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ABBREVIATIONS AND ACRONYMS

ADB	- Asian Development Bank
APC	- Areas of Particular Concern
Aus AID	- Australian Agency for International Development
BEPZ	- Biyagama Export Promotion Zone
BOD	- Biological Oxygen Demand
BOI	- Board Of Investment
CBO	- Community Based Organization
CCD	- Coast Conservation Department
CEA	- Central Environment Authority
CEIP	- Colombo Environment Improvement Project
COD	- Chemical Oxygen Demand
CORDIO	- Coral Reef Degradation in Indian Ocean
CPC	- Ceylon Petroleum Corporation
CRMP	- Coastal Resources Management Project
CZMP	- Coastal Zone Management Plan
DFAR	- Department of Fisheries and Aquatic Resources
DO	- Dissolved Oxygen
DWL	- Department of Wildlife
EEZ	- Exclusive Economic Zone
EIA	- Environment Impact Assessment
EPL	- Environment Protection License
EPZ	- Export Promotion Zone
FAO	- Food and Agricultural Organization
FRN	- Swedish Council for Planning and Coordination of Research
GCA	- Greater Colombo Area
GCRMN	- Global Coral Reef Monitoring Network
GEF	- Global Environmental Facility
GTZ	- German Technical Corporation
HPA	- High Priority Area
HICZMP	- Hambantota Integrated Coastal Zone Management Project
INSTOM	- Institutional Strengthening of the Oil Spill Contingency Management
IOTC	- Indian Ocean Tuna Commission
IP	- Industrial Park
IPCC	- International Panel on Climate Change
IRG/UK	- International Resources Group of United Kingdom
IUCN	- International Union for the Conservation of Nature
IWMI	- International Water Management Institute
JICA	- Japan International Corporation Agency
KEPZ	- Katunayake Export Promotion Zone
LHI	- Lanka Hydraulic Institute
LME	- Large Marine Ecosystem
LOA	- Length Overall
MCS	- Monitoring, Controlling and Surveillance
MENR -	- Ministry of Environment & Natural Resources
MFOR	- Ministry of Fisheries & Ocean Resources
MISTRA	- Foundation for Strategic Environment Research
MOFE	- Ministry of Forestry & Environment
MPCEM	- Master Plan for Coastal Erosion Management
MPPA	- Marine Pollution Prevention Authority
NAQDA	- National Aquaculture Development Authority
NARESA	- Natural Resources Energy and Science Authority of Sri Lanka
NARA	- National Aquatic Resources Research and Development Agency
NEA	- National Environmental Act

NEAP	- National Environmental Action Plan
NGO	- Non-Governmental Organization
NORAD	- Norwegian Agency for Development
NOSCP	- National Oil Spill Contingency Plan
NWS&DB	- National Water Supply & Drainage Board
NWP	- North Western Province
PEA	- Provincial Environmental Authority
PPTA	- Project Preparation Technical Assistance
REEL	- Real Estate Exchange Limited
SAM	- Special Area Management
SAP	- Strategic Action Plan
SAREC	- Swedish Agency for Research Cooperation
SDA	- Southern Development Authority
SIDA	- Swedish International Development Agency
SLPA	- Sri Lanka Ports Authority
STP	- Sustainable Township Programme
TCP	- Turtle Conservation Project
TDA	- Transboundary Diagnostic Analysis
UC	- Urban Council
UDA	- Urban development Authority
UNDP	- United Nations Development Programme
UNEP	- United Nations Environment Programme
UNESCO	- United Nations Education, Science and Cultural Organization
WHO	- World Health Organization
WWF	- World Wide Fund

1.0 INTRODUCTION

The Bay of Bengal, bounded by eight countries (Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand), has been identified as one of the world's forty-nine Large Marine Ecosystems. About one quarter of the world's population resides in the littoral countries of the Bay of Bengal, with approximately 400 million living in the Bay's catchment area, many at or below the poverty level. Large coastal cities in these countries accommodate close to 65% of the urban population, with increasing migration into coastal regions.

With the assistance of FAO, the eight countries have forwarded a proposal to the Global Environmental Facility for a project to address issues related to the management of the coastal and near shore environment and resources in an integrated and coordinated manner and within the LME approach. Funds have been made available by GEF to develop a Bay of Bengal Large Marine Ecosystem Programme, to be implemented by the World Bank with FAO as the executing agency. The Swedish International Development Agency (SIDA) also supports the development phase.

The first phase in operation is aimed at developing a Transboundary Diagnostic Analysis (TDA) and Strategic Action Plan (SAP), which will identify specific actions required to address priority transboundary issues and also provide a comprehensive framework to address such issues.

1.1 Aim of the national report

The national report for Sri Lanka is intended to contribute to the development of the Transboundary Diagnostic Analysis and Strategic Action Plan in respect of the Bay of Bengal Large Marine Ecosystem.

It identifies national and regional priorities relevant to the coastal and marine environment, its living resources and critical habitats. In particular, the report assesses the status and the development potential, as well as threats to the coastal and marine environment and its living resources, with special reference to those with transboundary effects. The report also reviews ongoing and planned programmes and projects of national, regional and international organizations relevant to the coastal and marine environment and its living resources, identifies data gaps requiring further study and proposes specific priority actions to address issues and concerns in regard to the health and well being of the coastal and marine environment and its living resources.

1.2 Country background

The island Republic of Sri Lanka is located in the Indian Ocean, southeast of India, between 5°55' and 9°51' N latitude, and 79°41' and 81°53' E longitude. Its area is approximately 65,610 sq. km.; with a coastline of about 1,620 km.

Sri Lanka and the southern tip of India stand on the same continental shelf and are separated by a shallow sea, the Palk Strait, which is barely 30 m deep. However, the shelf ends more abruptly in the south and east of Sri Lanka, averaging 22.5 km in width and rarely extending beyond 40 km. Within the shelf area, estimated to cover about 30,000 sq. km., the mean water depth is about 75 m, but the submarine elevations drop abruptly to 900 m within 3 km and 1,800 m within about 15 km of the shelf's edge. Beyond this there is a steep descent of over 5,500 m bringing it to the general bottom level of the Indian Ocean (Madduma Bandara, 1989).

Climate and oceanography

Sri Lanka has a tropical climate with an annual weather cycle divided into two main periods:

- the south-west monsoon, from May to August, which brings rains to the southern and western coastal regions, and the central hill country. The dry season in these regions is from December to March;

- the north-east monsoon, from October to January, which brings rain to the north and east of the island. This is weaker and shorter-lived than the southwest monsoon.

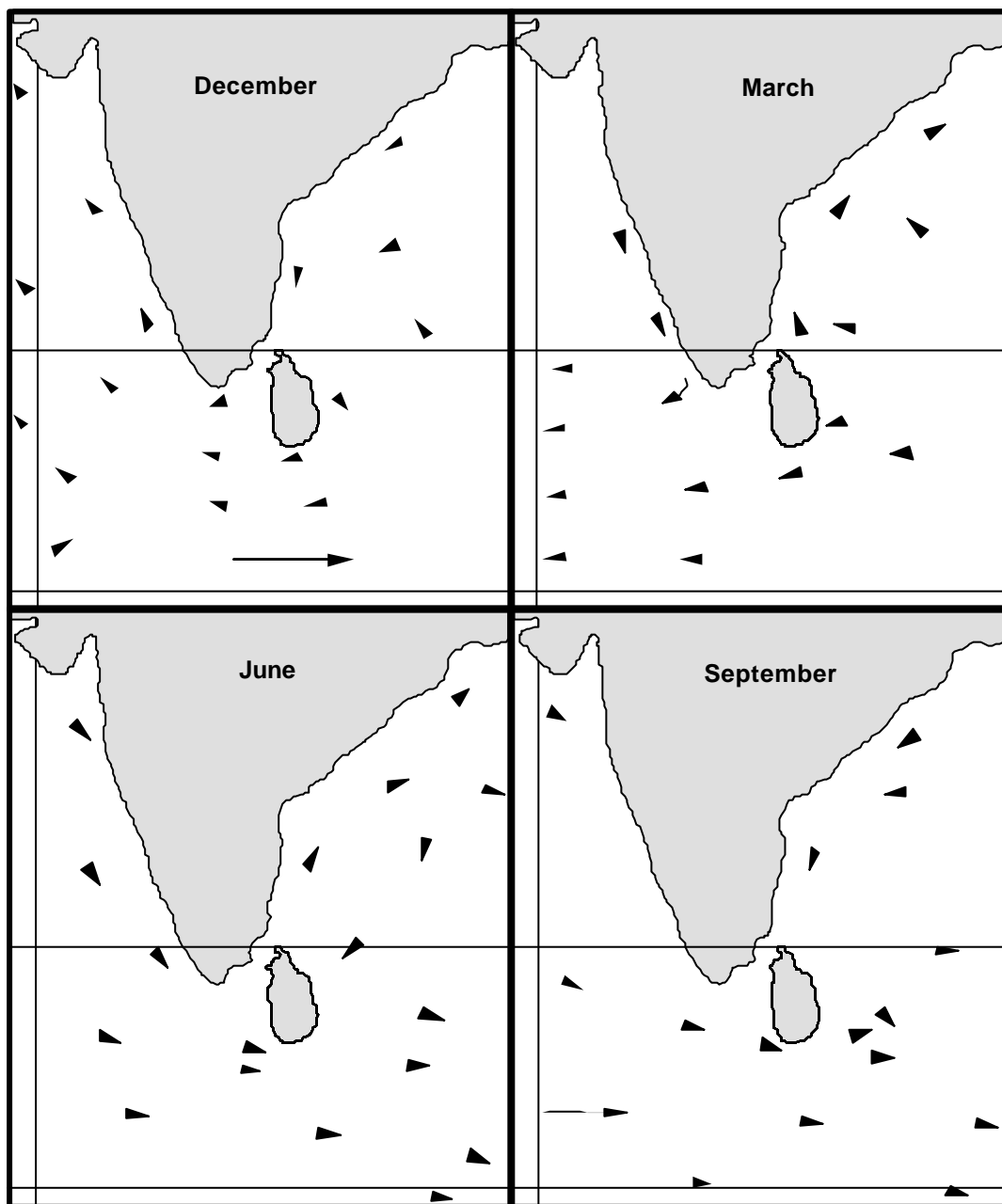


Figure 1.1: Surface currents around Sri Lanka (from De Bruin, Russell and Bogusch, 1994)

There is also an inter-monsoon period in October and November when rain and thunderstorms can occur in many parts of the country. These climatic features have consequences for fisheries and marine resources. The seasonality of many resources is markedly different on the eastern and western sides of the island. In addition, seasonal wind patterns previously resulted in the mass relocation of west-coast fishermen to fishing camps on the east for part of the year in order to take advantage of calmer waters there. This pattern of migration has been severely restricted in recent years due to the armed conflict, which extends into areas of the east coast.

The large-scale oceanic currents around Sri Lanka undergo complete seasonal reversals. Currents to the east of the island are strongest during the north-east monsoon (November-March), and follow a

gyre which changes from clockwise to anti-clockwise and back again during the course of the year (**Figure 1.1**). Currents to the south of the island flow eastwards from about May to about October, and westwards for the remainder of the year. In general the currents off the east coast are stronger than those off the west coast, while those off the southern coast are among the strongest of all, with velocities of around 1 m/sec (De Bruin, Russell and Bogusch, 1994).

The seas around Sri Lanka are micro-tidal and predominantly semi-diurnal. The rise and fall of the tides is within 0.7 m at spring tides and 0.05 m at neap tides. The highest tidal range is generally around Colombo (west coast), while the lowest is around Delft and Trincomalee (east coast). De Bruin, Russell and Bogusch (1994) state “due to the small tidal range there is little change in the level of water in most river mouths, leading to the formation of sand and mud banks blocking the entrances to rivers”.

Maritime jurisdiction

Under the Maritime Zones Law No. 22 of 1976, Sri Lanka has proclaimed several areas of national maritime jurisdiction, in conformity with the provisions of the United Nations Convention on the Law of the Sea (**Fig. 1.2**).

The maritime jurisdiction of Sri Lanka cover the following major areas:

Internal waters – Defined as waters in the landward side of the baseline from which the limits of the territorial sea is measured. Internal waters include numerous embayment and areas of coastal sea, as well as all of Sri Lanka’s inland waters, and are treated as integral parts of Sri Lanka’s national territory.

Historic waters - Include the Palk Bay, Palk Strait, and Gulf of Mannar areas claimed on the basis of traditional use by Sri Lankans. The Historic waters in the Palk Bay and Palk Strait are considered to form part of Sri Lanka’s internal waters, while those in the Gulf of Mannar form part of the territorial sea.

The **Territorial sea** extends to a distance of 12 nautical miles. Sri Lanka asserts its sovereign rights over this area, including the right to control movement of foreign ships and aircraft through the water and air spaces of the territorial sea. The extent of the Territorial Sea is reported to be 21,500 sq. km. (MFOR, 2002).

The **Contiguous zone** extends to a distance of 24 nautical miles, within which Sri Lanka asserts its rights to take measures necessary to secure the enforcement or prevent the contravention of its laws relating to security, immigration, health, sanitation, customs or other revenue matters.

The **Exclusive Economic Zone** extends to a distance of 200 nautical miles from the baseline. Within this zone Sri Lanka asserts, among others, sovereign rights to explore, exploit, conserve and manage natural resources, both living and non-living and, exclusive rights to authorize regulate and control scientific research. The area enclosed by the exclusive economic zone (EEZ) is reported as 517,000 sq. km. (MFOR, 2002), which is 7.8 times the total land area of the country.

Sri Lanka’s only international border is its maritime boundary with India. In the northwestern quadrant of Sri Lanka the EEZ and other areas of maritime jurisdiction adjoin those of India and as a result are restricted to narrower zones than around the rest of the island.

The establishment of EEZs by Sri Lanka and other countries of the region led to Sri Lanka losing access to the Wadge Bank after 1979, as well as to one third of the Pedro Bank, and some areas to the north of it. These areas, which are now in Indian waters, were the only grounds in Sri Lanka known to be suitable for the use of large trawlers.

The country can also claim an extensive but yet to be determined additional extent of seabed area under the United Nations Convention on Law of the Sea. The total area including the EEZ is suspected to be 23 times larger than the total land area and can be used for exploration and exploitation of minerals and hydrocarbon resources (MFOR, 2002).

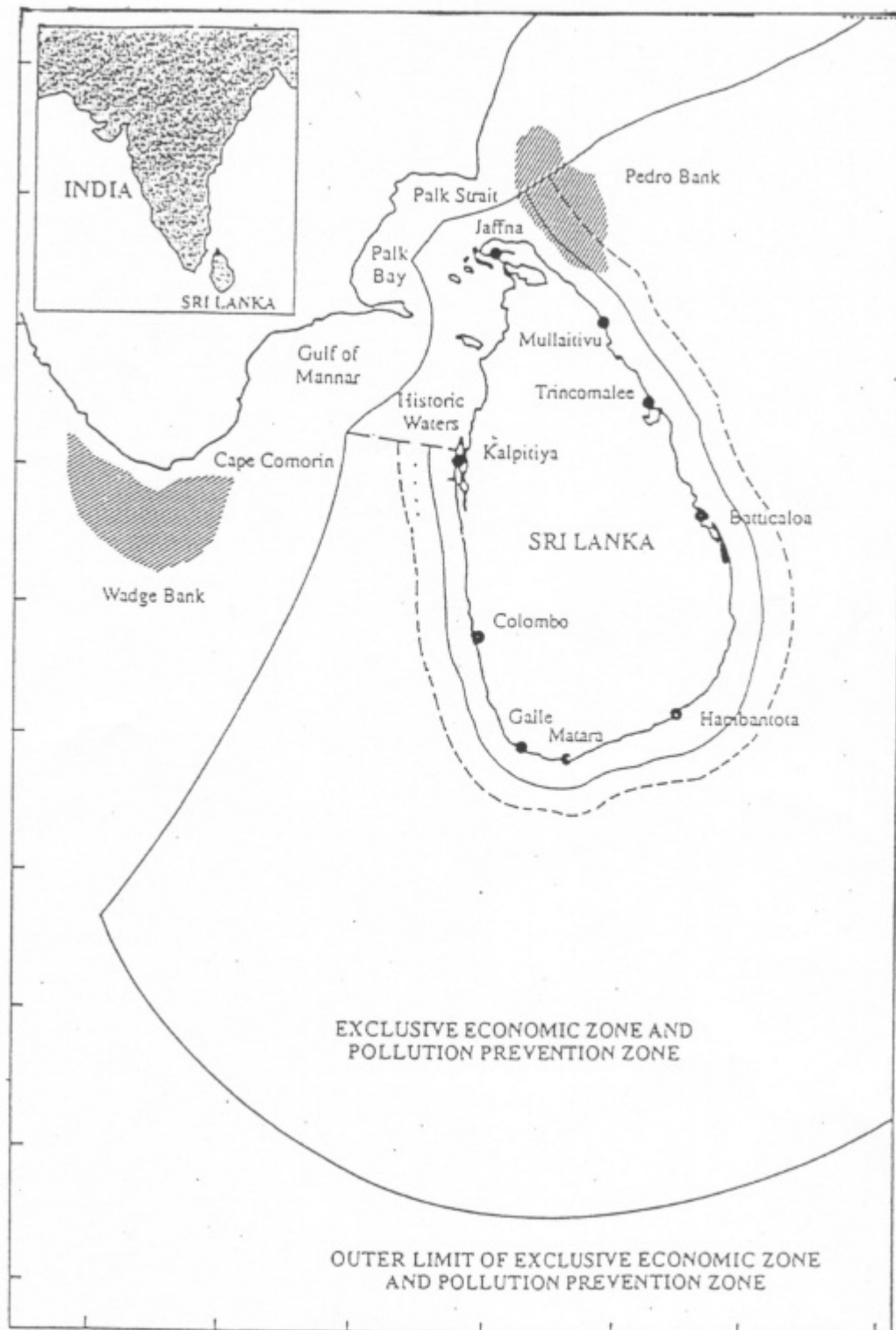


Figure 1.2: Location Map of Sri Lanka showing the 200 mile Exclusive Economic Zone (from De Bruin, Russell and Bogusch, 1994)

Fresh water resources

Sri Lanka's river system comprising 103 rivers flowing from the central highlands makes up a total collective length of about 4560 km. Monsoon rains received in central highlands are carried down as surface run off, through the 103 distinct natural river basins covering 90% of the island. The mean annual rainfall of the country ranges between 900 mm and 6000 mm, with an island wide average of about 1,900mm (MOFE, 2001). There is a high degree of variation in the availability of water, seasonally and geographically. The rainfall divides the country into wet, intermediate and dry zones (Madduma Bandara, 2000).

The total amount of fresh water received annually is 131230 million m³. The average annual river flow, which is 31% of the rainfall, is 40680 million m³ (MOFE, 2001).

In addition to the rivers, major and minor irrigation reservoirs and numerous other wetlands, there are significant ground water resources. Sri Lanka does not have natural lakes but only man made reservoirs built mainly for irrigation and power generation. The water to land ratio of 3 ha per sq. km. is considered to be one of the highest such ratio in the world (MOFE, 2001). Fresh water resources of Sri Lanka comprise of 260,000 ha of fresh water bodies made up of 155,000 ha of large, medium and small perennial reservoirs and tanks, 100,000 ha of seasonal tanks and 5000 ha of 'villus' or flood plains scattered all over the country (MFOR, 2002).

Fishing is not an important economic activity of the communities bordering the rivers upstream. Fishing activities in upstream parts of rivers are of relatively low intensity, sporadic and undertaken mostly to provide fish for family meals. Occasional use of explosives for fishing by outsiders has been reported from some upstream locations of Maha Oya and Kelani river (Joseph, 1999). Fishing in downstream lagoons and estuaries are considered under brackish water fisheries. Fresh water fisheries are largely confined to the reservoirs and are not covered in this report.

1.3 Geographic divisions used in the analysis

Administratively the country is divided into 25 districts grouped into 9 Provinces. 14 districts are located within the five Maritime Provinces (**Fig. 1.3**).

Province	District
Northern Province	Mannar
	Kilinochchi
	Jaffna
	Mullaitivu
Eastern Province	Trincomalee
	Batticaloa
	Ampara
Southern Province	Hambantota
	Matara
	Galle
Western Province	Kalutara
	Colombo
	Gampaha
North-Western Province	Puttalam

A total of 15 coastal fisheries districts have been set up for administration of marine fisheries in the country. There are two fisheries districts under Puttalam (Puttalam and Chilaw). Kilinochchi was earlier included under Jaffna district but has been separated since 2001.

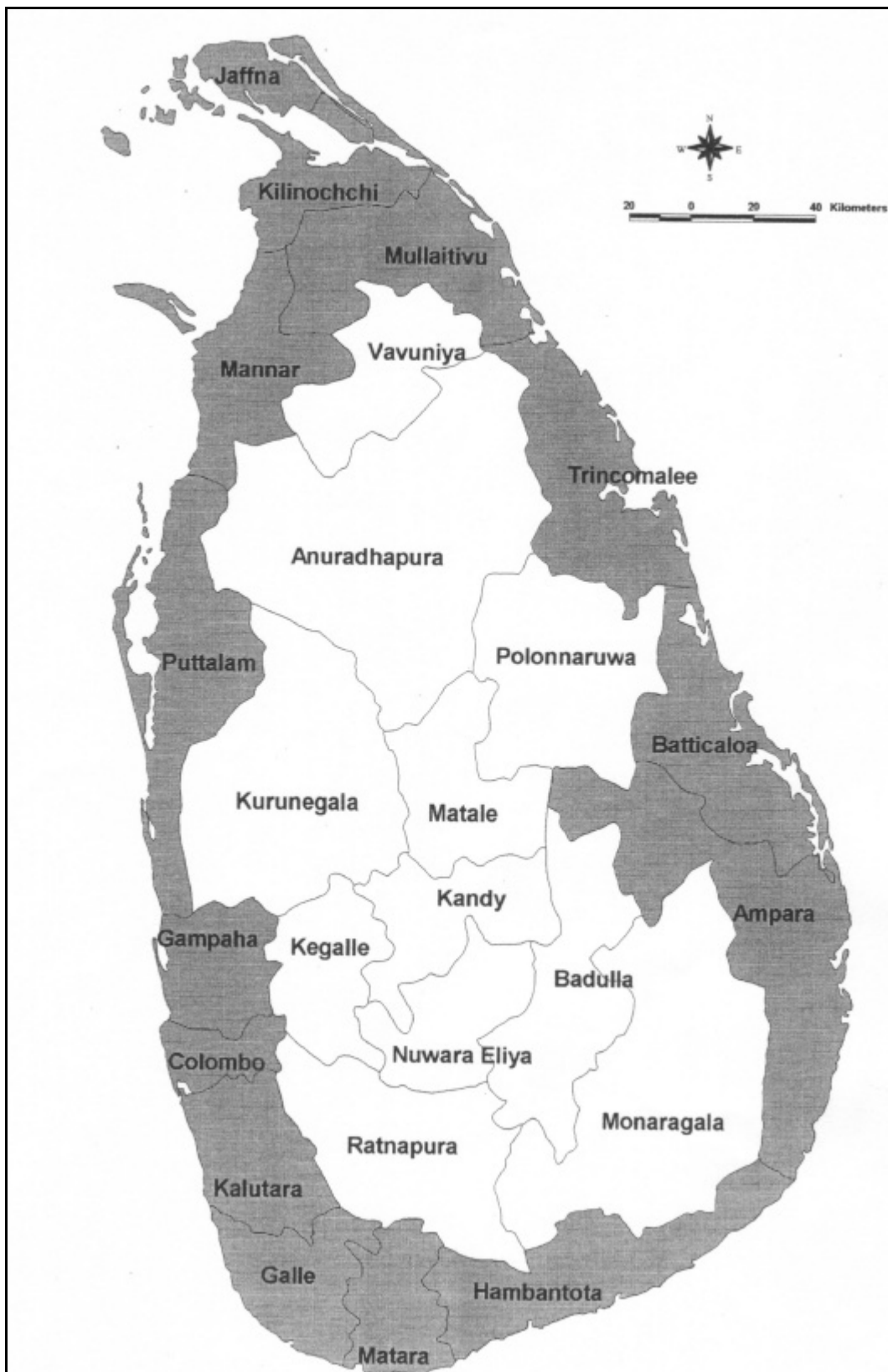


Figure 1.3: Administrative Districts of Sri Lanka

Coastal Zone - Sri Lanka's coastal zone is defined in the Coast Conservation Act No. 57 of 1981 as "that area lying within a limit of three hundred metres landwards of the Mean High Water line and a limit of two kilometers seawards of the Mean Low water line and in the case of rivers, streams, lagoons, or any other body of water connected to the sea either permanently or periodically, the landward boundary shall extend to a limit of two kilometers measured perpendicularly to the straight baseline drawn between the natural entrance points thereof and shall include the waters of such rivers, streams and lagoons or any other body of water so connected to the sea" (**Fig. 1. 4**).

The area defined for management purposes as the **coastal region** comprises all of the 74 administrative divisions (Divisional Secretary) with a coastal boundary. This area extends about 50 km inland from the coast and contains about:

- 23% of the islands 65,610 km² land area and,
- Approximately one fourth of the population, including 65% of the total urban population

(Source: Draft CZMP, 2003)

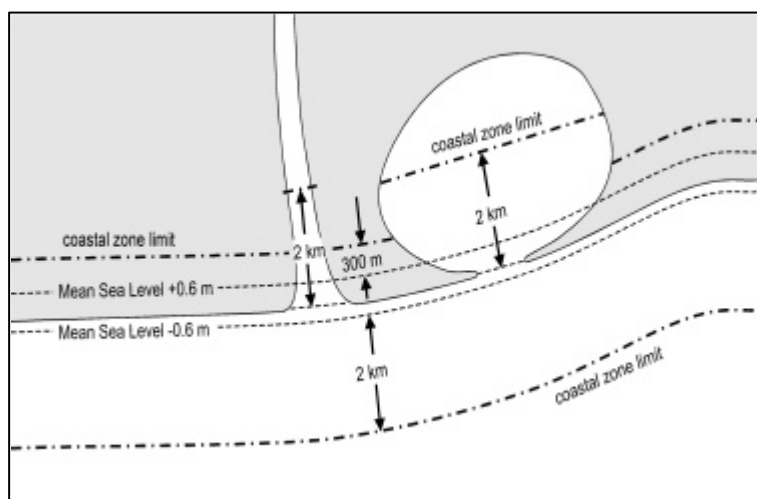


Figure 1.4: Legal Boundaries of the Coastal Zone

1. 4 Marine protected areas

Sri Lanka has 4 National Parks adjoining coastal waters and a total of 17 other protected areas designated as marine sanctuaries (draft CZMP, 2003). The distribution of these protected areas on a district basis; extent and the year of establishment are given in **Annex 1**.

Under the NOAA/IUCN (National Oceanic and Atmospheric Administration of U.S. and the World Conservation Union) project on "World Heritage Biodiversity", two sites from Sri Lanka have been identified as 'High Regional Priority Areas' within the Central Indian Ocean region (Ward, 2003). The two areas are:

- Trincomalee Bay and Pigeon Island
- The Gulf of Mannar cluster (Palk Bay – Mannar Island – Adams Bridge – Dhanuskodi – Rameshwaram of Sri Lanka and India).

2. STATUS AND DEVELOPMENT POTENTIAL OF THE COASTAL AND MARINE ENVIRONMENT AND ITS LIVING RESOURCES

The coastal and marine environment of Sri Lanka, with its varied habitats and resources, play a dominant role in the economy of the country. The resources of the coastal region include the land, minerals, surface and ground water, flora and fauna and other natural habitats which include coral reefs, mangroves, sea grass beds, lagoons, tidal flats (salt marshes), sand dunes, beaches and spits and the coastal waters. About a decade back, the coastal region has contributed 40% of the national GDP (Saundranayagam et al. 1994). It could be more today, considering the economic development that had taken place within the coastal region since then, compared to the rest of the country. In particular, the coastal zone contains about:

- 62% of the industrial units
- 70% of the tourist infrastructure facilities (hotels) and,
- the coastal seas provide nearly 65% of the marine fish production in the country
- rich mineral resources such as ilmenite and monozite bearing beach sands, silica sands, miocene limestone, kaolin, china clays, copper, magnetite and peat.

Agriculture accounts for only 10% of the coastal GDP, behind trade (32%), manufacturing (17%), and transport/communication (13%). Fishing accounts for nearly 57% of the coastal agricultural GDP.

2.1 Quality of coastal water

The problem of water pollution in Sri Lanka's coastal region has been growing over the past few decades. Ocean waters, coastal waters and ground water in coastal areas receive high pollution loads from development activities and human settlements located in and outside the Coastal Zone.

Investigations into coastal water pollution in Sri Lanka are limited. Water quality in Hikkaduwa marine sanctuary was studied by the National Aquatic Resources Research and Development Agency (NARA) in early 1990's and the results did not indicate any pollution (Silva, 1996). NARA has also just completed a survey of tracer metals (industrial pollution) in coastal waters from Kalpitiya (northwest) to Kirinda (south), which has also not indicated high concentrations of tracer metals in the areas studied (*Suresh Kumar /personal communication*)

The University of Moratuwa, under the Coastal Resources Management Project (CRMP) implemented by the Ministry of Fisheries and Ocean Resources (MFOR) has completed a one-year water quality monitoring in the coastal sea at 13 locations from Norachchola (Puttalam district) to Mirijjawila (Hambantota district). This study of the coastal waters off Marawila (northwest province), Beruwala (western province) and Unawatuna (southern province) showed that organic pollution was apparent throughout the year at Beruwala while faecal and oil and grease pollution were high only during the northeast monsoon. In terms of BOD, the coastal waters off Beruwala were polluted throughout the year and faecal pollution was apparent during December- January. Tar balls observed on the beaches in the southwest region from August to January suggest oil pollution from ships and fishing boats. In Unawatuna too, organic pollution was apparent throughout the year while faecal and oil and grease pollution were high during certain periods. The findings are summarized in **Table 2.1**.

Estuaries and lagoons are subject to heavy pollution loads, though the level of pollutants in them changes due to dilution and flushing by riverine flow or tidal action. Pollution of these waters has an impact on the important habitats associated with them and the diverse and economically important fauna and flora they contain. For example:

Table 2.1: Coastal water pollution at selected sites (Jayaweera, 2003)

Parameter	Marawila	Beruwala	Unawatuna
Total suspended solids (mg/l)		High levels during rains and low levels during dry periods	High during southwest monsoon due to accumulation of pollutants along the shore by wave and current action
Dissolved Oxygen DO (mg/l)	Above permissible levels	High for all beneficial uses all year	High for all beneficial uses
Chemical Oxygen Demand COD (mg/l)	High in April-May due to release of pesticides and fertilizer	Similar pattern all year	High in southwest monsoon due to trapping by wave and current actions
Biochemical Oxygen Demand BOD (mg/l)	High mainly due to run off from catchment area	High in both monsoons and due to tourism in November-December	High in southwest monsoon due to trapping by wave and current actions
Total Nitrogen (N-mg/l)	Mostly within limits. High on occasions due to fertilizer	Within permissible limits. High values in September-October period.	Within permissible limits
Total phosphorus (P- mg/l)	Within permissible limits	Within permissible limits	Within permissible limits
Oil & grease (mg/l)	High during northeast monsoon	Slight pollution from August to January	High levels during certain periods
Total and faecal coliform	High in November-December due to enhanced tourism	Faecal pollution apparent in December-January due to tourism	High. Water unsuitable for contact sports.
Heavy metals and organochlorine	Low and no threat	Low and no threat	Low and no threat

(Source: Jayaweera, 2003)

- Lunawa lagoon (Colombo district) has been severely affected by industrial effluents.
- Negombo estuary (Gampaha district) has been affected due to industrial effluents, sewage, oil from fishing crafts, boat repair stations and fuel supply stations along the bank
- Kelani estuary (Colombo district) is polluted with industrial effluents and sewage
- Valaichchenai (Batticaloa district) and Walawe river (Ratnapura district) estuaries are polluted due to wastes received from state owned paper factories.

Investigations on pollution related water quality parameters in lagoons/estuaries and inland water bodies have been reported from a number of locations (**Table 2.2**).

Table 2.2: List of water bodies subjected to studies on water quality

Lagoons / Estuaries	Inland water bodies
Kelaniya estuary	Kelani river
Negombo estuary	Kalu ganga
Bolgoda lake estuary	Maha Oya
Koggala lagoon	Kala wewa
Rekawa lagoon	Kotmale reservoir
Malala lagoon	Kandy Lake
Embilikala lagoon	Rajangana tank
Batticaloa lagoon	Horton Plains
Puttalam lagoon	Sinharaja streams
	Belihuloya
	Nachchduwa tank

	Tissa wewa
	Nuwara wewa
	Parakrama Samudra
	MinnEriya tank

(Sources: Silva, 1996 / Joseph, 1999/ NARA)

Parameters monitored have included Biochemical Oxygen Demand (BOD₅), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), suspended solids, bacteriological counts (total faecal *coliform*), micronutrients (N & P), heavy metals, etc.

2.2 River pollution

A review of the water quality of some inland water bodies by Joseph (1999) in relation to fisheries indicates pollution in the inland waters due to agriculture, industrialization, discharge of domestic waste and sewage (Table 2.3).

Table 2. 3: Water quality and impact on fish and fisheries

Water body	Parameter monitored	Causes of Pollution	Impact
Kalu ganga (Kalutara district) <i>Sources:</i> - de Alwis, 1998 - Abeynayake & Nissanka, 1992	BOD upstream 6.7-7.8 mg/l BOD downstream 6.2-7.1 mg/l High Ammonia / Nitrate levels High <i>E. coli</i> counts BOD of 9.9 -11.5 mg/l and 820-1040 mg/l suspended solids in waste water from distilleries	Excessive nutrients from domestic sewage/ fertilizer run off Increased nutrients due to upland tea/rubber plantations In sand mining areas	Heavy mortality of fish eggs/larvae in polluted tributaries. Decreased abundance of snakehead, Olive barb, Stinging catfish, Climbing perch
Kelani river <i>Sources:</i> - de Alwis, 1991 - de Alwis, 1998 - Silva, 1996 - Dissanayake, 1988	BOD 53.2 mg/l in estuary Increasing trend in downstream BOD values (4.29- 7.65 mg/l) Upstream BOD 7.29-7.48 mg/l at Dick Oya, Maussakelle and Karawanella. Very high total <i>coliform</i> and <i>E. coli</i> counts and Ammonia concentrations High DO values (6.75-7.59 mg/l) in both upstream and downstream areas High nitrate and phosphate in upstream	Excess fertilizer run off from Tea estates.	Fish kills
Bolgoda Lake estuary <i>Sources:</i> - Dassanayake, et al, 1991	BOD values vary by tide and depth -4.46 mg/l at surface and 17.8 mg/l at the bottom	Organic pollution due to Chemicals and pesticides from Ratmalana industrial zone Effluents from garment factories	Decline in fish catches and skin lacerations in some species (Gobies, snakehead, etroplus) Fish unfit for sale/consumption due to smell of kerosene
Negombo estuary <i>Sources:</i> - Silva, 1996	Surface water DO vary from 5.54 mg/l to 9.24 mg/l High BOD and Coliform counts	High organic pollution	Skin ulcerations in chromides and rabbit fish

Fishermen perceive that the abundance of a number of fish species has declined over time; the most notable ones reported being the Giant fresh water prawn, snakehead and Bar-eyed Goby. Some species of fish were reported to develop epidermal lacerations, which may even lead to death, particularly during the dry season. These are the snakehead, Olive Barb, Climbing Perch, and the Bar-eyed Goby. In Kalu ganga, Bolgoda Lake and Attanagalu Oya, fishermen attributed the observed epidermal lacerations on some species of fish and, to a lesser extent, the decreased abundance of more or less the same species of fish to be due to agricultural run off (pesticides, weedicides and fertilizer). However, it is now known that epidermal lacerations of fish are due to Epizootic Ulcerative Syndrome caused by microorganisms and not due to chemical pollution.

Kelaniya estuary has been subjected to conventional organic pollution. Studies conducted in 1982 following fish kills yielded very high BOD values indicative of gross organic pollution. Kelani river also receives the highest load of domestic sewage and other organic waste. It is also the largest recipient of industrial effluents in the country. A study on accumulation of chromium in two fish species in Kelani river has been the only attempt at correlating the impact of pollution on aquatic organisms (Wijegunawardene, 1995).

Fish kills and decreased abundance of some species have been observed in Maha Oya but not linked to any cause. Hardly any water quality information is available for Maha Oya where effluents from textiles, rubber, and coconut processing industries contribute to high BOD and COD values in water (Gomez and Kodippili, 1998).

Effluents from two garment factories located close to the Pinwatte/Thalpitiya river mouth of the Bolgoda Lake have made the fish smell of kerosene, depriving about ten families of their livelihood (Joseph, 1999). Elsewhere in the Bolgoda Lake, the results of various studies on water quality and pollution aspects are considered to be inconclusive (Silva, 1996).

Eutrophication of stagnant waters due to excessive usage of fertilizer is becoming a significant water pollution issue. The Kandy Lake and Gregory Lake have become victims of nutrient enrichment. Many irrigation reservoirs and channels (Mahaweli System H and reservoirs in Anuradhapura and Polonnaruwa) were found to contain high nutrient levels (MOFE, 2001).

2. 3 Availability and quality of fresh water

Surface water - The macro picture with regard to water availability appears to be satisfactory (MOFE, 2001). The annual renewable fresh water resources of Sri Lanka amounts to 2,431 m³ per capita (source: 'Water Resources 1998/99' Water Resources Secretariat, 1999). However, studies by the International Water Management Institute (IWMI) have revealed that aggregate figures masks the significant spatial and temporal variations in water supply and demand. It has been estimated that 79% of the water in the Wet Zone escapes to the sea as against 51% from the Dry Zone.

Table 2.4: Sources of water Supply - 1998

Population in 1998	Urban 5.61 million	Rural 13.04 million	Total 16.65 million
Served by piped water supply	75%	14%	32%
Served by dug wells	10%	11%	11%
Served by protected dug wells	10%	40%	24%
Other	05%	35%	33%

(Source: MOFE, 2001)

With regard to water supply for domestic purposes, only 14% of the rural population has access to piped water compared to 75% of the urban population (**Table 2.4**).

Colombo is the only city with piped sewerage – an ageing system with 18 pumping stations and two sea outfalls at Mutwal and Wellawatte (draft CZMP, 2003).

Ground water -Groundwater is derived mainly from rainwater seepage and the recharge from surface water bodies such as streams, canals and reservoirs. The contribution from rain to the ground water recharge is estimated to be 10-30% of the rainfall, or 200-600 mm/year (MOFE, 2001). The rate of recharge varies from one geological formation to the other. Manchanayake and Madduma Bandara (1999) have also estimated the ground water availability in the island at around 7,250 million cubic meters. There are several aquifers in limestone around the north and west of the island with substantial groundwater resources. The richest source of ground water in Sri Lanka is the Karst limestone aquifers in the coastal districts of Puttalm and Mannar extending to the Jaffna peninsula. Its water potential varies between 5-20 million m³/year.

Over the past years ground water has been extracted increasingly for domestic, agricultural and industrial purposes from both shallow dug wells and deep tube wells. Aquifers are stressed both in terms of quality and quantity. Nearly 40% of the tube wells dug during the last decade have been abandoned due to contamination with iron, manganese and fluorides.

Another concern is that higher rates of water extraction in coastal areas than is sustainable has led to brackish water intrusion into wells, particularly in the northern and north western coastal areas where well water is extensively used for agriculture. Over exploitation of ground water for irrigation purposes has caused salt-water intrusion in Puttalam, Mannar, Paranthan, Kilinochchi and Mullaitivu areas.

2. 4 Coastal and marine habitats

Sri Lanka's varied coastal habitats include estuaries and lagoons (126,989 ha), mangroves (6083 ha), sea grass beds, salt marshes (23,797 ha), coral reefs and large extents of beaches including barrier beaches, spits (5621 ha) and dunes (15,546 ha). These habitats contain a rich component of the country's biodiversity. Many coastal and inshore resources associated with the coastal habitats support a thriving export industry based on export of shrimp, lobster, chank, Beche de mer, ornamental fish, etc., which earned over Rupees 9000 million in 2001.

The extents of these habitats by district are given in **Table 2. 5**.

Natural causes and human interventions, accelerated by the increased coastal population during the last two decades, have combined to cause considerable degradation of the coastal habitats, resulting in the decline of their resources as well as extents at an unprecedented rate.

Mangroves - Sri Lanka's mangrove areas amounted to only about 6,083 ha in 2002. Sri Lanka's tidal variation being low (rarely exceeding 75 cm), mangroves generally occur as a narrow belt in inter-tidal areas of lagoons, estuaries or associated islands and river mouths. However, they do not occur in all inter-tidal areas and are confined to areas with low wave action. Although mangroves rarely extend beyond 1 km landwards from the mean low water tidal level (Amarasinghe, 1996), they may spread upriver to the upper limit of brackish water intrusion in some riverine estuaries, even up to a distance of 20 km (e.g. Galatara in the Kalutara district) (CRMP, 2002).

The mangal vegetation in Sri Lanka comprises around 40 different species of trees, bushes, herbs and vines. Of these about 25 are true mangroves occurring only in mangrove areas, while the other mangrove-associated species can be found in other aquatic environments as well. Mangroves of considerable extent can be found in areas with relatively low population densities (e.g. in the eastern and north-western coasts). Recent surveys have shown relatively undisturbed mangals in the Kala Oya

estuary, the islands in the Puttalam estuary and Dutch Bay, the Kokkilai estuary, the Nai Aru estuary, the Panama lagoon, the Uppar (Panichchankerni) estuary, the Nanthikadal lagoon, the Yan Oya estuary and in some areas of the Batticaloa estuary.

Table 2. 5: District-wise total extent of Coastal habitats in Sri Lanka, 2003 (in ha).

District	Mangroves	Salt Marshes	Dunes	Beaches, Barrier beaches, Spits	Lagoons	Estuaries	Other Water Bodies	Fresh Water Marsh	Shrimp Farms
Colombo	5	-	-	44	23	624	68	38	
Kalutara	45	-	-	64	6	930	-	1895	
Galle	217	338	-	86	1197	988	9	1917	
Matara	78	42	-	218	33	109	24	473	
Hambantota	166	270	1610	435	2921	175	-	-	
Ampara	76	985	1078	352	5054	987	-	290	
Batticaloa	1638	2823	-	1338	-	14268	637	78	43
Trincomalee	348	1973	-	280	1733	6886	313	-	
Mullaitivu	975	1146	-	274	4470	3768	238	165	
Jaffna	1088	6524	6710	565	9983	29613	343	-	
Kilinochchi	471	5738	918	325	6387	3781	38	228	
Mannar	413	2813	945	843	1392	400	670	-	
Puttalam	478	499	4232	748	2979	24993	-	123	5395
Gampaha	85	647	53	49	-	3289	10	1348	17
Total Extent	6083	23797	15546	5621	36178	90811	2350	6555	5455

(Source: Draft CZMP, 2003)

Overall, there has been about a 50% reduction of the mangrove cover between 1986 and 2002. The most significant change in the extent of mangroves over the last 17 years has been recorded in the districts listed in **Table 2.6**.

Table 2. 6: A comparison of the extent of Mangroves between 1986 and 2003 in selected districts

District	Extent of Mangrove in 1986 (ha)	Extent of Mangrove in 2003 (ha)	Percentage Reduction (%)
Jaffna	2276	1088	52
Kilinochchi	770	471	38
Mannar	874	413	53
Puttalam	3210	478	85

(Source: draft CZMP, 2003)

Coral reefs - Reefs in Sri Lanka are categorized under coral reefs, sandstone reefs and rocky reefs. Corals in varying degree may also cover the latter two reef types. All three habitats are distinctly different, but may be found mixed together (Rajasuriya and White, 1995).

The most extensive coral reefs in Sri Lanka are the patchy coral reefs in the northwestern coastal and offshore waters, occurring within the Gulf of Mannar and west of the Kalpitiya Peninsula. Patchy coral reefs have also been recorded in the western and eastern coastal areas of the island at a distance of about 15-20 km from the shore, at an average depth of 20 m. The southwestern, eastern and northern coasts also contain fringing coral reefs adjacent to the shore, growing from the sea floor usually on a nucleus of rock (Rajasuriya and Premaratne, 2000).

It has been estimated that about 2% of the coastline contains fringing coral reefs (Swan, 1983). Hikkaduwa, Unawatuna and Rumassala are some of the main fringing reefs along the southwestern coast and Passikudah is one of the best known fringing reefs in the eastern coast. Coral reefs also occur around the Jaffna Peninsula - mainly around the small coastal islets, but they are not extensively developed (Rajasuriya et al, 2000). Barrier coral reefs, consisting of ridges of coral lying some distance from the shore, parallel with it and forming a broad 'reef lagoon', are rare in Sri Lanka but some are found at Vankalai and Silavathurai in the north-western coast (Rajasuriya and White, 1995).

Sandstone reefs are widespread along the coast. Many of these are located along the bathymetric contours of the continental shelf. Rocky reefs occur from south of Colombo in the west coast to the southern areas of the Trincomalee district in the northeast (Rajasuriya and White, 1995).

A rise in sea surface temperature in April/May 1998 caused bleaching of corals in much of the Indian Ocean, including Sri Lanka. The status of some of the coral reefs in Sri Lanka prior to this event as well as the current status is summarized in **Table 2.7** (Rajasuriya, 2003).

Table 2. 7: Status of Coral reefs in Sri Lanka.

Location	Depth (m)	Pre-bleaching Live Coral cover	1999–2000 Live Coral cover	2001–2002 Live Coral cover
Bar reef marine sanctuary	0 – 3	78.5%	Nearly 100% mortality	New growth present
Bar reef marine sanctuary	7 – 8	-	Nearly 100% mortality	14%
Kandakuliya	0 – 5	22%	New growth after bleaching	New growth destroyed by Halimeda
Hikkaduwa	0 – 4	47.2%	7%	12%
Weligama	0 – 2	92%	30%	54%
Rumassala	1 – 5	45%	19.6%	23%

(Source: Rajasuriya, 2003)

The 1999-2000 live coral cover reflects the situation of reefs after bleaching.

Reefs in Sri Lanka are now degraded at many sites, due to both natural causes and human impacts. Especially affected are the near-shore coral reefs in the western and southern coastal areas.

Seagrass beds - Seagrass beds often occur in association with coral reef ecosystems or estuaries and lagoons such as the basin estuaries and lagoons of Puttalam, Negombo, Mawella, Koggala, Kokilai, Jaffna and Batticaloa (CRMP, 2002). Very extensive seagrass beds are reported from the Dutch Bay (in Kalpitiya) to the western end of the Jaffna Peninsula, and from Mannar to the northwest across the Palk Bay to Rameswaram Island on the Indian coast (Samarakoon and Pinto, 1988). The seagrass

beds in the Palk Bay-Gulf of Mannr area are the main habitat of the endangered dugong (*Dugong dugong*).

Estuaries and Lagoons - The estuaries and lagoons of Sri Lanka form complex systems containing a diversity of species and a variety of coastal habitats including, mangroves, salt marshes, sea grass beds and mud flats.

Sri Lanka's estuaries have been defined in the Draft CZMP (2003) as natural systems that are transitional between rivers/ streams and the sea, and within which the salinity of the water is measurably different from the salinity in the open ocean. All estuaries have free connection with the open sea – either continuously (e.g. Puttalam, Negombo, Jaffna, Batticaloa, Kelani Ganga, Bentota and Kalu Ganga estuaries) or intermittently (e.g. Maha Oya, Kirindi Oya, Kirama Oya, Madu Ganga, Menik Ganga and Walawe Ganga estuaries).

There are two different types of estuaries; Riverine estuaries where the rivers or streams discharges directly into the sea through relatively narrow channels (e.g. the Kelani Ganga, Maha Oya, Kalu Ganga and Nilwala Ganga estuaries) and, Basin estuaries where the river or stream first discharges into a relatively shallow basin before entering the sea. In some places riverine estuaries open into a bay that opens to the sea (e.g. the Kala Oya riverine estuary opens to Dutch Bay; the Mahaweli estuary opens to Koddiyar and Thambalagam Bays, and the Polatumodara estuary to Weligam Bay). Overall, there are 45 estuaries of which 28 are of the riverine type and 17 of the basin type. The total extent of basin estuaries in the country amounts to about 90,811 ha (basin area only), and riverine estuaries cover about 2,110 ha (draft CZMP, 2003). The district-wise distribution of individual estuaries, extent and the condition of the mouth is given in **Annex 2**.

Sri Lanka's lagoons are defined in the Draft CZMP as coastal bodies of water that may be brackish, fresh or hyper saline, and are separated from the sea over a very long period of time by any of several types of barriers that restrict water circulation. There are around 89 lagoons ranging from 3 ha to 7,589 ha in extent, of which 8 cover more than 1,000 ha each (**Annex 3**). Total extent of lagoons amounts to 36364 ha. Lagoons are more abundant along the southern, southeastern and eastern coasts where the littoral drift causes an accumulation of sand to form barriers and spits at river mouths through which the freshwater discharge is low.

Many of the lagoons and estuaries and the biodiversity they contain are affected mainly by pollution, eutrophication, siltation, salinity changes, encroachment and over-harvesting of resources. Following are some of the affected lagoons:

Pollution	- Negombo, Kelani, Walawe,Valaichchenai, Madu ganga estuaries, Lunawa lagoon
Eutrophication	- Negombo, Kelani and Valaichchenai, Bentota, Kirama Oya estuaries, Lunawa lagoon,
Siltation	- Negombo estuary
Salinity changes	-Malala, Ambilikala, Kalametiya and Puttalam lagoons.
Encroachment	- Negombo estuary, Bolgoda Lake estuary
Over-harvesting of resources	- Negombo estuary, Batticaloa lagoon

Salt marshes - There are around 23,797 ha of salt marshes in the country (draft CRMP, 2002). The conditions under which salt marshes occur vary, but more often they are found close to the landward

margin of the inter-tidal zone where the soil salinity is relatively high due to insufficient freshwater runoff to flush out the accumulated salts.

Extensive salt marshes occur in the Mannar area (mainly on tidal flats and containing about 56 species of marsh vegetation) in the coastal belt from Mantai to Vankalai. Patchy salt marshes occur mainly in sediment lagoon/estuarine areas such as Hambantota, Puttalam, Kalpitiya and Mundel (Samarakoon and Pinto, 1988).

The present estimates of salt marshes in the country show a 20% reduction over a period of 16 years (draft CZMP, 2003). Over 85% reduction is reported from Puttalam district, from 3461 ha in 1986 to 499 ha in 2002.

Barrier beaches, spits and dunes - Sri Lanka's wide and sandy beaches along much of the 1620 km coastline support a distinct littoral fauna and flora. Beaches have been formed by accumulation of sediment deposited on the shore. Among them, barrier beaches, spits and dunes are the most delicate and vulnerable due to their changing nature.

- Barrier beaches are accumulations of unconsolidated sediments transported ashore by waves and moulded into a form that lies across a body of water, isolating it from the sea.

(E.g. the beaches at Rekawa, Kosgoda, and Panama, between Bentota and Balapitiya on the southwest coast, at Weligama Bay, between Dondra and Ambalantota, Thambalagam Bay and Karativu)

- Spits are incipient barrier beaches that project from the shore in the direction of the dominant drift and are free at one end.

Examples are the shoal that builds seasonally at the mouth of the Negombo estuary and the sand spit at the Kalu Ganga estuary. Most spits appear to be unstable, especially those which protrude into estuaries. Consequently they shift position from time to time, causing changes in the form and precise location of the inlets of estuaries (Kalu Ganga and Batticaloa estuary).

The most commercially important spit is in Pulmoddai, north of Trincomalee at the outlet of Kokkilai estuary. The ilmenite rich deposits that constitute this spit are mined on a large scale but are replenished annually from terrestrial sources during the northeast monsoons.

- Dunes are wind blown accumulations of sand which are distinctive from adjacent land forms such as beaches and tidal flats mainly due to the fact that dunes do not get the effect of tides.

The most prominent sand dunes lie along the northeastern, northwestern and southeastern coasts of Sri Lanka, between Mullaittivu and Point Pedro, Elephant Pass and Chavakachcheri across Mannar Island, Ambakandawila and Kalpitiya, and from Ambalantota (Godawaya) in the Hambantota district to Sangamankande Point in the Ampara district. The latter is identified as the longest stretch of dunes in the world close to the equator.

2.5 Shoreline stability

Coastal erosion is a long-standing problem in Sri Lanka, aggravated in recent years due to human interferences of natural processes. The Coast Conservation Department (CCD), having the sole responsibility of combating coastal erosion, has prepared a Master Plan for Coastal Erosion Management (MPCEM) in 1986 (CCD/DHI, 1986). While seeking structural solutions, the MPCEM recognizes the need for coastal erosion management as a part of a holistic exercise in the management of the Coastal Zone.

Coastal erosion management under MPCEM has consisted primarily of installing traditional coast protection structures, use of setback lines, directing development away from eroding areas and enforcement of regulatory mechanisms. The length of coast protection structures currently in existence around the island's coastline is summarized in **Table 2. 8.**

Approximately 270 to 350 km of Sri Lanka's coastline - from a total length of 685 km between Dutch Bay and Hambantota - is considered erosion prone. While the entire erosion prone area does not require active protection with the use of structures, such structures up to now protect only about 86 km, amounting to 25 – 32% of the erosion prone area.

Several structures are also planned for the north and east, namely two groynes to be erected at Vankali in the north and a 100 m revetment at Jamaliyapura in Trincomalee in the east.

Table 2. 8: Length of existing coast protection structures by coastal sector

Coastal Sector	Total length (m) in 2002
Revetments*	
West coast	21,890
Southwest coast	40,381
South coast	11,227
East coast	300
Total Revetments	73,798
Groynes	
West coast	1,168
Southwest coast	1,782
South coast	645
Total Groynes	3,595
Coastal breakwaters	
West Coast	1004
Southwest Coast	60
Total Breakwaters	1,064
Grand total length	78,457

* Mainly boulder revetments

Source: CCD database - unpublished information from coastal surveys

Despite many such initiatives by the government, coastal erosion continues to be an issue in coastal zone management. This is because managing human activities and development initiatives along an eroding coast is complicated, and key problems that underlie erosion - such as the inadequate supply of sand from rivers for beach nourishment - continue unabated.

The MPCEM of 1986 has identified 15 key areas and a further 11 singular sites where erosion is more localized (draft CZMP, 2003). Areas with highest erosion rates are given in **Table 2. 9.**

Coastal accretion rates are generally lower than erosion rates. Notable natural accretions have been reported from Kalpitiya (Northwestern province) and Batticaloa (Eastern province). Available records indicate an average erosion rate of about 0.5 m/yr and an accretion rate of about 0.2 m/yr.

Table 2.9: Critical erosion areas and erosion rates along the coast of Sri Lanka

Main area	Province	Local stretches and time periods (where relevant)	Erosion rate in m/yr
Maha Oya - Lansigama	Northwestern province	Waikkal (1988-1998) Gin Oya sand bar (1991-1999) Wellamankara (1994-1998)	8-10 10-12 11-13
Colombo North - Dickowita	Western province	Mutwal to Kelani river Palliyawatte -Uswetakeiyawa	0-1 2-3
Moratuwa – Korawalwella	Western province		Seasonal fluctuations, no overall erosion
Wadduwa	Western province		0-2
Kalu ganga – Payagala	Western province		1-3
Beruwala – Bentota	Western province	Beruwala – Bentota Bentota – Robolgoda Headland	1-2
Hikkaduwa	Southern province	Seenigama – Coral Garden Headland Coral Garden Headland - Dodanduwa	0-2
Galle north	Southern province		0-1
Matara	Southern province		0.9-1.0
Hambantota	Southern province		N. A. -0.2
Ampara	Eastern province		N. A. – 0.2
Batticaloa	Eastern province		0.1 – 0.2
Trincomalee	Eastern province		N. A. – 0.2
Mullaitivu	Northern province		N. A. – 0.2
Jaffna	Northern province		N. A. – 0.3
Mannar	Northern province		N. A. – 0.5

(Source: CCD 1979 and draft CZMP, 2003)

2. 6 Exploitation of coastal and marine living resources

Living marine resource endowment -The narrow continental shelf as well as the lack of significant upwellings imposes natural limitations on the marine fish resources around Sri Lanka (Joseph, 1993). Sivasubramaniam (1995) has reported on the various estimates of the potential yield from coastal fisheries that have been made using different approaches (**Table 2.10**).

Table 2.10: Coastal fish potential estimates

Resource type	Potential (t)	Methodology	Author
Demersal	60,000	Exploratory trawl survey	Tiews (1966)
Demersal	52,000	Organic Productivity	Jones & Bannerji (1973)
Demersal	80,000	Acoustic survey	Blendheim & Foeyn (1980)
Demersal	74,000	Acoustic & Swept area	Sivasubramaniam (1983)
Pelagics	90,000	Organic Productivity	Jones & Bannerji (1973)
Pelagics	170,000	Acoustic survey	Blendheim & Foeyn (1980)

(Source: Sivasubramaniam, 1995)

Reliable estimates of the potential yield from the offshore/ deep-sea areas of Sri Lanka are not available, but some preliminary estimates based on the commercial fishery, surveys, school sightings, etc. are summarized in **Table 2.11** (Joseph, 1993). However, these estimates are of little relevance in view of the fact that the resources supporting offshore fisheries are the highly migratory tunas, billfish and sharks that are shared by coastal states as well as some distant water nations fishing in Indian Ocean.

There are some offshore areas, in the northwest, discovered during a survey by the Soviet vessel *Optimist* in 1972, (and in the south) which may be capable of sustaining trawling operations for deep-sea lobsters, shrimp and a few commercially important species of fish. Most of the fish stocks discovered are only suitable for conversion into fishmeal, and since the declaration of EEZ's, some of these stocks now lie within Indian territorial waters. Whether the deep-water lobsters and shrimp can support a commercial fishery remains a question that needs further investigation (Joseph, 1993).

Table 2. 11: Estimated potential yields from Sri Lanka's offshore areas

Source	Method	Estimated potential yield (t)
Sivasubramaniam (1978)	Using information on existing fisheries	29,000
BOBP/ WP/ 31 (1985)	Based on exploratory fishing, resource surveys, school counting, etc.	
	• Yield/ unit area	98,874
	• School count	56,600
	• Mean catch rate	44,188
FAO/ ADB (1988)	Based on a variety of approaches	40,000

(Source: Joseph, 1993)

Many of the deeper water demersal and mesopelagic fin-fishes, deep sea crabs, lobsters, shrimp, octopus, squids and cuttlefish varieties have no established market, and the economics of exploiting even those for which markets exist remain doubtful (Nishida and Sivasubramaniam, 1986). The consensus of opinion is that demersal fisheries beyond the continental shelf do not present any substantial potential for expansion.

Coastal and marine fisheries in national economy - The fisheries sector provides direct employment to 150,000 in fishing and to another 100,000 in fishery related industries, while sustaining nearly 1.25 million persons. In addition, fish contribute to nearly 70% to the animal protein intake of the population and 2.7% to the national GDP (MFOR, 2002). It has also emerged as an important foreign exchange earner, with current annual exports being worth Rs.9000 million. It is estimates that around 100,000 fishermen are directly engaged in coastal fisheries, including those fishing in lagoons/estuaries. Approximately 500,000 fisherfolk are dependent on coastal fisheries for their livelihood. Majority of the fishermen are low to moderate income earners with annual incomes between Rs.30, 000 to 63,000 (Gunawardena, 2000).

According to statistics maintained by the Statistical Unit of MFOR, marine fish landings in Sri Lanka have increased from 57,457 t in 1960 to 76,883 in 1970 and, to 167,412 t in 1980. The onset of ethnic disturbances in early 1980's disrupted fishing in north and east and the landings in 1990 was estimated at 145,798 t. The increase in total marine landings in more recent years (263, 680 t in 2000 and 274,760 t in 2002) has been attributed to the rapid development of the offshore fishery, which developed mainly in the west and south.

Marine fish production in 2002 reached 274,760 t (coastal 176,250 t and offshore 98,510 t). While fisheries in north and east were severely disrupted due to civil war during the last 20 years, coastal fisheries in the rest of the country has stagnated during the last few years, mainly due to intense fishing pressure which had led to overexploitation.

Overview of Marine Fisheries -Sri Lanka's main fisheries and their associated resources are categorized below:

- **Small pelagic fish:** Sardines, herrings, anchovies and mackerels are exploited primarily by beach seines and small-mesh gill nets. Total catches in this fishery are currently of the order of 65,000-70,000-t/ year. With the increasing effort through gill nets the contribution of the beach seine fishery, once dominant, has declined in recent years (Preston, 1998).
- **Medium pelagic fish:** These include mainly small tunas, which tend to be exploited within the shelf area, although they also occur as by-catch in the large pelagic fishery. Catches of these species are thought to be of the order of 6,500-10,000-t/ year at present. The main fishing technique, drift gillnetting and ring netting, is similar to those used in the small pelagic fishery, but the fishery is considered separate because of the different resources exploited (Preston, 1998).
- **Large pelagic fish:** large tunas, pelagic sharks and billfishes currently contribute about 85,000-95,000t to Sri Lanka's annual fish production. Fishing is principally by the use of large-mesh drift gill nets, which account for the vast majority of the catch, and shark loglines. The tunas, billfishes, and pelagic sharks are primarily oceanic species that predominate beyond the continental shelf (Preston, 1998).
- **Demersal fish:** these are caught principally by trawling in the north and north-west, and by bottom set nets, bottom longlines and hand lines in other areas. Landings are currently estimated to be about 25,000-30,000t annually, down from 40,000t year in the 1980s. Catches are highly diverse but about 8 species groups (surgeon fishes, jacks and trevallies, grunts and sweetlips, ponyfishes, emperors, snappers, groupers, and sharks and rays) are predominant, each making up more than 10% of the catch (Preston, 1998).
- There are about 30 species of **prawns** but only a few (*Penaeus indicus*, *P. merguensis*, *P. monodon*, *P. semisulcatus* and *Metapenaeus* spp) contribute significantly to the resource. About 9800 t were harvested in 2002. Wild-caught and cultured prawns together account for over half the value of Sri Lanka's fishery exports. Potential yields of wild prawns are unknown, but the catch trends do not indicate the potential for a substantial increase in production (Preston, 1998).
- Six species of **spiny lobsters** are present around Sri Lanka and over 2000 t per year production has been recorded in recent years. They are variously found in coral reefs, sandstone, rocks and mud banks up to a depth of 25 m, and comprise one of Sri Lanka's most valuable export fisheries.

In addition to these fisheries, there are also a number other important or potentially important fisheries or resources. Various species of aquarium fish are currently being harvested and exported. About 1,500t of at least two, and possibly three crab species are landed annually. About 1,000t of squids and cuttlefish are taken each year, mainly as by-catch from the prawn grounds. Over 150t of chanks (*Turbinella pyrum*) are collected and exported annually from the Palk Bay area, east coast and Hambantota banks. Little is known about their potential yield. Sea cucumbers are found primarily in the muddy bottom off the shores of the northwest coast. The main exploited species is *Holothuria scabra*. Production is estimated to be about 100-150 t/ annum. There is no information on the potential yield. Little is known about the production and potential of edible oysters. Window-pane oysters contributed to an important industry in the past, the main production coming from Tamblegam Bay (Trincomalee). Pearl oysters are abundant in the pearl banks off the northwest coast and contributed to a major fishery until about 50 years ago. In 1958, 4.5 million pearl oysters were fished out from a stock of about 258 million (Preston, 1998).

Except for operations by few private firms, fishing in Sri Lanka is largely small-scale. Marine fisheries are generally divided into two categories; coastal fishery and the offshore fishery.

Status of coastal fisheries - These are broadly defined as fishing activities taking place in the area of the continental shelf. All fisheries conducted within a day (24 hrs) are considered as coastal fisheries. Coastal fisheries include a very diverse range of activities and species. The most important fishing gear is the gill net. The beach seine, which in the past was the most widespread fishing method, has

declined in importance but is still seasonally important in some areas. Other gear used includes trolling lines, bottom set nets, bottom longlines, hand-lines, shrimp trawls and pole-and-line with live bait (mainly in the south).

Export oriented fisheries for high-value invertebrates such as shrimp, lobster, chank, sea cucumber, etc. take place in the inshore waters. A substantial fishery for aquarium fish has also developed recently.

Fishing activities in north and east has been severely disrupted during the last 20 years on account of the ethnic conflict. Although fishing has recommenced in 2002, with the cessation of hostilities, fishery is still much below its full potential. Fishing assets lost were considerable and included over 6300 motorized boats, 3600 traditional crafts and almost all infrastructure facilities (**Annex 4**). The 34,570 t catch recorded in the northern province during 2002 is still less than 50% of the peak catch of 72,798 t recorded in the same province during 1983.

Excluding the north, the number of active fishermen in the rest of the country has increased from 63,635 in 1989 to 114,230 in 2002. The number of active fishermen given in **Table 2.12** includes those involved in both the offshore and coastal fisheries. Reliable data on the offshore fishing fleet in 1989 and 1996 are not available to estimate the number of fishermen likely to have been involved in the offshore fisheries during these years. In 2002, the 1600 strong offshore fleet may have engaged about 8000-9000 in offshore fisheries. It is clear that despite the significant increase in the numbers of active fishermen in the coastal fishery over the years, the increase in fish production from coastal fisheries is marginal (**Table 2.12**) and is in fact lower in 2002 compared to 1996. The stagnant nature of the coastal fishery is mainly due to the over-exploitation of coastal fish resources.

The sedentary or slow moving inshore coastal resources such as prawns, lobsters, Beche de Mer, chank, etc. have come under intense exploitation due to the lucrative export markets. Trends in the export of selected items during the last 17 years are shown in **Table 2.13**. In the case of shrimp, the quantity exported had decreased in 2002, as is the farmgate production from aquaculture from nearly 7000 t in 2000 to 4630 t in 2002. On the other hand, production from the wild has increased from 7540 t in 2000 to 9820 t in 2002, mainly as a result of the opening up of the prawn grounds in the north and east following the cessation of hostilities.

Table 2.12: No. of Active fishermen and Coastal fish production, Sri Lanka.

Year	No. of Active Fishermen	Coastal fish Production (t)
1989 ¹	63,635	129,771
1996 ²	83,776	143,700
2002 ³	114,230	141,680

¹ - Fisheries survey conducted by DFAR

² - Census of Marine Fisheries in Sri Lanka, 1996

³ - Statistical Unit / MFOR

The downward trends in export of lobster and crabs in the 1990's have been upturned in 2002, with supplies coming from north and east. In the late 1990's, a fishery for Beche de Mer in the east and a fishery for chank in the south opened up, leading to high exports of these products. It is reported that the Beche de Mer resources in the east have been virtually wiped out by intense harvesting that took place in late 1990s, by a group of divers who then moved onto south for chank (Rajasuriya, 1999).

Status of the offshore fishery – The offshore fishery is an extension of the coastal large-mesh drift gill net fishery and shark/ tuna long line fishery into the offshore waters, up to the margin of EEZ and also in high seas. The fishery has developed rapidly since mid 1980s and today, over 1500 vessels operate in the fishery. Offshore boats stay out for more than a day (some boats stay out for over a month) during a single fishing trip and are popularly referred to as multi-day boats. Most of the catch

is used for domestic consumption, with the lowest quality component, such as shark meat, often being used for dried fish production. However, the export of fins is a valuable adjunct to the shark fishery, and there are also attempts to develop an export trade in fresh sashimi-grade tuna.

Table 2.13: Trends in the export of selected marine products from Sri Lanka (in tonnes)

Item	1985	1988	1991	1995	1998	2002*
Prawns	1648	1826	943	2781	5092	3368
Lobster	64	223	188	283	164	272
Crabs	26	45	323	898	486	1302
Beche de Mer	23	34	19	248	203	140
Ornamental fish	104	162	98	331	1043	640
Chank and shells				746	603	324
Shark fins				127	77	83
Fish (chilled and frozen)				1979	3679	7724

(Source: Statistical Unit / MFOR)

The offshore fishery targeting the migratory stocks of tuna, billfish and sharks was the fastest growing sector in the marine fishing industry during the last decade; production increasing from 11,670 t in 1990 to 98,510 t in 2002, equivalent to 32% of the national fish production and worth nearly Rs.6000 at the wharf. The offshore fishery is characterized by its heavy reliance on gillnetting and associated post harvest losses (Amarasiri, 2003).

The over reliance on gillnetting has resulted in imbalance exploitation of offshore resources. The surface pelagics (skipjack, immature yellowfin, sharks and billfish) are taken in gillnets while the deep-water resources (large yellowfin and bigeye tuna) remain largely unexploited by the local boats. It has been estimated that nearly 30% of the off shore catch landed by multi-day boats are of very poor quality and also contaminated with *E. coli*. Fish is brought on ice in all multi-day boats and boats that make fishing trips lasting over a month are known to land more poor quality fish. The situation is made worse by other conditions on board, mainly the fish storage systems and bad and unhygienic practices in fish handling (Amarasiri, 2003).

The tuna long line fishery conducted by the 6-7m long open decked FRP boats, mainly from northwest (Kalpitiya) and northeast (Trincomalee) areas bring adult yellowfin tuna targeted for export market. Ice is not used in these boats and the fish is brought on open deck, covered with a wet gunny bag. The export demand for these fish is poor as they contain high histamine levels in their muscles. Both the above situations represent a significant economic loss from the resource (Amarasiri, 2003 & FAO, 2003).

Overview of Brackish water fisheries -The total extent of brackish water lagoons and estuaries in Sri Lanka is estimated at 128,000 ha. Area covered by mangrove swamps, mud flats and salt marshes is 71,000 ha. The estuaries and lagoons of Sri Lanka form complex systems containing a diversity of species and a variety of coastal habitats including, mangroves, salt marshes, sea grass beds and mud flats.

Pillai (1965) has recorded a total of 112 edible species from the brackish waters of Sri Lanka: 65 percent migrants from the sea, 30 percent strictly brackish water species and 5 percent from fresh waters. On the whole, 70 percent or the bulk of the brackish water population is maintained by continuous migration from the sea and fresh waters. De Silva and Silva (1979) identified a total of 62 fish species belonging to 36 families from Negombo lagoon. More recently, for the same lagoon, Wijeyaratne and Perera (1992) have recorded 82 fish species of which 98% were edible.

Productivity in Sri Lankan lagoons and estuaries range from a high 71 kg/ha/yr for Negombo estuary in west coast to a low 18.5 kg/ha/yr for the Ratgama lake in southwest coast. Schuster (1951) has

estimated an average natural production of the brackish waters in Sri Lanka to be less than 20 kg / ha/annum, while it is around 87 kg/ha/annum in other countries. Jayasuriya (1985) has obtained an estimate of 49 kg/ha as the average annual production from Puttalam lagoon while Wijeyaratne (1984) has obtained a value of 15 kg/ha for the Negombo lagoon finfish, excluding shrimp and crab production. Based on an average natural production of 27 kg/ha/yr, Pillai (1965) has estimated an annual production of about 3,350 tons from Sri Lanka's brackish waters. The annual production from capture fisheries from the lagoons and estuaries of Sri Lanka would not exceed 6,000 t (Joseph, 1993).

Dominant finfish in brackish water fisheries include the Milkfish (*Chanos chanos*), catfish, half beaks (*Hemirhamphidae*), grey mullets, Giant perch, surgeonfish, Banded *Etroplus*, silver whiting, pony fish, etc. Besides finfish, the crustaceans, molluscs and holothurians form important constituents of the country's brackish water resources.

Of the penaeid prawns, the most abundant species in estuaries, *Metapenaeus dobsoni*, is small in size and commercially not as important as the next most abundant species such as *P. indicus*, *M. elegans* and *P. semisulcatus*. The largest species *P. monodon*, is the least abundant (De Bruin, 1970). Prawn fishery in lagoons employ a range of methods, from cast nets to stationery bamboo kraals (seen in Panadura, Balapitiya and Puttalam lagoons), and stake nets with wings and a cod end as seen in the Negombo lagoon and operated at low tide in the night.

Puttalam, Negombo and Nilaweli are some of the major lagoons where the green lagoon crabs, *Scylla serrata* are caught with baited traps. The blue crab, *Portunus pelagicus*, which occurs in large quantities during certain seasons, is caught using various nets.

Beche-de-mer or the sea cucumber is harvested from large high salinity lagoons for export. Among the molluscs, the Window Pane oyster (*Placuna placenta*) resources supported an important fishery in Thambalagam Bay, Trincomalee, which yielded much state revenue until the floods destroyed the oyster beds in 1957.

Other bivalve resources are considerable in Sri Lanka waters. Yet exploitation at present is far below the level of natural production and is confined to wild stocks, as bivalve culture is not commercially practiced in the country. Present utilization of bivalves, mostly of clams and cockles, is at subsistence levels in areas where the resources are plentiful.

Bivalve resources in Mundel Lake and Chilaw lagoon have been harvested since the mid 1980's in order to use their shells to feed the limekilns located around the lagoons. Female members of fishing households often engage in the harvesting.

The deep lagoons and the estuaries are the sites of important fisheries. Nearly 30,000 full time and part-time fishermen are engaged in lagoon fisheries in Sri Lanka (FAO/ADB, 1988), using gillnets, cast nets, trammel nets, hook and lines, traps, stake nets, etc. Many are also subsistence sea fishermen who would switch to lagoon fishing during the rough monsoon season. While over 4,000 non-motorized traditional crafts are estimated to be operating in brackish water lagoons and estuaries, (FAO/ADB, 1988), many lagoon fishermen conduct fishing operations without using crafts.

Statistics on fish production from the brackish waters, mainly lagoons, are incorporated with those of coastal marine fisheries. As a result, there are no separate, national level data on lagoon fish production, fishing effort or catch composition although such data may be available for lagoons in some districts.

Brackish water aquaculture - Commercial scale brackish water aquaculture in Sri Lanka is limited to shrimp farming. Milkfish culture had developed to some extent until the early 1980's, mainly concentrated in the northwestern and western areas with seed being collected from the wild. Since the early 1980's, shrimp farming became popular, with the Government offering various incentives, a number of small-scale entrepreneurs and a few large multi-national companies ventured into shrimp

farming. Due to its faster growth, large size attained and export potential, the black tiger prawn *Penaeus monodon* has been almost exclusively used in brackish water shrimp culture.

In the northwestern province, the coastal area between Maha Oya and Puttalam/Kalpitiya has become the hub of the country's shrimp farming industry. The Dutch canal and the lagoons serve both as the source of water for these shrimp farms as well as 'sinks' for their waste/effluents.

The shrimp farming industry in the northwestern province recorded a phenomenal growth after 1990, in terms of the number of farms as well as the extent of land brought under shrimp culture. This period also saw the proliferation of a large number on un-authorized farms, set up in mangrove areas/salt marshes, on the lagoon and canal reservations and, on any available state land.

The total number of farms has increased from about 60 farms with a total pond area of 405 ha in 1990, to nearly 1350 farms with a total pond area of around 4,500 ha in year 2000 (Draft CZMP, 2003). The high percentage (76%) of small farms of less than 2 ha indicates that it is now established as a predominantly small-scale activity. Nearly 48% of all the farms are unauthorized or illegal, meaning that they had not been subjected to a proper technical appraisal (Siriwardene, 2001).

In 1998, a total of over 8000 persons were engaged in the shrimp industry: 6388 in farms, 652 in hatcheries and 1010 in processing factories (Hettiarachchi, 2000). In more recent years, export of cultured shrimp has contributed to over 50% of the total export earnings from the fisheries sector. Data maintained at the Statistical Unit of MFOR shows that in absolute terms, the industry has consistently netted in well over Rs. 2,000 million in foreign exchange since 1995, with a peak of Rs. 4,027 million in 1998, equivalent to 60% of the total foreign exchange earned by the fisheries sector in 1998.

The shrimp farming industry in the northwest is currently in decline. The impact of illegal farms, pollution of waterways and the spread of diseases have been fatal for the industry. The area under cultivation has declined from 39% in 2002 to 17% in 2003 (*Siriwardene /personal communication*). According to Perera (2003), only about 25% of the farms are operating at present. Of the 12 processing plants, only 4 are functioning. The average yield per hectare per annum has also gone down from a peak of 6175 kg in 1994 to an all time low 650 kg in 2002.

Government has started closing down illegal farms and 15 court cases have been filed. In six months, courts have ordered 7 farms to be closed down (Perera, 2003).

In Batticaloa district (where shrimp farming in Sri Lanka first began in late 1970s but was abandoned due to the civil unrest) shrimp farming has recommenced in recent years. Unpublished data kept by the Regional Aquaculture Extension Officer of NAQDA in Batticaloa show that over 60 farms were in operation at end 2002, with a total pond area of 155 ha.

2.7 Coastal and marine Biodiversity

The Global Biodiversity Strategy and the Convention on Biological Diversity recognize three functionally related components of biodiversity: Genetic diversity, Species diversity and Ecosystem diversity. Only the species diversity and ecosystem diversity are considered in this report.

The inland waters provide aquatic habitats for a large number of fresh water species, notably, the fish fauna. The many critical near-shore habitats of the coastal areas - estuaries and lagoons, coral reefs, mangroves, sea grass beds and salt marshes also function as vital breeding and/or nursery grounds for numerous species of fish, crustaceans and molluscs, many of which are of commercial value in the coastal fishery. These habitats comprise a rich component of the country's biodiversity, although much of the various groups of marine and coastal organisms are as yet incompletely documented.

Genetic diversity within coastal habitats is also believed to be high, and of possible economic value, but this aspect has not been investigated adequately as yet.

The species richness recorded in literature in regard to major aquatic ecosystems is summarized in **Table 2.14**.

Table 2.14: Species richness in major aquatic ecosystems in Sri Lanka

Fresh water fish (riverine or marsh dwelling)	65 (about half endemic) 80 (27 endemic) (Ekaratne, 2000)
Introduced fresh water fish	22 (MOFE, 1999)
Marine fish (Food fish and ornamental fish)	350 Food fish (MOFE, 1999) 1800 (including Ornamental Fish 250)
Marine turtles	5 (MOFE, 1999, draft CZMP, 2003)
Marine mammals	38 (MOFE, 1999)
Coral reef ecosystem	
Corals	180 (MOFE, 1999) 183 hard corals / 68 genera (Rajasuriya & Silva, 1988 and Rajasuriya, 1994)
Coral reef fish	900-1000 (draft CZMP, 2003)
Marine invertebrates	50 (6 species of spiny lobsters, shrimps, molluscs (e.g. sacred chanks, cowries, cones and murex), sea anemones and sea cucumbers.
Mangrove ecosystem	
Mangroves	40 (25 true mangrove species)
Fish	53
Crustaceans	13
Birds	100 (16 migrants)
Amphibians	9
Reptiles	33
Mammals	26 (3 endemic)
Seagrass beds	
Sea grasses	Species of about 10 genera.
Fauna	Polychaete worms, shrimps, ornamental fish, food fish, Dugong dugong.

(Source :MOFE, 1999, CZMP, 2003, Ekaratne, 2000)

Marine Mammals -Incidental catching of marine mammals, particularly dolphins during commercial fishing operations in Sri Lanka has a long history, with literature dating back to the late 19th century. It became a major environmental issue in Sri Lanka in the 1980's, consequent to the worldwide concern over the incidental catches of cetaceans, sea birds and marine turtles in many different fishing operations around the world. A number of investigations conducted during the 1980's and 1990's have provided estimates of dolphins killed, ranging from 8000 to nearly 50,000 per annum. The highest estimate of 49,863 made by Leatherwood and Reeves (1989) was later revised to 8042-11,821 by the authors themselves, admitting to an error in the original calculations.

A total of 10 species of dolphins and 8 species of small whales have been identified during the different studies conducted from 1983 to 1998. A comparison of species recorded during these studies, covering different areas is provided in **Table 2. 15**.

Five species of dolphins - the Spinner, Striped, Bottlenose, Risso's and Spotted dolphin are the most common among the dolphin by-catch. Among the smaller whales, the Pygmy killer whale, the False Killer whale and the Dwarf Sperm whale have been reported in most studies. Dolphins accidentally entangled in the large-mesh drift gillnets were observed at practically all the landing/sampling sites but harpooned animals were observed only at few sites, notably Negombo (west), Beruwala (south-west), Mirissa and Dondra (south). Harpooning has accounted for nearly 32 percent of the marine

mammals estimated as ‘by-catch’ in the study by Dayaratne & Joseph (1993), which covered the northwest, west, southwest and the south. Of the harpooned dolphins, 81 percent were from Mirissa and 11 percent from Beruwala.

Table 2.15: Percentage species composition of ‘dolphin’ catches in different studies

	<i>J&S</i>	<i>A/83</i>	<i>A/85</i>	<i>L&R</i>	<i>D&J</i>	<i>M</i>
Dolphins						
Spinner dolphin	34.1	40	46	45.3	58.2	71
Bottlenose dolphin	25.4	7	4	5.4	8.4	3
Striped dolphin	10.9	8	7	8.1	7.2	19
Spotted dolphin	-	13	14	16.7	6.9	1
Risso’s dolphin	6.5	17	19	14.7	4.4	3
Roughtoothed dolphin	-	4	1	0.6	1.3	1
Fraser’s dolphin	-	-	-	0.1	0.5	-
Common dolphin	3.6	-	-	-	0.1	-
Shortsnout dolphin	2.2	-	-	-	-	-
Bridled dolphin	0.7	-	-	-	-	-
Unidentified dolphins	5.1	-	-	-	6.3	1
Small whales						
Melonheaded whale	-	-	-	-	2.6	-
Pygmy killer whale	0.7	4	1	1.8	1.8	1
False Killer whale	-	1	3	1.4	1.2	-
Dwarf Sperm whale	2.9	4	3	2.6	0.5	-
Pygmy Sperm whale	6.5	-	-	0.8	0.5	-
Southern Bottlenose whale	-	-	-	-	0.1	-
Shortfinned Pilot whale	-	-	2	1.1	-	-
Cuvier’s Beaked whale	-	1	-	-	-	-
Unidentified whale	1.4	1	-	0.8	-	-

Source: J&S - Joseph and Siddeek (1985) – Negombo / Beruwala
A/83 - Alling, A (1983) – Beruwala
A/85 - Alling, A (1985) – Trincomalee
L&R - Leatherwood & Reeves (1989) – Trincomalee
D&J - Dayaratne & Joseph (1993) – Kandakuliya/ Negombo/ Beruwala/ Mirissa
M - Miththapala, S. (1998) – Mirissa, Kirinda

During a 12 month study on landings of cetaceans in association with commercial fisheries, Miththapala (1998) has observed nearly 60% increase in the landings at Mirissa over a ten year period. Harpooning, which began in Mirissa in early 1980’s, has accounted for 74% of cetacean landings in 1996/97.

All the marine mammals encountered during the study by Dayaratne & Joseph (1993) have been landed by inboard engine crafts; 27 percent by the coastal day boats and 73 percent by the offshore boats. A comparison of the species composition of marine mammals between entangled and harpooned as well as between those landed by the coastal boats as against the offshore boats showed notable differences, which could reflect differences in the relative abundance of these animals in different ranges.

There were a number of initiatives in 1990’s to raise awareness amongst fishermen and the general public on the conservation of marine mammals. Many agencies such as the MFAR, DFAR, CCD, and

IUCN were involved in these attempts, which included preparation and distribution of posters, pamphlets etc.

Sea Turtles - Out of the 7 species of marine turtles found in the world, five are reported from around the seas off Sri Lanka and all five species are also reported to come ashore for nesting. These species – the Olive Ridley (*Lepidochelys olivacea*), the green turtle (*Chelonia mydas*), the leatherback turtle (*Dermochelys coriacea*), the loggerhead turtle (*Caretta caretta*) and the hawksbill turtle (*Eretmochelys imbricata*) are also listed as either endangered or vulnerable in the IUCN Red List. An amendment to the Fauna and Flora Protection Ordinance in 1972 has provided legal protection to all species of marine turtles in Sri Lanka. However, marine turtles continue to be exploited by coastal communities for their eggs, meat and carapace.

In Sri Lanka, turtle nesting beaches are located all round the coast, except in Puttalam and Gampaha districts. Turtles still occasionally visit some beaches off Colombo, Kalutara and Matara districts. Best nesting beaches are located in Galle and Hambantota districts. Kosgoda-Induruwa area in Galle district and Rekawa beach in Hambantota district have been identified as turtle rookeries. Amarasooriya (2000) has classified Sri Lanka's turtle nesting beaches from Kalpitiya to Hambantota, on the basis of nesting visits by species and frequency (**Table 2. 16**).

Table 2. 16: Classification of Turtle nesting beaches of Sri Lanka from Kalpitiya to Hambantota

Class	Basis of Classification	Location of beach	District
Class 1	Nests of all five species reported Average Nestings per month exceed 10	1. Koggala –Induruwa beach 2. Rekawa beach	Galle Hambantota
Class 2	Nests of all five species reported Average Nestings per month exceed 5	1. Bundala beach	Hambantota
Class 3	Nests of four species reported Average Nestings per month exceed 5	1. Warahena-Habakkala beach	
Class 4	Nests of four species reported Average Nestings per year exceed 20	1. Bentota beach	
Class 5	Nests of 2-3 species reported Average Nestings per year exceed 20	1. Ussangoda beach 2. Unawatuna	Hambantota
Class 6	Nests of 1-2 species reported Average Nestings per year exceed 5	1. Mount Lavinia beach 2. Haraspola 3. Kahawa 4. Paraliya 5. Wellaboda 6. Hadiwatta 7. Habaraduwa 8. Koggala 9. Wellaode 10. Kahandamodera 11. Kalametiya 12. Welipatanwila 13. Godawaya 14. Sisilasagama 15. Suriyawalana 16. Uraniya 17. Magamoya 18. Palatupana 19. Patnangala	Colombo Galle Galle Galle Galle Galle Galle Galle Hambantota Hambantota Hambantota Hambantota Hambantota Hambantota Hambantota Hambantota Hambantota Hambantota Hambantota

The coast of Yala National Park in the southeastern coast has proved to be a major nesting ground for the leatherback turtle. Yet, Jayawardene and Pereira (1988) reported a significant reduction in the number of nesting leatherbacks in 1988, compared to those during the period 1982-1984.

The first organized effort at turtle conservation through hatchery management began in 1977 and IUCN (1999) has recorded a total of 23 such establishments in operation in the southern and southwestern coasts.

The Turtle Conservation Project (TCP), an NGO established in 1993 commenced an *in situ* marine turtle nest protection and research programme in Rekawa from 1996 and in its first year of operation, 776 nests out of the 962 nests laid were successfully protected and over 62,000 hatchlings released to the sea (Richardson, 1998). During a three-year period (1996 -1999), 600 female turtles have visited Rekawa and the nests laid have totaled 2660 (Kapurusinghe and Ekanayake, 2000). 96% of the nests belonged to green turtles which is the most common species nesting in Rekawa. The nesting turtles in Rekawa lay an average of over 800 nests per year and the number of eggs laid is estimated at almost 100,000.

In a study of nesting habits of the leatherback turtle at Godawaya rookery during the 2001 nesting season, Ekanayake et al (2002) have estimated a total of 333 nests from 68 individuals.

Extensive egg collection, destruction of nesting and foraging grounds of turtles, incidental by-catch in fisheries and certain activities at turtle hatcheries have been identified as major threats to marine turtles in Sri Lanka. Over thousands of eggs in the protected nests have been washed away in Rekawa during March-April 1997 due to coastal erosion (Amarasooriya, 2000).

In mid-1970's, about 1500 turtles were taken annually in Jaffna and the total caught around the island was estimated at 3,000-5,000 (Frazier, 1980). Turtle eggs consumed annually was estimated at 20,000 (Wickremasinghe, 1981).

The first organized effort at turtle conservation through hatchery management in Sri Lanka began in 1970 and there had been as many as 23 turtle hatcheries in operation in south and southwest towards the end of 1990's (IUCN, 1999). Majority of these operate as commercial enterprises in response to the burgeoning tourism industry. It has been reported that current management techniques in operation at majority of these hatcheries are not conducive for conservation of marine turtles and may be contributing directly to the decline in turtle populations (Amarasooriya, 2000 & IUCN, 1999).

Entanglement of turtles is reported in both small and large mesh gillnet fisheries and tuna longline fishery. While animals entangled in these cases can come up to breathe, those animals entangled in 4.5"-18" mesh bottom set nets laid to catch demersal sharks and skates are unable to come to the surface and ultimately drown. Jinadasa (1984) has estimated an annual by-catch of 400 turtles from local gillnet fisheries. Sri Lanka's fishery, particularly the gillnet dominated offshore fishery has expanded rapidly during the last two decades, with potential for greater turtle by catch. In fact, the marine turtle by-catch in Sri Lankan fisheries may be as high as 13,000 per year (Kapurusinghe and Saman 2001). In Hambantota district, the number of turtle by-catch recorded at selected fish landing sites during a period of one year (1999/2000) was 8 in Hambantota, 629 in Kirinda and 192 in Tangalle.

2. 8 Development potential in coastal and marine environment and its living resources

Sri Lanka is yet to realize the full potential of its coastal and marine environment and its living resources. The relative importance of the coastal areas has increased over the years, with the development of commercial harbours, fishery harbours, transport, communication, recreational facilities and tourism. The coastal region is characterized by a higher density of population and a greater degree of urbanization than in the rest of the country. There is a high concentration of industry in the western coastal region around Colombo. Because of the central position of Colombo, and the development of Colombo and Galle, becoming important trading ports even in earlier times, development has been particularly intense in the western and southwestern coastal region.

The potential for development in other coastal areas remain largely untapped. However, there was significant increase in economic activity around important coastal towns such as Trincomalee and Batticaloa. The development potential in the coastal and marine environment will be significantly

enhanced by some important economic and infrastructure development activities, which have received the attention of concerned ministries of the government in recent times. These include:

Port and shipping development

- A new commercial harbour is to be developed at Hambantota, with container handling/transshipment facilities as well as an oil refinery. A Canadian company has almost completed the feasibility studies.
- A commercial cum fishery harbour is planned at Oluvil in Ampara district (eastern province). Feasibility studies and details designs have been completed and funding secured from the Danish government. This harbour is expected to accommodate about 240 offshore multi-day boats.
- A project to expand Colombo port is currently in progress to increase its transshipment capacity.
- Construction of two small fishery harbours and an anchorage are being planned under the ADB financed Coastal Resources Management Project. These are to be located at Ambalangoda, Kalametiya (fishery harbours), and Chilaw (anchorage), mainly for use by the offshore fishing fleet. Detail designs have been completed for all sites and a reassessment of costing is currently on going.

Oil and gas exploration

A new Authority for oil exploration has been established under an Act passed in parliament in April 2002. There has been renewed interest in exploring for oil and gas in Pesalai/Gulf of Mannar area as well as in the west coast.

Mineral exploitation

An area in southwest (around Beruwala) where large deposits of mineral sands were located has been surveyed (seismic surveys) with assistance from UN Revolving Fund. The Marine Pollution Prevention Authority (MPPA) has recently called for expressions of interest from interested investors.

Potential for expanded coastal tourism

Tourism is the fifth largest foreign exchange earner in Sri Lanka. The prevailing peaceful situation in the country has resulted in increased tourist arrivals - total number of tourist arrivals from January to June 2003 shows an increase of nearly 25% compared to the same period in 2002. Gross earnings from Tourism increased from US \$ 213 million in 2001 to 248 million in 2002 (**Perera, 2003**).

Opening up the east coast for tourism would allow year round coastal tourism, May to October in the east coast and April to November on the west and south coasts.

Eco-tourism, identified as responsible travel to natural and cultural areas, which conserves the environment and sustains local host communities is fast gaining in popularity. Between 1990 and 1995, world eco-tourism had grown by 30% while conventional tourism has grown only by 8% during the same period. The WWF estimates that eco-tourism accounts for nearly a quarter of total tourism earnings in developing countries (Anon, 2003).

Sri Lanka's spectacular eco-tourism resources make it one of the top potential nature and eco-travel destinations. The country boasts of seven UNESCO World Heritage sites, 13 National Parks, a biodiversity park and 93 other protected natural areas, adding value to an eco-tourism resource base of immense abundance. The coast-based eco assets of the country include 24 protected areas bordering the coastal zone (draft CZMP, 2003), associated with coastal habitats such as lagoons/estuaries, mangroves, salt marshes, etc. In addition, the coral reefs rich in biodiversity with over 180-recorded

hard corals, nearly 1000 species of fish and many other invertebrate species such as lobsters, shrimp, mollusks, etc. offer unique opportunities for the undersea nature lovers.

Oceanic waters around Sri Lanka support populations of whales and dolphins, including the Blue whale and the Sperm whale. These large whales are seasonally sighted close to the coast in areas like Gulf of Mannar and Trincomalee, offering opportunities for establishing whale watching as a commercial tourist activity. Migrant birds and the marine turtles, which come ashore for nesting, already support ecotourism initiatives, particularly in the south.

An 'Ecotourism Plan' is being developed under the on-going Biodiversity Conservation Project at Rakawa, Ussangoda and Kalametiya (Hambantota district); a project supported by UNDP and implemented by the Coast Conservation Department of the MFOR.

Delimitation of Extended Continental margin for Sri Lanka

Sri Lanka has until 2009 to lodge its claim to an extended area of seabed beyond the EEZ margin. This activity has been accorded very high priority in "Regaining Sri Lanka", the major policy document of the Government. While desk studies have been completed, negotiations are on going with the funding agency (NORAD). Seismic surveys are expected to commence by end of 2004 (*Wijayananda /personal communication*)

Transboundary implications from this activity is expected to be more political - if and when the area claimed by Sri Lanka outside its EEZ overlap with a similar claim by India.

Transportation

The Government of Sri Lanka plans to have a road link between Sri Lanka and India. This is to be part of the 'Asian Highway' programme of the Economic and Social Commission for Asia and Pacific (ESCAP), which is a programme to link all major capital cities of Asia. Such a road link between the northern Sri Lanka with the south coast of India will have major transboundary implications, particularly in the Gulf of Mannar area.

Accelerated development in north and east

In addition, success in the on going 'peace process' is likely to lead to an accelerated economic and infrastructure development of the north and east, particularly in the coastal zone. These developments will have major impacts on the coastal and marine environment and its resources, including 'transboundary' implications.

Increased potential from fisheries

Potential for increased benefits from the coastal and marine living resources is reflected in some of the targets in respect of fish production, employment generation and export earnings set out in the latest policy document of the Ministry of Fisheries and Ocean Resources, which envisage:

- A 5% increase per annum in coastal fish production, with the return of normalcy to the North and the East (67,890 t in 10 years).
- An incremental contribution of 51,740 tons from the offshore fishery over the ten-year period
- Around 60,000 tons of fish production from high seas fishing by the year 2012.
- A production increase up to 27,500 t from brackish water aquaculture, particularly from extension of shrimp farming activities in the untapped south and eastern sectors of the country.

3. THREATS TO THE COASTAL AND MARINE ENVIRONMENT AND ITS LIVING RESOURCES

The economic development and increased population pressures within the coastal region have taken its toll on the carrying capacity of the coastal and marine environment and its living resources. The impact of urbanization on the physical environment in the coastal area is seen from the strong evidence of environmental stress. Urbanization is more likely to damage the physical environment in the coastal areas than in non-coastal areas. The coastal habitats have been severely damaged by uncontrolled sea front construction and the destruction of mangroves and coral reefs, which are a direct result of unplanned development and poverty. This has been aggravated by the discharge of industrial waste into rivers and other waterways.

An attempt has been made to rank the identified threats to the coastal and marine environment and its living resources, broadly on the basis of frequency of occurrence, extent of the damage (geographical coverage) as well as severity of damage, including socio-economic impacts.

3.1 Threats to coastal and marine environment

Coastal waters in Sri Lanka are polluted due to a number of threats, which can be ranked as follows:

- Release of untreated or partially treated wastewater and toxic substances from industries,
- The dumping of solid waste in coastal areas
- The receipt of raw sewage
- Waste from squatter settlements and other domestic sources
- Release of untreated or partially treated wastewater and toxic substances from tourist resorts
- Contamination with waste oil from fishing boats, ships, coastal service stations and oil spills
- Release of untreated or partially treated wastewater and toxic substances from aquaculture
- Fertilizer and agro-chemical run-off from agricultural lands
- Oil spills from ships
- Exotic invasives associated with shipping

The pollutants that reach coastal waters may:

- (a) originate from specific point sources such as industries, urban sewers or sewage treatment plants and coconut husk retting sites, etc.
- (b) be transported through coastal waterways such as rivers, streams and estuaries, or
- (c) be through direct leakage and seepage.

They may also originate from non-point sources (run-off) that are more difficult to control, such as agricultural lands, sewage from built-up areas and mines.

Pollution from Offshore oil spills - Potential risk factors associated with oil spills and other discharges include the following:

- Oil transported in tankers (about 525 million tones annually) in the EEZ of Sri Lanka
- High density of marine traffic, mainly the East-West Shipping Route used by ships plying between the industrial centers in the Far east and the West
- The offshore terminal of the Ceylon Petroleum Corporation (Approximately two tankers carrying 120,000 tonne parcels of crude oil are transferred to the tanks ashore every month)
- Operation of the Trincomalee Oil Tank Farm
- Expansion and development of ports, and construction of ports and harbours
- Existing marine services industry, including offshore supply of bunkers and ship repairing industry
- Exploration of oil within the EEZ of Sri Lanka

(Source: MPPA/INSTCOM, 2003)

3.2 River Pollution

Agricultural expansion, urbanization and industrialization exert major pressure on inland water resources and its quality. These threats can be ranked as follows:

- Release of industrial effluents and dumping of solid wastes near waterways causing unintentional pressures
- Urbanization which has increased the loads of domestic waste and sewage dumped into rivers
- Agricultural expansion, which has resulted in excessive use of agrochemicals and fertilizer.

The Accelerated Mahaweli Development Programme of late 1970's increased the irrigable area of the country to 1.9 million ha (Steel et al, 1996), significantly increasing the use of agrochemicals and fertilizers and contributing to water pollution.

These threats collectively interact and produce multiple impacts on water resources. In addition, exploitation of natural forests for timber, clearing of forests for plantations (tea, coffee), and; agriculture and human settlements have caused soil erosion, contributing to destabilization of rivers.

3.3 Threats to availability and quality of fresh water

Major threats to availability and quality of surface and ground water originate from:

- Discharge of waste water containing untreated sewage
- Discharge of industrial effluents and industrial solid waste
- Leachate of fertilizer
- Over-exploitation for irrigation purposes
- Over-exploitation for shrimp farms

3.4 Threats to coastal and marine habitats

Threats to mangroves - Extensive mangrove areas have been cleared for shrimp culture, lowland agriculture and housing construction. Major threats to mangroves in Sri Lanka are listed in **Table 3.1**.

There is also over-use of mangrove resources. For example the extraction of poles and fuel wood for domestic use and twigs for brush pile fishery is beyond sustainable levels. Mangrove ecosystems are also degraded by water pollution and siltation.

Between 1986 and 2002, over 2,730 ha of mangrove have been lost in the Puttalam district, mainly due to shrimp farming (Draft CZMP, 2003). Large extents of mangroves in the northern districts have been cleared by the security forces during the 20 year old ethnic conflict.

In terms of current and immediate past threats, the ranking would be as follows:

- Clearing for shrimp farming
- Clearing for security

- Clearing for urban development
- Clearing for domestic uses
- Clearing for fishery related uses

Table 3. 1: Major threats to mangrove resources

Human related causes	
Non-site specific damage	Site specific damage
<ul style="list-style-type: none"> ▪ Clearance for housing, coconut, domestic uses ▪ Clearing to obtain twigs for brush piles 	<ul style="list-style-type: none"> ▪ Clearing for urban development (most urban areas) ▪ Clearing for shrimp culture (in the North Western province) ▪ Erosion of banks (due to operation of high speed boats) of estuaries/lagoons destroy mangroves adjoining the water edges (e.g. Madu ganga, Kaluwamodara) ▪ Change of water regimes (eg. in Kalametiya, the mangroves are dying as a result of salinity reductions)

Threats to coral reefs - The main causes of reef damage and degradation are summarised in **Table 3.2**. In order of occurrence, extent and severity, the threats can be ranked as follows:

- Coral mining
- Coral bleaching
- Destructive fishing practices
- Pollution
- High visitor pressure
- Sedimentation and,
- Over harvesting of resources

Threats to seagrass beds – Seagrass beds are threatened by the following major threats:

- Use of destructive fishing practices
- Sedimentation (natural erosion)
- Pollution

Various human related and natural causes damaging seagrass beds are summarized in **Table 3. 3**.

Threats to Lagoon and Estuarine habitats -Lagoons and estuaries and the biodiversity they contain are increasingly affected by pollution due to untreated industrial effluents, the inflow of sewage, urban wastes and waste oil, land filling and encroachment, eutrophication due to excessive nutrients and changes in salinity regime. A summary of major threats to lagoons/estuaries is given in **Table 3. 4**. These threats can be ranked as follows:

- Pollution from industrial effluents
- Sewage and solid waste disposal
- Land filling / encroachment
- Eutrophication
- Changes in salinity regime

Table 3. 2 Major threats to coral reefs in Sri Lanka

Human related causes		
	Threats	Causes
Non-site specific damages	Sedimentation	Sediment transport by rivers at Hikkaduwa, Rumassala (Galle)
	Destructive fishing practices (e.g. blast fishing using explosives, bottom-set nets, moxy nets)	Bar Reef (Puttalam) - Use of gillnets/bottom set nets and Laila net (Surrounding net) Pigeon Island (Trincomalee) – Bottom set nets, Moxy net, Blast fishing
	Uncontrolled harvesting of reef resources including food fish and ornamental fish, lobsters and other invertebrates	Ornamental fish collection at Rumassala and Unawatuna (Galle), Polhena (Matara), Bar Reef (Puttalam), Trincomalee and Batticaloa.
	Pollution	Pollution from hotels and pollution from ships and tankers at Hikkaduwa, Rumassala (Galle) and from unplanned tourism at Unawatuna bay (Galle). Pollution from oil discharged from fishing boats and waste water discharge from hotels at Weligama (Matara)
	Change of water quality	Coconut husk retting at Polhena (Matara) Effluents from paper factory at Vandalooos Bay (Batticaloa)
Site specific damages	Coral mining from the sea	
	Coral damage by ramming glass bottom boats and fishing boats against reefs and anchoring boats on reefs	Glass bottom boats and anchor damage at Hikkaduwa, anchor damage by fishing boats at Weligama (Matara)
	High visitor pressure (leading to damage by trampling and removing coral)	Hikkaduwa, Polhena (Matara), Pigeon Island (Trincomalee)
	Destructive collecting techniques for ornamental fish and lobsters such as bottom-set nets and moxy nets	Blast fishing at Rumassala (Galle), Hikkaduwa, use of Moxy net at Weligama (Matara),
	Urban pollution	
	Coastal and harbour development	
	Increased levels of sedimentation due to coastal erosion	
	Increased freshwater flow due to upstream irrigation schemes	
Natural causes		
Coral bleaching		
Crown of thorns starfish (<i>Acanthaster planci</i>).		
Other invasive organisms such as tunicates, corallimorphs (coral anemones/ false corals) and algae (Halimeda, Caulerpa and filamentous algae)		
Sedimentation due to natural erosion		
Cyclones and monsoons		

(Rajasuriya, 2002).

Threats to of Salt marshes -Salt marsh areas in the country that serve many vital ecological functions have been reduced mainly due to reclamation (e.g. part of the Muthurajawela marsh) and by their conversion to salterns and shrimp farms. The main threats to these systems are from transformative uses.

Table 3. 3: Major threats to Seagrass beds in Sri Lanka

Human related causes		Natural causes
Non-site specific damage	Site specific damage	
<ul style="list-style-type: none"> ▪ Sedimentation and pollution due to land based activities ▪ Destructive fishing practices (e.g. blast fishing using explosives, bottom-set nets, moxy nets in coral associated areas, push nets in estuaries/lagoons) ▪ Introduction of excessive nutrients or pesticides 	<ul style="list-style-type: none"> ▪ Destructive collecting techniques (digging) for polychaete worms ▪ Urban pollution ▪ Harbours and other coastal developments ▪ Eutrophication - excessive algal blooms occurring as a result of high levels of nutrient inputs from upstream activities (e.g. agricultural discharges and aquaculture discharges change the seagrass beds) 	<p>Other invasive organisms such as algae (e.g. <i>Chaetomorpha</i> in the Negombo estuary)</p> <p>Sedimentation due to natural erosion.</p>

Table 3. 4: Summary of information on degraded lagoons/estuaries in Sri Lanka.

Cause of degradation		Affected Lagoons/Estuaries
Pollution	Industrial effluents and urban waste	Negombo, Kelani and Valaichchenai estuaries, Lunawa lagoon
	Effluents from paper factories	Walawe and Valaichchenai estuaries
	Oil	Negombo estuary receive oil from fishing crafts anchored in it and boat repair and fuel supply stations situated along the banks Kelaniya estuary is polluted by oil leaking from underground pipelines.
	Coir retting	Pollution of some lagoons in the south e.g. Madu Ganga estuary
Introduction of excessive nutrients or pesticides	Rainwater runoffs, effluents from shrimp farms	Shrimp farm effluents in Puttalam, Chilaw, Negombo and Batticaloa
Sewage disposal		Illegal disposal sites for sewage in the Kelani and Negombo estuaries and the Lunawa Lagoon
Solid waste disposal		Bentota, Kirama Oya, Negombo estuary, Lunawa lagoon and Kelani Ganaga estuary
Sand mining		Lowering the riverbed below mean sea level leading to saltwater intrusion (e.g. Kelani estuary, Maha Oya, Deduru Oya).

Siltation	-due to upstream development activities (irrigation schemes, soil disturbance from agriculture, onstruction, deforestation, mining, etc.) -due to construction of jetties/piers for boat anchor - Clearance of mangroves	Negombo estuary
Unauthorized encroachment and land reclamation		Negombo estuary, Bolgoda Lake estuary
Over harvesting - over extracting food fish, ornamental fish and other species	Shrimp and ornamental fish	Negombo estuary
Use of destructive fishing gear/methods	Fishing methods (e.g. trammel net) that deplete fish/ shrimp stocks Fishing methods (Push net, bottom trawl) that damage the submerged and fringing vegetation	Negombo estuary
Changes in salinity regimes due to upstream development activities (e.g. irrigation)	Drop in salinity due to excess fresh water influx or increase in salinity due to reduction in fresh water inflow	Drop in salinity in Malala, Ambilikala and Kalametiya lagoons. High salinity in Puttalam lagoon.

Threats to Barrier beaches, spits and dunes - Sand dunes, barrier beaches and sand spits in Sri Lanka are increasingly affected due to;

- Encroachments for construction of dwellings, indiscriminate allocation of land for construction of hotels, and
- Transformation to agricultural lands for cultivation of coconut, tobacco, chili, onion and other crops.
- Coastal erosion
- Sand mining

3. 5 Threats to shoreline stability

Shoreline stability is threatened by both natural causes and human interventions, and causes loss of beach and landscape quality; damage to or loss of private dwellings, public buildings, hotels and other infrastructure.

Natural processes contributing to coastal erosion - Sri Lanka's dynamic shoreline undergoes continual retreat and accretion; some changes being seasonal while others are more permanent. The natural processes contributing to coastal erosion are summarized below:

- Increase in gradient of sediment transport rate (e.g. the curved coastline along the southwest of Sri Lanka - from Galle to Akurala).
- Loss of sand inland due to breaching and wash-over of a sand berm (e.g. the Dickowita area).
- Offshore loss during extreme wave and storm surge conditions (e.g. southwest coast).
- Loss of sand into canyons (e.g. the canyon in the Trincomalee Bay traps most of the sediment supplied by the Mahaweli river).

- Deposition of sand at sand spits. (e.g. Negombo).
- Beach rock and reef collapse (e.g. receded coastline north of Pegasus Reef Hotel/Pamunugama in Gampaha district).
- Loss of material from 'nodal areas'.
- Natural variation in the sand supply to the coast from rivers.
- Seasonal and long-term variations in the wind climate.
- Sea level changes.

(Source: draft CZMP, 2003)

The impact of winds, waves and surges are balanced to some extent by natural defenses from the coral and sandstone reefs, rocky headlands and gently sloping beaches.

Vulnerability to erosion along the coast also differs considerably with shoreline type. Straight sandy shorelines are the most vulnerable to erosion, as they have no fixed element. The heavy erosion along the straight sandy beach at Lansigama (a village north of Wennappuwa in Puttalan district) exemplifies this. In contrast the bay and headland type coastline is less vulnerable to erosion due to the stabilizing function of the headlands, especially when there is only a short distance between them.

The drift budget - The most important feature influencing the stability of Sri Lanka's coasts, as elsewhere, is the littoral drift budget. The supply of less sand than is transported out of it, results in a deficit in the littoral budget and causes erosion. Some examples are;

- The transport capacity along the southwest coast is noticeably more than the sand supply from the rivers. This difference constitutes the main cause of erosion in the southwest coast.
- The erosion north of Negombo is particularly severe because of a high deficit in the littoral budget due to sand mining in the Maha Oya, compounded by the straight sandy shoreline prevalent in this area.
- The sand supply along the south coast is also low, but the coastline is relatively stable due to the bay and headland shoreline that predominates here.
- The shoreline in the area north of Sangamankanda Point is the straight sandy type. Thus erosion may increase here with the decreased sand supply (i.e. in the Southern Province and the southern part of the Eastern Province) owing to the dams constructed across the Walawe Ganga and Gal Oya. These dams have already reduced the sand supply from the two rivers, from 160,000 to 15,000 m³/year, and 70,000 to 15,000 m³/year, respectively (LHI, 2002).

3.6 Threats to coastal and marine fisheries

Coastal fisheries in Sri Lanka are afflicted by a number of threats, major ones of which could be ranked in the following order:

- Over exploitation of resources
- Use of destructive fishing practices
- Poaching by foreign vessels
- Post harvest losses
- Taking of non-target species

3.7 Threats to Brackish water fisheries and culture

Many of the threats identified in the coastal fishery, such as over-exploitation and the use of destructive fishing gear and methods are prevalent in many lagoons and estuaries. Fishing pressure has intensified with large numbers of part time fishermen entering lagoon/estuarine fisheries (e.g. Batticaloa lagoon, Jaffna lagoon, Negombo estuary).

Use of destructive fishing gear such as push nets, lagoon trawls and digging for polychaete worms (Negombo etuary, Chilaw lagoon) destroy the ecosystem itself, with negative consequences to the fishery.

Threats to brackish water culture

Shrimp farming in the northwestern province face major threats from:

- Proliferation of illegal farms
- Disease outbreaks
- Adverse environmental and social impacts

3.8 Threats to coastal and marine biodiversity

Biodiversity in the coastal and marine environment and its living resources is threatened by;

- Over exploitation
- Habitat destruction / alterations
- Incidental by-catch
- Pollution
- Detrimental conservation practices
- Spread of invasive species

3.9 Threats with transboundary effects

Of the threats to coastal and marine environment and its living resources identified above, the following can be listed as threats with potential transboundary effects.

- Oil spills from ships
- Exotic invasives associated with shipping
- Oil exploration activities
- Threats to coral reefs (e.g. bleaching)
- Sea level changes
- Over-exploitation of resources (e.g. offshore resources)
- Poaching
- Taking of non-target species (marine mammals and turtles)

These are in addition to transboundary impacts that may arise as a result of the various development activities listed under 2.8.

4.0 ANALYSIS OF MAJOR CAUSES ASSOCIATED WITH THE THREATS TO COASTAL AND MARINE ENVIRONMENT AND ITS LIVING RESOURCES

4.1 Causes associated with threats to coastal and marine environment

Following are some of the major causes for pollution of coastal waters including Lagoons/ Estuaries:

- **Release of untreated or partially treated waste water and toxic substances from industries**

Industrial effluents that have undergone little or no treatment are frequently discharged into near shore waters, lagoons and estuaries through run-off, leakage and seepage.

The Lunawa lagoon in Colombo district is a coastal water body seriously affected by industrial pollution. About seven large scale and 14 small-scale industries for dyeing and finishing of textiles/garments, washing plants and manufacturing foot wear directly discharge their effluents into the lagoon. As a result, the once flourishing fishery in this lagoon has almost ceased; and it is now a mosquito-ridden body of stagnant water with a dense growth of water plants and thick sludge at the bottom.

Source: Ministry of Urban Development, Construction and Public Utilities, 2001

Negombo lagoon is polluted in respect of both bacteriological and heavy metal concentrations. Increased nutrient loading is also suspected from land based human activities in the watershed. Reported values for coliform counts and BOD levels are indicative of organic pollution in the lagoon.

The number of industries located in coastal areas, with their respective wastewater loads is given in **Table 4.1**. These include industries set up under the Board of Investment (BOI).

Table 4. 1: Number of industries located in coastal areas with high or medium pollution potential and their waste loads

Type of industry or process	No. of units	Total wastewater load (m ³ /day)	Estimated pollution load (kg/day)		
			BOD ₅	COD	Total toxic metals
Textiles	41	7100	4970	11360	-
Food and beverages	47	4111	6166	12333	-
Desiccated coconut	53	1200	4200	7200	-
Rubber processing	229	4840	9670	29040	-
Tanning ⁺	15	750	2000	5200	-
Metal finishing and preparation	76	6692	-	-	669*
Paints and chemicals	33	928	-	-	92.8*

- not measured * based on assumed average concentration of 100 mg/l

(Source: ERM 1994 cited in Mubarak 2000; ⁺MoEDIP 2002 (unpubl))

Most of the industries located in the coastal area belong to either the medium or low polluting category. In 1994 Sri Lanka had 336 industries with a high or medium pollution potential in the Coastal Zone (Mubarak, 2000). Industries that contribute most to water pollution are those dealing with textiles, paper, tanning, metal finishing and engineering, paints, chemicals, cement, food and beverages and distilleries. Small Industries that deal with coconut fibre retting also have highly localized impacts on water pollution as they result in high BOD and COD values.

There are nine Export Processing Zones (EPZ) and two large scale Industrial Parks (IP) operating under the purview of the BOI. Of these, two EPZs (Katunayake and Koggala) and one IP (of 20 ha in Mirijawilla) are located in the coastal region. In addition there are seventeen other Industrial Parks managed by the Ministry of Enterprise Development, Industrial Policy and Investment Promotion. Of these, four parks - at Beliatta, Bata-atha, Ratmalana and Udukawa - are located in the coastal region. Various other institutions manage another eleven IPs. Of these, four at Panadura, Weligama, Ekala and St. Martin Estate, Chilaw are located in the coastal region, and another IP is planned in Mirijjawela (*Source: Ministry of Enterprise Development, Industrial Policy and Investment Promotion*).

Most industries are not yet equipped with the basic infrastructure for waste treatment, while others are constrained in the use of available waste treatment facilities due to the high costs involved. It is reported that only the Export Processing Zones at Katunayake (KEPZ) and Biyagama (BEPZ) have facilities for central treatment of wastewater prior to discharge (draft CZMP, 2003).

- **Unsanitary disposal of solid waste**

Solid waste includes non-liquid garbage and refuses from houses, institutions, markets, medical, commercial and industrial establishments as well as street and garden wastes. Such waste would include discarded organic waste (i.e. food, vegetation, paper, cardboard, rubber, leather, discarded clothing, etc.), packaging in the form of metals, plastics or glass and cut pieces from garment factories.

Over the years, environmental hazards related to solid waste have grown in Sri Lanka and continue to be a problem. About 2,694 t of waste is collected daily by the Local Authorities island- wide. Of this, nearly 75% is collected from the five Maritime Provinces. While western province account for 54% (1448 tonnes) of the total solid waste, Colombo district alone has a daily collection of 1171 tonnes (43%). Other coastal towns also have problems of waste disposal. In the eastern province, the amount of solid waste produced estimated in tons/day is 45.75 in Ampara, 124.5 in Batticaloa and 87.4 in Trincomalee (ADB, 2003). Though the issue is more prevalent in urban areas, it is rapidly becoming a problem in rural areas as well.

Many Local Authorities face problems in finding suitable vacant sites for safe disposal of solid waste. There is little or no infrastructure for collection and disposal of solid waste. Waste is often disposed at open dumps, sometimes in low-lying marshy lands within the coastal region. There are 746 open dumping sites in the island and 200 of these are located within the coastal region between Puttalam and Hambantota (CCD, 2003). There is also the problem of garbage littering beaches near squatter settlements and tourist resorts, and indiscriminate solid waste dumping within the shore area.

A survey by the Department of Census & Statistics in 1998 found that a Solid Waste Collection Programme covers 32% of the housing units in the country (Anon, 1998). While there were variations among districts, the highest coverage was in Colombo (77%). Out of the total workforce of 40,761 employees in Local Government Agencies (Municipal Councils, Urban Councils and Pradeshiya Sabhas), 10,108 (25%) were involved either directly or indirectly in solid waste collection and removal.

The daily collection of solid waste was estimated at 2,694 t; consisting of organic matter (65%), paper (13%), plastic (8%), metal (8%) and glass (2%). The annual collection of 906,660 t was dumped in 746 solid waste disposal yards.

In addition to poorly planned solid waste management, inadequate staff, facilities (vehicles and machines) and financial resources have been identified as the major constraints in implementing a proper municipal solid waste collection programme.

No sanitary landfills are available in the country. Communities and local groups have a 'not in my backyard' syndrome in regard to development landfills and often file lawsuits to stop them. Politicians often respond by adopting a safe 'not in my term of office' attitude. As a result, no landfills have won approval (Kodikara, 2003). Incineration has also not found favour due mainly to toxic air pollution and disposal of resultant ash. Although 75% of the waste generated can be recycled and there are many recycling programmes, only a very few are run properly (*Batuwitage / personal communication*). For example, only 16% of the 186,000 tonnes/year of cardboard and paper in western province is recycled. The Ministry of Environment currently implement a pilot project, jointly with the Maharagama Poradeshiya Sabha, where 3000 households are involved in a waste recycling programme. Another approach to garbage disposal is garbage composting. Composting is also less common and only a few urban authorotirs have their own small composting facility.

The expenditure incurred on solid waste removal in the coastal provinces during 1998 is given in **Table 4.2**. Approximately 16% of the revenue generated by the Local Government Agencies in these provinces has been spent on solid waste disposal.

Table 4.2: Expenditure incurred on solid waste disposal by Local Government Agencies, 1998 (Rs.)

Province	Municipal Councils	Urban Councils	Pradeshiya Sabhas	Total Expenditure	Expenditure as a percentage of total revenue
Western	59,831,777	34,745,957	45,948,322	140,526,056	12.5
Southern	14,162,933	18,797,860	13,827,643	46,788,436	13.6
Northern	19,963,592	6,035,550	18,044,800	44,043,942	19.6
Eastern	307,298	14,416,295	8,735,447	23,459,040	26.9
North-western	1,316,425	6,992,000	9,011,728	17,320,153	14.7
Total	95,582,025	80,987,662	95,567,940	272,137,627	15.8

(Source: Dept. Census & Statistics, 1998)

▪ **Inadequate municipal sewage disposal facilities**

Faecal pollution is a major problem in some coastal waters due to the direct discharge of untreated municipal sewage into land and waterways. Colombo is one of the few cities in Sri Lanka with an installed sewerage system, which however, is about 100 years old, needs frequent repairs and inadequate to cater for the entire city. Another problem is the illegal sewage connections to sewerage lines and unauthorized connections to storm water drainage systems and combined sewers.

The growing urban population in coastal areas, with inadequate housing and sewage disposal facilities compounds faecal contamination of surface and ground waters. For instance, the Colombo Municipal Council Area had a population of 642,163 in 2001 (Mubarak, 2000). In 1992 roughly about 19% of the Greater Colombo Population was served by sewers, 59% had on site facilities, but about 22% had none, or grossly inadequate, sewage disposal systems. The latter category - primarily from low-income squatter settlements that are underserved - releases about 138 t of sewage/day into the city's waterways.

- **Inadequate facilities for waste disposal in underserved settlements**

At the turn of the last century, 51% of the population of Colombo city lived in 1,500 shanty settlements comprising around 66,000 households (Central Bank, 2001). These settlements are underserved in respect of sanitation, safe water and waste disposal facilities, compounding the problem of sewage disposal in the city. Pollution from these sources cause reduction of dissolved oxygen in the canals and streams, resulting in an anoxic environment and a foul odour that is harmful to human health and aquatic organisms.

Many highly populated coastal low-lying areas have a shallow water table and a high vulnerability for flooding. Inadequate drainage facilities and *ad hoc* development in these areas have further intensified the impacts of inappropriate sewage disposal in low-lying flood prone coastal areas leading to severe faecal pollution in internal and near shore waters.

- **Pollution from the tourist sector**

About 70% of tourist hotels registered with the Tourist Board are located within the coastal region. The near shore waters receive untreated sewage, sullage in the form of kitchen and laundry wastewater, and solid waste including plastics. This causes pollution problems, as apparent in most major tourist centres along the south and southwest coasts. Tourism expansion in Hikkaduwa, Beruwala and Unawatuna areas has led to water quality degradation as well as visual pollution on beaches and near shore waters. The problem of sullage is particularly perceived as a problem associated with the larger hotels. The development of squatter settlements connected with tourism development is another cause for concern as it contributes to faecal pollution that is a severe threat to recreational activities such as contact sports in coastal waters (Draft CZMP, 2003).

The high BOD and COD levels found during the one year study conducted by the University of Moratuwa in the coastal waters coincided with areas where tourism is predominant – Marawila, Mount Lavinia, Wadduwa and Beruwala showed high levels during the northeast monsoon as tourist season falls in the months of December and January (Jayaweera, 2003). Tar balls observed on the beaches in the southwest region from August to January suggest oil pollution from ships and fishing boats

Mount Lavinia and Unawatuna were faecally polluted even in northeast monsoon period, implying that these locations are extensively utilized for tourism activities. Although Jayaweera (2003) presumed that the high faecal coliform levels at Ambakandawila were caused by effluent discharge from prawn hatcheries, doubts were raised at the national workshop in regard to the exact source of faecal coliform.

Like in the industrial sector, many tourist establishments lack treatment facilities while those that possess such facilities seldom use them.

- **Pollution from oil spills and other discharges**

Waste oil from oil tankers, discharge of oil in bilge and ballast waters, cleaning out of fuel tanks and repair and maintenance work by motorized fishing boats and ships around ports and fishing harbours cause minor oil discharges and slicks. While they may not cause serious impacts, they result in visual pollution leading to depreciation of aesthetic quality of the beaches for recreation.

In the recent past, four moderate spills of crude oil were reported in Sri Lanka's marine waters (MPPA, 2002) and intrusions of tar balls on to the beaches (Wickremaratne and Pereira, 1986).

The M/V Komsomolets Azerbaydzhana reportedly spilt 100 tonnes of fuel oil after grounding outside Galle harbour in 1994. No oil reached the coastline.

In June 1998, an oil spill occurred at the bunkering terminal due to the rupture of a connecting hose during loading. Investigations done by NARA indicated very high concentrations of oil - 595 ppm near the vicinity of the spill (bunkering terminal) and 991 ppm opposite the bunkering terminal (NARA, 1998). These values were very much in excess of the Sri Lanka standards for oil (20 ppm) in marine coastal waters

An oil spill was reported in August 1999 when the 146 m M/V Melikash, carrying 10992 tonnes of fertilizer, broke into two and sank 1000 m off Bundala (south coast). The oil slick lasted about 10 weeks while about 40-50 km stretch of the beach was polluted with oil and tar balls. Oil has also moved about 100 m inside Kirindi Oya and had a concentration of 4.2 mg/l, about one month after the accident (NARA, 2000).

Waste oil released from ships in the Colombo harbour has increased from 879 tonnes in 1997 to 1258 tonnes in 1998. Waste oil and bilge from boats operating from various anchorages and fishery harbours are also discharged into the coastal waters. In addition, ships anchored in near shore waters discharge wastewater, which constitutes another source of coastal water pollution. Although there is no data on environment impacts of such discharges, coastal water pollution arising from all these sources is considered to be significant.

Waste oil from service stations also ends up in coastal waters, underlining need for service stations to intercept the oil with separators. Currently most lack these devices, and even when present they are often defective.

Major commercial ports contribute to pollution of coastal waters due to accidental release of oil. Poor reception facilities for waste oil, ballast and bilge waters cause the port waters to be polluted.

There are specific arrangements for the disposal of waste oil from ships that call at the Port of Colombo during loading or unloading of cargo. About 36 private companies are registered with the Marine Pollution Prevention Authority (MPPA) to collect the oil waste, which is pumped, into bowsers directly from the ships (Jayaweera, 1999). The waste oil collected by the operators during the past five years from Colombo Port is given in **Table 4.3**. However, no regulating authority monitors the final disposal of this oil.

Table 4. 3: Amounts of waste oil collected or removed by collectors in the Colombo Port

1997 (t)	1998 (t)	1999 (t)	2000 (t)	2001 (t)
1403.6	1403.6	1667.5	2078.0	1878.0

(Source: MPPA, 2002)

▪ **Pollution from the Fisheries and Aquaculture sector**

In the absence of proper management, fishery harbours and fish landing sites can contribute to pollution of coastal waters due to improper disposal of used oil from fishing boats and accidental release of oil. The improper handling of fish and the resultant fish waste in fishery harbours/landing sites also causes higher COD levels in the affected coastal waters.

Much of the coastal pollution in the Northwestern Province has been attributed to *ad hoc* development of aquaculture leading to the discharge of high amounts of effluents from shrimp ponds. This has

already caused considerable pollution in the Dutch Canal and the surrounding coastal areas. High levels of nitrates and phosphates released from shrimp farms into the coastal waters have caused eutrophication of nearby watercourses in the region and pollution of ground water.

Shrimp farm effluents reaching the Dutch Canal are high in total suspended solids (200-600 mg/l) and have high BOD levels (60-180 mg/l). These effluents cause heavy siltation in the canal increasing turbidity. High sulphides and ammonia levels in these waters are also attributed to shrimp farm effluents (Corea, et al 1995).

▪ **Pollution from Agriculture Practices**

Pesticide pollution, eutrophication and ground water pollution are the major water pollution issues related to agricultural practices.

The use chemical fertilizer in Sri Lanka has increased from 20,000 t of N, P, K during 1950-51, to 195,000 t in 1974-1975 and to 525,651 t in 1995. This trend has continued and 612,000 t have been used in 1999. It is significant that the annual average level of chemical fertilizer use in Sri Lanka is estimated to be 77 kg/ha, which is 2-8 times more than used in other Asian countries (*Source: MOENR 2002, Central Bank 2000*).

There is heavy use of chemical pesticides, herbicides and fungicides in agriculture, some of which are persistent. These substances degrade the soil as it adsorbs contaminants in the leachate, culminating in pollution of ground water. Polluted ground water used for agriculture and the resultant run-off from agricultural lands contaminates coastal surface waters. In addition, the excessive use of fertilizers causes nitrate pollution in coastal areas.

▪ **Pollution from the power sector**

At present Sri Lanka depends mainly on hydropower, which is low in terms of environmental pollution, for power generation. In 2001 hydropower contributed 61 % to the total installed capacity of 1,909 MW. However its contribution towards annual power generation is steadily decreasing. The shortfall between power demand and hydropower output is expected to be bridged in the future by the establishment of coal powered thermal power plants and the establishment of such plants in the coastal region can result in the thermal pollution of coastal waters.

The impacts of pollution on the coastal and marine ecosystems and their resultant biological and socio-economic implications are many and varied.

There are strong indications that the cost of coastal water pollution in Sri Lanka is on the rise. For example the cost to human health from coastal water pollution in the Colombo Metropolitan Area is estimated to have increased from SLRs 2 million in 1992, to SLRs 4 million in 1997 and SLRs 14 million in 2002 respectively (MOFE, 2001).

There are also losses associated with decreased biological diversity; reduced aesthetic, recreational, cultural and archaeological value; declining land prices and reduced revenue from tourism, fisheries and other development activities. There are some definite links between increasing levels of pollution and decreasing coastal land values and fishery productivity.

- The estimated annual loss of income from fish sales in the Lunawa lagoon due to pollution is approximately SLRs 1,963 million, and the total annual land value decline in the area is estimated to be SLRs 712 million (UDA, 1994).
- The clean up costs due to water pollution is Rs. 454 million for Ja-ela and Ratmalana waste water collection system and Rs. 500 million for Beira lake rehabilitation (UDA, 1994).

More than one third of the people in Colombo Metropolitan Region do not have access to safe drinking water, and use wells, rivers and tanks. Only 17.5% have access to pipe-borne water, nearly 73% use deep or shallow wells and the rest use rivers and tanks (UDA, 1994). Close to 20% of the wells are unprotected, subject to inflow of polluted water and cause water related diseases.

4.2 Pollution of surface and ground water

The major causes for depletion and deterioration of surface and ground water are:

- The urban poor live with inadequate facilities, usually in slums or shanties, which lack basic utilities such as safe water and proper toilet facilities.
- Lack of adequate waste disposal facilities as well as treatment facilities before discharge
- Excessive use of fertilizers in agriculture
- Untreated effluent discharge from industries
- Over-exploitation of ground water resources for irrigation and agriculture

About 21.5% of the total population of Sri Lanka lives in urban areas. Colombo alone covers only 1% of the land area but contains 11% of the total population. Colombo, Kandy and Jaffna already have serious problems in the disposal of liquid wastes, sewage, industrial effluents and industrial solid wastes (MOFE, 2001).

Out of a total of 370,000 m³ of wastewater generated in the Greater Colombo Area per day, 90,000 m³ /day is discharged through ocean outfalls and the remaining 280,000 m³ /day re-enters the environment as wastewater (MOFE, 2001). The main reason for this high domestic water pollution in the area is the discharge of untreated faecal matter.

Serious threats to ground water have been observed in many coastal areas due to nitrate and bacterial contamination.

The main pollution problems in the ground water of coastal areas are leachate of fertilizers causing nitrate pollution; seepage from faecal matter and pollution with heavy metals in industrial zones (Anon. 2001). Treatment of ground water is very costly so that preventing pollution is of considerable importance.

Although an accurate assessment of water pollution caused by agricultural run-off has not yet been established, some studies show a connection between the two. In the Kalpitiya peninsula, characterized by highly permeable soils and a shallow water table, the irrigation wells in extensively cultivated areas have high nitrate concentrations (i.e. in excess of the WHO guideline of 10 mg/l) and a chloride concentration ranging from 50-200 mg/l. In contrast domestic wells located outside these areas have nitrate levels less than 2 mg/l and chloride concentrations less than 100 mg/l (Mubarak, 2000). There is widespread ground water contamination in the Jaffna peninsula attributed to agricultural run-off and the extensive use of pit latrines. High concentration of nitrates have been recorded in the ground water of the Jaffna peninsula resulting in the “*methaemoglobinaemia*” or blue baby syndrome among those who use the contaminated waters (Manchanayake and Madduma Bandara, 1999).

Shrimp farms in high saline areas in the northwest (Mundal to Kalpitiya) utilize ground water to control salinity in ponds. In an area where lack of adequate supplies of fresh water for drinking and other uses is a major problem and 80% of the required water for domestic and agricultural purposes is drawn from ground water, the use of ground water for shrimp aquaculture will further aggravate the situation in regard to the availability and use of ground water (*Siriwardene /personal communication*).

4.3 Causes for degradation of coastal and marine habitats

In general, the degradation of coastal habitats can be attributed to:

- A general lack of appreciation of the role and functions of coastal habitats, particularly their non-extractive uses, at all levels of the society
- Lack of integrated development planning within and outside the coastal region
- Inadequate efforts and inadequate support for rehabilitation programmes
- Natural causes

The specific causes of degradation of different coastal habitats are discussed below:

4.3.1 Causes for degradation of coral reefs:

Coral mining - The principal cause for coral reef destruction is the mining of corals for quicklime used in the construction industry, despite the fact that mining, collecting, transporting and processing of sea coral has been banned since 1988. Available data show a perceptible decline of sea coral mining along the western and southern coastal belt between 1984 and 1998 (**Table 4. 4**), mainly due to the successful enforcement of the ban on sea coral mining since 1988.

Table 4. 4: Quantity of coral mined from west and south coasts (Ambalangoda to Dickwella)

Type of coral	1984		1994		1998	
	Amount (tons)	% of Total	Amount (tons)	% of Total	Amount (tons)	% of Total
Inland coral	10,400	58	15,800	80	28,300	93
Sea coral	7,660	42	4,020	20	2,200	7
Total	18,060	100	19,820	100	30,500	100

(Source: draft CZMP, 2003)

Even so, about 211 persons were engaged in mining, collecting and transporting of sea coral from this area in 1998 (Katupotha and Wickremasinghe, 1999). Some coral mining also occurs in the eastern coastal stretch from Nilaveli to Akkaraipattu, particularly at Mankerni, Vandeloos Bay, Passikudah and Kalkudah.

Coral bleaching in Sri Lanka -Corals in most shallow reef areas of Sri Lanka were destroyed in 1998 due to bleaching caused by high water temperatures associated with the 'El Nino' Southern Oscillation (ENSO) effect. Coral reefs at depths of 3-5 m lost virtually most of their live coral from the northwest to the east coast except near Trincomalee (i.e. the reef near Pigeon Island).

Since then, coral species at different locations have shown varied levels of impact and recovery from the bleaching event. Bleached corals have been recorded even at 42 m depth off the east coast, although almost all bleached corals at depths below 10-15 m recovered after about six months.

A cause for concern is that at many locations the dead corals in shallow waters have been covered by rapidly growing algae, tunicates and invertebrates such as corallimorphs. This may inhibit the re-establishment of live coral (Rajasuriya et al, 2000).

4.3.2 Causes for degradation of seagrass beds:

Seagrass beds associated with lagoons and coral reefs are damaged due to destructive fishing techniques. There is large scale commercial trawling and drift netting over the seagrass beds that occur between Puttalam and Jaffna, while beach seining conducted in certain sections of this area of the coastline also affects seagrass beds. In certain areas, digging for polychaete worms as brood stock feed for shrimp hatcheries and the use of push nets to catch ornamental fish also causes severe damage to sea grass beds (e.g. Negombo and Chilaw estuaries).

In Negombo estuary, Samarakoon and van Zon (1991) have estimated a dry weight of 16.8 t sea grass destroyed due to destructive fishing practices (Push net 7.04 t, Trawl 7.78 t and Polychaete extraction 2.02 t).

Other adverse impacts are from siltation resulting from land-based activities such as changes in catchment hydrology through irrigation schemes. Sandbar formation, either through natural causes or induced by human activity - such as siltation - may also cause degradation of seagrass beds.

4.3.3 Causes of degradation of lagoons and estuaries

Lagoons and estuaries and the biodiversity they contain are increasingly affected by pollution due to untreated industrial effluents, the inflow of sewage, urban wastes and waste oil, land filling and encroachment, eutrophication due to excessive nutrients and changes in salinity regime.

Land filling for encroachment, building new piers, jetties, and bridges that restricting water flow and promoting siltation, and deposition of garbage has resulted in the reduction of the effective water area of Negombo estuary by 791 ha between 1956 and 1981 (MOFE, 1998). Similar situations prevail in Bolgoda Lake estuary and Mawella and Lunawa lagoons.

Several lagoons/ estuaries have been affected by changes in natural flows due to irrigation schemes. A marked drop has occurred in the salinity of the Kalametiya lagoon due to the overflow from the Uda Walawe reservoir, which was diverted into the lagoon in 1950. Excess fresh water from Lunugamwehera reservoir entering Malala-Embilikala lagoon system has considerably reduced salinity in these lagoons. In contrast the salinity of the Puttalam estuary has increased by 25% in last 30 years, due to the decreased freshwater input from the Kala Oya and Mi Oya as a result of dam and irrigation constructions (draft CZMP, 2003). Influx of fresh water sometimes triggers off the growth of invasive plant species such as *Najas marina* and *Salvinia molesta*.

In a study on livelihoods of coastal communities associated with Rekawa, Kalametiya and Malala lagoons in the south, Sellamuttu (2003) observed a 48% change in livelihoods over the past 10 years, primarily due to natural resource degradation. The number of lagoon fishermen has declined because irrigation developments upland has affected lagoons and many fishermen are facing more economic and environmental hardships today than 10 years ago. In Kalametiya, only 20% of the villagers are involved in lagoon fishing, as against 80% in the past. Changes to natural rainfall patterns and development of irrigation infrastructures, leading to lack of water and siltation (which reduces the size and depth of the lagoon), encroachment by plants and agro-chemical pollution has resulted in a decline of fish and shrimp resources in the lagoon.

In addition, lagoons and estuaries face threats from natural causes such as sand bar formation, invasive plants and shifting of the lagoon mouth. Sedimentation of lagoons/estuaries can be accelerated by many human activities such as garbage disposal. Some lagoon and estuaries have been negatively affected by haphazard removal of sand bars. For example, the salinity of Koggala lagoon has increased five fold after the removal of sand bar six years ago.

4.3.4 Causes of degradation of barrier beaches, spits and dunes

Most of the stable dunes at Kalpitiya and Hambantota have been cleared and converted to coconut plantations, vegetable plots (mainly tobacco, gherkin and onion), homesteads and for siting tourist hotels and other buildings. Consequently, the 'littoral woodland zone', which typically has a thick growth of shrubs and low tree species, is now greatly reduced in many areas.

It is also evident in some areas of the southern and eastern coasts that some beaches and spits, as well as mangroves has been lost due to sea erosion. Coral mining, construction of embankments, revetments and groynes and sand mining on beaches and in the rivers, has aggravated this problem.

Kumari (2003), writing in a Sinhala newspaper "Lankadeepa" has reported that as a result of various restrictions placed on river sand mining, sand dunes in the Kalpitiya peninsula have now come under threat from the sand miners. The amount of sand mined and transported from the dunes has doubled during the last one year.

Another problem is that beaches are treated as dumping grounds of solid wastes, particularly in urban areas. Beaches are also polluted due to accumulation of tar balls formed when bilge waters from ships get washed ashore as reported from Wadduwa to Mirissa on the western and southern coasts (Wickremaratne and Pereira, 1986). This may also adversely affect other coastal habitats such as coral reefs and sea grasses. There are also some concerns regarding the adverse impacts from the use of exotic plant species (e.g. Casuarina in Hambantota district) introduced for dune stabilization.

4.4 Shoreline stability

4.4.1 Coastal structures that interfere with the littoral transport -Coastal structures that interfere actively with the littoral transport aggravate coastal erosion. These structures induce downstream lee-side erosion relative to the direction of the net littoral transport. Groynes, detached breakwaters, ports and inlet jetties at tidal inlets and river mouths may cause this type of erosion, as do passive coastal protection structures - such as seawalls and revetments - that do not protrude into the sea (**Table 4.5**).

Table 4.5: Coastal structures/activities interfering with the littoral transport and contributing to coastal erosion (Source: Draft CZMP, 2003)

Structure	Process	Effect on coast	Examples of sites affected
Groynes	Accumulation of sand and offshore loss	Protect upstream shore but cause local lee-side erosion	At all locations where groynes are used
Detached breakwaters	Creation of shelters for waves and trapping of sand	Protect against wave action and provide shore protection behind and upstream, but cause local lee-side erosion	Negombo breakwater scheme
Ports	Interruption of littoral transport, accumulation of sand, causing sedimentation and offshore loss	Protect upstream shore by accumulating sand, but cause lee-side erosion	Beruwala and Kirinda Fishery harbours
Inlet/river mouth jetties	Interruption of littoral transport, accumulation of sand, causing sedimentation and offshore loss	Protect upstream shore by accumulating sand, but cause lee-side erosion	Jetties at Panadura, Wellawatta and Dehiwala
Revetments and seawalls	Stoppage of coastal erosion and flooding at location of structures	Cause beach disappearance and increase downstream erosion	This is a contributory factor to sea erosion north of Lansigama, although the main reason for erosion here is sand mining in the Maha Oya

4.4.2 Human activities that accelerate erosion - Coastal erosion is accelerated along many areas of Sri Lanka's coastline due to human activities both within and outside of the Coastal Zone. They include extractive and non-extractive actions, some of which are development oriented. Examples are sand mining on beaches and in rivers, sea coral mining, removal of coastal vegetation, location of buildings too near the shoreline and the construction of dams and irrigation schemes inland. A summary of human activities and their impacts, which contribute to coastal erosion, are presented in **Table 4.6**.

Table 4.6: Human activities impacting on coastal stability in Sri Lanka

Activity		Effect on Coast	Examples of sites affected
Beach sand mining	Reduction of beach sand volume available for littoral processes	Induces beach and coast erosion	Panadura, Lunawa, Angulana and Palliyawatte
River sand mining	Reduction of river sand supply to the beach	Induces erosion of beaches and of river banks	Nilwala Ganga, Gin Ganga, Kalu Ganga, Kelani Ganga, Maha Oya and Deduru Oya
Inland coral mining	Conversion of productive land into waterlogged areas	Creates inland waste dumps and abandoned pits; reduces long-term coastal stability by creation of low-lying areas	Akurala, Kahawa, Ahangama and Midigama
Collecting coral from beaches and shore face	Reduction in volume of beach material	Induces beach and coastal erosion	Ambalangoda to Hikkaduwa, Midigama, Ahangama and Polhena
Reef breaking or dynamiting for coral mining or fishing	Damage to the reef, reduction of reef size, creation of gaps in reef	Increases wave energy on beaches and reduces supply of coral debris to beaches resulting in erosion	Ambalangoda to Hikkaduwa, Koggala, Midigama, Polhena, Rekawa, Passikudah, Kuchchaveli and Nilaveli
Constructing buildings and infrastructure installations, etc. too close to the coastline	Reduction of coastal stability	Causes loss of buildings, etc. and necessitates the performance of coast protection which may interfere with coastal processes	Hikkaduwa, Bentota, Beruwala, Negombo
Maintenance dredging in access channels and port entrances	Removal of sand from the littoral budget (unless the sand is pumped back to the downstream beach)	Causes erosion in adjacent coastal stretches	Colombo Port
Sea level rise due to the greenhouse effect	Generation of offshore movement of sand	Expected to cause erosion along all coastlines and to increase the frequency of flooding of low lying areas	Erosion to be expected along all sedimentary shores
Loss of coastal vegetation (e.g. due to grazing and traffic).	Creation of exposed areas subject to more rapid rates of wind erosion	Induces dune and coastal erosion	Palliyawatta, Koggala, Polhena, Negombo

(Source: draft CZMP 2003)

4.4.3 Development activities in the coastal zone - Some development activities in the Coastal Zone, including inadequately planned tourism, have resulted in adverse impacts. Examples are the pollution of beaches and coastal waters due to the release of sewage, solid waste and wastewater. Infrastructure - including dwellings - located too close to the coastline restricts coastal processes and promotes erosion.

4.4.4 Development activities landward of the Coastal Zone - Activities having an impact on river discharge - including establishment of irrigation schemes and tanks - which thereby reduce the supply of sand to the coast contributes to coastal erosion.

River sand mining - River sand mining, which decreases the supply of sediment to the shore, is widely acknowledged as the main cause of coastal erosion in Sri Lanka. The present sand requirement for the entire country has been estimated at 7-7.5 million cubic metres per year, of which about 40% is used in the Western Province (Byrne and Nanayakkara, 2002). The construction industry in Sri Lanka is heavily dependant on river sand, and its mining represents a significant economic activity, both in terms of employment generation and the supply of an important commodity for the construction industry

Sand mining in rivers is most severe in the Northwestern, Western and Southern Provinces where much of the construction activity and the major coastal erosion problems are concentrated. Significant increase in sand mining is reported from six rivers - Deduru Oya, Maha Oya, Kelani Ganga, Kalu Ganga, Gin Ganga and Nilwala Ganga - from 1.2 million cubic metres in 1984 to 5.5 million cubic metres in 2001 (Byrne and Nanayakkara, 2002).

Overall, sand mining in rivers at current rates to meet the requirements of the construction industry is considered unsustainable, and could lead to rapid riverbed degradation and a further decrease in the supply of sand to the coast in time to come.

Sand mining in rivers requires a license from the Divisional Secretary and the Geological Survey and Mines Bureau (GSMB). Within the coastal zone, a permit from CCD is also required. Much of the ongoing river sand mining is illegal. In some rivers this even extends to large-scale mining with the use of modern hydraulic excavators.

Finding alternatives for river sand in construction is equally important. One such alternative is to use offshore sand. Several major construction projects, such as the Negombo Coast Protection Scheme, reclamation projects in the Colombo Port, the Muthurajawela Reclamation Project and the Colombo Katunayake express highway use offshore sand (Byrne and Nanayakkara 2002).

Sand mining on the beaches - There has been a perceptible decrease of beach sand mining due to the regulatory mechanisms enforced by the CCD, although instances of small-scale sand mining continue in most coastal areas primarily to meet local needs.

Estimates indicate that beach sand mining in the populated areas along the east coast is around 500 to 1000 m³/ km/ year. This corresponds to an estimated extraction of 60,000 - 120,000 m³/year from the coastal stretch between the Yala National Park and Trincomalee, assuming that two thirds of this area is populated. Even so, sand mining in the east coast has had hardly any impact on coastal stability due to the abundance of sand along this stretch.

Although the volume extracted is less, beach sand mining is much more damaging to the stability of the shore than river sand mining in relation to the volume of sand extracted as it has instantaneous impact on the deficit side of the littoral drift budget.

Coral mining – Sea coral mining has caused severe coastal erosion along the southwest coast of Sri Lanka. The growth of the construction industry since the late 1960s has led to accelerated sea coral mining. Sea coral mining has increasingly become apparent in the east coast too. At Mankerni, local fishers have turned to coral mining as a livelihood after the collapse of the lagoon fishery due to a salinity drop in the Uppar Lagoon (attributed by local people to the Mahaweli irrigation scheme). Consequently erosion is reportedly heavy in this coastal segment during the northeast monsoon. At Vandeloos Bay active mining of the reef flat is causing erosion of the beach. Coastal erosion was taking place at Kayankerni, 9 km north of Valachchenai, due to the removal of sea coral.

There is also some concern regarding the drastic increase in inland coral mining, in response to increased market demand and the ban on sea coral mining. About 980 persons were engaged in inland

coral mining activities in 1998 (Katupotha and Wickramasinghe, 1999). This may create low-lying areas that are more prone to flooding and coastal erosion in the long-term

4.4.5 Impacts of climate change

Coastal planning for the future is expected to take into account the impacts of climate change, especially the effects of global warming resulting in sea level rise, higher temperatures, prolonged droughts, high intensity rainfall and other changed weather patterns. The latter includes higher frequency and intensity of extreme events such as cyclones and storm surges.

Sea level rise can cause inundation of low-lying areas, shoreline retreat, saltwater intrusion into inland water bodies, geomorphologic changes in sediment transport, etc. The forecasts for global sea level rise in this century vary considerably, but the International Panel on Climate Change (IPCC) has provided a central estimate of 0.2 m and 0.5 m rise by the years 2050 and 2100 respectively. While sea level rise of this magnitude will cause considerable coastal erosion along all segments of Sri Lanka's coastline, it is expected to be a very slow process.

Other natural phenomena important for coastal erosion management planning are cyclones and strong storms which occur frequently in the Bay of Bengal region during October and November when the inter-tropical convergence zone shifts southwards towards the equator (MOENR. 2002).

Sri Lanka has been less affected by cyclone than landmasses to the north due to its location (MOLGHC, 1979), with only about 13 cyclones and strong storms being felt in the island from 1901–1995 (Anon 1997). This situation could change, however, with the alteration of weather patterns due to climate change, and the island could be subject to more frequent and intense cyclones and storms in the future. This should therefore be given due consideration in all future coastal planning and protection initiatives.

4.4.6 Inadequate funds

Government funds are not adequate to control coastal erosion. The annual expenditure incurred in combating coastal erosion has increased from a modest Rupees 3.7 million in 1985 to Rupees 230 million in 1991, with the bulk coming from external donor funds, particularly during the late 1980's and early 1990's (Table 4.7). Annual expenditure from government funds has been much lower during the other years.

Table 4.7: Annual Expenditure for controlling Coastal Erosion

Year	Expenditure (SL Rs. Million)
1985	3.7
1986	14.4
1987	121.4
1988	121.4
1989	164.3
1990	230.3
1991	230.3
1992	226.9
1993	56.9
1994	63.3
1995	34.5
1996	32.0
1997	45.5
1998	79.0
1999	96.0

(Source: Byrne and Nanayakkara, 2002)

4.5 Causes of threats to marine fisheries

4.5.1. Over-exploitation - The primary reason for declining catches in many of the coastal inshore fisheries is the increase in fishing effort and is usually reflected in reduced catch per unit effort.

- *Catch rates in the small mesh gillnet fishery conducted by 5-6m FRP boats in Negombo have decreased from 95 kg/operation in 1979 to 31 kg/operation in 1996 (Sanders & Dayaratne, 1996)*

- *Catch rates in the south coast spiny lobster fishery have declined from 3.3 kg/boat/day in 1986 to 1.0 kg/boat/day in 1995 (Sanders and Jayakody, 1996)*

- *Catch rates in the shrimp trawl fishery conducted by the outrigger canoes in Negombo have fallen from 7-8 kg/canoe/day in 1978/79 to 4.5-4.8 kg/canoe/day in 1985/86 (Jayakody and Jayawickrema, 1987)*

In many instances, fishermen's response to reduced catch rates has been to reduce the mesh size of nets to catch smaller and smaller fish; contributing to growth over-fishing. In many areas the traditional 1 1/8" mesh gillnet for sardines have been replaced by nets of 1" mesh.

Sedentary or slow moving resources inhabiting easily accessible inshore waters, such as Beche de Mer and chank have a high degree of vulnerability to over-exploitation. These resources have been depleted in some areas.

4.5.2 Destructive fishing practices - Destructive fishing practices can have a direct negative impact on the resource, leading to subsequent decline in the resource itself and catches. The impact could also be indirect - on the habitat or the ecosystem supporting the resource in which case both the resource and the habitat would be adversely affected.

The common destructive fishing gear and methods prevalent in Sri Lanka's coastal fishery include the use of explosives (dynamite fishing), operation of trammel nets and bottom set gillnets on corals and rocks and, the use of moxi nets on corals and rocks to catch ornamental fish.

Fishing with explosives (dynamite) is one of the oldest illegal fishing practices, which still continues, particularly in the southwest, south and east. It is also reported to occur in Pallimunai area (Mannar district) (FAO, 2003). The use of trammel nets and bottom set gillnets on corals and rocks and the use of moxi net have also been banned since 1996. However, these illegal fishing methods are still being practiced in many parts of the country. Use of explosives cause considerable damage directly to both the resource as well as the habitat whereas the use of bottom set gillnets and moxi nets damage the environment/habitat, which will then impact adversely on the resource itself.

4.5.3 Uncontrolled selective harvesting of resources - Selective harvesting of one or few species is seen in many coastal fisheries. The Beche de Mer fishery selectively harvests only one species, *Holothuria scabra*. Ornamental fish collectors prime target would be the high valued species. A new bottom longline fishery, using skate as bait and targeting large sized groupers for the export market, appeared on the west coast a few years back and has now extended to the east coast. Groupers over 6 kg per fish are paid Rs.200/kg while smaller fish below 6 kg/fish are paid Rs.150/kg (FAO, 2003). In the long term, such practices of uncontrolled selective harvesting may be detrimental to the resource. It is of greater concern in the case of resources such as groupers, which are slow growing fish with a long life span.

4.5.4 Poaching by Foreign fishing boats / Inadequate MCS capabilities - Sri Lanka's Monitoring, Control and Surveillance (MCS) capabilities are rudimentary and leave its waters exposed to poaching by foreign fishing boats. MFOR has a coast guard service with a cadre of 175 who lack skills and

training for MCS work. The limited cadre as well as the meager resources including a few small vessels is grossly inadequate to carry out the expected surveillance work (MFOR, 2002).

Local fishermen, particularly off east, southeast and south coasts, report poaching by large trawlers in Sri Lanka's coastal waters. In the north (Jaffna and Mannar areas), there is heavy poaching by small shrimp trawlers (40 ft LOA) from south India. Fishermen in Mannar and Jaffna claim that the Indian trawlers which come in large numbers is the primary cause for the decline in prawn and fish catches for their smaller boats. Good catches are reported for gill-netters when the Indian trawlers are not fishing in the vicinity (FAO, 2003).

Large numbers of Indian trawlers are particularly seen on certain days of the week (FAO, 2003), presumably as a consequence of a management measure adopted by the Tamilnadu government which, in order to provide some protection to the small scale artisanal fishermen in Tamilnadu, has banned the operation of these boats in the inshore waters of Tamilnadu on these days.

4.5.5 Post harvest losses – The National Policy and Development Plan of MFOR (2002) also identifies post harvest losses as major issues in coastal and marine fisheries. This is related to excessive reliance on gillnet fishing in Sri Lanka's marine fisheries which also restrict export potential due to poor quality of fish landed by gillnets. Consequently, commercially valuable fish in deeper water (large yellowfin and bigeye tuna) are under-exploited. Tuna long lining is not popular or wide spread due to large investment needed, lack of trained manpower and, problems with bait.

Lack of modern and specialized fishing boats is also responsible for the increased popularity in gillnets. Fishing boats are non –specialized and not properly equipped. Offshore boats have no onboard cooling or freezing facilities and deck equipment to make optimum economic use of high seas resources.

4.5.6 Non-target species in gillnet fisheries – The resources supporting the offshore fishery are highly migratory oceanic species such as skipjack tuna, yellowfin tuna, bill fishes and sharks which are now being managed by regional laws and agreements: the UN Convention on Law of the Sea, the Code of Conduct for Responsible Fisheries (1995), UN Convention on Biological Diversity (1994) and UN Fish Stocks Agreement which covers straddling fish stocks and highly migratory fish stocks (1995). Most of these international laws and agreements focus on the conservation of non-target species such as marine mammals, turtles and sea birds. Industrial gillnetting is now banned in high seas, mainly as a conservation measure to protect marine mammals, turtles and sea birds. Although Sri Lanka has a small-scale gill net fishery, which is currently overlooked, there is a growing international concern that operation of a large number of small gill net boats can cause the same impact as few large industrial boats. Any limitation on gillnet fishing will have significant adverse impacts on the local fishery as over 85% of the offshore catch comes from gill net fishing.

4.5.7 Exploitation of sharks - Exploitation of sharks in the Indian Ocean has also increased dramatically in recent years as many countries are involved in catching shark primarily for their fins. Sharks constitute a major target species in Sri Lanka's marine fisheries, particularly the offshore fishery, for both the meat and fins. There is serious concern regarding the shark populations and both the Indian Ocean Tuna Commission (IOTC) as well as the FAO has begun to address this issue

4.5.8 Inadequate management

Inadequate fisheries management overrides many of the causes described above. Sri Lanka has over one hundred years history in fisheries management. Until the first quarter of the 20th century, the local government authorities largely took fisheries management initiatives. There were separate Ordinances to manage certain special fisheries, some of which were generating revenue to the state coffers (e.g. the chank fishery and the pearl oyster fishery).

In addition to local level fisheries management initiatives, the **Fisheries Ordinance** No.24 of 1940 introduced many fisheries regulations of island-wide application. The **Fisheries and Aquatic Resources Act No. 2 of 1996** repealed the Fisheries Ordinance of 1940 and all other ordinances. While the Act provides for enhanced community participation in fisheries management, it also provided for the introduction of a licensing scheme whereby all fishing operations conducted in Sri Lanka waters required a license from the Department of Fisheries and Aquatic Resources. The annual license fee ranged from Rs.25 to Rs.500 but is linked more to the craft category than the resource taken or the income generated.

Boat Registration and Licensing - During the year 2002, only 54% of the fishing fleet (15,271 out of 28,450) was duly registered (first registrations and renewals) with the Department of Fisheries and Aquatic Resources (DFAR). Non-compliance was marked in north and east. It was only 20% in Jaffna. Compliance with Fishing Operations License was still weaker, with only 6160 licenses issued in the whole island and no Licenses issued in Jaffna, Kilinochchi and Mullaitivu districts. In addition, no fishery is controlled or managed through license limitations.

Community based fisheries management - Section 31 of the Act provides for the minister in charge of the subject of fisheries to declare prescribed areas (inland water body, lagoon or sea area) as **Fishery Management Areas**. Section 32 provides for the establishment of **Fisheries Committees** composed of over 51% of the resident and migrant fishermen fishing in a Fishery Management Area.

Under Section 32, a Fisheries Committee can be transformed into a Fisheries Management Authority. The Fisheries Management Authority can make recommendations to the Minister on:

- Fishing gear / operations in the management area
- Closed seasons/ species to be taken
- Fishing time

Up to the end of 2002, the progress in setting up Fisheries Committees and Fisheries Management Authorities was as follows:

	Marine areas	Lagoons/estuaries	Inland waters
Fishery Management Areas	Madiha-Polhena coral reef area in Matara district	Negombo lagoon in Gampaha district	Udukiriwila reservoir in Hambantota district
	Coral reef area off Yala sanctuary in Hambantota district	Rekawa lagoon in Hambantota district	Muruthawela tank in Hambantota district
		Bolgoda estuary in Colombo district	Ridiyagama tank in Hambantota district
		Batticaloa lagoon in Batticaloa district	Parakrama Samudra in Polnaruwa district
			Kiriibban wewa Moneragala district
Fisheries Committees		Negombo lagoon	Udukiriwila reservoir
		Rekawa lagoon	
Fish. Mang. Authorities		Negombo lagoon	Udukiriwila reservoir
		Rekawa lagoon	Muruthawela tank
			Ridiyagama tank

A total of 10 sites (two coastal, four lagoons and four inland) have been declared as Fishery Management Areas. Fisheries Committees registered in five of these sites have been elevated as

Fishery Management Authorities. The experience of fishing communities at these sites in managing fisheries through the Fisheries Committees and Fisheries Management Authorities are discussed in Joseph et al (2002). Village /ethnic bias, concerns and interaction of other Fisheries societies, Socio-political pressures and non-participation of other stakeholder groups are some of the major issues that have weakened the successful implementation of community based fisheries management in the above sites.

Lack of resource information – While offshore fishermen do not have access to information on distribution and abundance of high seas fish stocks, resource estimates made in 1978/79 for coastal fisheries is considered outdated. Non-availability of resource information, particularly in the offshore, impedes investment in this sector.

Offshore fishery - Even though the fishery has grown rapidly, it is beset with many problems and issues, mainly as a result of unplanned development and lack of proper management. In addition to the issues related to lack of resource information and over reliance of gill net fishing, the following issues have also been identified in the case of the offshore fishery (Amarasiri, 2003).

- **Inadequate research/information** – At national level, research on tuna has a fairly long history dating back to 1960's, but largely confined to monitoring of the commercial fisheries and biological studies on selected species. There have been a few exploratory and experimental surveys conducted with the assistance of international agencies (FAO, UNDP and ADB) as well as surveys by commercial vessels of other countries (Japan). Although a substantial body of information is available on the distribution and biology of the resource, information required for new initiatives for development seems to be lacking. For example, no comprehensive investigations have been conducted to determine the distribution of deep swimming, large tuna around Sri Lanka in relation to oceanographic characteristics (thermocline), information that would greatly help in the development of a domestic tuna long line fishery.

Tunas are highly migratory and as such, there is a need for collaborative research by countries exploiting these resources in the Indian Ocean. In the recent past, Sri Lanka has joined in a couple of short term collaborative research (joint resources survey and a tagging programme) with Maldives but there is a clear need for more elaborate research involving more than just two countries.

- **Lack of management policies** – In the absence of a development and management plan for the offshore fishery, there is no clear policy guidelines to the industry, particularly in respect of long term investments such as in boat building, construction of fishery harbors, etc. The industry may have already run the risk of overcapitalizing itself.
- **Threat from industrial purse seine fishery** – The industrial purse seine fishery targeting skipjack and immature yellowfin tuna has expanded rapidly in the Indian Ocean since early 1980's. Concerns were expressed at the national workshop regarding the purse seiners operating in the migratory routes of tuna and the possible adverse impacts on the availability of this resource to the coastal states.

Deficiencies in fisheries data - There are also problems and issues related to fisheries statistics that hamper satisfactory fisheries management. The current data collection system operated by MFOR at beaches and harbors, through the Fisheries Inspectors attached to DFAR, is generally considered to be weak and inadequate for the use of the data for fisheries development and management activities. The majority of the problems relate to lack of sampling procedure for catch and effort estimation, inadequate supervision and data validation, low field allowances and office operating funds, etc.

Fish export data are also sometimes erroneously recorded and does not allow proper monitoring for management purposes. Sri Lanka Customs keeps records of all fish exports. The Customs Department records data on quantities of tuna, shrimp, seaweed, ornamental live fish and other fisheries products exported by air and by sea. Customs sells a monthly data report to DFAR, but there is no crosschecking to verify the accuracy of the data. Further, quantities of fish exports are exclusively recorded as weight (and not number). Lobsters and tuna are recorded as net weight, excluding packaging. Ornamental fish consignments are recorded as gross weight of the carton and the water it contains (and not numbers of fish). This creates problems in interpreting the quantity of exported ornamental fish. The consignment weight data is meaningless because it is too difficult to devise a conversion factor between consignment weight and numbers of fish. In addition, no arrangement is in place to obtain data regarding the export of ornamental fish under the 'restricted list'. Further, no quotas or limits have been set on the numbers allowed under the 'restricted list'.

Permits for export from DFAR are required for only two commodities: live ornamental aquarium fish and lobsters. Exports (i.e. 'dead' fish) other than lobster and chank (since August 2003) do not require an export license and is completely 'liberalized'. (Exports of seaweed and ornamental fresh water aquarium plants fall under the Forestry Act and require export license). However this results in a lack of monitoring information on fish exports by DFAR. This lack of data would be critical in the case of export-oriented fisheries based on highly vulnerable resources, such as the recently developed fishery for large sized groupers (long lived, slow growing species which are highly vulnerable to over-exploitation).

Institutional deficiencies – According to the policy document of MFOR (2003), institutions within the sector are not sufficiently oriented to meet the present day market driven challenges. The rigid financial and administrative regulations do not provide institutions the flexibility to operate effectively in a competitive.

4.6 Causes of threats to Brackish water fisheries and culture

Many of the causes of threats identified in the coastal fishery, such as over-exploitation and the use of destructive fishing gear and methods are prevalent in many lagoons and estuaries. Fishing pressure has intensified with large numbers of part time fishermen entering lagoon/estuarine fisheries (e.g. Batticaloa lagoon, Jaffna lagoon, Negombo estuary).

Use of destructive fishing gear such as push nets, lagoon trawls and digging for polychaete worms (Negombo etuary, Chilaw lagoon) destroy the ecosystem itself, with negative consequences to the fishery. The high diversity of fishing gear and methods used in lagoons and estuaries is also seen as contributing to over-exploitation and also user conflicts as observed in Negombo estuary and Puttalam lagoon.

4.6.1 Causes of threats to brackish water culture

Degradation of environment - Many adverse environmental and social impacts of shrimp farming have emerged from the northwest. Dayaratne et al (1997) have reported that 63% of the mangrove cover and as much as 50% of the salt marshes around Puttalam lagoon area have been lost within a ten year period, 1981-1992, largely on account of shrimp farms. Siriwardena (1999) has estimated that out of a total of 750 ha of mangroves lost in Puttalam area between 1981 and 1992, 160 ha (21%) have been lost due to shrimp farming.

The Dutch Canal in Puttalam and the Puttalam estuary act as a source of water for the shrimp farms as well as the 'sink' for their waste/effluents. Shrimp farms in northwest are reported to discharge around 1,699 m³ of pond water (containing high levels of nutrients and chemicals – lime and pesticides) weekly into the Dutch canal. Also, about 1,246 m³ of water is discharged daily from the

shrimp hatcheries in the area (draft CZMP, 2003). It was revealed at the National Workshop that current levels of pond water discharge are much higher than those already published.

Pollution of the lagoons and estuaries also result in eutrophication, causing algal blooms that are often toxic, and oxygen depletion leading to mortality of natural fish and shrimp stocks in these water bodies.

Disease outbreaks - Unplanned development of the industry in which the discharge of untreated waste water/effluents of one farm that may be taken in by an adjoining farm has caused considerable concern regarding disease outbreaks that could reach epidemic proportions, particularly since the lagoon system is considered to have already reached critical levels. There have been two major diseases outbreaks, in 1988/89 and in 1996. The first one caused a 50% production loss. The second one affected nearly 90% of the entire culture area and around Rs.1000 million loss.

It is estimated that Rs.14 billion has gone into the shrimp farming industry in northwest. The collapse of the industry in 1996 left the farmers with bank loans amounting to Rs. 672 million, which, with accrued interests, has now soared to Rs. 1.7 billion. The 1996 loans were rescheduled for five years with a moratorium of 27 months. In 1998, Rs. 100 million was given to modernize the farms. In 1999, the Government waived 25% and the banks 35% of the accrued interest that had accumulated. One commercial bank has agreed to freeze Rs. 300 million in loans obtained from that bank and to a rebate on accrued interest (Perera, 2003).

Illegal or unauthorized farms - On the management side, the proliferation of illegal farms continue unabated, particularly when the industry has over-utilized the natural resources and, adding to the already critical adverse impacts. Lack of an effective monitoring mechanism has allowed non-compliance with the conditions of approval and there is also hardly any self-monitoring by the developers themselves.

Adverse social impacts - In shrimp farming, the construction of shallow ponds, which disturb the drainage patterns of the area, resulted in the inundation of Chilaw and Puttalam areas during the heavy monsoon rains in 1995, adversely affecting over 3000 households (Firth, 1997). Salinization of wells used for drinking purposes has been reported from some villages (Foell et al, 2000). Soil erosion, eutrophication of the lagoon due to heavy nutrient loads, indiscriminate disposal of solid waste causing salt contamination of nearby agricultural land are some of the other adverse environmental impacts of shrimp farming.

Some of the reported adverse social impacts of shrimp farming include the denial of access to sea /lagoon on account of the enclosure of land for shrimp farming, artificially high land values, conversion of agricultural land for shrimp farming and accompanied loss of livelihood for those engaged in cultivation, fewer employment opportunities within the industry for the people of the area, loss of grazing land for cattle, etc.

- Firth (1997) has estimated that the livelihood of around 5950 households in 27 villages have been affected due to loss of access to sea/lagoon as a result of shrimp farms.
- Siriwardene (1999) has estimated a loss of 292 ha of paddy land (currently valued at Rs. 108 million) and 340 ha coconut land (valued at Rs. 255 million) due to shrimp farming industry.

The lack of an effective monitoring mechanism and self-monitoring by developers is the overriding factor for many of the threats evident in shrimp aquaculture.

4.7 Causes of degradation of coastal and marine biodiversity

Biodiversity in the aquatic ecosystems in Sri Lanka is threatened by:

- **Pollution** – Pollution from land based activities (agrochemicals, industrial effluents) can adversely impact on the health, biological functions and life cycles of organisms. Fish kills, skin lacerations of fish have been recorded from many rivers. Oil pollution of near shore waters may adversely affect both species diversity and ecosystem diversity.
- **Alteration / Destruction of habitats** – Destruction of mangroves (shrimp farming, homesteads), coral reefs and sea grass beds (use of explosives, and other harmful gear for fishing) cause loss of species biodiversity in these habitats as well as loss of habitat itself.

Haphazard reclamation of lowland wetlands (ie. salt marshes, mangroves, lagoons and estuaries) for development activities has led to the loss of habitats of aquatic species, leading to population decline (Bambaradeniya, 2002 b).

- **Over-exploitation** - Over-exploitation of resources (lobster, shrimp) as well as selective over-harvesting of resources (chank, beche de mer, ornamental fish) can adversely impact on species biodiversity, directly as well as indirectly through resultant ecological imbalances.

In the aquarium fish export trade; there is a clear trend towards expansion of the trade to include more species – from 139 species in 1985 to over 200 species in 1995 (Ekaratne, 2000). Numbers exported have also gone up; from 200,000 in 1985 to over one million in 1995. The Fauna and Flora Protection Act, No. 49 of 1993 provides legal protection to seven species of marine fish and 12 species of fresh water fish. Regulations under the Fisheries and Aquatic Resources Act No. 2 of 1996 prohibit the export of 12 species of marine fish and 12 species of fresh water fish. It also allows restricted export under permits of 17 marine fish species and 8 fresh water fish species.

Of the 59 fresh water aquarium fish species exported from Sri Lanka, 20 are endemic. IUCN in 1994 listed 19 of these species as ‘threatened’ but reduced the list to 8 species in 1996. Two marine fish species are also in the IUCN ‘threatened’ list of 1996.

The ornamental fish and plant trade, including aquaculture initiatives, have also contributed to the spread of several aquatic invasive species, which are causing a severe threat to aquatic biodiversity of the island. About 15 species of invasive alien plants and animals are currently posing a threat to aquatic ecosystems and associated native aquatic species (Bambaradeniya, 2001, 2002a).

- **Incidental by-catch** – Mainly in the case of marine mammals and marine turtles. The heavy reliance on gillnetting in Sri Lanka’s marine fisheries poses a major threat to marine mammals and marine turtles.

4.8 Common causes for threats to coastal and marine environment and its living resources

There are a host of cross cutting issues which impact on the quality of the coastal and marine environment and its living resources. These include:

- **Population pressure and poverty in coastal communities**
- **Lack of integrated development planning and effective implementation**
- **Lack of public awareness and public participation in management/conservation**

- **Inability of the economy to provide adequate resources**
- **Inadequate commitment of decision/policy makers and lack of accountability**
- **Political interference**

Coastal communities are not sufficiently aware of the links between the ecosystem and their livelihoods, with the result that they do not have cohesive and active organizations capable of influencing policy makers. As a result, the level of participation of communities in management has been inadequate. The continued dependence of the poor on natural resources based activities for their sustenance as well as the globalization and opening up of trade have far reaching implications on the conservation of natural coastal resources. High levels of profit may serve as an incentive to exploit natural coastal resources beyond sustainable limits.

While the national economy is not robust enough to meet the demands of environmental and resources degradation, the commitment and accountability of the government and service providers to clients (civil society) also leave much to be desired. Political interference is an added burden, compromising on transparency and accountability in sound environment and natural resource management.

- **Institutions and Legislation:**
 - **Adequate institutions and legislations available**
 - **Overlapping and conflicting provisions**

With a plethora of agencies and legislation dealing with coastal marine environment, its living resources and critical habitats, there is bound to be substantial overlaps as well as conflicts between different legislation. This situation invariably leads to conflicts among the agencies and confusion among the stakeholders; and calls for continuous coordination and collaboration between agencies in order to ensure sustainable conservation and management of coastal environment, its resources and habitats.

In order to resolve the conflicts and issues of various agencies involved in environmental affairs MENR has established eight Committees on Environment Policy and Management (CEPOM) that are linked to an apex Committee on Integrating Environment and Development (CIEDP). There is one such committee for coastal and marine affairs. These CEPOM's are expected to strengthen the co-operation and co-ordination among public and private sector agencies as well as NGOs and CBOs for implementing the relevant environmental plans and programmes.

Fisheries and Aquaculture - MFOR (2002) identifies several overlapping and conflicting provisions in the Fisheries and Aquatic Resources Act No. 2 of 1996, the Coast Conservation Act No. 57 of 1981 and its Amendments and the National Aquaculture Development Authority Act No. 53 of 1998 that lead to ambiguities in regard to certain functions in respect of fisheries and aquaculture, and impede management of fisheries and coastal resources.

Provisions in other laws such as the Fauna and Flora Protection Ordinance and the Forest Ordinance can conflict with the fisheries development goals and policies. For example, section 40 of the Fauna and Flora Protection Ordinance prohibit the export of all non-domestic indigenous animals including fish and other aquatic animals for commercial purposes. This could have serious repercussions for the fish export industry.

In the case of aquaculture, the Agrarian Services Act does not recognize aquaculture as a legitimate activity for land use purposes. According to existing laws, priority use of minor irrigation tanks or seasonal tanks is given to agriculture although in some instances aquaculture is more productive than agriculture.

Further, the penalties meted out in the various Acts are considered grossly insufficient to have any deterrent effect (e.g. Under the Fisheries and Aquatic Resources Act No. 2 of 1996, the penalty for fishing with explosives is 6 months to 2 years imprisonment and a fine not less than Rs.5000).

Marine Pollution Prevention - Muthukuda et al (2003) has identified several instances where legal provision of the Marine Pollution Prevention Authority overlap with a number of other legislation. They contend that CEA's role is not properly defined in terms of area of jurisdiction and linkages to MPPA responsibilities, leading to a lack of integration with regard to resource allocation both in terms of funding and manpower at field level to manage marine pollution.

There is also overlapping responsibilities between CCD and MPPA in respect of pollution arising from ship based or shore based maritime activities. CCD is responsible for conducting investigations and inquiries on all pollution activities in Coastal Zone, while MPPA's mandate is restricted to pollution prevention relating to ship based or shore based maritime activities.

MPPA's mandate also overlap with Sri Lanka Ports Authority (SLPA), which has responsibility for pollution prevention and regulating pollution prevention activities within commercial harbours. SLPA also issue licenses to private sector operators capable of reception facilities for oil and waste disposal.

The contingency planning adopted by Ceylon Petroleum Corporation (CPC) in their operation of transferring petroleum products from ships to shore based storage has no linkage with the National Oil Spill Contingency Plan (NOSCP) of MPPA at present.

Coastal Erosion - The responsibility for coastal erosion control lies with CCD and its coast protection works usually prioritize protection of public infrastructure (roads, railway lines, bridges, etc.), followed by public utilities and buildings. CCD permits individuals and/or public or private agencies to implement coast protection measures in conformity with CCD criteria and guidelines.

The CCD can demand EIA's for development activities carried out by both private as well as state agencies within the Coastal Zone. If such activities go beyond the boundaries of the Coastal Zone, adherence to EIA requirements under the regulations of the National Environmental Act No. 47 of 1980 and its Amendment Act No. 56 of 1988 becomes necessary. However, any special concerns of CCD and/or other relevant sectoral and inter-sectoral Acts such as the State Lands Ordinance No. 8 of 1947 and its amendments, the Agrarian Development Act No. 46 of 2000, etc. need to be considered.

Pollution of Coastal water - There are many laws in place for controlling coastal water pollution. For example, major development projects in the coastal zone (except fishing) are subject to Environmental Impact Assessments (EIA). These include prescribed projects listed in regulations gazetted under the provisions of the National Environmental Act No. 56 of 1988, with CCD acting as the project-approving agency.

Industrial pollution of coastal waters is controlled through EIA's and Environmental Pollution Licensing (EPL) scheme. EPL is mandatory for prescribed activities listed under the Gazette Notification Extraordinary No. 1159/22 of November 22nd, 2000. An EPL can be obtained from the CEA or the Provincial Environmental Authority of the North Western Province, and is valid for three years. However, there are lapses in enforcement of pollution control. Coastal water pollution from industrial sources also occurs due to poor technology for pollution abatement in a large number of industries.

The National Water Supply and Drainage Board (NWS&DB) is responsible for providing good quality water and adequate sanitation in rural and urban areas at national level. The problem of inadequate sanitation for under-served settlements in Colombo is also being addressed by many agencies (e.g. Sustainable Township Programme – STP for occupants in under-served settlements in Colombo under the direction of the Real Estate Exchange Limited- REEL).

Water quality Monitoring - Monitoring water quality is an essential prerequisite for mitigation of pollution in coastal waters. Several agencies – BOI, CEA and CCD have authority to monitor water quality in the Coastal Zone and to regulate discharges from development activities. Other agencies such as NARA, NWDB, SLRDC, ITI and universities and other research institutions carry out monitoring and research from time to time. NARA also carries out water quality monitoring at the request of MFOR and other agencies. The NWDB and Sri Lanka Land Reclamation and Development Corporation (SLRDC) also engage in water quality monitoring, although they are not mandated to do so. The Industrial Technology Institute (ITI) also conducts water quality monitoring at the request of other agencies and organizations. The MPPA is mandated to control pollution of marine waters, but only when it involves offshore sources.

However, there is no single institution mandated with legal responsibility for regular water quality monitoring in the near shore waters, lagoons/estuaries and inland in the Coastal Zone. (CZMP, 2003)

- **Inadequate powers**

Some of the laws do not provide sufficient teeth to the agencies concerned in order to carry out the regulatory responsibilities expected of them. For instance, provisions under the Coast Conservation Act are limited to a very narrow strip of land and debar CCD from exerting any influence over activities outside this strip that may cause considerable adverse impacts on the coastal environment and resources (sand mining outside the 2 km limit, operation of lime kilns outside the 300 m limit and over-exploitation of mangroves outside the coastal zone).

There is also lack of necessary provisions to empower the community, such as Community Coordinating Committees set up under the SAM process.

- **Weak enforcement**

Enforcement of the majority of existing laws is far from satisfactory. Over 50 % of the shrimp farms are reported to be illegal. Lack of political commitment often demoralizes and weakens the capabilities of enforcement officers. Most times the enforcement capacity of the institution itself is quite weak. Resources necessary for effective enforcement, particularly trained manpower is not available within the institute. The Police are often busy with their own day-to-day work or are pressurized by local politicians and other vested interests.

The MFOR established a Coast Guard Service to assist DFAR and CCD in checking illegal activities such as coral mining, use of banned fishing gear and methods, etc. It has failed to develop into an effective unit due to weak recruitment and selection procedure, lack of proper training and non-availability of other facilities.

There is also a general lack of civic consciousness of the general public, largely due to inadequate awareness regarding the serious consequences of resource degradation. As a result, very few assist the enforcement officers or the legal processes. Prosecutions are also known to fail due to trivial technical grounds and/or lack of sufficient evidence.

The Provincial Councils have shown very little initiative to become actively involved in subject areas like natural resource management; the only important deviation from this is the adoption of a Provincial Environmental Statute and the establishment of a Provincial Environmental Authority by the NWP. Although 13th Amendment to the Constitution was adopted in 1987, implementation has been weak. There are many reasons for that situation. One is confusion over the division of power between the central and provincial governments. Another reason is lack of technical capacity among

the provincial staff. Still most of the Provincial Councils have not passed the statutes with respect to certain subject areas set out in the 'Concurrent list'. Up to now only NWP has passed statutes for the subject of environment.

- **Inadequate information flow**

Inadequate information and data required for planning purposes among the users at national, provincial and local levels is another major issue, despite the existence of a vast wealth of data, some of which may not be readily retrievable.

- **Inadequate Local Authority involvement in coastal resources management**

Provincial Councils are in operation in five of the provinces with a maritime boundary viz. Western, Southern, Northern and Eastern (operate as one single Council at present) and North Western areas. Under the 13th amendment of the Constitution, Provincial Council share power with the Centre in a number of areas called "Concurrent Subjects". These include subjects of importance in respect of coastal and marine resources such as fisheries other than fishing beyond territorial waters, development and control of the tourist industry within the province, protection of the environment, archaeological sites and remains other than those declared to be of national significance, protection of the environment and water storage and management, drainage and embankments, flood protection and planning of water resources.

The local level state institutions are the local government bodies, which are elected bodies with powers conferred on them by the Local Government Act and Ordinance. While they are involved in the maintenance of a cleaner environment through the disposal (not necessarily "management") of solid waste, maintenance of drainage systems etc within their areas of jurisdiction, they have practically no involvement in coastal and marine resource management. However it is encouraging to note that largely due to the Special Area Management Planning initiatives implemented at Rekawa, Hikkaduwa, Mawella, Kudawella and Hambantota, some of the local bodies (Pradeshiya Sabhas) have shown an interest and an inclination in participating in resource management interventions within their areas of jurisdiction.

Associations such as Fisheries Committees and Fisheries Corporative Societies are legally empowered to be involved in conservation and management of coastal and marine resources. Although not legally empowered, there are also other bodies involved in conservation and management of coastal and marine resources. Foremost among them are the NGO's such as the Wild Life and Nature Protection Society of Sri Lanka, the Environment Foundation and Mihikatha Foundation. There are also other groupings representing various economic activities based on coastal and marine resources, particularly fisheries and coastal aquaculture: Zonal Shrimp Farmers Associations, Ornamental Fish Breeders Association, Multi-day Boat Owners Association, Beach Seine Owners Association and Small Fishers Federation. These private sector organizations and NGO's have assumed increasing significance in recent years.

5. ASSESSMENT OF ON-GOING AND PLANNED ACTIVITIES TO ADDRESS THREATS (AND THEIR CAUSES) TO COASTAL AND MARINE ENVIRONMENT AND ITS LIVING RESOURCES

5.1 Institutions and Legislation

A number of institutions at national and local levels are having responsibility in management of coastal environment and resources. At national level, there are policy-making bodies such as the Ministry of Fisheries and Ocean Resources (MFOR) and the Ministry of Environment and Natural Resources (MENR) and implementing agencies such as the CCD and DFAR. At the provincial level there are Provincial Councils while there are Divisional Secretaries, Local Authorities, NGO's and Community Based Organisations (CBO's) at the local level. MFOR and MENR are the two ministries with the main responsibility of formulating national policies for the conservation and management of coastal environment and its resources.

The ministries, institutions and the legislation relevant to coastal and marine environment, its living resources and habitats are summarized in **Table 5.1**.

Table 5.1: Summary information on Institutions and Legislations relevant to coastal and marine environment and its living resources.

Ministry	Institution	Mandate	Relevant Legal Enactment
Ministry of Fisheries and Ocean Resources	CCD	CCD is required to develop and implement a Coastal Zone Management Plan, which should be revised every four years. The act mandates CCD to protect and preserve the coast from erosion or encroachment by the sea and control over planning and management of development activities within the designated coastal zone through a Permit System, Prohibition of activities, Designation of setback standards, Development restrictions, Provision of guidelines and standards for specified activities, etc. The Director also has discretionary powers to call for EIA's. This legislation also encourages linkages and collaboration among various government agencies involved in research and development activities within the coastal zone.	The Coast Conservation Act No. 57 of 1981 Coast Conservation Amendment Act, No. 64 of 1988
-do-	DFAR	Act provides for the management, regulation, conservation and development of fisheries and aquatic resources in Sri Lanka. It has provisions for banning the use of destructive fishing gear, declaration of fisheries reserves and a licensing system for all fishing operations, including provisions to manage designated fisheries through stakeholder 'Committees'.	The Fisheries and Aquatic Resources Act No. 2 of 1996
-do-	NARA	Promotion and conduct of research and development activities in aquatic resources including oceanography, fishing technology, fish processing, information dissemination, training, etc. and contribute to development,	National Aquatic Resources Research and Development Agency Act, No. 54 of 1981 Amended Act No. 32 of 1996

		management and conservation of aquatic resources in both inland and marine habitats.	
-do-	MPPA	Responsible for the prevention, reduction and control of pollution in Sri Lanka waters. MPPA has prepared a National Oil Spill Contingency Plan (NOSCP) to coordinate and manage response to incidence of oil spills and to provide a guide and control on such activities. The Act also has provision for penal action for any form of marine pollution or damage to live marine resources and wildlife.	Marine Pollution Prevention Act, No. 59 of 1981
-do-	CFHC	Construction and management of fishery harbours and anchorages, marine structures and other shore facilities	Incorporated under the Industrial Corporations Act No. 49 of 1957
-do-	NAQDA	Develop coastal and brackish water aquaculture, fresh water aquaculture and inland fisheries	National Aquaculture Development Authority Act 53 of 1998
Ministry of Environment and Natural Resources	CEA	It is the first legislative enactment to primarily address the issue of environment protection and management in Sri Lanka. Sections 18 and 19 directly concern fisheries and Section 23 concerns discharge of waste. The regulatory powers are exercised through two provisions: the Environment Impact Assessment Procedure (EIA) for major development projects and the Environment Protection License (EPL) for the control of industrial discharges.	National Environment Act No. 47 of 1980 and Amendment Act No. 56 of 1988
-do-	DWLC	Protect certain categories of endangered animals and plants wherever they are found, including threatened species of corals, fish, turtles and their nesting habitats and all marine mammals in Sri Lanka waters. It provides for declaration of any area of state land as a national reserve/marine reserve or sanctuary. The Director also has powers to call for EIA's.	Fauna and Flora Protection Ordinance, No. 2 of 1937 Fauna and Flora Protection Amendment Act No. 49 of 1993
-do-	Dept. of Forests	Declaration of any area of state land or forest as a reserve and for the controlled commercial exploitation of forest resources, including mangroves.	The Forest Ordinance No. 16 of 1907 and subsequent amendments in 1982, 1988 and 1995
	Geological Survey and Mines Bureau	Issues Licenses to mine or explore minerals	Mines and Minerals Act No. 33 of 1992
Ministry of Tourism	Ceylon Tourist Board	Regulate locations, constructions and operations of tourist activities through CTB guidelines	Tourist Development Act No. 14 of 1968
Ministry of Science and Technology	National Science Foundation	Act provided for the establishment of the Natural Resources, Energy and Science Authority of Sri Lanka (now re-named as the National Science Foundation of Sri Lanka) to initiate, sponsor and support scientific and technological research relevant to	Natural Resources, Energy and Science Authority of Sri Lanka Act, No.78 of 1981

		development, management and conservation of natural resources of Sri Lanka and, to advise the Minister on formulation and implementation of science and technology policy and review thereof.	
Ministry of Plantation, Infrastructure and Construction	Urban Development Authority (UDA)	The Act designates all areas within 1 km of the coastline as 'Urban areas' subject to the planning and regulatory requirements of the Act. All building constructions within the coastal area require a permit from UDA.	Urban Development Authority Act No. 41 of 1978 Amended in 1984 and 1988
-do-	Sri Lanka Land Reclamation and Development Corporation	Reclamation of low lying marsh, waste or swamps	Low Lying Land Reclamation Act No. 52 Of 1982
Ministry of Industries	Board of Investment (BOI)	Approval and regulation of investments	Board of Investments Act No. 49 Of 1992
Ministry of Irrigation and Water Management	Department of Irrigation	Construction and maintenance of irrigation works including those in the coastal region	Irrigation Ordinance No. 32 of 1946
Ministry of Provincial Councils and Local Government	Provincial Councils	Administration of activities pertaining to subjects listed as List No.1 (Provincial Council List) of Chapter 154-G of the 13 th Amendment to the constitution, including fisheries and industrial development in the province.	13 th Amendment to the Constitution
Provincial Ministry of Local Government, Education, Industries and Environment	Provincial Environmental Authority of the North western Province (PEA)	Protection and Management of the North Western Province	North Western Province Environmental Statute No. 12 of 1990

CEA plans to open 10 new regional and sub-regional offices to take conservation and regulatory prerogatives to the regions. This is expected to expand CEA's activities onto more pro-active levels and encourage regional level awareness raising, monitoring and regulatory network that will work with local communities to identify potential resources, redress possible threats and develop strategies to encourage prudent resource usage that does not compromise environmental concerns. Over Rs. 70 million has been channeled for this purpose. These regional offices will also help to make CEA expertise will available at regional level and promote better liaison with communities, Provincial Councils and District Secretariats. New regional offices are to be opened at Galle, Hambantota, Kandy, Anuradhapura, Jaffna, Batticaloa, Ampara, Trincomalee and other parts of the country. The first regional office has already been opened at Kegalle (Goonathilake, 2003).

The MENR (first established as Ministry of Environment in 1990) functions as a focal point for the development and management of natural resources of the country. The National Environment Act and the National Environmental Action Plan (NEAP) are major policy initiatives on natural resource management and directly impinges on coastal and marine resources as well.

The National Environment Act No. 47 of 1980 is the first legislative enactment to primarily address the issue of environment protection and management in Sri Lanka. Until 1988, CEA functioned

mainly as a coordinating and a policy making body. The Act was amended in 1988, giving CEA regulatory powers in environment protection and management. The regulatory powers are exercised through two provisions: the Environment Impact Assessment Procedure (EIA) for major development projects and the Environment Protection License (EPL) for the control of industrial discharges.

EIA Procedure - Since 1993, all major development projects are required by law to undergo an EIA prior to implementation. The EIA ensures that environmental impacts of any major project are identified and mitigatory measures are incorporated into the project at an early stage in project planning. An **IEE** (Initial Environmental Examination) is required for small and medium development projects.

EPL for industries - Since July 1990, all industries which discharge or deposit wastes, effluents or emissions into the environment are required to obtain an Environment Protection License from the CEA. The License stipulates the conditions (standards and criteria) under which the industry is permitted to discharge its waste.

The North Western Provincial Council has enacted a statute for the subject of environment, which is in the Concurrent List of the 13th Amendment. As such, the relevant laws enacted under the relevant Parliamentary Act become non-operative in that province. Therefore, the National Environment Act No. 47 of 1980 and subsequent Amendments are non-operative in the North Western Province (NWP) and the CEA has no power in NWP. This power is vested in the Provincial Environmental Authority (PEA) of the NWP. This is the only PEA in the country.

5.2 Current Initiatives

5.2.1 Major initiatives to conserve Coastal habitats

Although there have been attempts in the past for conservation of specific coastal sites, the first initiative to manage coastal habitats in a comprehensive and holistic manner were taken by the CCD through its CZM Plans, beginning 1990. The key management strategies adopted by CCD for conservation of coastal habitats are summarized in **Table 5.2**.

Table 5.2: Key management strategies adopted by CCD for coastal habitat conservation

Regulatory	<ul style="list-style-type: none"> ▪ Banning of all activities pertaining to sea coral mining ▪ Permits from CCD made mandatory for all development activities within the Coastal Zone
Education and Awareness	<ul style="list-style-type: none"> ▪ Dissemination of knowledge through printed materials on the value of, and issues pertaining to coastal habitats ▪ Inclusion of facts about problems affecting coastal habitats into the secondary school curriculum ▪ Conducting awareness programmes on different coastal habitats for school children, teachers and key stakeholders
Planning and policy development	<ul style="list-style-type: none"> ▪ Conservation of coastal habitats through Special Area Management Plans
Monitoring	<ul style="list-style-type: none"> ▪ Implementing a monitoring programme on coral and sand mining
Research	<ul style="list-style-type: none"> ▪ Supporting research on coral reefs and mangroves
Co-ordination	<ul style="list-style-type: none"> ▪ At national level – Coast Conservation Advisory Council ▪ At local level – Coast Conservation Coordinating Committee, Steering Committees and Community Coordinating Committees.
Direct development	<ul style="list-style-type: none"> ▪ Rehabilitation ▪ Replantation

SAM Planning by CCD- Special Area Management (SAM) is a locally based, geographically specific, participatory planning process that allows for the comprehensive management of natural resources with the active involvement of the local community as the main stakeholder group. It involves co-management of resources through which decision-making, responsibility and authority in respect of natural resource use and management are shared between the government and the local resource users or community.

The first attempts at SAM planning in coastal areas by the CCD were at Rekawa and Hikkaduwa in 1991. Encouraged by the outcome and experience gained from these initiatives, the second generation Coastal Zone Management Plan of 1997 promoted the SAM process by recommending the formulation and implementation of Special Area Management (SAM) Plans for 23 selected coastal areas. The selection was based on four criteria, namely: Severity of issues, Biodiversity, Viability of the project and Economic significance.

Based on the rating obtained nine were identified as high priority sites. These are Arugam Bay, Batticaloa Estuary, Bar Reef, Chilaw Estuary, Beruwala/Bentota, Hikkaduwa town and Sanctuary, Negombo Estuary, Rekawa Lagoon and Unawatuna Bay.

The CCD with the assistance of the Coastal Resources Management Project of 2000-2005 has extended the SAM process to several sites, namely the Bar Reef, Negombo Estuary/Muthurajawela Marsh, Lunawa Lagoon, Madu Ganga Estuary, Hikkaduwa Nature Reserve and environs, Unawatuna Bay including Koggala Estuary, the Mawella and Kalametiya Lagoons. Environmental profiles of these sites have been made and draft management plans are under preparation.

Areas of Particular Concern (APC) - These are geographically smaller and less complex sites characterized by fewer user conflicts that can be more easily resolved. However, APC management plans (APCM) also follow the same planning processes and principles as the more comprehensive SAM plans. It is expected that projects for managing Areas of Particular Concern could be handled without too many complicated administrative constraints and can be achieved through a smaller financial component obtained at the local level.

The sites at which the SAM process is ongoing are given in **Table 5.3**. Out of the balance 50 sites listed for management in this document, 27 are identified as potential SAM sites and the remaining 23 sites are identified as potential APC sites (**Annex 5**).

Table 5.3: On-going SAM sites

District	Site
Colombo	Lunawa Lagoon
Galle	Madu Ganga Estuary Hikkaduwa Nature Reserve and environs Unawatuna Bay and Koggala Estuary
Hambantota	Coastal stretch in Hamabantota Mawella lagoon Kalametiya lagoon
Gampaha	Negombo Estuary/Muthurajawela marsh
Puttalam	Bar Reef

Some of the major initiatives taken by various agencies, NGO's and CBO's for conservation of coastal resources and habitats are summarized below.

Coral reefs

- **Establishment of marine protected areas containing coral reefs**

- Hikkaduwa Nature Reserve declared in 1998 (upgraded from Marine Sanctuary declared in 1979)
- Bar Reef Marine Sanctuary declared in 1992.

Both managed by DWLC and are SAM sites under CCD.

- Pigeon Island national park (Trincomalee district)
- Bounavista marine sanctuary (Galle district)

- **Coral reef research**

- NARA research programme commenced in 1985 (Significant contribution to taxonomy and distribution of corals)
- Survey of coral reef fish and invertebrates and socio-economic condition of user communities conducted jointly with the Marine Conservation Society (UK).
- A database for coral reefs developed by NARA and GCRMN
- Research and rehabilitation initiatives by University of Colombo
- Research by Ruhuna University

- **Global Coral Reef Monitoring Network (GCRMN)**

GCRMN is a global, inter-agency initiative supported by IOC-UNESCO, UNEP, IUCN and World Bank to assist in developing a long term coral reef monitoring to raise awareness on coral reef issues among all stakeholders and contribute to sustainable livelihood development, biodiversity and habitat protection. Sri Lanka is an active member of the GCRMN.

The Regional Coordinator for South Asia was supported financially through IOC-UNESCO up to April 2003. Upon completion of his tenure in South Asia it was decided that the CORDIO component of South Asia will support a part time Regional Coordinator for South Asia and will also support the upkeep of the GCRMN office based at the Sri Lanka country office of the IUCN. (IUCN is a funding partner for GCRMN). At present, the office is temporarily closed due to the lack of a regional coordinator. Discussions are underway between CORDIO and IOC-UNESCO to fund a part time regional coordinator for South Asia.

Much of the initial coordination has been done already and there is an active network between India, Sri Lanka and Maldives through the country coordinators.

- **Coral Reef Degradation in Indian Ocean (CORDIO)**

Supported by SIDA, World Bank, WWF, FRN (Swedish Council for Planning and Coordination of Research), MISTRA (Foundation for Strategic Environment Research), it is a programme created to respond to coral reef degradation in Indian Ocean. Project focus on biophysical impact of coral degradation, socio-economic impacts, reef rehabilitation, management options and development of alternate livelihoods. Sri Lanka is a participant of CORDIO.

CORDIO is active in 11 countries around the Indian Ocean, and is co-ordinated through sub-regional offices in Colombo, Sri Lanka (South Asia), Mombassa, Kenya (East Africa) and Victoria, Seychelles (Indian Ocean Islands).

CORDIO objectives are:

- a. To determine the biophysical impacts of the bleaching and mortality of corals, and the long term prospects for recovery.
- b. To determine the socio-economic impacts of the coral reef degradation, and investigate options for mitigating these through management and development of alternative livelihoods.
- c. To determine the prospects for restoration and rehabilitation of reefs to accelerate the ecological and economic recovery

Activities undertaken in Sri Lanka under CORDIO include:

Activity	Period
1 Monitoring of the coral reefs	1999-ongoing
2 Baseline survey of the coral reefs in Passikudah, Batticaloa	2003-ongoing
3 Effect of coral reef degradation on reef fisheries	1999-ongoing
4 Effects of coral reef degradation on tourism	1999-2001
5 Monitoring of the collection and trade of marine ornamental fish, building a database.	1999-ongoing
6 Support to GCRMN's pilot socio-economic monitoring at selected sites	2001
7 Sri Lanka Reef Watch, Public Awareness program implemented by IUCN with support from CORDIO, GCRMN, and NARA	2001
8 Sri Lanka Reef Watch phase 2, Production of education material	2002-2003
9 Alternative livelihoods for dependants of coral reefs	2002-ongoing
10 Training course in coral reef monitoring techniques, Eastern University, Batticaloa	1999
11 Alternative livelihoods through coral reef tourism	2003-ongoing

▪ **Coral reef areas as Fisheries Management Areas**

The following coral reef areas have been declared as Fisheries Management Areas under the Fisheries and Aquatic Resources Act No. 2 of 1996

- Off Yala, encompassing Great Basses and Little Basses reefs (Hambantota district), in July 2001
- Madiha-Polhena coral reef (Matara district) in July 2001

- **Export restrictions on threatened marine fish species**

- The Fauna and Flora Protection Act No. 49 of 1993 provides legal protection to seven species of marine fish
- The Fisheries and Aquatic Resources Act No. 2 of 1996 prohibit the export of 12 species of marine fish

Lagoons and Estuaries

- **Lagoons/estuaries as Fisheries Management Areas**

Some lagoons/estuaries have been declared as Fisheries Management Areas under the Fisheries and Aquatic Resources Act No. 2 of 1996, for the purpose of regulating and managing the fisheries.

- Fisheries Management Areas declared in Negombo estuary (Gampaha district, July 1998), Rekawa lagoon (Hambantota district, Feb. 1999), Batticaloa lagoon (Batticaloa district, Jan. 2001) and Bolgoda Lake estuary (Colombo district, July 2001)
- Fisheries Committees established and management by local communities commenced in Negombo estuary and Rekawa lagoon

- **Export restrictions on threatened lagoon/estuarine fish species**

Regulations introduced in 1998 under the Fisheries and Aquatic Resources Act No. 2 of 1996 has placed groupers under the 'restricted export' category

- **NGO/CBO involvement in protection and conservation**

- 'Saviya' Development Foundation established for the protection and conservation of Madu ganga estuary (Galle district)

Mangroves

- **Conservation and management**

- Conservation and management of ten mangrove habitats south of Colombo and ten northwest of Colombo by Forest Department based on management plans
- Mangrove rehabilitation initiatives by 'Small Fisher Federation' in Puttalam district and Hambantota district

5.2.2 Policy initiatives in Fisheries and Aquaculture

Over the years, the developments in the fisheries sector have contributed considerably to the economic development of the country through increased supply of fish, increased employment opportunities and increased foreign exchange earnings. However, the production driven policy initiatives have caused increased fishing pressure in the coastal fishery, problems of over exploitation, competition and conflicts between resource users and degradation of habitats through the use of destructive fishing practices.

Since 1990, several key policy initiatives have been taken to promote sustainable development and management of the fishery. These include the phasing out of the producer subsidies to reduce the pressure on coastal fishing, diversifying the fishing effort by promoting the expansion of offshore fishing through the provision of better infrastructure such as harbours and anchorages and amendment of existing laws to protect habitats. The development of inland fisheries was also another means of increasing fish production whilst containing the pressure on coastal fisheries. It must be noted that international pressure from donor agencies also influenced the policies of the Ministry to focus more on sustainable management and conservation of coastal and marine resources in a sustainable way.

DFAR, through the Fisheries and Aquatic Resources Act No. 2 of 1996 has introduced a number of regulations for the purpose of managing, conserving and protecting fisheries resources and habitats. These include the following:

Regulation	Purpose/Objective
Spiny Lobster Regulations of 1973	Ban on catching, possessing and sale of gravid female lobsters and under-size lobsters
Lobster Fisheries Management Regulations of 2000	License for catching, and export introduced. Size limits revised for some species
Chilaw Lagoon Fisheries Regulations of 1996	Management of fisheries in Chilaw Lagoon
Old Dutch Canal and Mundal Lagoon Fishing Regulation of 1996	Management of fisheries in Old Dutch Canal and Mundal Lagoon
Fishing Operations Regulations of 1996	Ban catching, possession and sale of Marine mammals and turtles Ban use of Push nets, Moxi nets, Gillnet/Trammel net operations on reefs and rocks, Harpooning of marine mammals License system introduced for all fishing operations
Inland Fisheries Management Regulations of 1996	Gillnets less than 85mm mesh banned Surrounding nets/ trammel nets/ monofilament nets banned. Licensing system introduced
Aquaculture Management Regulations of 1996	License for aquaculture operations
Fisheries Committee Regulations of 1996	Provisions for community based fisheries management. Two coral reef areas and four lagoons declared as Fishery management Areas
Export and Import of Live Fish Regulations of 1998	Export of 12 species of marine and 13 species of fresh water fish banned.

Permits for restricted export of 33 species including groupers in live form. Import of some species also banned.

Aquaculture Management (Disease Control) Regulations of 2000

Guidelines for maintenance of enterprises and provisions for monitoring and inspection

Aquaculture (Monitoring of Residues) Regulations of 2002

Provisions for monitoring and compliance of with a national residue monitoring plan

Other recent initiatives taken by MFOR / DFAR supported by the ADB/CRMP include:

- A new Fisheries Management and Development Bill to strengthen fisheries management
- Restructuring of MFOR and DFAR in accordance with the extended mandate and for greater efficiency of operation
- Improvements to Fishing boat registration, Licensing and Fisheries statistical collection systems to strengthen fisheries management

Draft Fisheries Management and Development Bill, 2003

A draft Fisheries Management and Development Bill has been prepared by MFOR/DFAR, with the assistance of the ADB funded Coastal Resources Management Project to provide for the management and development of fisheries in Sri Lanka; the implementation of Sri Lanka's international fisheries obligations; to repeal the Fisheries and Aquatic Resources Act No.2 of 1996; the Regulation of Foreign Fishing Boats Act no.59 of 1996; to amend the Mortgage Act No.6 of 1949; and to provide for matters connected therewith or incidental thereto.

Some of the key features of the draft Act are that it –

- Provides a comprehensive, integrated framework for managing and developing the fisheries resources for the benefit of the people of Sri Lanka.
- Includes institutional reforms to support the management and development functions and enable participatory management,
- Implements Sri Lanka's international obligations to provide a clear basis for foreign fishing and related activities in Sri Lanka waters,
- Provides a framework for a clear, transparent licensing and registration system to ensure that the fisheries resources will continue to yield maximum benefits to the people of Sri Lanka,
- Incorporate clear powers of Officers and Inspectors for monitoring, control and surveillance purposes including use of cameras, position fixing instruments and other up-to-date technology and
- Clarifies the role of the courts and legal procedures to enable clear and efficient enforcement.

Section 12 of the draft Act provides for the establishment of committees for participatory fisheries management. Committees may be established at village landing sites; anchorages and harbours, local area, district and national levels in accordance with this Bill, for the purpose of providing for participatory fisheries management. These committees may take the form of –

- (a) Fisheries Committees established at anchorages, harbour, village and local area levels, comprised of fishers, boat owners and/or skippers; and

- (b) Fisheries Advisory Committees, established at the district and/or national level, comprised of fishers and other stakeholders in such a manner as to ensure that the objectives of participatory management is attained.

Fisheries Committees – may be established in respect of area, including inland, landing sites, anchorages, harbour, village, local and offshore; species and such other area of authority as may be prescribed.

The principal functions of a Fisheries Committee may include – providing a forum for discussion and resolution of issues relating to the management of the relevant fisheries; coordinating inputs of fishers and, as appropriate, other stakeholders into the development, implementation, review and amendment of Fishery Management Plans, regulations, local laws, agreements or other management mechanisms within the scope of this Bill and; seeking agreements among fishers and stakeholders in matters relating to management arrangements, monitoring mechanisms, surveillance and enforcement priorities and research priorities in accordance with the objectives of fisheries resources management.

Over 750 such committees, called ‘Thtupola Committees’ have already being established islandwide during this year.

Fisheries Advisory Committees – may be established in respect of a Fisheries Committee established with species, area or other authority within the jurisdiction of the Fisheries Advisory Committee and such other area of authority as may be prescribed.

The principal function of a Fisheries Advisory Committee shall include – supporting the relevant Fisheries Committee or Committees in the carrying out of their functions and such other function or functions as may be prescribed. Both Fisheries Committees and Fisheries Advisory Committees need to be registered with the Director general of DFAR.

5.2.3 Controlling oil pollution

The **National Oil Spill Contingency Plan (NOSCP)** outlines the national arrangements for responding to oil spills in the marine environment, with the aim of protecting it from oil pollution or, where this is not possible, to minimize such effects. However, there is no contingency plan for accidental toxic waste release.

The NOSCP applies to all oil spills, which cause or could cause damage to the environment covering coastal area and the sea. It applies to the waters, which are under the jurisdiction of Sri Lanka for pollution prevention purposes, including the EEZ or pollution zone and the territorial sea.

The area of response also extends to high seas where the oil spill has the potential to harm Sri Lanka’s interests like beaches, estuaries and other areas connected to the sea in terms of powers of intervention, under the Intervention Convention of 1969.

Legal Framework for Prevention of Oil Spill Pollution -Existing laws, offences, penalties and responsible agencies in enforcing these laws are summarized in **Table 5.4**.

The first NOSCP was prepared by MPPA in 1996 and was revised in 1998 and 1999. It received Cabinet approval in 2000. The NOSCP again needed revision in view of the yet to be finalized Regional Oil Spill Contingency Plan and other national and international developments. This has been accomplished under the INSTCOM project.

Table 5.4: Laws and penalties against oil spill pollution

Offence	Penalty	Enforcement
Dumping, discharging or causing the escape of oil and other pollutants into Sri Lanka waters without a permit	Fine >Rupees one million	Marine Pollution Prevention Authority
Placing, depositing, dumping or causing the escape of waste oil or harmful substances into Sri Lanka waters	Fine <Rupees two thousand	Department of Fisheries and Aquatic Resources
Engaging in any development activity within the Coastal Zone without a permit	Fine Rs.1500 – 25,000 and/or imprisonment	Coast Conservation Department
Discharging waste and oil into the environment without a license	Fine <Rupees Ten thousand and/or imprisonment	Central Environment Authority.

International conventions - International conventions dealing with marine pollution ratified/signed by the Government of Sri Lanka given in **Table 5.5**.

Table 5.5: International conventions signed by Sri Lanka on marine pollution.

	Convention on	Established	Ratified /Signed
1	Intervention on the High Seas of Oil Pollution casualties	1969	1969
2	Civil Liability for Oil Pollution Damage	1969	1983
3	Establishment of an International Fund for Compensation for Oil Pollution Damage	1971	1983
4	Prevention of Pollution from Ships (MARPOL)	1973/78	1997
5	Oil Pollution Preparedness, Response and Co-operation (OPRC)	1990	Not ratified

Regional collaboration - India, Maldives, Pakistan and Sri Lanka lie close to the main shipping route from the Middle East to the Far East. Annually, a total of some 525 million tonnes of crude oil or about 25% of the total world movement of crude oil by sea pass through this region. Although there is some capacity in these countries to respond to oil spills in harbours and at sea, response to a major oil spill at sea would probably require cooperation from other states in the region or assistance from further afield.

SACEP and IMO have jointly funded a project to assist the region in developing a ‘South Asian Regional Oil Spill Contingency Plan’. Bangladesh, India and Sri Lanka have already conveyed their concurrence and Pakistan and Maldives are expected to follow. The Contingency Plan would establish a mechanism for mutual assistance, under which competent national authorities of the participating countries will coordinate and integrate their response to marine pollution incidents either affecting or likely to affect the territorial sea, coasts and related interests of one or more of these countries, or to incidents surpassing the available response capacity of each of these countries alone.

Other opportunities for seeking bi-lateral and multi-lateral assistance include the Singapore Oil Spill Response Centre (SOSRC), the Petroleum Association of Japan (PAJ) and the East Asia Response Pte Limited (EARL). Most of these agencies store and lend oil spill response equipment free of charge to minimise damages from oil contamination due to spills caused by tanker accidents (Muthukuda et al, 2003).

5.2.4 Initiatives for pollution control

Industrial Parks (IP) - Government has taken a decision to establish more industrial parks in order to relocate high polluting industries within these parks. This is a major step towards reducing pollution incidences in coastal waters by stemming the persistent influx of industrial discharges.

As mentioned under 2.1.1, there are two large-scale IP's operating under BOI and another 17 managed by the Ministry of Enterprise Development, Industrial Policy and Investment Promotion. The Ministry of Rural Economy is currently planning to establish an IP to be associated with the printing industry.

Solid waste management - Financial constraints are a primary cause for improper solid waste management. The following projects have been supported by donor agencies:

- Colombo Environmental Improvement Project (CEIP) funded by the World Bank. Development of a suitable waste disposal facility for the Greater Colombo Area (GCA) was one component of the project.
- The Urban Development and Low Income Housing Project funded by the ADB addresses solid waste management in selected Local Authorities outside the GCA.
- Bilateral donor agencies including Japan International Corporation Agency (JICA) and the Australian Agency for International Development (Aus AID) have programmes in waste transport and disposal.

National Solid Waste Management Strategy – The MENR has prepared a National Solid Waste Management Strategy based on suitable regulatory controls necessary for its implementation through an integrated waste management system with central /regional authority to coordinate solid waste management initiatives. Major emphasis is on:

- Waste segregation at source
- Promoting waste avoidance / reduction
- Promoting re-use / recycling

Greater private sector participation is envisaged through:

- Contracting private sector in solid waste collection and disposal
- Financial and technical support for small and medium recycling industries (glass, metal paper) at provincial / regional level

Other areas highlighted in the strategy include infrastructure facilities for collection and transport of waste (for recycling and composting) and promotion of community participation through:

- Education and awareness
- Community based pilot activities for composting and material recovery

In recent years, a few local authorities, including Colombo Municipal Council, have privatized waste collection service. However, there are instances where such arrangements have been unsuccessful and the contracted party continues to practice open dumping, probably due to a weakness in the condition of the contract.

Hazardous waste - The Ministry of Environment and Natural Resources is working towards setting up a Hazardous Waste Management System. Regulations for control of collection, storage, transport and disposal of hazardous waste have been gazetted in 1996. However, there had been no implementation due to protests from industrialists and there was also no disposal facility. In order to obtain various ISO standards, industrialists need to provide details of hazardous waste disposal and therefore, they have recently shown interest in the implementation of the regulation. Meanwhile, the CEA has amended the existing regulation to include all hazardous waste, including clinical waste, to comply with the BASAL convention. The amended regulation is due to be forwarded to legal

draftsman (Batuwitige /CEA, personal communication). The government is also expected to join hands with the private sector in establishing a disposal facility.

5.2.5 Alternatives to river sand

CCD, supported by the ADB/CRMP has been investigating the possibility of using offshore sand as an alternative to river sand in the construction industry, initially in the western province where river sand mining is acute. After initial studies, which showed that offshore sand is ideally suited to replace river sand in the construction industry, a proposal for a pilot project has been prepared for foreign funding for which Cabinet approval has been obtained.

5.2.6 Review of on-going and planned projects related to coastal and marine environment and its living resources

The following is a review of the donor assisted on going and planned projects related to coastal and marine environment, its living resources and critical habitats.

▪ Hikkaduwa Coastal Zone Management Project

Project Objective:	To improve the environment and welfare of the people in Hikkaduwa Through sustainable solid and liquid waste management systems and minimize marine pollution
Project Components:	Solid waste management Pipe borne sewerage system Community building Project management
Funding Agency:	Australian Aid for International Development (AUS AID)
Implementing Agency:	NWSDB and Hikkaduwa Pradeshiya Saba
Executing Agency:	Ministry of Urban Development and Housing/ and Ministry of Provincial Councils & Local Government
Project duration and Cost	2000 – 2004 Rs. 271 million
Project Interventions:	75% of sewerage and sanitation components completed. Garbage collection is done free of charge and a mechanism is to be devised to levy charges from commercial premises in the area

▪ Pavithra Ganga Programme

Project Objective:	To establish a water quality monitoring system in Kelani river and take mitigatory measures to prevent pollution (this project is to be extended to Maha Oya)
Project Components:	- Mobilise community in minimizing river pollution - Mobilize local authorities for monitoring - Promote integrated river basin management

Funding Agency: World Bank
Implementing Agency: CEA
Executing Agency: Ministry of Irrigation & Water Management

Project duration and Cost:

Project Interventions: 12 monitoring points established along the Kelani river and handed over to relevant local government agencies (Pradeshiya Saba and U.C.)

Environmentally sensitive areas in the river basin identified and steps taken to avoid location of industries of medium and high polluting categories within these areas.

Water quality monitoring and feedback mechanisms introduced.

Authorisation to issue closure orders and to take legal action as necessary to ensure prevention of pollution.

▪ **Clean Industry Development Project**

Project Objective: Integrating central planning (CP) into industrial development in order to reduce industrial pollution by employing a strategy for CP.

Project Components: Formulate policies, strategies and actions to integrate concepts of CP into industrial development

Develop strategies and guidelines to introduce CP principle in the design and operation of industrial estates.

Mount a national campaign to promote CP into industrial activities.

Funding Agency: ADB

Implementing Agency: International Resource Group (IRG) of U.K.

Executing Agency: Ministry of Enterprise Development, Industrial Promotion and Industrial Policy

Project duration and Cost: I year (2002)

Project Interventions:

▪ **Hambantota Integrated Coastal Zone management Project (HICZMP) Phase II**

Project Objective: Implementation of recommended small-scale actions and Interventions from Phase I, to promote sustainable use and development of the coastal resources

Project Components: - Assist in the implementation of SAM plans at the two sites

- Identified (Mawella/Kudawella and Hambantota dunes)
- Rehabilitation and management of selected environmentally sensitive areas
 - Implementation of selected interventions for abatement of adverse environmental impacts from development activities
 - Improvement of environmental quality at selected fish landing sites
 - Establishment of an environmental education and awareness programme
 - Implementation of alternate income generating activities
 - Capacity building in selected local institutions
 - Legalization of Zoning Plan for Hambantota district
 - Exchange/transfer of ICZM knowledge and experiences with other coastal districts

Funding Agency: NORAD

Implementing Agency: CCD

Executing Agency: MFOR

Project duration and Cost: 2002 – 2004

10.7 million NOK

- Project Interventions:
- Development of Blow hole area in Kudawella
 - Rehabilitation of sensitive areas (Tangalle beach park and Hambantota town)
 - Solid waste management at Tangalle and Kirama Oya
 - Environmental quality improvement at tangalle and Kirinda fishery harbours
 - Environmental education and awareness programmes
 - Capacity building of local institutions
 - Legalizing zonal plans of Hambantota district
 - Alternative income generating activities for resource abusers

▪ **Lunawa Environment and Community Development Project
(Part of Greater Clombo Flood Control and Environment Improvement Project)**

- Project Objective:
- Upgrading the living conditions of communities through provision of improved infrastructure at resettlements sites
 - Rehabilitation and improvement of existing canals and structures in drainage area of Lunawa lake

- Project Components:
- Improvement of storm water drainage system in the area
 - Upgrading under-served settlements and re-settlements
 - Institutional strengthening

Funding Agency: Japan Bank for International Corporation (JBIC)

Implementing Agency: Sri Lanka Land Reclamation & Development corporation and USIP

Executing Agency: Ministry of Urban Development, Housing and Construction

Project duration and Cost: 2002 (one year) / Rs.7900 million

Project Interventions: Target households earmarked
Land reclamation for resettlement on going

▪ **Coastal Resources Management Project (CRMP)**

Project Objective: Enhance environmental protection of coastal areas and contribute to poverty reduction among fishing communities through interventions that will establish sustainable systems for integrated management of coastal resources

Project Components: - Coastal stabilization (erosion control measures, erosion management activities)
- Coastal environment and resource management (preparation of special area management plans for 7 sites; reduction of resource degradation, resource rehabilitation, water quality improvement, solid waste and sanitation management and improving social infrastructure in 9 sites)
- Institutional strengthening (MFOR/DFAR/CCD)
- Harbour development in three locations

Funding Agency: ADB / Netherlands

Implementing Agency: CCD

Executing Agency: MFOR

Project duration and Cost: 2000 – 2005 / US \$ 80 million

Project Interventions: - Bathymetric surveys and sand surveys
- Sand nourishment (2 sites)
- Lagoon rehabilitation
- Improving and construction of fishery harbours (one construction, two improvement)
- Revised Coastal Zone Management Plan
- New Fisheries Bill (Act)
- Improvements to fisheries management (Boat registration, Licensing and Fisheries statistics)

▪ **Conservation of Bio-diversity through Integrated Collaborative Management in the Rekawa, Ussangoda and Kalametiya Coastal Ecosystems**

Project Objective: Ensure conservation and sustainable use of the bio-diversity of this globally significant site through the development of a collaborative management system, actively involving local communities, NGO's and government agencies

Project Components: - Conduct surveys and research on bio-diversity and socio-economic situation in the area

- Develop collaborative management framework to control destructive livelihood practices and encourage development of sustainable alternatives
- Implement conservation programmes with support and participation of local communities for globally threatened marine turtles, mangroves and avifauna
- Establish a Committee for policy level coordination and a Biodiversity Task Force for improved law enforcement
- Establish a monitoring programme to assess processes and development activities that have or likely to have adverse impacts on the conservation and sustainable use of biodiversity

Funding Agency: UNDP
Implementing Agency: CCD
Executing Agency: MFOR
Project duration and Cost: 2000-2005 / US \$ 750,000
Project Interventions:

▪ **Institutional Strengthening of the Oil Spill Contingency Management (INSTCOM)**

Project Objective: Implement the National Oil Spill Contingency Plan (NOSCP) and strengthen oil spill contingency management in Sri Lanka

Project Components:

- Revision of the Oil spill Contingency Plan
- Mapping of environmentally sensitive coastal areas
- Oil spill damage to specific areas assessed
- Establishment of Ecological baseline, monitoring programs and training for impact assessment completed
- Develop Procedure for economic valuation of resources and accounting of oil spill damage
- Evaluate and strengthen Oil spill combat and clean up capacities
- Investigate on measures to enhance law enforcement capacities
- Develop an awareness creation programme on oil spill prevention
- Strengthen capacity of national Authority on marine pollution prevention, control and mitigation

Funding Agency: Norway
Implementing Agency: MPPA
Executing Agency: MFOR
Project duration and Cost: 2000-2003
Project Interventions: All components (Outputs) completed

▪ **Regional Technical Assistance for Coastal & Marine Resources Management & Poverty Reduction in South Asia (ADB RETA TA No. 5974)**

Project Objective: Promote cooperation among participating countries towards strengthening the management of environmentally sensitive coastal and marine resources.

Project Components:

- A Regional Strategic Plan for collaboration, cooperation, information exchange, etc.
- Compendium of High Priority geographical areas (HPAs)
- Analysis of policy, institutional and legal constraints and recommendations
- Strategy for application of Integrated Coastal Zone Management approaches in HPAs

Funding Agency: ADB

Implementing Agency: IUCN/CCD/MENR

Executing Agency: IUCN

Project duration and Cost: 21 months (2001-2003)

Project Interventions: HPAs identified and Situation Analysis completed
Strategies for selected HPAs identified and implementation of few begun

▪ **Aquatic Resources Development and Quality Improvement Project**

Project Objective: Improvement of food security and poverty alleviation through promotion of market driven sustainable management of inland fisheries and development of aquaculture

Project Components:

- Development of inland fisheries and aquaculture
- Increased fish production through community based fisheries management
- Quality improvement and marketing
- Social mobilization and micro credit
- Institutional strengthening

Funding Agency: ADB

Implementing Agency: NAQDA

Executing Agency: MFOR

Project duration and Cost: 2003-2009 (7 yrs) / US \$ 30 million

Project Interventions: - Promote culture-based fisheries in 10,000 ha of minor irrigation

- reservoirs and 3,000 ha of seasonal tanks
- Upgrade existing capacity of seed production centres of NAQDA
- Construction of 25 mini-hatcheries
- Introduce community-based management in 50 major and medium irrigation reservoirs
- Promote private sector aquaculture enterprises

▪ **Eastern Province Coastal Communities Development Project**

- Project Objective:** Poverty alleviation and economic development in the three districts
of eastern province through sustainable livelihood development and sound management of natural resources
- Project Components:** -Coastal resources planning
- Integrated coastal resources management and development
- Small-scale community improvement
- Funding Agency:** ADB
- Implementing Agency:** North East Provincial Council
- Executing Agency:** Ministry of Provincial Councils and Local Government
- Project duration and Cost:** 2003-2009 (6 yrs) / US \$ 20.1 million
- Project Interventions:** Project Preparation Technical Assistance (PPTA) completed.
Implementation expected in 2004

▪ **North – East Community Restoration and Development Project (NECORD)**

- Project Objective:** Improve living conditions of people affected by conflict, in particular the internally displaced people
- Project Components:** Large scale anchor sub-projects and small scale community level projects (health, education, water supply and sanitation, agriculture, fisheries, irrigation, housing, income generation)
- Funding Agency:** ADB (70%) and GTZ
- Implementing Agency:** Provincial Council /North East
- Executing Agency:** Ministry of Provincial Councils and Local Government
- Project duration and Cost:** Six years from 2000 / US \$ 40 million
- Project Interventions:** Some Fisheries infrastructure (rest rooms) completed

▪ **Secondary Towns Rural Community-Based Water Supply and Sanitation Project**

On mid-August 2003, ADB and the Government of Sri Lanka signed an agreement for the “Secondary Towns Rural Community-Based Water Supply and Sanitation project”, amounting to US \$ 60.3 million.

This project will target five towns - Batticaloa, Hambantota, Muttur, Matara and Polonnaruwa as well as rural areas of the North-Central Province and is expected to provide clean water to nearly one million people and improved sanitation to more than 170,000. The project will support the Government’s efforts to devolve rural water supply and sanitation to the Provincial Councils and Pradeshiya Sabhas, sector reforms including achievement of full cost recovery, independent regulation of the water sector and increased participation of the private sector. Assistance will also be provided to the NWSDB to strengthen its operational efficiency and financial management.

The Ministry of Housing and Plantation Infrastructure will be the executing agency and the NWSDB will be the implementing agency for this project (CDN, 2003).

▪ **Sanitation projects in pipeline**

Several foreign funded projects are set to commence early 2004, to help expand the sewerage systems in the island (Gnanaraj, 2003).

- DANIDA has pledged a sum of US \$ 25 million to help rehabilitate the Greater Colombo sewerage system and the main pumping station at Madampitiya.
- ADB and JIBC have jointly agreed to fund an overall rehabilitation programme of all sewerage pumping stations in the Greater Colombo Area including setting up of a new sewerage system for the Sri Jayawardenepura area.
- The Swedish government has promised to fund new sewerage projects in Ja-Ela, Ekala, Moratuwa and Ratmalana to help broaden the sewerage network.
- A sewerage system for Kandy, including setting up of a pre-treatment plant, is also in the pipeline, with JBIC offering financial assistance

6. SPECIFIC PRIORITY ACTIONS NEEDED TO ADDRESS THREATS (AND CAUSES) TO MARINE AND COASTAL ENVIRONMENT AND ITS LIVING RESOURCES

Population increase and rising standards of living will continue to put more pressure on the coastal and marine environment, its resources and habitats. Successive governments have been able to achieve success in reducing the population growth rate down to 1% from 2.8% in 1950's. However, policies and programmes on natural resources management have not met with similar success.

Sri Lanka has very comprehensive legislation to deal with environment and natural resources but the enforcement of these laws has been poor. In addition, lack of appropriate development planning and effective implementation is seen as a major drawback to achieve sustainable development. Alleviation of poverty, greater public awareness and the commitment and the will of decision makers and implementers are essential to ensure long term coastal environment and resource management.

6.1 Implementation of 2003 Coastal Zone Management Plan

The Coast Conservation Department, assisted by the ADB/CRMP has developed a draft Coastal Zone Management Plan (Draft CZMP 2003) that would be approved by the government very shortly. The draft CZMP/2003 has a comprehensive Plan of Action to address issues related to the coastal environment, its resources and critical habitats. Policies, strategies and actions are proposed to control coastal erosion, pollution, degradation of coastal habitats, fisheries and aquaculture and special area management. .

A multiplicity of agencies and institutions has responsibility for some specific aspects of coastal area management as mandated by their own legal instruments. The CZMP/2003 has identified the lead agencies as well as the supporting agencies for all activities proposed. The implementation of the Plan of Action is indeed a challenging task that would require innovative practices and procedures and a greater commitment from the stakeholders as well as the civil society. The CCD needs to be actively supported by the other concerned agencies in the implementation of the CZMP/2003. This makes it imperative that there is very close harmony and co-operation among the respective agencies. Achieving such co-operation and collaboration requires an effective **coordinating mechanism** which would focus on the wider national interest instead of the narrow parochial "agency or sectoral interest".

Activities proposed in CZMP/2003 have been prioritised so that most urgent ones can be implemented first, depending on available resources. The complexity of the coastal zone requires a long-term approach to solving problems instead of one based on issue-by-issue approach. This calls for a **commitment at the national level** from the government to make available the requisite financial resources through budgetary allocations to the Coast Conservation Department for implementation of at least the prioritised actions.

In addition, **concomitant initiatives are also required from the other agencies** concerned with various aspects of coastal zone management in incorporating some of the identified coastal zone management related actions in their own annual work plans and budgets. Failure to undertake investments in coastal area management now is bound to result in a degraded coastal environment in the future and in continuing to keep the already poor coastal communities in poverty thus limiting the prospects for the general socio-economic advancement of the country.

One noteworthy feature of the implementation arrangements envisaged under this CZMP is that greater reliance is placed on, and more responsibility assigned, to the local level institutions such as the Pradeshiya Sabhas and the Divisional Secretariats while a greater level of active participation is expected from the fishing and coastal communities and their organizations, primarily the Management Committees at Fish Landing Centres and the Community Co-ordinating Committees of Special Area

Management sites. Thus the envisaged implementation arrangements will be largely based on harnessing the co-operation and commitment of the local institutions and community organizations. The Plan of Action in the CZMP/2003 is given in **Annex 6**.

The following in respect of controlling coastal water pollution, and waste management further elaborate or supplement activities proposed in CZMP/2003.

6.2 Controlling coastal water pollution

In addition to strategies and actions proposed in CZMP/2003, the following also needs urgent intervention

- Mandate an authority with legal responsibility for regular water quality monitoring in the near shore water, lagoons/estuaries and inland in the coastal zone (involving other agencies/institutions including Local bodies through adequate support)
- Introduce legislation to make developers pay for damages caused to the environment
- Develop Ambient Water Quality Standards for different uses of Coastal waters
- Develop two different permissible levels for the two monsoon seasons (northeast and south west)
- Development of proper water quality indices to rank coastal water resources
- Development of a Protocol for coastal water quality analysis and its implementation within the country as well as between countries in the BOBLME.

6.3 Solid waste management

The Ministry of Forestry and Environment has developed a 3-yr National Waste Management Strategy to address issues including regulation and enforcement, recycling, research and development and private sector and community participation.

The recommendations made by the Ministry of Forestry and Environment (2001) to address some of the major problems and issues in waste management, shown in **Table 6.1** have been incorporated in the National Waste Management Strategy.

Table 6.1: problems/Issues and recommendations for waste management

Problems and Issues	Recommendations
Lack of coherent and coordinated plans at local, provincial and national level	Develop an integrated waste management system, including plans for waste reduction, reuse, treatment and disposal
Waste disposal receive low priority at decision making levels	Form strong centralized/regional authority to coordinate solid waste management initiatives
Lack of political commitment to support waste treatment and disposal technologies	Develop alternative solutions for waste management
Ad-hoc arrangements of waste disposal practiced by Local Authorities, causing high environmental and social costs	Provide incentives for enhancing materials recovery, recycling and reuse.
	Enhance community based pilot activities for composting and materials recovery
	Encourage private sector participation

(Source: MOFE, 2001)

The main areas of focus in the National Waste Management Strategy are:

- Development of an integrated waste management system
- Establishment of centralized/regional authority to coordinate solid waste management initiatives
- Promotion of materials recovery, recycling and re-use
- Promotion of community based pilot activities for composting and materials recovery

6.4 Fisheries and aquaculture

6.4.1 Policy reforms and Structural adjustments

The National Policy and Development Plan 2002 of MFOR sets out several policy reforms and structural adjustments in relation to the sustainable development of fisheries, with due regard to the conservation of resources, environment and biodiversity. The following key policy reforms and structural adjustments need to be effected on an urgent basis.

- a) Revision of Fisheries Laws and Regulations to facilitate effective fisheries management through stakeholder involvement.

A new Fisheries Bill has been drafted, which include provision to establish stakeholder committees at local, district and national levels. This bill needs to become law for DFAR to mobilize stakeholder participation in fisheries management.

- b) Institutional Re-organization - MFOR, DFAR and CCD to be restructured in accordance with the extended mandate of MFOR.

The proposed reorganization of DFAR, which is awaiting government approval, has strengthened the management capabilities of DFAR. The Director/Fisheries Management will have one Deputy Director overlooking Monitoring, Control and Surveillance and another Deputy Director overlooking Licensing and Registration. In addition, management of offshore fisheries and coastal/brackish water fisheries are handled separately. At field level, statistics and enforcement functions are separated for greater efficiency (See Annex Z).

- c) Overlapping and Conflicting Provisions in Existing Laws

Legal reforms to remove overlapping and conflicting provisions among agencies under MFOR as well as provisions in other laws which impede development of the fishing industry.

6.4.2 Ecosystem – based approach to fisheries research and management

Ecosystem-based management is currently a highly topical issue and is being widely discussed in the context of fisheries management. Marine fisheries are one of the remaining examples of human endeavor involving the direct exploitation of wild animal populations. Fisheries are dependent on the productivity of the ecosystem and fisheries have an effect on, and are affected by, the supporting ecosystem of the target species. Responsible fisheries management therefore should take account of the profound interactions between fisheries and their supporting ecosystem.

Ecosystem-based management is concerned with ensuring that fishery management decisions do not adversely affect the ecosystem functions and productivity, so that harvesting of target stocks (and resultant economic benefits) is sustainable in the long term. Traditional systems of management, which have tended to focus on individual stocks, have not achieved this objective and consequently the economic activity that the ecosystem support has become compromised.

The underlying principles of ecosystem-based management are:

- Ecosystem identification (physical, biological and human-dependency relationships)
- Fisheries management objectives should address local and national needs, and should be decentralized to the maximum extent possible
- Ecosystem-based management should aim for long-term benefits
- Incentives should be realigned to support the aims of the ecosystem-based approach
- Information necessary to implement the ecosystem-based approach should be made available
- When information is insufficient, 'Adaptive management' or 'Precautionary principles' should be followed.

Therefore, as happened in the past, fisheries research too cannot be undertaken in isolation and need to be integrated with environment/ecosystem research. When fishing causes depletion of stocks through over-exploitation or lead to uncontrolled removal of non-target species, the survival of species, which are already vulnerable, could be threatened. Similarly, when habitats are degraded due to fishing or other activities, survival of species may be threatened. Thus, Biodiversity conservation too becomes an important issue and fisheries research needs to be integrated with environment and biodiversity.

Research institutions like NARA need to strengthen multidisciplinary and integrated research programmes where fisheries research is linked to research on environment/habitat and other interacting biota. This is of particular relevance to fisheries associated with habitats such as coral reefs, mangroves and sea grass beds.

6.4.3 Resource assessment in Coastal fisheries

A) The last major fisheries resources survey conducted in Sri Lanka was during 1978-1980 period and the estimates of annual potential made for the coastal fishery is considered somewhat outdated, in the context of today's development and management needs. The lack of reliable catch and effort time series data from the fishery also does not allow mathematical estimates of MSY. MFOR has accorded high priority to the conduct of resources surveys, stock assessment and exploratory fishing in order to build up an information base relating to fish resources, which could be utilized for sustainable development and management of the industry.

B) Sedentary and/or slow moving resources inhabiting inshore waters, such as prawns, lobsters, chank, beche de mer, etc. are currently under intense exploitation, with no restrictions on fishing effort. Except for prawn and lobster stocks in some locations, no information is available on the distribution and abundance of these resources. Resource assessment studies need to be initiated for the above species, at least in the major fishing areas to establish sustainable levels of harvesting and provide the basis for management.

6.4.4 National fisheries management plan

Sri Lanka needs to develop a national fisheries management plan, incorporating management plans for the different sectors within an overall national plan, in conformity with the sector development policies over a period of time.

6.4.5 Precautionary approach to fisheries management through Licensing

Except in the case of the beach seine fishery and few isolated cases of traditional community based management, Sri Lanka's fisheries are still conducted under an 'open access' regime. Although all fishing operations since 1996 required a License (Fishing Operations Licenses), no fishery has been brought under management through license limitations. It is proposed that fisheries conducted on sedentary and highly vulnerable resources such as lobsters, prawns, chank, Beche de Mer and Ornamental fish are managed through Licensing limitations as many of these resources are already showing signs of overexploitation at specific sites. Until research provides more reliable information and data on stock sizes and potential yields, a **precautionary approach** can be adopted in the first instance.

6.4.6 Promotion of mariculture

Sri Lanka has not made great strides in the development and promotion of mariculture for want of technology and funds. With increased pressure on wild stocks, the need for production increase through mariculture is more pronounced, not only for food fish but also for culture of marine ornamental fish. This is an area which needs special and urgent attention.

6.5 Proposed actions of transboundary implications

6.5.1 Application of remote sensing

Remote sensing is widely being used in a host of different fields, including natural resource management, oceanography, etc. Countries in the BOBLME, including Sri Lanka lag behind in the use and application of remote sensing. It is proposed that remote sensing applications are promoted on a regional basis, including capacity building in areas such as:

- Mapping of mass movement of pollutants in the coastal and marine environment
- Mapping, predicting and providing early warnings of extreme events in the coastal and marine environment
- Mapping of potential fishing grounds

6.5.2 Management of shared/straddling stocks between Sri Lanka and India

- **Fish and Shrimp resources in the Gulf of Mannar / Palk Bay area**

The continental shelf of northern Sri Lanka is separated from the continental shelf of southern India by a median line across the shallow Palk Bay. The coastal fish resources in this area are shared/straddling stocks fished by fishermen of both countries. The shrimp resources support important fisheries on both sides and over the years there have been countless occasions where fishermen from India have been apprehended by the Sri Lankan navy for illegal fishing. Recently the northern fishermen themselves have apprehended some Indian trawlers fishing within Sri Lankan waters.

It is reported that on the advise of the Federal Government, the state government of Tamil Nadu has introduced a closed season for fishing for 45 days from mid-April to end-May. However in Gulf of Mannar area particularly Rameswaram, Ramnad, Mandapam, Pamban and other adjoining areas, the fishermen themselves have imposed certain restrictions for fishing by motorized boats and the catamarans. They are allowed fishing on alternate days; Monday, Wednesday and Friday for motorized boats and the remaining days for catamarans. This is a self-imposed restriction by the fishermen community and not by the Government.

Sri Lankan fishermen in the north have reported the entry of large numbers of Indian trawlers of around 40 ft length into Sri Lankan waters, particularly on certain days of the week; the days when they are banned from fishing in their own waters.

The straddling stocks occurring across such political boundaries but belonging to a common environment/ecosystem needs to be managed with the active participation of fishers and fisheries managers of both sides. The shrimp fishery is vital to the economy of the coastal communities on either side of the Gulf of Manna/Palk Bay to be left unmanaged.

Fisheries research therefore need to be focused more on assessing the distribution and abundance of resources/stocks in the context of natural as well as political boundaries.

▪ **Development and management of fisheries in Pedro Bank**

With the EEZ delimitation, the Pedro Bank was divided between Sri Lanka and India. There has been no fishing by Sri Lankan boats on Pedro Bank for over thirty years. However, in the event of a permanent solution to the country's ethnic conflict, an accelerated development of fisheries is envisaged for the north and fish resources (both demersal and pelagic) in the southern half of the Pedro Bank, which belongs to Sri Lanka, can make a significant contribution to the fish production from the north.

However, the current state of exploitation in the Indian half of Pedro Bank as well as the abundance of stocks in the Sri Lanka's half of Pedro Bank is not known. Further, the present state of the resources in Sri Lanka's half of Pedro Bank depends on the level of exploitation by Indian trawlers as well as poaching by other vessels.

In the event of a fishery on Pedro Bank by vessels from both India and Sri Lanka, there is a need to regulate the fishery, which is possible only if the two governments cooperate through a bilateral management mechanism.

A joint research programme between Sri Lanka and India to assess the distribution and magnitude of the fish resources shared between the two countries across Palk Strait and Gulf of Mannar, estimation of annual harvestable potentials, and levels of current fishing effort and catch, etc. should lead to the development of bilateral fisheries management plans between the two countries, with due regard to traditional pwnership and customary user righjts in the area.

▪ **Deep sea lobster in Gulf of Mannar**

Deep-sea lobster stocks were discovered off Gulf of Mannar during surveys conducted in 1978-1980 period. Although there is no fishery on these stocks by Sri Lankan boats, it is suspected that Indian trawlers may be fishing on these stocks. Fisheries on these stocks could be developed and managed sustainably through a joint effort between the two countries.

6.5.3 Extension of Biosphere region in the Gulf of Mannar

India has declared their part of the Gulf of Mannar as a Biosphere Region in 1989 and has developed resource management systems to improve the conservation and environment management of the area. Sri Lanka needs to join India and adopt similar measures for full realization of the goal of conservation and management of the natural resources and environment of the Gulf.

In India, a multinational company has commenced large-scale farming of red seaweeds (*Eucheuma cottonii* and *Hypnea musciformis*) adjoining the Gulf of Mannar Biosphere in Mandapam area. Indian scientists have already voiced concern regarding the impact of this activity on the biosphere (Krishnakumar, 2003). Adverse impacts of such activities are bound to spread throughout the Gulf. Therefore, it is important for Sri Lanka to join India and become an active partner in maintaining the ecology and biodiversity of the region.

6.5.4 Offshore Fisheries Development and Management

The migratory offshore fish resources in the BOBLME provide excellent opportunities for the border countries to extend and expand their national fisheries in order to maximize benefits from such resources, a significant proportion of which are now being taken by countries outside the region. As far as Sri Lanka is concerned, lack of access to information on distribution and abundance of high seas fish stocks, excessive reliance on gillnet fishing which land poor quality fish with no export potential and, under utilization of commercially valuable deeper water tuna resources (large yellowfin and bigeye tuna) are some of the key issues and constraints identified in the National Policy and Development Plan of MFOR (2002).

Within an overall regional development programme aimed at assisting member countries to maximize benefits from the offshore highly migratory fish resources, the following major programmes are proposed to achieve sustainable development and management of the offshore fishery in Sri Lanka.

- Development of prototype boats (equipped with on board cooling or freezing facilities and deck equipment) to replace the existing non-specialized gillnets boats.
- Assistance to install onboard cooling or freezing facilities in existing gillnet boats

The above activities would help in reducing post harvest losses, provide better quality fish to consumers and increased earnings to offshore boats and fishermen.

- Development of prototype tuna longliner (60-75 ft) to be followed by the introduction of a fleet of 30-50 boats through a pilot project
- Assistance to small boat tuna long line fishermen to integrate them into an export oriented domestic tuna longline industry.

The above activities would help Sri Lanka to broaden its use of resources within her EEZ, develop fisheries targeting export markets and shift fishing effort from gillnet fishery.

- Development and implementation of a participatory 'Offshore Fishery Management Plan' involving all stakeholders and in which the above activities are incorporated.

A participatory offshore fishery management plan will bring together all stakeholders of the industry, including the government (administrators, managers, researchers, etc.), the private sector (boat yards, engine/gear suppliers, processors, exporters, etc.) and the fishers (boat owners, skippers and fishermen) together in an agreed programme of actions where each stakeholder group is required

fulfill specific obligations and/or responsibilities to achieve common objectives/goals. Such a plan will invariably need to address international concerns expressed through the IOTC.

The ADB financed Coastal Resources Management Project has developed a framework for a fisheries management and development plan for the offshore fishery in Sri Lanka, which needs to be carried forward to its logical conclusion.

6.5.5 Upgrading MCS capabilities

MFOR has a coast guard service with a cadre of 175 who lack skills and training for MCS work. The limited cadre as well as the meager resources including a few small vessels is grossly inadequate to carry out the expected surveillance work.

The ADB financed Coastal Resources Management Project has completed an evaluation of the current system and likely future needs in MCS and has also developed comprehensive manuals and training programmes for establishing a competent MCS system in Sri Lanka. While the draft Fisheries Bill has brought MCS on par with international requirements, MFOR has yet to finalize the role and function of the coast guard service and its position within the umbrella of MFOR. In view of the prevalent high frequency and magnitude of coastal resources and habitat degradation, establishment of an adequate MCS capability is of high priority.

The Development of a Regional MCS Capability - It is also worthwhile to examine the possibility of establishing a regional MCS capability to assist member countries to protect their own resources as well as minimize conflicts between fishermen of neighbouring countries.

6.5.6 Conservation of Marine mammals and Marine turtles

Marine mammals and marine turtles reported from Sri Lanka are part of the Indian Ocean population and are likely to be taken as incidental catches (or even in target fisheries) in many of the countries bordering the Bay of Bengal. It is proposed that a regional programme of activities, involving all countries coming under the BOBLMEP is developed for the conservation of endangered marine mammals and marine turtles, which could also include assessment of marine mammal and turtle populations in the BOBLM ecosystem.

Such a regional programme could also assist national initiatives and also consolidate gains made through other ongoing regional programmes such as GCRMN and CORDIO. In the case of Sri Lanka, support to national initiatives could include assistance to implement the National Marine Turtle Conservation Action Plan.

6.5.7 Establishment of a regional database on coastal ecosystems

Many of the coastal habitats such as coral reefs and mangroves are part of the natural heritage of the tropical region and needs to be conserved on a regional basis rather than on a national basis. An establishment of a regional database on coastal ecosystems would significantly contribute to management and conservation of these ecosystems. In addition, countries need also be assisted to develop their own database.

6.5.8 Transboundary movement of aquatic animals

Support for implementation on a regional of the FAO guidelines for Asia Pacific Transboundary movement of aquatic animals.

6.5.9 Regional networking of Marine Protected Areas

BOBLME programme can also consider establishment of a regional network of marine protected areas, supported by research.

6.5.10 Regional promotion of coastal aquaculture

BOBLME programme can also consider setting up a regional mechanism to assist member countries to develop coastal aquaculture, particularly to combat disease problems attributed to exotic microorganisms.

6.5.11 Protocol for discharge of ballast water from ships

Discharge of ballst water from ships is a growing problem to marine and coastal wetland biodiversity. Therefore, a protocol should be prepared to address this issue, under a transboundary machanism.

6.5.12 Data/Information sharing

A regional mechanism for data/information sharing in the field of environment, oceanography, fisheries, etc. would be of immense benefit to all member countries of the BOBLME. In addition, there is also a need to promote inter-agency /institutional cooperation amongst member countries.

6.5.13 Human Resource Development

Human resources development needs to become an intergral part of the BOBLME programme, particularly if new technologies are proposed to be introduced and promoted in the region for natural resources and environment management.

Areas of interest in human resources development identified for Sri Lanka include:

- Remote sensing and GIS application
- Oceanography and Ocean engineering
- Oil and gas exploration
- Fish stock assessment
- Marine ornamental fish breeding
- Post harvest (value addition)
- Biotechnology
- New technologies in pollution monitoring

In addition, programmes are proposed for the strengthening of national institutions for better conservation and management of the coastal and marine environment and living resources.

7. Benefits from proposed Priority Actions

Benefits likely to accrue from the proposed priority actions are broadly summarized below:

Proposed Action	Benefits		
	National	Regional	Global
Implementing proposed CZMP 2003	<ul style="list-style-type: none"> * Minimize degradation of coastal zone, its habitats and biodiversity * Promote inter-agency collaboration * Promote sustainable use of coastal resources * Active stakeholder participation in coastal zone management 	<ul style="list-style-type: none"> * Contribute to biodiversity conservation * Contribute to conservation of coastal habitats 	<ul style="list-style-type: none"> * Contribute to biodiversity conservation * Contribute to conservation of coastal habitats
Fisheries and Aquaculture	<ul style="list-style-type: none"> * Sustainable development and management of fisheries * Increased national fish catch and exports * Increased catches and income to fishers * Increased export earnings * Contribution to poverty alleviation and food security 	<ul style="list-style-type: none"> *Contribution to the conservation of offshore fish resources *Compliance with international regulations 	<ul style="list-style-type: none"> *Contribution to the conservation of global fish resources * Contribute to sustainable global fish catch
Actions proposed for regional collaboration	<ul style="list-style-type: none"> * Threats/impacts of coastal water pollution minimized. * Sustainable benefits from shared and migratory stocks * Increased catches/incomes for local fishermen *Optimum economic benefits through protection of critical ecosystems. 	<ul style="list-style-type: none"> *Threats/impacts of marine pollution minimized. * Sustainable use of shared and migratory stocks promoted * Minimized user conflicts between fishers of different countries * Conservation of critical ecosystems in the region * Conservation of endangered species(cetaceans/turtles) * Foster cooperation and linkages among Policy makers, Managers, Researchers in the region 	<ul style="list-style-type: none"> * Conservation of shared and migratory fish resources * Conservation of endangered species (cetaceans/turtles)

8. Data gaps requiring further study:

Extensive data gaps exist in relation to coastal and marine environment and its living resources in Sri Lanka. Some of these have already been highlighted under specific actions proposed. For example, Annex 4 of the draft CZMP 2003 provides a comprehensive list of activities to address issues related to coastal and marine environment and its living resources and also identifies data gaps requiring attention. Some of the other specific proposals also refer to the need for studies and investigations. In addition, the following data gaps need urgent attention.

- The social and economic costs of damage to coastal and marine environment and its living resources in terms of various threats.
- The extent and distribution of critical coastal habitats (corals, mangrove, seagrasses, etc.) for the whole island.
- Extent of the use of environmentally harmful fishing methods and their impact on the environment and resources
- Socio-economic data on impact of development on traditional livelihood opportunities of coastal communities, particularly fishing communities
- Detailed fish catch data in the Gulf of Mannar/Palk Bay area from both Sri Lankan and Indian sides

The proposed road link between Sri Lanka and India also pass through this area and the impact of this development on the environment and resources of the region need to be carefully assessed.

- Area specific catch and effort data for fisheries targeting commercially important but highly vulnerable resources (lobster, prawn, Beche de Mer, chank, ornamental fish)
- Reliable export statistics for selected types fish exports (e.g. ornamental fish)

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Annex 1: Marine Protected areas bordering the coast of Sri Lanka.

District	National Parks	Sanctuaries	Extent (ha)	Year Established
Puttalam	Wilpattu national park		131,667.1	1938
		Bar Reef sanctuary	30,669.9	1992
Gampaha		Muthurajawela sanctuary	1,285.4	1996
Galle		Rocky islets sanctuary	1.2	1940
		Honduwa island sanctuary	8.4	1973
		Telwatte sanctuary	1425.0	1938
		Hikkaduwa sanctuary	45.0	1961/1979
		Polgasduwa sanctuary	190.0	1988
Hambantota	Ruhunu (Yala) National Park		97,880.7	1938
			18,148.5	1970
			6,216.0	1993
		Kalametiya lagoon sanctuary	712.0	1984
		Nimalawa sanctuary	1,066.0	1993
Ampara		Kudimbigala sanctuary	4,403.0	1973
Trincomalee		Great Sober Island sanctuary	64.7	1963
		Little Sober Island sanctuary	6.5	1963
		Seruwila - Allai sanctuary	15,540.0	1970
		Pigeon Island sanctuary	4.6	1974
Mullaitivu		Kokilai lagoon sanctuary	1,995	1951
Jaffna		Chunddikulam sanctuary	11,149.1	1938
		Paravitivu Island sanctuary	97.1	1973

(Source: draft CZMP 2003)

Annex 2: District-wise distribution of Estuaries, extent and the condition of the mouth

District	Name of Riverine estuary	Extent (ha)*	Name of Basin estuary	Extent (ha)*	Condition of the mouth			
					1956	1974	1981	2002*
Colombo & Gampaha	Kelani Ganga	84			open	open	open	open
Colombo & Kalutara			Bolgoda	1290	open	open	open	open
Kalutara	Kalu Ganga	173			open	open	open	open
Kalutara & Galle	Bentota	185			open	open	open	open
Galle			Madu Ganga	826	open	open	open	open
	Gin Ganga	35			open	open	open	open
	Mahamodara	18			open	open	open	open
Matara	Polatu Modara	71			open	open	open	open
	Nilwala	38			open	open	open	open
Hambantota	Kirama Oya	5			open	open	open	open
	Walawe Ganga	69			open	open	open	open
	Kirindi Oya	21			open	open	open	open
	Manik Ganga	63			open	open	open	open
Ham: & Ampara	Kumbukkan Oya	35			open	open	open	open
Ampara	Heda Oya	14			open	open	open	open
	Gal Oya (Kalioda Aru)	23			open	open	open	open
Ampara & Batticaloa			Batticaloa	10990	open	open	open	open
Batticaloa			Valachchinai	1321	open	open	open	open
			Uppar or Panichchankerni	2851	open	open	open	◆
Batt:& Trincomalee	Verugal Aru	58			open	open	open	◆
Tricomalee			Thambalagam Bay**	2094	open	open	open	open
	Mahaveli (6mouths)	242			open	open	open	◆
			Sinnakarachchi	764	open	open	◆	open
			Periyakarachchi	688	open	open	◆	open
	Kodikkaddi Aru	145			open	open	◆	open
	Yan Oya	88			open		◆	◆
Trinco: & Mulaittivu			Kokkilai	5439	open	open	◆	◆
Mulaittivu			Nayaru	1155	open	◆	◆	◆
Jaffna & Kilinochchi			Jaffna	33305	open	open	open	open
Kilinochchi	Mandakal Aru	46			open	◆	◆	◆
			Variyakadangu	33	open	◆	◆	◆
Mannar	Pali Aru	15			◆	◆	◆	◆
	Manal Aru	62			◆	◆	◆	◆
	Aruvi Aru	273			◆	◆	◆	◆
	Kalaru	19			◆	◆	◆	◆
Mannar & Puttalam	Uppu Aru	61			◆	◆	◆	◆
Puttalam	Pomparippu Aru	54			◆	◆	◆	◆
	Kala Oya	54			◆	◆	◆	◆
			Vellaimanal	523	open	open	open	open.
			Puttalam Estuary	23401	open	open	open	open
	Deduru Oya	103			open	open	open	open
			Chilaw	729	open	open	open	open

Gampaha	Maha Oya	59			open	open	open	◆
			Negombo	3289	open	open	open	open
Total Extent		2113		88698				

◆ Lagoon mouth closed

*CRMP, 2002), 1956,1974,1981data from Aerial photographs

Aerial photographs not available & no surveys carried out in year 2002 ** although called a bay, it has features of a basin estuary

Annex 3: District-wise distribution of Lagoons, extent and the condition of the mouth

District	Name	Extent (ha)*	1956	1974	1981	2002*
Colombo	Lunawa	23	closed	closed	closed	closed
Kalutara	Maggona	6	closed	closed	closed	closed
Galle	Nape	20	closed	closed	closed	closed
	Madampe	148	closed	closed	closed	closed
	Hikkaduwa	183	closed	closed	closed	closed
	Ratgama	258	closed	closed	closed	closed
	Koggala	588	closed	closed	closed	closed
Matara	Garanduwa	25	closed	closed	closed	closed
	Donra	8	closed	closed	closed	closed
Hambantota	Mawella	99	closed	closed	closed	closed
	Kotuwattawa	6	closed	closed	closed	closed
	Rekawa	256	closed	closed	closed	closed
	Kahanda	51	closed	closed	closed	closed
	Kunukalli	59	closed	closed	closed	closed
	Kalametiya	574	closed	closed	closed	closed
	Lunama	179	closed	closed	closed	closed
	Godawaya	28	closed	closed	closed	closed
	Mahasittarakala	119	closed	closed	closed	closed
	Karagan	395	closed	closed	closed	closed
	Malala	568	closed	closed	closed	closed
	Embilikala	329	closed	closed	closed	closed
	Palatupanagoda	63	closed	closed	closed	closed
	Butuwa	15	closed	closed	closed	closed
	Ethiliwela	38	closed	closed	closed	closed
	Udagajaba Eliya	45	closed	closed	closed	closed
	Yakkala	94	closed	closed	closed	◆
	Mahaselawa	3	closed	closed	closed	◆
Ampara	Itikala	78	closed	closed	closed	◆
	Andarakala	33	closed	closed	closed	◆
	Bagura	108	closed	closed	closed	◆
	Girikula	10	closed	closed	closed	◆
	Okanda	4	closed	closed	closed	◆
	Helawa	106	closed	closed	closed	◆
	Kunukala	71	closed	closed	closed	◆
	Salambe	26	closed	closed	closed	◆
	Panakala	116	closed	closed	closed	◆
	Panama	103	closed	closed	closed	closed
	Arugam	348	closed	closed	closed	closed
	Kotukal	171	closed	closed	closed	closed
	Urani Paladi	204	closed	closed	closed	closed
	Murungatena	33	closed	closed	closed	closed
	Komari	426	closed	closed	closed	closed
	Timbatu	61	closed	closed	closed	closed
	Periya & Sewanaru	1954	closed	closed	closed	closed
	Korai	263	closed	◆	◆	closed
	Omari	238	closed	◆	◆	closed
	Thandiadi	391	closed	◆	◆	closed
	Mulladi	203	closed	◆	◆	closed
	Konawatta	15	closed	◆	◆	closed
	Addippalaim	21	closed	◆	◆	closed
	Wowal	15	closed	◆	◆	closed
	Karative	56	closed	◆	◆	closed
Trincomalee	Ullackalie	1123	closed	◆	◆	◆

	Ilakkanthai	18	closed	◆	◆	◆
	Kuddaipirichchan	183	closed	◆	◆	◆
	Kokkativu	11	closed	◆	◆	◆
	Situvalliammal Kulam	43	closed	◆	◆	◆
	Pokkayakilachenai	40	closed	◆	◆	◆
	Uppuveli	196	closed	◆	◆	closed
	Pulmuddai	78	closed	◆	◆	closed
	Kaikerni	41	closed	◆	◆	closed
Mulaittivu	Kokkudoduvur	76	closed	◆	◆	◆
	Chemmalai	8	closed	◆	◆	◆
	Mulaittivu	9	closed	◆	◆	◆
	Nanthi Kadal	3239	closed	◆	◆	◆
	Chalai	1138	closed	◆	◆	◆
Kilinochchi & Jaffna	Chundi Kukam	7589	closed	◆	◆	◆
	Tondaimanaru	6179	closed	◆	◆	◆
Jaffna	Uppu Aru	1783	closed	◆	◆	◆
	Manatkadu	9	closed	◆	◆	◆
	Pungudutivu	335	closed	◆	◆	◆
	Kamanvilappu	20	closed	◆	◆	◆
	Iruvili	8	closed	◆	◆	◆
	Iruvandi Kulam	19	closed	◆	◆	◆
	Periya Kulam	61	closed	◆	◆	◆
	Vedduk Kulam	76	closed	◆	◆	◆
	Arichandrapiddi Kulam	25	closed	◆	◆	◆
	Vellaikkali Kulam	14	closed	◆	◆	◆
Kilinochchi	Uppulavan	89	closed	◆	◆	◆
	Vallaipadu	8	closed	◆	◆	◆
	Nochchimunai	155	closed	◆	◆	◆
Mannar	Kaththampidi	438	closed	◆	◆	closed
	Vidattaitivu	491	closed	◆	◆	closed
	Periya	364	closed	◆	◆	closed
	Vankali	99	closed	◆	◆	closed
Puttalam	Mundal	2931	closed	closed	closed	closed
	Mutupantiya	48	closed	closed	closed	closed
Total		36178				

*CRMP (2002), 1956,1974,1981 data from Aerial photographs

◆ Aerial photographs not available & no surveys carried out in year 2002

Annex. 4: Fisheries assets destroyed during North East conflict

Item	Unit Price (Rs.)	North (Jaffna, Mannar, Mullaitivu)	East Batticaloa, Ampara, Trincomalee	Total Estimated loss Rs. m
Multi-day boats	810,000	-	28	22.6
28-32ft Day boats	410,000	617	110	297.9
18-23ft FRP boats	150,000	4139	229	664.1
Other motorized craft	110,000	1567	-	172.3
Non-motorized craft	33,500	3630	1250	163.6
Out Board Motor Engines	80,000	116	10	10.1
Inboard Motor Engines	175,000	-	101	17.7
Fishing gear	40,000	793	2178	118.7
Beach seine boats/nets	120,000	143	101	29.2
Fuel depots	1,000,000	3	-	3.0
Ice plants	750,000	3	-	2.3
Houses	75,000	24349	1204	1916.4
Total				3482.0

(Source: FAO, 2003)

Annex 5: List of potential SAM sites and APC sites in the coastal area

District	Special Area Management Site	Area of Particular Concern
Ampara	<ul style="list-style-type: none"> ▪ Periya Kalapu and Korai Kalapu (Lagoons) ▪ Panama dunes, Arugam Bay and Arugam Kalapu (Lagoon) 	<ul style="list-style-type: none"> ▪ Kalmunai fishing area ▪ Konawatte Lagoon and Oluvil fishing area ▪ Komari Lagoon
Batticaloa	<ul style="list-style-type: none"> ▪ Batticaloa Estuary ▪ Uppar Panichchankerni Estuary (Vakarai) ▪ Kalkudah- Passikudah bays, Vandaloos and Thenadi bays, Valachchinai Estuary 	<ul style="list-style-type: none"> ▪ Punnaikuddah, Kaluwankerni Bays ▪ Kaththankudi Thona coastal area ▪ Verugal aru
Colombo		<ul style="list-style-type: none"> ▪ Dehiwala - Mt. Lavinia beach
Galle	<ul style="list-style-type: none"> ▪ Beruwala coastal stretch – and Bentota Estuary ▪ Dodanduwa Lagoon (Ratgama Lake) 	<ul style="list-style-type: none"> ▪ Kosgoda Lagoon & beach ▪ Madampe Lake
Hambantota	<ul style="list-style-type: none"> ▪ Rekawa Lagoon 	
Jaffna	<ul style="list-style-type: none"> ▪ Manalkadu Dunes ▪ Jaffna Estuary (town area) ▪ Thondaimanaru Lagoon ▪ Kankesanthurai and Keeramalai coastal area ▪ Mandativu, Delft, Nainativu Islands ▪ Karainagar (including Cashuarina beach) coastal area ▪ Navali coastal area 	<ul style="list-style-type: none"> ▪ Vadamarachchi coast ▪ Thiruvadinalai – Sankanai coastal area ▪ Palaitivu Island
Kalutara		<ul style="list-style-type: none"> ▪ Kalu Ganga Estuary
Mannar	<ul style="list-style-type: none"> ▪ Gulf of Mannar ▪ Thalaimannar coastal area ▪ Sillavathurai , Arippu and Aruvi Aru coastal area and Bay of Kondachchi, 	<ul style="list-style-type: none"> ▪ Periya Kadai coastal area ▪ South Bar coastal area ▪ Erukulampiddi coastal area ▪ Manthai West coastal area ▪ Pesalai coastal area ▪ Vankalai coastal area
Matara	<ul style="list-style-type: none"> ▪ Weligam Bay 	<ul style="list-style-type: none"> ▪ Polhena beach
Mullaitivu	<ul style="list-style-type: none"> ▪ Nanthikadal Lagoon ▪ Nai Aru Estuary 	
Puttalam	<ul style="list-style-type: none"> ▪ Puttalam Estuary ▪ Chilaw Estuary ▪ Mundal Lake & Puttalam Corridor Channel 	
Trincomalee	<ul style="list-style-type: none"> ▪ Trincomalee Bay ▪ Nilaweli beach, Pigeon Island, Periyakarachchi and Sinnakarachchi Estuaries ▪ Clappenberg bay 	<ul style="list-style-type: none"> ▪ Kuchchiveli-Puduvakattu (including Pirate Coves) coastal area ▪ Thambalagam Bay ▪ Pulmudai coastal area

Annex 6: Coastal Zone Management Plan Institutional Arrangements for Implementation of Identified Prioritised asks

Area	Activity	P	T	Agencies Responsible
1. Coastal Erosion Management	1.1 Study and identify erosion trends and the critically erosion prone areas/sites and recommend appropriate protection measures Outputs: 1.Status Report prepared and periodically updated; 2.Areas requiring protection prioritized; 3.Site specific responses to erosion management formulated	H	L	CCD
	1.2 Develop a shoreline Management Plan including coastal and marine structures with a monitoring and evaluation programme and Initiate Shoreline Management on a pilot basis Outputs: 1.Shoreline management concepts agreed upon; 2.Suitable sites/areas for shoreline management identified; 3.Guidelines for state and private sector for construction of marine and coastal structures prepared & disseminated; 4.Mitigatory measures introduced 5.Pilot projects launched; 6.Implementation monitored.	M	M	CCD UDA / LB
	1.3 Prepare a programme for acquisition of land to implement re-location of houses / establishments-industries where necessary Outputs: 1.New land/sites identified; 2.Households & establishments to be relocated identified; 3.Financial incentives / mechanisms formulated & implemented.	H	M	CCD UDA / DNP DFAR / LB
	1.4 Establish and update a central data base through a coastal processes monitoring programme Outputs: 1.Data collected on sedimental balance/ sediment resources, erosion trends/status, threats to dwellings, land, habitats, hydrographic conditions, socio-economic features of the CZ; 2.Data exchange/access mechanism designed & implemented.	H	L	CCD Universities NARA / CFHC CTB / DFAR
	1.5 Identify areas/sites suitable for reclamation, provide guidelines for reclaiming coastal frontages by relevant state agencies & private developers. Outputs: 1.List of prospective sites prepared; 2.Guidelines prepared and disseminated; 3.Mechanism for approval designed; 4.System for Compliance monitoring set up & implemented	M	M	CCD SLRDC BOI / CTB UDA / LB
	1.6 Develop and implement a Setback Compliance Monitoring Plan Outputs: 1.Set Back Standards publicized; 2.Coastal Segments demarcated and boundaries/sign boards displayed; 3.Permit system implemented and compliance ensures; 4.Monitoring /surveillance mechanism with community co-operation implemented	H	L	CCD UDA / DS LB / DS CTB / F&CC
	1.7 Prepare list of activities outside CZ that have an impact on the CZ and prepare guidelines for use by concerned authorities. Outputs: 1.Suitable coordinating mechanisms established; 2.Developers, local bodies/communities sensitized.	M	M	CCD CEA / LB
	1.8 Conduct survey on all aspects of sand mining within and outside CZ & formulate and implement measures to prevent/reduce river sand/beach mining. Outputs: 1.Locations, intensity, impacts identified; 2.Sustainable limits and site specific sand budgets determined; 3.Monitoring and enforcement strategy agreed upon & implemented	M	M	CCD GSMB Universities CEA
	1.9 Promote the use of alternatives to river sand for use in the construction industry, particularly offshore sand. Outputs: 1.Pilot project for dredging and sale of offshore sand	H	S	CCD Universities

Area	Activity	P	T	Agencies Responsible
	implemented; 2.Technical acceptability ensured by continuous monitoring; 3.Awareness created among building industry/users			M/Cons.I GSMB
	1.10 Prepare and implement plan to effectively enforce the ban on coral mining & promote the use of alternative materials to coral based lime. Outputs: 1.Alternative sources of lime identified; 2.Measures to promote alternatives implemented; 3.Alternative livelihoods to miners promoted; 4.Inter agency coordination strengthened for enforcement; 5.Ban on coral lime in government buildings enforced; 6.Awareness programmes conducted.	H	M	PC CCD / DS Samurdi.M NGO / CBO
	1.11 Collect and analyse data on climate change parameters to predict impacts of sea level rise on the Coastal Zone. Outputs: 1.Data base on climatic change relevant to CZM set up; 2.Mechanism for data analysis & exchange set up; 3.Early warning System re: impending hazards and mitigatory action set up; 4.Monitoring system of sea level rise set up.	M	M	MENR CCD Meterological Dept
2. Coastal Habitats	2.1 Undertake research and identify causes of coral reef damage /destruction (sediments, star fish, ascidians, coconut husk retting, tourism, resource damaging fishing practices etc) and implement mitigatory measures addressing bio-diversity concerns to preserve the reefs through inter-agency collaboration. Outputs: 1.Information collected, analysed and disseminated; 2.Sites & measures for coral reef restoration identified; 3.Measures including control and law enforcement implemented with stakeholder participation.	H	S	NARA CCD / IUCN Universities
	2.2 Study the impacts of water diversion /irrigation on estuaries /lagoons and develop mechanisms to integrate lagoon and estuary management with watershed management Outputs: 1.Impacts on lagoons studied; 2.Mitigatory measures identified; 3.Coordinating mechanism set up and activated	M	L	CCD Irrigation Dept.
	2.3 Survey and demarcate the boundaries of estuaries /lagoons and set up reservations and prevent encroachments /reclamation Outputs: 1.Survey Plans showing boundaries prepared; 2.Boundaries marked with signage; 3.Awareness programmes conducted; 4.Laws enforced with community participation	H	S	CCD Survey Dept. DS / LB F&CC
	2.4 Identify sensitive mangrove areas requiring urgent management / rehabilitation & formulate & implement suitable measures with community participation in line with the plans prepared by the Forest Dept: for selected mangrove areas. Outputs: 1.Sensitive mangrove areas mapped; 2.Measures for management/ mitigation identified; 3.Measures implemented with stakeholder participation; 4.Inter-agency co-operation established; 5.Monitoring mechanism design and implemented.	H	L	CCD Forest Dept.
	2.5 Identify critically important salt marsh areas & sea grass beds based on their ecological/ socio-economic importance and formulate and implement plans for their management /rehabilitation Outputs: 1.Study on salt marshes and sea grass conducted; 2.Plans for management prepared; 3.Stakeholders sensitized; 3.Mitigatory/rehabilitation measures implemented	M	L	CCD / NARA IUCN / DS F & CC
	2.6 Establish Dune Protection Lines (DPL) in critical dune areas using 2003 setback standards, ban new development activities or/and expansion of existing structures within the DPLs & obtain stakeholder co-operation to maintain DPLs. Outputs: 1.Topographic surveys conducted; 2.DPLs given publicity,	H	M	CCD / UDA LB / DS F & CC

Area	Activity	P	T	Agencies Responsible
	signage used; 3.Stakeholders made aware; 4.Laws enforced with inter-agency collaboration.			
	2.7 Manage/regulate exploration /extraction of minerals and mineral sands from barrier beaches, spits and sand dunes in conformity with the Minerals and Mines Act & in consultation with the GSMB and enforce legal action against violators. Outputs: 1.Guidelines prepared & developers informed; 2.Laws enforced	H	L	CCD / LB DS / GSMB
	2.8 Form management groups/protection societies among dwellers in beaches/spits/sand dunes areas and prevent pollution and ensure conservation of flora and ensure their stability Outputs: 1.Local groups organized for protection; 2.Awareness raised on prevention of pollution & preventing damage to/destruction of flora; 3.Plant indigenous flora; 4.Use signage 5.Enforce regulations.	M	M	CCD / DS LB / F & CC
	2.9 Identify areas important as nesting sites for sea turtles and take collaborative action to conserve such sites. Outputs: 1.Studies conducted; 2.Conservation plans prepared; 3.Plans implemented with community participation/incentive schemes.	M	M	CCD / DWL NARA / IUCN TCP
	2.10 Conduct Awareness programmes focused on coastal habitats targeting on all stakeholder groups, politicians, public officers, school children and the general public. Outputs: 1.Awareness materials prepared/updated; 2.Meetings /workshops conducted; 3.Signage used	H	S	CCD NARA / IUCN Educ. Dept NGO / CBO
3. Coastal Pollution	3.1 Initiate Water Quality monitoring studies in coastal waters to capture high incidence of pollution and help identifying polluting industries affecting the coastal area and establish a WQ data base Outputs: 1.Surveys conducted; 2.Data base set up & periodically updated; 3.Polluting activities & causes/sources identified; 4.Mitigatory action proposed & implemented.	M	M	CCD / CEA MPPA / NARA Universities
	3.2 Promote formulation of effluent disposal standards where such standards are currently not available and ensure compliance by developers Outputs: 1.Standards set up; 2.Developers made aware; 3.Standards enforced/compliance monitored	M	M	CCD / CEA NARA Universities
	3.3 Prepare a plan for re-location of polluting industries, abatement of pollution, the introduction of cleaner production technologies and facilitate their implementation Outputs: 1.Industries which require re-location identified; 2.Alternative sites identified; 3.Financial and other incentive schemes proposed; 4.Information on pollution abatement / cleaner production disseminated; 5.Plan implemented/laws enforced	M	L	CCD / CEA M/Indus. UDA / LB DS
	3.4 Identify potential/selected uses of coastal waters & sites for new development activities based on ambient WQ of the sites Outputs: 1.Water quality studies carried out at specific sites; 2.Zoning plans prepared with agency collaboration; 3..Developers informed; 3.Compliance monitored.	M	M	CCD / CEA NARA Universities
	3.5 Formulate and implement a programme to control dumping sites encouraging the use of environmentally sound and economical gainful ways of solid waste management such as composting, bio-gas generation Outputs: 1.Sites with acute solid waste problems identified and environmental degradation monitored; 2.Alternative dumping sites	H	S	CCD / CEA Local Bodies MENR

Area	Activity	P	T	Agencies Responsible
	identified; 3.Facilitate land acquisition and implementation			
	3.6 Reduce pollution of ground water in collaboration with the relevant agencies Outputs: 1.Sites of high economic value identified; 2.Quality of ground water ascertained and sources/causes of pollution identified; 3.Mitigatory action taken on a collaborative basis	H	S	CCD / WRB NWSDB
	3.7 Conduct Education, Information and Communication programmes to raise awareness on pollution and the necessary abatement measures Outputs: 1.Target groups and specific issues and methods for awareness raising identified; 2.Information material prepared and disseminated; 3.Training/awareness programmes conducted	M	M	CCD / NARA CEA Universities
4.Archeological and Scenic Sites	4.1 Prepare and implement a programme for development of coastal sites of archeological, historical/religious/cultural significance in the Coastal Zone (including shipwrecks) on a consultative basis in accordance with laws and guidelines and based on AIAs Outputs: 1.Inter-agency Committee appointed; 2.General guidelines & site specific Guideline book prepared and enforced; 3.Plans for sites including war affected sites prepared and reviewed; 4.AIAs carried out; 5.Permits issued for develop: activities; 6.Compliance monitoring mechanism se up; 7.Donor assisted sought for implementation.	M	M	D/Arch. D/Cultural Affairs CCD / UDA LB
	4.2 Formulate and implement education and awareness programmes and disseminate information on coastal communities & other stakeholders on significance of high priority archeological, historic, religious & cultural sites Outputs: 1.Target groups identified; 2.Awareness/educational Materials prepared; 3.Workshops/meetings conducted	M	M	D/Arch. D/Cultural Affairs CCD
	4.3 Formulate & implement development plans and revitalization programmes for the identified coastal recreational and scenic sites through agency/stakeholder consultations and based on guidelines and EIA/IEEs. Outputs: 1.Coordinating mechanisms set up; 2.Plans/Guidelines prepared, reviewed & disseminated; 3.Development permits issued; 4.Compliance monitoring undertaken; 5.Benefits to local communities ensured	M	M	CTB / CCD LB / UDA F&CCs SAMCCs
	4.4 Formulate and implement participatory management plans for identified narrow coastal strips and view corridors/open spaces. Outputs: 1.Study on narrow coastal strips/view corridors/open spaces conducted; 2.Priority sites identified; 3.Design /development guidelines prepared for such sites; 4.Development activities implemented with community involvement 5.Compliance with guidelines/laws monitored	H	S	DS / CCD LB / F&CC UDA
	4.5 Formulate and implement coastal access maintenance and improvement programmes on a Divisional basis Outputs: 1.Findings of the access studies (97,99 & 02) reviewed; 2.Critical CAPs identified; 3.Impediments for access removed using with co-operation of agencies & local communities; 4.Enforcement measures (permit/land use conditions, land acquisition) used; 5.CAP signs displayed; 6.Compliance monitoring carried out.	H	S	DS / LB UDA / CCD F&CCs SAMCCs
5. Coastal Fisheries and Aquaculture	5.1 Identify harmful practices in coastal & lagoon fisheries & introduce measures to reduce threats to bio-diversity & damage to habitats and environmental, and resource user conflicts Outputs: 1.Studies conducted to identify harmful practices; 2.Existing	H	L	DFAR / NARA NAQDA / CCD F&CC / NGO

Area	Activity	P	T	Agencies Responsible
	laws and regulations reviewed and new laws introduced; 3.Management measures prepared; 3.Measures implemented with community participation.			CBO
	5.2 Introduce programmes for providing alternate livelihoods / income enhancing measures to communities affected by management measures. Outputs: 1.Alternative livelihoods identified; 2.Programmes to promote identified livelihoods formulated and implemented.	H	L	DFAR / CCD F&CC / PC
	5.3 Provide adequate infrastructure facilities at fish landing centers to minimize problems of solid waste (fish waste and offal). Outputs: 1.Locations identified; 2.Development plans including waste management prepared; 3.Funding obtained; 4.Measures implemented	H	M	MFOR DFAR / CFHC NARA / LB
	5.4 Identify illegal /unauthorized structures and activities associated with tourism and other development activities adversely affecting fishermen/fishing activities and initiate action to mitigate such impacts, with particular reference to the madel fishery. Outputs: 1.Surveys conducted; 2.Measures including demolition /removal of structures or suspension of activities identified; 3.Measures implemented/enforced with community participation	H	M	DFAR CCD LB / DS F & CC
	5.5 Prepare and implement an integrated programme for rehabilitating the shrimp farming industry on the NW coast on an environmentally sustainable basis. Outputs: 1.Agency coordination strengthened; 2.Carrying capacity determined & moratorium considered on new approvals 3.Farm extents reduced to match carrying capacity; 4.Environment guidelines and good farming/hatchery practices reviewed and enforced; 5.Technical assistance and incentives provided to farms to comply with guidelines; 6.Monitoring capacity/mechanism strengthened;	H	S	CCD / MFOR NAQDA NARA / NEPC CEA / Shrimp farmers
	5.6 Prepare & implement a proposal highlighting the multi-benefits of the Dutch Canal for its rehabilitation Outputs: 1.Finalize proposal; 2.Seek donor funding; Implement Plan with agency co-operation	H	S	MFOR NAQDA / NARA
	5.7 Prepare and implement a programme to introduce sustainable shrimp farming to new areas. Outputs: 1.Potential for coastal aquaculture in new areas of SL ascertained; 2.Zonal plans and manuals /guidelines prepared 3.Approval process simplified; 4.State land allocation made transparent; 5.Traditional community land uses and bio-diversity protected.; 6.Guidelines enforced/compliance monitored; 7.Provisions made to enforce mitigatory measures; 8.Where environment is harmed and the responsibility for mitigation made the responsibility of the developer. .	H	L	MFOR NAQDA / NARA CCD / CEA PC
6. Special Area Management	6.1 Identify and prioritize SAM/APC sites, prepare and implement plans for them with local collaboration and carry out participatory monitoring. Outputs: 1.Rank/Prioritize identified sites; 2.Prepare Plans with community participation; 3.Design and implement a participatory monitoring programme	M	M	CCD / CRMP DS / LB SAMCCs F&CC
	6.2 Establish a mechanism to facilitate the sustainability of the SAM/APC programmes. Outputs: 1.Identify a mechanism to incorporate SAM plans in regional project / integrated national projects and execute it 2.Donor assistance	M	M	CCD / CRMP DER / M/PI DNP

Area	Activity	P	T	Agencies Responsible
	obtained; 3. Plan for obtaining stakeholder collaboration prepared with in-built incentives; 4. Tangible benefits to communities ensured. 5. A monitoring and evaluation plan institutionalized			
	6.3 Promote training & awareness on SAMP / APCM processes Outputs: 1. Legal framework strengthened; 2. Collaborative management mechanism introduced; 3. Guidelines on responsibilities for stakeholders introduced.		L	CCD / CRMP NARA / IUCN
	6.4 Establish mechanisms to facilitate private sector participation in activities of SAMP/APCM processes in keeping with the SAM concept Outputs: 1. A consultative mechanism set up to deal with private sector; 2. Activities suitable for private sector identified; 3. Schemes to ensure benefits to local communities prepared; 4. A co-monitoring mechanism set up to ensure 3 above.	M	M	CCD / District Chambers Industry Groups / F&CC NGO/CBO
	6.5 Develop an inbuilt mechanism with the experience gained during implementation of the plan to enable the project to become financially independent Outputs: 1. Periodic Review of implementation conducted; 2. Measures for improvements including financial aspects identified; 3. Community SAMCC/funds established by channeling part of benefits received from SAMPs	M	L	CCD / CRMP SAMCCs Development Banks

NOTE: Abbreviations used in the table below are –

- P - Priority Ranking
- T - Time Span
- CCD - Coast Conservation Dept:
- UDA - Urban Development authority
- LB - Local Bodies
- DNP - Department of National Planning
- DFAR - Dept: of Fisheries and Aquatic Resources
- CFHC - Ceylon Fishery Harbours Corporation
- CTB - Ceylon Tourist Board
- SLRDC - Sri Lanka Land Reclamation and Development Board
- DS - Divisional Secretary
- F&CC - Fishing and Coastal Communities
- MENR - Ministry of Environment & Natural Resources
- MCI - Ministry of Construction Industry

The lead agencies indicated in bold lettering