemic

Restricted to a specified region or locality (UNEP-WCMC glossary).

Environmental Impact Assessment

A method of analysis which attempts to predict the likely repercussions of a proposed major development (usually industrial) upon the social and physical environment of the surrounding area (UNEP-WCMC glossary).

Existence value

The benefit an individual or society receives from merely knowing that a good or service exists. Society's willingness to pay towards the conservation of biological resources for their own sake regardless of their current or optional uses.

Food and Agricultural Organization (FAO) Code of Conduct for Responsible Fisheries

This code is voluntary but certain parts of it are based on international law. The Code is global in scope and is directed towards members and non-members of FAO, fishing entities, sub regional, regional and global organizations, whether governmental or non-governmental, and all persons concerned with the conservation of fishery resources and management and development of fisheries, such as fishers, those engaged in processing and marketing of fish and fishery products and other users of the aquatic environment in relation to fisheries.

The Code "sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity". The Code also recognizes the nutritional, economic, social, environmental and cultural importance of fisheries and the interest of those concerned with the fishery sector.

Genetic Diversity

The variation within and between populations of species (i.e. individual plants, animals and micro-organisms), measured in terms of the variations between genes or DNA or amino acid sequences, as well as numbers of breeds, strains and distinct populations.

Genetic Resources

The genetic material of plants, animals and micro-organisms of value as a resource for future social, economic, environmental purposes.

Goods

Articles for sale or use, often produced for later consumption as opposed to services

Hotspot

An area on earth with an unusual concentration of species, many of which are often endemic to the area.

Indigenous cultural communities or Indigenous people

Refer to a homogenous society identified by self-ascription and ascription by others, who have continuously lived as community on communally bounded and defined territory, sharing common bonds of language, customs, traditions and other distinctive cultural traits, and who, through resistance to the political, social and cultural inroads of colonization, became historically differentiated from the majority of other people.

Indirect use value

The value of an environment's ecological functions which support or protect the life forms dependent on that environment, or an economic activity.

Integrated Coastal Zone/Area Management (ICZM/ICAM)

Used to describe a continuous and dynamic process that unites government and the community, science and management, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal systems and resources (GESAMP, 1996).

Inventory

The collection and/or collation of core information for management, including the provision of an information base for specific assessment and monitoring activities. (Ramsar definition)

ISME

The International Society for Mangrove Ecosystems was established in August 1990. ISME is recognised as an international non-governmental organisation dedicated to the study and conservation of mangrove ecosystems. A secretariat for ISME was established on the island of Okinawa in Japan through the support of the Government of Japan, the prefecture of Okinawa and the University of Ryukyus. There are four sub-regional centres located in Fiji (Oceania and Australia), Ghana (Africa), Brazil (Americas) and India (South and Southeast Asia). There are about 1000 members worldwide. (http://www.mangrove.or.jp/index.html)

IUCN (World Conservation Union) Protected Area Categories (IUCN, 1994)

Category Ia: Strict Nature Reserve – Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring

Category Ib: Wilderness Area – Large area of unmodified or slightly modified land and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed to preserve its natural condition

Category II: National Park – 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 harmful to the purposes of designation of the area, and c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

Category III: Natural Monument – Area containing one, or more, specific natural or natural/cultural features which are of outstanding or unique value because of their inherent rarity, representative or aesthetic qualities or cultural significance.

Category IV: Habitat/Species Management Area – Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

Category V: Protected Landscape/Seascape – Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

Category VI: Managed Resource Protection Area – Area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

IUCN Red List of Threatened Species

Provides taxonomic, conservation status and distribution information on taxa that have been evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable). The IUCN Red List also includes information on taxa that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e. are Data Deficient); and on taxa that are either close to meeting the threatened thresholds or that would be threatened were it not for on-going taxon-specific conservation programmes (i.e. Near Threatened).

Jakarta Mandate on Marine and Coastal Biological Diversity

This program was adopted in 1995 at the Second meeting of the Conference of the Parties (COP) of the Convention on Biological Diversity (CBD) in Jakarta, Indonesia. Five key thematic issues were identified and are

shown below together with their operational objectives for the work programme:

1. Integrated marine and coastal area management (IMCAM)

1.1 Reviewing existing instruments related to IMCAM

1.2 Promoting the development and implementation of IMCAM at the local, national and regional level

1.3 Developing guidelines for ecosystem evaluation and assessment (including indicators)

2. Marine and coastal living resources

2.1 Promoting ecosystem approaches to the sustainable use of marine and coastal living resources

2.2 Making available to Parties information on marine and coastal gene resources, including bioprospecting

3. Marine and coastal protected areas

3.1 Facilitating research and monitoring activities on the value and effect of marine and coastal protected areas or similarly restricted areas on sustainable use of marine and coastal living resources

3.2 Developing criteria for the establishment and management of marine and coastal protected areas

4. Mariculture

4.1 Assessing the consequences of mariculture for marine and coastal biological diversity and promoting techniques to minimize adverse impacts

5. Alien species and genotypes

5.1 Achieving better understanding of the causes and impacts of introductions of alien species and genotypes

5.2 Identifying gaps in existing or proposed legal instruments, guidelines and procedures and collecting information on national and international actions

5.3 Establishing an "incidental list" of introductions

Management

The act or practice of handling, administering, supervising or controlling, entities, resources and activities.

Mangrove Action Project (MAP)

A non-profit organisation based in USA, which is dedicated to reversing the degradation of mangrove forest ecosystems worldwide. Its central tenet is to promote the rights of local coastal peoples, including fishers and farmers, in the sustainable management of coastal environments. MAP provides four essential services to grassroots associations and other proponents of mangrove conservation:

1) It coordinates a unique international NGO network and information clearinghouse on mangrove forests;

2) It promotes public awareness of mangrove forest issues;

3) It develops technical and financial support for NGO projects; and

4) MAP helps publicize within the developed nations the basic needs and struggles of Third World coastal fishing and farming communities affected by the consumer demands of the wealthy nations. (This we do through our quarterly newsletter, bi-weekly news bulletins, action alerts, and published articles, as well as planned public forums and presentations.)

Mangrove ecosystems

Important wetland systems that fringe the intertidal zone along sheltered coastal, estuarine and riverine areas in tropical and subtropical latitudes.

They support many types of plants and animals. The majority of plants are evergreen trees, although deciduous trees, perennial and evergreen shrubs, epiphytes, parasites and climbers, grasses, palms and perennial ferns are also common constituents (Tomlinson, 1986), together with algae, fungi and microflora. Micro and macroscopic, terrestrial and aquatic (marine and freshwater), temporary and residential wildlife are all supported by mangroves (Hutchings & Recher, 1982; Hutchings & Saenger, 1987) forming a heterogeneous habitat.

The mangrove physical environment includes waterways (estuaries, deltas, rivers, creeks, canals, lagoons and backwaters), mudflats, salt pans and islands (Kjerfve, 1990), and is often highly saline, frequently inundated, soft bottomed anaerobic mud.

Mariculture

Saltwater seafood farming
(http://environment.jbpub.com/mckinney/interactive_glossary_showterm.cfm?term=mariculture%20)

Marine agriculture, i.e., farming the seas to grow algae or to raise finfish and shellfish
(http://www.jbpub.com/oceanlink/interactive_glossary_showterm.cfm?term=Mariculture).

Marine protected Areas (MPA)

In 1986, the IUCN Commission on National Parks and Protected Areas (CNPPA) began promoting the establishment and management of a global representative systems of marine protected areas. IUCN defines MPA as "any area of intertidal, subtidal terrain, together with its overlying water and associated flora and fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" (Gubbay, 1995).

Monitoring

The collection of specific information for management purposes in response to hypotheses derived from assessment activities, and the use of these monitoring results for implementing management. The collection of time-series information that is not hypothesis-driven from wetland/mangrove assessment is here termed surveillance rather than monitoring (Ramsar definition).

Non-Governmental Organisation (NGO)

A non-profit group or association organized outside of institutionalised political structures to realize particular social objectives (such as environmental protection) or serve particular constituencies (such as indigenous peoples or other local communities). NGO activities range from research, information distribution, training, local organization and community service to legal advocacy, lobbying for legislative change, and civil disobedience. NGOs range in size from small groups within a particular community to huge membership groups with a national or international scope (UNEP-WCMC glossary).

Option value

The potential value of a resource for future (direct and indirect) use by protecting or preserving it today.

Precautionary Approach

A decision to take action, based on the possibility of significant environmental damage, even before there is conclusive, scientific evidence, that the damage will occur (European Commission, 1999. Integrating environmental concerns into development and economic cooperation. Brussels).

Principle 15 of the Rio Declaration on Environment and development states that:

"In order to protect the environment, the precautionary approach shall be widely applied by the States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

Ramsar Convention on Wetlands of International Importance especially as waterfowl habitat

Adopted in Ramsar, Iran February 1971 and came into force December 1975. Legally binding agreement now signed by over 110 countries with the following objectives:

- To promote the wise use and conservation of wetlands
- To make environmental assessments before transforming wetlands
- To establish nature reserves on wetlands
- To increase waterfowl populations in appropriate wetlands through management

Reforestation

Planting of forests on lands that have previously contained forests but that have been converted to some other use (IPCC, 2001). The reestablishment of forest cover either naturally (by natural seeding, coppice, or root suckers) or artificially (by direct seeding or planting) (IUFRO Silva term database http://iufro.boku.ac.at/

Rehabilitation

The recovery of specific ecosystem services in a degraded ecosystem or habitat (UNEP-WCMC glossary). Establishment of mangroves in degraded/destroyed mangrove areas through activities by man namely hydrology and planting restoration. A functioning system reinstated by man but not necessarily what was there before.

Restoration

The return of an ecosystem or habitat to its original community structure, natural complement of species, and natural functions (UNEP-WCMC glossary). Returning a former mangrove forest area to forest cover through hydrological restoration and either followed by planting of seeds, seedlings or saplings or allowed to naturally recolonise.

Species diversity

The variation of species and subspecies among living organisms on Earth.

Stability

The ability of a system to return to the initial equilibrium state following a temporary disturbance.

Stakeholder

An institution, organisation, or group that has some interest in a particular sector or system (WHO. http://www.who.int/terminology/ter/Health_futures.html).

People who use, affect or otherwise have an interest in the mangrove ecosystem.

Sustainable development

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987) or "the management and conservation of the natural resource base and the orientation of technological change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable" (FAO, 1988).

Sustainable Tourism

All forms of tourism development, management and activity, which maintain the environmental, social and economic integrity and well being of natural, built and cultural resources in perpetuity (Federation of Nature and National Parks of Europe, 1993, p. 5).

Taxon

A grouping of species: taxonomic group at any level, e.g. Kingdom, Phylum or Division, Class, Order, Family, Genus, Species, Sub-species (http://212.187.155.84/wnv/Subdirectories_for_Search/Glossary&References_Contents/KeywordsContents/t/Taxon.htm)

Total Economic Value (TEV)

Comprises direct use value, indirect use value, option value and existence value.

Valuation

The process of placing monetary value on goods and services that do not have accepted market prices (such as biodiversity).

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International Society for Mangrove Ecosystems, Japan

http://www.mangrove.or.jp/index.html

Mangrove Web Home Page, Murdoch University, Western Australia

http://wwwscience.murdoch.edu.au/centres/others/mangrove/

Wetlands Ecology and Management journal

http://www.kluweronline.com/issn/0923-4861

Guide to the Mangrove of Singapore handbooks

http://mangrove.nus.edu.sg/guidebooks/

East African Mangroves, Kenya

http://www.specola.unifi.it/mangroves/Index.htm

Mangrove Action Project, USA
http://www.earthisland.org/map/index.htm
Mangrove Replenishment Initiative, Florida, USA
http://www.mangrove.org/
Mangrove Environmental Protection Group, Mexico
http://www.elmanglar.com/
Wetlands International
http://www.wetlands.org/
World Conservation Monitoring Centre, Cambridge, UK
http://www.wcmc.org.uk/marine/data/coral_mangrove/mangrove.main.html

ANNEX 1: GUIDELINES FOR PLANTING MANGROVES

Seed and propagule collection

- Collect local seeds to ensure survival and adaptation of young plants to planting site and reduce the incidence of seed damage because of handling and transport
- Collect only mature seeds (immature seeds often don't survive)
- Tree collection of seeds is easiest at high tide from a boat. Seeds collected from the ground have a higher incidence of insect attack and are to be used as little as possible
- Prepare a seedling collection and planting timetable as production varies from place to place and tree species

Seed and propagule quality

- Discard abnormal and injured seeds.
- Eliminate seeds with holes (even pin sized) because these are usually infested by a beetle *Poecellips fallax*. Infested seeds can easily contaminate the other seeds

Seed and propagule Handling and Transport

- Retain pericarp (brown cap structure in *Rhizophora*) to provide protection to the shoot
- Keep seeds under a shed and cover with green banana leaves or thatch to prevent excessive loss of seed moisture
- Bundle seeds in 50s or 100s to facilitate counting and handling
- Keep seeds horizontal and covered with moist sacks to properly protect from heat when transporting

Seed and propagule storage

- Clean and treat the seeds (avoid using fungicides and insecticides as much as possible)
- Air dry seeds for one day
- Place seeds in plastic bags, seal and keep at room temperature (can keep like this for 1 to 4 months and still have 60-90% germination depending on the species)
- *Rhizophora* propagules can be kept in a shed under room temperature for two weeks without adversely affecting viability, as long as they don't get wet

Seedling production

- *Rhizophora* can be directly seeded by placing the hypocotyl end vertically in mud and removing pericarp
- *Ceriops* and *Bruguiera* although having shorter propagules can be planted directly in less inundated areas
- *Sonneratia* and other small seed mangrove species should be raised in a nursery. Best *Sonneratia* germination obtained if fruits are soaked in tap water for 7 days, mashed and seeds sown on flooded seedbeds using waterlogged mangrove soil.
- In nurseries use mangrove forest top soil in polyethylene plastic bags, directly sow seeds, place under partial shade and irrigate daily with brackishwater or freshwater.
- *Avicennia* and other small seed mangrove species wildlings (wild seedlings) can be transplanted to planting site successfully. Best size range for *Avicennia* is 60 to 90 cm tall. Can be planted earthballed or bareroot. Bareroot collected wildlings must be placed in plastic bags to prevent roots drying

Selection of Planting Sites and Species

- Mangrove zonation results from the combined affects of tidal inundation, exposure to wind, waves and water currents, soil properties, morphology of species, salinity, light and species association. Environmental factors and natural mangrove zonation should be taken into account in determining what species are particularly suited to the planting site.
- Seaward zone - daily inundated. Soil ranges from sandy to sandy loam, mudflat or coralline type.

Usually inhabited with *Avicennia, Sonneratia, Aegiceras* and *Rhizophora mucronata.*

- Middle zone - daily inundated except during neap tides. Soil clayey, silty to silty clay. Usually inhabitated with *Avicennia, Aegiceras, Bruguiera, Ceriops, Excoecaria agallocha, Lumnitzera racemosa, Scyphiphora hydrophyllacea* and *Nypa*
- Landward zone – unaffected by tidal inundation over long periods of time except during high Spring tides. Soil clayey to silt clay. Vegetation highly diverse because of the presence of mangrove associates, vines and epiphytes. Mangrove species similar to middle zone but can also include *Acanthus, Heritiera littoralis, Barringtonia racemosa, Hibiscus tilaceus* and *Thespesia populnea*
- Riverine fringes at mouths of rivers commonly have *Avicennia*, *Aegiceras* and *Rhizophora* species and in interior riverbanks these species and *Bruguiera* and *Xylocapus granatum* can be found

Preparation of Planting Site

- Compartmentalize plantation area into manageable sizes for each planter/family/community to allow planting, maintenance and monitoring activities easier.
- Leave 3–5 m between compartments for pathways or in extensive areas a 10 m waterway for passage of boats, which should be determined by the users.
- Establish fence or stakes around the perimeter to protect young plants from trespassers while providing them a guide on the way to take especially at high tide.
- Clear planting sites from debris because these injure young plants as tide rises

Planting

- Use species that match the intertidal zonation and soil characteristics
- Direct seeding is recommended as entails less labour costs and has high survival rate.
- On soft ground push seeds one third to one half of the total length of the hypocotyls. On hard grounds firstly dig hole and plant one quarter to one third total length of hypocotyls. Best spacing 1 m x 1 m (Gan, 1995).
- Wildlings should be directly planted on the same day they are collected. Hole dug to freely accommodate earth and roots, ideal spacing 2 m x 2 m.
- Proper timing is critical for success. Should coincide with season of available mature seeds, calm weather and long days of low tide during the day

Protection

- Beetles (Coleoptera: Scolytidae) bore into seedlings and can cause mortality. Air drying of seedlings for 7-14 days before planting protects seedling from infestation during critical first 3 months
- Scale insects (Homoptera:Diaspididae) attack leaves of *Rhizophora* causing premature leaf fall. Severe infestation can lead to complete defoliation and seedling mortality. Infected seedlings should be buried in the mud to prevent destructive population build up. Spraying of insecticides is not practical it will only contaminate area and affect other life forms.
- Barnacles (Crustacea: Cirripedae) can attach to seedlings in high numbers and adversely affect respiration and photosynthesis. Infestation can be minimised by planting fully hardened seedlings, planting the right species at the right site, planting in shallowly inundated sites during high tides, or areas that are fully exposed for at least 3-4 hours a day at low tide. Barnacles can be scraped off every two months if done carefully but tedious and impractical.
- Sesarmid crabs (Crustacea: Grapsidae) inflict damage on young seedlings by eating bark and young leaves. When crab damage and also attack by monkeys is severe, shielding with bamboo tubes can protect the seedlings, although this is expensive. Drying seedlings for two weeks prior to planting makes seedlings less prone to damage.
- Diseases. Cuts can serve as entry for microoganisms. To prevent infection coat with coal tar or paint.
- Weeds. *Acrostichum* fern forms dense, tall thickets under open canopy. Natural colonization is difficult and survival of seedling reduced. Fern can be manually uprooted.

Sources: PCARRD, 1991.

ANNEX 2: THE TEXT OF THE ARTICLES

Article 1: Mangrove Management Objectives

The fundamental objective of mangrove management is to promote conservation, rehabilitation and sustainable utilisation of mangrove ecosystems to benefit the global population.

Article 2: Precautionary Approach to Management

The overall approach to mangrove management should be a precautionary one, but a lack of scientific information should not be used as an argument for postponing, or failing to implement mangrove conservation and sustainable management measures.

Article 3: Legal Framework

National and international legal frameworks are required to provide overall guidance for the conservation and sustainable use of mangrove resources and to ensure protection for mangrove-associated biodiversity.

Article 4: Implementation

There is a general weakness in the implementation of the legal framework for mangroves and lack of consultation between the management agencies and the various mangrove stakeholders.

Article 5: Mangrove Inventory for Management

Mangrove survey, inventory and monitoring data are required to support sustainable management.

Article 6: Socio-Economic Considerations

Mangroves provide important socio-economic benefits to poor coastal communities worldwide and the sustainable management of mangrove resources is necessary to maintain and improve their livelihoods.

Article 7: Cultural and Community Issues

Mangrove ecosystems are associated with unique human traditions and knowledge, but they are also under severe pressure from some traditional and non-traditional forms of exploitation.

Article 8: Capacity Development

Capacity development for mangrove management and awareness raising about mangroves is needed at all levels from decision makers in government, to community leaders and educational institutions (teachers, students and school children).

Article 9: Forestry/Silviculture Management

Mangrove forestry/silviculture objectives may have an economic, environmental or aesthetic basis, or a combination of these. The specific objectives for forest management include timber and fuelwood production, shoreline and river channel stabilisation, landfill and waste management, fisheries and wildlife support, storm and flood protection, ecological and biodiversity restoration and land-scaping.

Article 10: Fisheries and Aquaculture

Mangrove associated fisheries and aquaculture have worldwide importance in providing subsistence food and income, as well as commercial benefits, for a wide range of stakeholders, from very poor fisher communities and coastal farmers, to major companies that have invested in aquaculture and seafood processing. Thus, the importance of effective management in relation to mangrove fisheries and aquaculture development cannot be overestimated. It should also be recognised that lack of enforcement of existing fisheries regulations to protect mangrove nursery sites is one of the major causes of unsustainable fishing. Similarly, many of the problems associated with mangroves and coastal aquaculture stem from poor aquaculture management practices and/or lack of enforcement of environmental regulations.

Article 11: Agriculture, Salt Production and Mining

The conversion of mangroves to other forms of land use, including agriculture and salt pans has been a major cause of wetland habitat loss in many countries. Mining has also caused significant localized damage to mangrove ecosystems, especially in Africa and parts of Asia.

Article 12: Tourism, Recreation and Education

Tourism is the World's largest and fastest growing sector of the global economy. Mangrove ecosystems are no exception; their unique habitat and biodiversity provide ecotourists with many potential opportunities, including recreational fishing, bird watching, viewing wildlife and scenic boat trips.

Article 13: Mangrove Products and Responsible Trade

Sustainably produced mangrove products should be promoted by "green labelling" and they should be traded following the principles of fair-trading and benefit sharing.

Article 14: Mangrove Research and Information Exchange

Poor understanding of the functions and values of mangrove ecosystems continues to hamper efforts to conserve and manage mangrove resources sustainably. However, there are considerable skills, information and opportunities worldwide to use research knowledge more effectively to improve management

Article 15: Integration of Mangrove Management into Coastal Zone and River Basin Management

Mangrove ecosystem management is an integral part of the coastal zone and river basin area management. Strong coordination is required at all levels between the authorities concerned with mangroves and other coastal and riverine ecosystems and resources.

BOXES, FIGURES AND TABLES

BOXES

FIGURES, MAPS and TABLES

ACRONYMS

CBD	Convention on Biological Diversity
CCD	Convention to Combat Desertification
cenTER	Centre for Tropical Ecosystems Research, Aarhus University, Denmark
CITES	Convention on the international Trade in Endangered Species (UN)
CMS	Convention on Migratory Species
Danida	Danish International Development Assistance
EIA	Environmental Impact Assessment
ESCAP	Economic and Social Commission for Asia and the Pacific (UN)
FAO	Food and Agricultural Organisation (UN)
GATT	Global Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GEF	Global Environment Facility
GESAMP	Group of Experts on Environmental Aspects of Marine Environmental Protection
GIS	Geographical Information Systems
GLOMIS	Global Mangrove Database and Information System
GOGLME	Gulf of Guinea Large Marine Ecosystem project
ICZM	Integrated Coastal Zone Management
IPRs	Intellectual Property Rights
ISME	International Society for Mangrove Ecosystems
IUCN	World Conservation Union
ITTO	International Tropical Timber Organisation
NePAD	New Partnership for Africas Development
NGO	Non-Governmental Organisation
PCARRDs	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Seas
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHC	World Heritage Convention
WRI	World Resources Institute