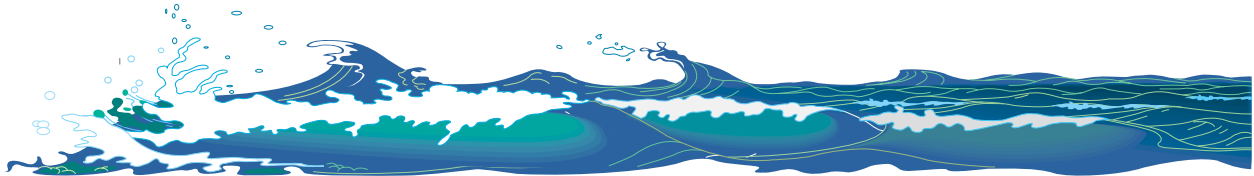


# MARINE REGION 10

## Central Indian Ocean

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### BIOGEOGRAPHY AND MARINE BIODIVERSITY

The Central Indian Ocean Marine Region includes the following countries: Bangladesh, the British Indian Ocean Territory (Chagos Archipelago), India (including the Laccadives, Andaman and Nicobar archipelagos), Maldives, Myanmar and Sri Lanka.

The region consists of three distinct areas: part of the Arabian Sea, the Bay of Bengal and a large area of the Indian Ocean proper south of India and Sri Lanka.

### Oceanography

The Indian land mass forms a major physical division between the Arabian Sea and the Bay of Bengal. Oceanographically, the Bay of Bengal differs from the Arabian Sea in maintaining a clockwise circulation of major currents during both the northeast and southwest monsoons. The circulation in the Arabian Sea reverses, with surface water masses circulating counterclockwise in the northeast monsoon (November–April, when the North Equatorial Current flows west) and clockwise in the southwest monsoon

(May–October when the surface current flows eastward and splits to form clockwise currents in the Arabian Sea and the Bay of Bengal). There is also a major difference in salinity. In the Arabian Sea, evaporation exceeds precipitation and runoff, leading to the formation of high salinity water masses that flow south. The Bay of Bengal has comparatively low salinity due to high runoff and precipitation; in the southwest monsoon, maximum salinity is found at depths of about 500 meters, as high salinity water moves into the Bay from the Indian Ocean (Pernetta 1993a).

The coastline surrounding the Bay of Bengal is heavily influenced by the monsoons, particularly the southwest monsoon that brings heavy rains. Tropical storms also have a major impact; of the 12–13 that occur each year in the Bay of Bengal, three or four of cyclonic strength affect India, Bangladesh and Burma. The northern part of the Bay of Bengal is prone to impact from storms because it concentrates energy from storm centers (Pernetta 1993b).

### **Coastal Geography and Geology**

Shallow accreting coastlines, with deltas and coastal lagoons, dominate in Bangladesh and parts of India and Sri Lanka. The Bay of Bengal has largely soft substrates off the mainland, due to the extensive river discharge, which are overlain by shallow, usually turbid waters. The coastline of Bangladesh is particularly low-lying, and is unique in the region in that the influence of the sea is felt for a long distance inland. It is characterized by a vast deltaic network, an enormous discharge of sediment laden water and numerous offshore sand and mud bars (Pernetta 1993b). The northern part of the coastline of Myanmar is similar, due to the Irrawaddy delta (UNEP/IUCN 1988). The east and west coasts of India have very different characteristics. The west coast is exposed with heavy surf, rocky shores and headlands, whilst the east coast is shelving and low lying with beaches, deltas, lagoons and marshes (Pernetta 1993c).

The Maldives, the Chagos Archipelago, and the island chains belonging to India (Laccadives, Andamans and Nicobars) are archipelagic. The Maldives, the Chagos Archipelago and Laccadives are composed entirely of atolls, with reefs and sandy islands, and form the Laccadive-Chagos chain that extends southward from India to the central Indian Ocean. In contrast, the Andaman and Nicobar Islands are high volcanic islands, arising from a submerged mountain chain that follows a southward extension of the continental shelf.

### **Ecosystem Diversity**

India has important examples of all the main ecosystems found in the region. Sri Lanka and Myanmar have similar diversity but on a smaller scale. Bangladesh is dominated by estuarine and mangrove ecosystems, and the Maldives and the Chagos Archipelago are made up entirely of atolls.

Ecosystem diversity is probably most comprehensively documented for Sri Lanka, where a number of surveys of critical coastal habitats have been carried out, and maps prepared (Pernetta 1993e). The economic value and pressures on the main ecosystem are discussed in the 1993 country reports edited by Pernetta.

### **Coral Reefs**

Information on the reefs of this region is available in UNEP/IUCN (1988). All three major reef types (atoll, fringing and barrier) occur, and the region includes some of the most diverse, extensive and least disturbed reef areas of the Indian Ocean, many of which are among the least scientifically known.

In the north, reef growth is inhibited by massive freshwater and sedimentary inputs from the Indus, Ganges and other rivers, and in the northwest by cold upwelling as well. Bangladesh has almost no reef development due to the high turbidity and soft substrates present, although there is a small reef around Jinjiradwip (St. Martin's Island).

The mainland coast of India has two widely separated areas containing reefs: the Gulf of Kutch in the northwest, which has some of the most northerly reefs in the world, and Palk Bay (with a long fringing reef) and the Gulf of Mannar (with numerous fringing reefs around small islands) in the southeast. There are patches of reef growth on the west coast, for example at Gaveshani Bank. The Andamans and Nicobars have fringing reefs around many islands, and a long barrier reef (320 kilometers) on the west coast. The reefs are poorly known scientifically but may prove to be the most diverse in India and those in the best condition. The Laccadives have extensive reefs but these are equally poorly known.

There are few true coral reefs in Sri Lanka but there are extensive areas of

coral around the coast, mainly close to the shore. Most consist of coral communities growing on ancient sandstone (along the west coast) or gneiss or granite outcrops (along the east coast). True reefs are found in various localities such as fringing reefs at Hikkaduwa and Trincomalee and other localities in the south and east, and offshore reefs in the north such as Bar Reef (probably the most extensive area of true reef in the country) and the south such as the Basses Reefs (reputed to be among the most spectacular and undisturbed in Sri Lanka). Fringing reefs are also found in the north along the Gulf of Mannar and off the Jaffna Peninsula, and on several places on the east coast (Pernetta 1993e).

The main reef areas in Myanmar are in the Mergui Archipelago, which lies sufficiently far from the coast to have clearer water. These reefs are barely known to science, although two brief studies have suggested that they are diverse and extensive (UNEP/IUCN 1988).

The Maldives contain extensive and largely intact reefs, and comprise perhaps one of the most complex reef systems in the world. Several of the atolls have unusual ring-shaped reefs (faroos) in the lagoons, each with its own sandy lagoon and rim of living corals. The atoll lagoons also have numerous knolls and patch reefs (UNEP/IUCN 1988).

The Chagos Archipelago has the largest expanse of undisturbed reef in the Indian Ocean, as well as some of the most diverse. In addition to five atolls, there are two areas of raised reef and several large submerged reefs. Blenheim Reef is notable for its large algal ridge, and the Great Chagos Bank is the world's largest atoll in terms of area (UNEP/IUCN 1988).

In the Laccadives-Chagos chain, a trend of increasing coral diversity has been recorded, from the Laccadives (with nine genera in the northern atolls) to the Maldives (with 41 genera in the northern atolls and 55 in the south) to the Chagos Archipelago

(with 60 genera). There is some variation in published figures for this area: for example, 66 genera (240 species) for the Maldives, and 67 genera (about 200 species) for Chagos, but these do not alter the general picture. The Chagos reefs are of particular interest for the presence of an endemic coral *Ctenella chagius* (UNEP/IUCN 1988).

A similar pattern is seen going north along the east and west coasts of India, with highest diversity in the south (134 species in Sri Lanka, 117 in the Gulf of Mannar and Palk Bay) and lower diversity to the north (44 species in the Gulf of Kutch and 13 genera at Jinjiradwip in Bangladesh). Other figures for coral diversity in these areas include 65 genera (171 species) in Sri Lanka; 39 genera (179 species) in the Andamans and Nicobars (Pande and Singh 1991); and 76 genera (342 species) for the whole of India. About 60 species in 30 genera have been recorded from the Mergui Archipelago in Myanmar, and it has been suggested that these reefs could have over 40 genera (UNEP/IUCN 1988).

### **Mangrove Forests**

Of the 22 countries containing the world's major mangrove areas, Bangladesh and India rank 12th and 14th respectively (Hutchings and Saenger 1987). Since half of the 22 countries occur in the Atlantic mangrove province, the South Asian mangroves assume considerable importance from a global perspective: within the Indo-Pacific, these countries rank third and fifth in importance.

Distribution of mangroves is a mirror image of that for coral reefs. While the most extensive and diverse reefs are found in the south of the region, the major mangrove areas are in the north. Figures for total area covered by mangrove are extremely variable but the northern Bay of Bengal, the Sunderbans and the Ganges delta support over 500,000 hectares. The Sunderbans make up the single largest contiguous block

of mangrove forest in the world, with 60 percent of the area within Bangladesh and the rest in India. Extensive stands are also found along the northern coastline of Myanmar, which has a total of some 517,000 hectares, mainly in the Irrawaddy Delta (much of which has been degraded), on the Tenasserim and Arakan coast and the offshore islands.

Total estimates for India range from about 100,000 to 700,000 hectares, depending on whether degraded areas are included. The most important area is the Sundarbans; good stands are also found in the Kaveri and Godavari Deltas, in Bhittarkanita and the Gulf of Kutch has about 52,500 hectares. Extensive stands are also found in the Andamans and Nicobars, totaling about 115,200 hectares, and much of this is still relatively pristine.

Mangroves are less developed in Sri Lanka and patchy or thin in the atoll islands of the Indian Ocean. In Sri Lanka, 60 percent of the mangroves in the country are found on the northwest coast in the Puttalam Lagoon and the Dutch and Portugal Bay areas. The total area for the country is estimated at 10,000–12,000 hectares. Pernetta (1993e) lists the most important stands, such as those at Puttalam, Batticaloa, Trincomalee, Jaffna and Gampahia. The Maldives has a few small stands, with very low diversity (Pernetta 1993d).

About 12 genera of mangroves are found within the region (compared with 13 in the Indo-Pacific) (Hutchings and Saenger 1987). Indian mangroves are most diverse with 45 recorded mangrove species and associates; Sri Lanka has 28 mangrove species and mangrove associates, Bangladesh 27 and Maldives about five (Pernetta 1993a). The total floral diversity of the Sundarbans amounts to some 330 species.

As is the case elsewhere, the mangroves of the region have great economic value and have been heavily utilized. For example, a 1977 study estimated that roughly 50 percent of India's mangroves had been de-

stroyed since 1963. Both in western and southern India, and throughout the Bay of Bengal, much of the originally extensive mangrove stands have been removed (UNEP 1985).

### ***Seagrass Beds***

Large seagrass beds are present in southern India in Palk Bay and the Gulf of Mannar and in the numerous estuaries and embayments of Sri Lanka. However along much of the coast of western India dense seagrass beds are uncommon or not extensive, probably because of the degree of exposure and turbidity of these waters. There are some seagrass beds in the Laccadives and they are possibly extensive around the Andamans and Nicobars.

In Sri Lanka seagrasses cover an area far in excess of that covered by mangroves and coral reefs, and probably make the largest contribution to the primary production of inshore waters (UNEP 1985). They are most extensive in the north, particularly from Dutch Bay to Jaffna Lagoon and from Mannar to Rameswaram, and may support more than 50 percent of the country's near shore fishery production. Other important seagrass areas are listed in Pernetta (1993e).

There is little evidence for the existence of major seagrass beds off the coast of Bangladesh, perhaps because of the large seasonal fluctuations in salinity (Pernetta 1993b), and there are only small areas of seagrass in the Maldives.

UNEP (1985) estimated that perhaps five percent of the seagrass beds of the Indian Ocean had been destroyed by dredging or infilling.

### ***Other Wetlands***

Wetlands, including mangroves (see above) are one of the dominant ecosystems in this region due to the presence of the large deltas of the Ganges, Brahmapu-

tra and Irrawaddy rivers that dominate the head of the Bay of Bengal, the delta in Bangladesh comprising the largest such system in the world. Bangladesh probably has the greatest area of coastal wetlands in the region, with an estimated total of 2.5 million hectares of tidally inundated land (although much has been diked or converted to shrimp ponds): floodplains and coastal mangrove swamps cover almost one third of the country (Pernetta 1993a,b). Scott (1989) provides a detailed description of the coastal wetlands of the Bay of Bengal.

India has about 3,900,000 hectares of estuarine wetlands (134 brackish and 19 coastal wetland areas have been documented). There are also extensive tidal wetlands in Sri Lanka that has an estimated 80,000 hectares of estuaries and deep lagoons and 40,000 hectares of shallow lagoons, tidal flats and mangroves. There are about 45 estuaries and 40 true coastal lagoons, many of which lie along the south and east coasts. Numerous seasonal lagoons form during the wet season and are important for fisheries, salt production and wildlife habitat (Pernetta 1993e). The main wetland sites in the region are described in Scott (1989).

### ***Beaches, Dunes, and Cliffs***

Bangladesh is notable for its 145 kilometer stretch of beach from Cox's Bazar to the tip of the Teknaf Peninsula (Pernetta 1993b), and there are numerous sandy beaches on the islands of the atoll chains. Sri Lanka has about 11,800 hectares of beaches and spits extending over 300 kilometer of coast, and sand dunes covering an area of 7,606 hectares (Pernetta 1993e). Sand dunes are present on some of the more exposed parts of the coast of northern Burma (UNEP/IUCN 1988) and on the south-facing coasts of the islets making up Adam's Bridge, which extends from Sri Lanka to India.

Rocky shores are absent from the Maldives, Laccadives, Chagos Archipelago, east coast of India and Bangladesh. There are small amounts in Sri Lanka, and more extensive areas on the west coast of India and in the Andaman and Nicobar Islands.

### ***Islets***

There are a number of large archipelagos in the region. The Andamans (50 islands, islets and rocks) and Nicobars (20 islands) are a volcanic chain. The Mergui Archipelago lies off the southern coast of Myanmar and consists of over 800 islands; two other groups of islands are found in Burmese waters, one extending from the Andaman and Nicobar islands to the mainland coast, and another lying off the northern coast. The Preparis Islands and Coco may have important seabird colonies. Numerous islands and islets are found in the Laccadives-Chagos chain; the Maldives, which is the largest group, has 1,200–2,000 islands, the majority of which are less than one square kilometer in size. The Laccadives has about 25 islands on 11 atolls.

There are also small rocky islets off the coasts of the continental countries, such as Sri Lanka (off Hikkaduwa, Trincomalee, Jaffna and the islets of Adam's Bridge) and India (the Gulf of Mannar islands).

In addition to the various rocky, coral or sandy islands lying off the coasts of the continental countries in the region, the deltaic areas are notable for the large number of temporary, semipermanent and permanent islands formed by the networks of distributaries. In the Sundarbans, these are called chars, and are constantly being formed where easily eroded sands and mud collect (Pernetta 1993b).

### ***Open Ocean, Deep Sea, and Upwellings***

The Swatch of No Ground is a deep canyon that runs across the continental shelf off Bangladesh; the Burma Trench is another

deep canyon in the Bay of Bengal (Pernetta 1993b). Upwellings occur off Orissa (north-east India), the Andamans and the west coast of Sri Lanka during the northeast monsoon.

## Species Diversity

### Algae

About 78 genera and 174 species of algae have been recorded from Sri Lankan waters (Pernetta 1993e), 285 species from the Maldives (Pernetta 1993d) and 624 species from India (Pernetta 1993c). Several species are exploited commercially on a large scale in the region, particularly in India and Sri Lanka.

### Invertebrates

Diversity is high, and for some groups may show a similar trend to that for corals described above, but it has not been possible to collate available data. A total of 384 mollusks has been recorded from the Chagos Archipelago, suggesting this area has a high diversity (UNEP/IUCN 1988). Many invertebrates are harvested and are of economic importance; there is evidence that some mollusks and crustaceans have been overexploited, and species such as the coconut crab, horseshoe crabs, and certain mollusks are of conservation concern.

### Fish

Commercial and subsistence fisheries are important throughout the region and are briefly described for Bangladesh, India, the Maldives and Sri Lanka in Pernetta (1993 b,c,d,e). In most countries the bulk of the catch is subsistence or artisanal. Hilsa is the main species taken in the Bay of Bengal; tuna fisheries are important in Sri Lanka and the Maldives; and although reef fisheries are not as important in this region

as in some others, both Sri Lanka and the Maldives export reef fish for the aquarium trade. The Bay of Bengal is particularly rich because of the nutrient input from the large rivers and there is extensive information available for the fisheries of this area through the Bay of Bengal Programme on marine fishery resources.

There has not been time to gather information on fish diversity but this is expected to be high particularly in regions where there are reefs; over 1,200 species of fish have been recorded from the reefs and surrounding ocean of the Maldives (UNEP/IUCN 1988). However, the Chagos Archipelago has a relatively low fish diversity (compared with that for corals and mollusks), perhaps because algal diversity and abundance is also low. The pygmy angel-fish *Centropyge flavipectoralis* is thought to be endemic to Sri Lanka.

### Marine Turtles

Five species of marine turtle are found in the Indian Ocean, and are considered to be at risk in most countries. These are the green (*Chelonia mydas*), the hawksbill (*Eretmochelys imbricata*), the loggerhead (*Caretta*), the leatherback (*Dermochelys coriacea*) and the Olive Ridley (*Lepidochelys olivacea*). Information on their distribution in Bangladesh, India, Sri Lanka and the Maldives is given in Pernetta (1993 b,c,d,e). There are a number of globally and regionally important nesting sites. These include:

- *Green*: Gulf of Kutch and Saurashtra Peninsula in India; uninhabited islands in Laccadives, Maldives and the Chagos Archipelago.
- *Hawksbill*: Largest population (probably of regional importance) in the Andamans, particularly South Reef and North Brother; probably also nests in the Chagos Archipelago and on uninhabited islands in the Maldives.

- *Olive Ridley*: The most common species in Bangladesh, India and Sri Lanka; about 300,000–500,000 nest in Orissa (two important nesting beaches); many other nesting sites on mainland coast, for example, Sundarbans, Andamans and Nicobar, Laccadives; several thousand nest in southwest Sri Lanka at several sites.
- *Leatherback*: Uncommon, but main populations in Andamans and Nicobars, with a small population in Sri Lanka.
- *Loggerhead*: Rare.

### **Birds**

Globally threatened marine and coastal species that occur in Bangladesh, India, Sri Lanka and the Maldives are listed in Pernetta (1993 b,c,d,e). There are a number of globally threatened coastal wetland species such as the Spot-billed Pelican *Pelecanus philipensis* and the Lesser Adjutant *Leptoptilos javanicus*. Important coastal areas for birds include the Gulf of Kutch, Chilka Lake, Coringa Wildlife Sanctuary and the Sundarbans in India and several areas in Sri Lanka.

The seabirds of the region are poorly known and do not appear to be abundant in India, Bangladesh or Sri Lanka. The Sundarbans are an important staging and wintering area for gulls and terns, and the islets of Adam's Bridge, off Sri Lanka have some seabird colonies. Many of the atoll islands in the Laccadives-Chagos chain may have seabird colonies, such as Pitti and Baliapani in the Laccadives and several of the Chagos Archipelago islands. Further information on seabirds in the Maldives and other island chains is available in Feare (1984).

### **Mammals**

Antarctic stocks of baleen whales move north into the Indian Ocean in the Antarctic

winter, but there may be small independent stocks in the northern Indian Ocean. There are a large number of small cetaceans, some of which are not well known, and many of which are harvested either intentionally or incidentally. The most threatened species are the river dolphins of the Ganges and Irrawaddy; these are sometimes found in estuarine waters but are not truly marine animals and so are not considered here. The Indian Ocean populations of the humpback dolphin *Sousa chinensis* and the spotted dolphin *Stenella attenuata* are considered at risk; the distribution of the latter appears to be closely correlated with mangroves (Pernetta 1993b). Cetaceans are reasonably well known in this region and further information is available in the 1993 country reports and in Gaskin (1985).

The distribution of the dugong extends over most of the region, but appreciable numbers are no longer found. The most important area for this species in the region, and possibly in the whole Indian Ocean, is the Gulf of Mannar and Palk Bay in India, and possibly also in the north of Sri Lanka. Small numbers may still occur in the Gulf of Kutch. In the Andamans and Nicobars the only remaining sites where they definitely occur are Ritchie's Archipelago and North Reef.

### **Biogeographic Classification**

The classification used here has been developed by Dwivedi, Singh, and Ivan (1994).

The Central Indian Ocean Marine Region lies in the middle of the decreasing trend in diversity from Southeast Asia to the East African coast. The eastern part shares biogeographic characteristics with Southeast Asia, while the western part is more like the Arabian Sea and western Indian Ocean. In terms of zoogeography, the region includes parts of both the Indian and Malayan subregions of the Indo-Malayan zoogeographic realm, with Myanmar in the latter, Bangla-

desh at the junction and the other countries in the former. Hayden, Ray, and Dolan (1984) place the whole region within the Indo-Polynesian province.

The Central Indian Ocean described in the report can be divided into five major areas as given here. These are in general conformity with Hayden (1984), but subsystems that are important and distinct from the point of view of species distribution have also been recognized. Some of these have been recognized earlier by Dwivedi, FAO-BOBP reports and Sherman and others (1993).

The Indian Ocean and the adjoining Arabian Sea and Bay of Bengal lie in the tropical monsoon belt. Here the oceans play a major role in determining the climate, rainfall, productivity and biodiversity. However due to the presence of a large continent, the oceanographic features change from one region to another.

The Arabian Sea does not have major estuaries and wind induced upwelling plays a dominant role in governing productivity, species distribution and biodiversity. The productivity of the area is affected due to the width of the shelf. The Bay of Bengal has a large number of estuaries and input of lower salinity water is significant. This coupled with storm surges and cyclones, which are a regular feature in the northern part of the Bay, has resulted in creating a surface layer up to 100 meter depth with low salinity and high temperature and a deeper layer with higher density and more saline water.

Bearing these considerations in mind, the Arabian Sea, Bay of Bengal, and open Indian Ocean are recognized as major subsystems. These are further divided due to coastal morphology, water and silt inputs by rivers and estuaries that determine the transparency, salinity and density of water. These form subsystems that are described here. Recognition and characterization of large marine ecosystems have been dealt with by Sherman and others (1993).

Dwivedi (1993, in same publication) has dis-

cussed the Bay of Bengal ecosystems. The major biogeographic divisions of the Central Indian Ocean are:

- Western Indian Ocean along the Indian Coastline:
  - Southwest coast of India
  - Central west coast of India
  - Northwest coast of India
- Eastern Indian Ocean:
  - Southeast coast of India and Sri Lanka including Palk Bay and Gulf of Mannar extending up to the Krishna delta.
  - Northeast coast of India off Andhra Pradesh and Orissa extending up to the border of west Bengal.
- Northern Bay of Bengal covering the coasts of West Bengal and Bangladesh.
- East Bay of Bengal off southern part of Bangladesh and the coast of Myanmar including the Irrawaddy mouth.
- The Central Indian Ocean including the Maldives and the Chagos Archipelago.

## ASSESSMENT OF EXISTING MPAS

### Description of National MPA Systems

There are a number of terrestrial and marine protected areas in the Central Indian Ocean Marine Region, that include habitats important for marine biodiversity, such as lagoons, mangroves or turtle nesting beaches. In many cases it has been difficult to determine how far the boundaries of these areas extend and to determine whether subtidal marine elements are included. Nevertheless, an attempt has been made to identify, on the basis of available information (the main sources being Dwivedi, Singh, and Ivan 1994; Pernetta 1993a,b,c,d,e; IUCN, 1990 and information in the World Conservation Monitoring Centre Protected Areas Database), which of these protected areas have a marine focus and which are primarily coastal land. Available information suggests that there are 15



**Table 10.1 Number of Existing MPAs by Country in the Central Indian Ocean Marine Region**

<i>Country</i>	<i>Marine Sites</i>	<i>Coastal Sites</i>
Bangladesh	0	3
British Indian Ocean Territory (Chagos Archipelago)	0	
India	10 <sup>a</sup>	6
Andaman and Nicobar Islands	1	13
Maldives	0	
Myanmar	0	
Sri Lanka	4	12
Total	15	34

protected areas that include subtidal elements and a further 33 that include terrestrial coastal and in some instances intertidal features.

Map 10 shows those MPAs that have been recorded as including a subtidal component; these areas are identified in the national sections below; other coastal protected areas are also listed. Table 10.1 shows the number of marine and coastal protected areas by country.

### ***Bangladesh***

The Forest Department of the Ministry of Environment and Forests is responsible for the management of protected areas. Wildlife Sanctuaries are established under the Bangladesh Wildlife (Preservation) Order 1973. The Marine Fisheries Ordinance 1983 provides for the establishment of marine reserves but none has been designated (Pernetta 1993b). There are two coastal protected areas that include intertidal habitat and may include subtidal habitat (although the latter could not be confirmed):

- Sundarbans Forest Reserve, east Wildlife Sanctuary, south Wildlife Sanctuary and west Wildlife Sanctuary: Important for mangroves; site accounts in Scott (1989) and IUCN (1990).

- Char Kukri-Mukri Forest Reserve and Wildlife Sanctuary: Important for mangroves and intertidal mudflats. Site accounts in IUCN (1990) and Scott (1989).
- Teknaf Game Reserve and Himchari National Park: Adjacent to the coast, but probably do not include intertidal habitats. Mangroves in the Chakaria Sundarbans Forest Reserve have been logged or so severely degraded that it can no longer be considered a protected area; Scott (1989) provides a site account.

### ***British Indian Ocean Territory (the Chagos Archipelago)***

No MPAs have been established; the inaccessibility of the area provides some measure of protection.

### ***India***

The Wildlife (Protection) Act 1972 provides for the establishment of national parks and sanctuaries by state governments, and they are administered by the Ministry of Environment and Forests. The Gulf of Kutch Marine Sanctuary and Marine National Park, the Gulf of Mannar National Park and Wandur Marine National Park have been established primarily to protect marine habitats. However, many other protected areas include important marine ecosystems (Pernetta 1993c) and it is often not clear where the seaward boundary is; for example, all protected areas in the Andaman and Nicobars have at least part of their boundaries adjacent to the marine environment, and in many cases cover saltwater creeks that extend inland (Pande and Singh 1991). The main MPAs are identified below. Other coastal areas are also listed:

- \ Gulf of Kutch Marine Sanctuary and Marine National Park (two areas): Important for fringing reefs, mud and sand flats, coastal marsh, mangrove forest (about 50,000 hectares) probably best developed on western Indian

- coast, nesting green turtles, occasional leatherback and Olive Ridley; dugong sometimes present; resident and migratory birds; site description in Scott (1989) and UNEP/IUCN (1988).
- \ Malvan Sanctuary: Important for coral reefs, sandy beaches, turtle nesting and mangroves.
  - \ Chora Island Wildlife Sanctuary: Estuary, mangroves; recreation and education centre.
  - \ Pichavaram Forest Reserve: Part of much larger (11,000 hectares) mangrove system—only remaining mangrove area in Tamil Nadu and one of the richest and most interesting in India; also important for coastal lagoon, fishing, mollusks, crocodiles; site description in Scott (1989).
  - \ Pulicat Lake Sanctuary (46,102 hectares in Tamil Nadu, 58,000 hectares in Andhra Pradesh): Important for saltwater lagoon (second largest in India), migratory shorebirds, fishing; one of the largest coastal lagoons in the country; site description in Scott (1989).
  - \ Gulf of Mannar National Park (20,000 hectares, of which 623 hectares is land): Most important mangroves in southern India, seagrass beds, many small islands major green turtle feeding ground, occasional olive ridleys, dugong, dolphins, coral reefs; site description in UNEP/IUCN (1988).
  - \ Chilka Lake Wildlife Sanctuary; Ramsar site: One of largest concentrations of migratory waterfowl in the region and one of the largest coastal lagoons; site description in Scott (1989).
  - \ Sundarbans National Park: Estuarine areas, important for mangrove forest; site description in Scott (1989).
  - \ Bhitarkanika Wildlife Sanctuary: Islands and beaches located in a deltaic area on the coast of Orissa; globally important site for nesting Olive Ridleys

(100,000 nesting turtles in 1970s); site description in Scott (1989).

Other coastal areas include:

- Phansad Wildlife Sanctuary; mangroves.
- Point Calimere Wildlife Sanctuary; important for saltmarsh, mudflats, waterfowl, wintering migrants and associated terrestrial habitats and wildlife; at eastern end of large Vedaranyan Swamp; adjacent turtle nesting project; site description in Scott (1989).
- Coringa Sanctuary; important for mangroves, shallow lagoons, saltwater crocodile; site description in Scott (1989).
- Krishna Reserved Forest; mangroves; site description in Scott (1989).
- Mahanadi Delta crocodile conservation area (16,835 hectares); important for saltwater crocodile, mangroves; site description in Scott (1989).
- Gahirmatha Wildlife Sanctuary; important for saltwater crocodile (main Indian population); mangroves, Olive Ridley turtle nesting; site description in Scott (1989).

Other protected areas on the mainland that may also have marine, or at least intertidal, habitats (see Pernetta 1993c) are Khijadiya Wildlife Sanctuary, Little Rann of Kutch Wildlife Sanctuary, Vedanthangal Wildlife Sanctuary, Vettangudi Wildlife Sanctuary, Balukhand Wildlife Sanctuary, Lotherian Island Wildlife Sanctuary, Halliday Island Wildlife Sanctuary, Sajnakhal Wildlife Sanctuary.

There may also be a seabird sanctuary on Pitti Island in the Laccadives, but this is unconfirmed.

### ***Andaman and Nicobar Islands***

All the 100 protected areas in the Andaman and Nicobars comprise part or all of small islands and have intertidal, coastal areas; many have mangroves. According to Pande and Singh (1991), a number of these have

subtidal habitat; however, it has not been possible to identify these in this report. Wandur Marine National Park includes subtidal marine elements and is highlighted below; other important coastal protected areas are listed:

- \ Wandur Marine National Park: Possibly the least disturbed group of islands and the richest coral reefs in the Andamans; four turtle species; dugong; mangroves; site description in UNEP/IUCN (1988) and Pande and Singh (1991).

Other coastal areas include:

- Saddle Peak National Park: includes a long rocky beach
- North, Middle and South Button Island National Park: nesting turtles, mangroves
- Barren I. Sanctuary: active volcano, with coral communities
- Battimalv I. Sanctuary (Nicobars): mangroves
- Interview I. Sanctuary: mangroves, hawksbills
- South Reef I. Sanctuary: lies off the tip of Interview I
- Megapode I. Sanctuary (Nicobars): reefs, mangroves
- Narcondam I. Sanctuary: mangroves
- North Reef I. Sanctuary: beaches, corals, mangroves
- La Touche I. Sanctuary: green turtle
- Saltwater Crocodile Sanctuary: an extension of Wandur Marine National Park to the north; numerous creeks and inlets, mangroves, turtles, crocodiles
- South Sentinel I. Sanctuary: small coral island, beaches, large green turtle nesting beach, mangroves; established mainly for coconut crab
- Tillongchang I. Sanctuary: cliffs, mangroves, beaches

Great Nicobar Biosphere Reserve, on the southernmost island of the Nicobars (only 145 kilometers from Sumatra) has no legal status yet but includes important marine ar-

eas and mangroves.

### **Maldives**

As yet no MPAs have been established. However, a number of other activities related to protection and management of the marine environment are under way. In particular, the National Environment Action Plan provides a framework for environmental planning and management. Measures are in place to restrict coral mining and reduce marine pollution.

### **Myanmar**

Current conservation and wildlife legislation does not provide specifically for the establishment of MPAs. Thamehla Kyun Wildlife Sanctuary and Moscos Island Sanctuary, managed by the Forest Department, are coastal but do not protect marine habitats (UNEP/IUCN 1988).

### **Sri Lanka**

The focus of marine conservation in Sri Lanka is coastal zone management, and MPAs *per se* have received less direct attention. The Coast Conservation Act enacted in 1981 covers the area within 300 meters landward of mean high water level and two kilometers seaward of mean low water. The Act required the development and implementation of a coastal zone management plan that places most emphasis on control of erosion and sand and coral mining, with a permit system for development activities (Lowry and Sadacharam 1993).

Marine Sanctuaries are established under the Fauna and Flora Protection Ordinance that is to be revised to include specific reference to MPAs. A draft new Fisheries Bill prepared in the early 1980s included provisions for marine reserves and sanctuaries, but it is not known if this is being

followed through. Marine areas come under the jurisdiction of many government departments: the Department of Wildlife Conservation is responsible for Marine Sanctuaries, the National Aquatic Resources Agency (NARA) for marine research, the Coast Conservation Department for coastal zone management, and the Ministry of Fisheries and Aquatic Resources for fisheries.

MPAs are being established through the Special Area Management (SAM) project that is establishing management areas at Hikkaduwa Reef and Rekawa Lagoon (see the Appendix).

There are 16 protected areas that include coastal elements, four of which include subtidal elements (Hikkaduwa Marine Sanctuary and Bar Reef Marine Sanctuary have been established specifically to conserve coral reef areas; other areas cover important estuarine, mangrove and other habitats):

- \ Hikkaduwa Marine Sanctuary: Coral reefs; includes the Rocky Islets Sanctuary; currently management being improved through a SAM project; site account in UNEP/IUCN (1988).
- \ Kokkilai Lagoon Sanctuary: Estuarine lagoon, sea grass beds, small amount of mangrove; water birds; poorly protected; site account in Scott (1989).
- \ Bar Reef Marine Sanctuary: Important for coral reefs; recently established and management plan being developed through NARA, which has a nearby research station.
- \ Ruhuna (Yala) National Park: Coastal area includes a complex of brackish lagoons, several estuaries and 64 kilometers of shore; mangroves and abundant wildlife; site account in Scott (1989).

Other coastal areas include:

- Pigeon Island Sanctuary: marine areas may not be included within boundary;

site account in UNEP/IUCN (1988) under "Trincomalee Reefs."

- Wilpattu National Park: includes 40 kilometers of rocky coastline with cliffs, some sandy beaches, dunes and mangroves; site account in Scott (1989).
- Chundikkulam Sanctuary: coastal lagoon, mangroves, seagrass beds; inadequate protection; site account in Scott (1989).
- Trincomalee Naval Headworks Sanctuary.
- Great Sober Island Sanctuary.
- Madhu Road Sanctuary.
- Seruvila-Allai Sanctuary: includes the western part of Ullackalie Lagoon; extensive mangrove, water birds; site account under "Ullackalie" in Scott (1989).
- Kudumbigala Sanctuary.
- Yala East National Park: coastal area includes a complex of brackish/saline lagoons and extensive sandy beaches; Kumana Villu Lagoon has extensive mangroves and is protected as a bird sanctuary; site account in Scott (1989).
- Bundala Sanctuary: includes four shallow brackish lagoons and adjacent sea coast; designated a Ramsar site in 1990; birds, fisheries, tourism; site account in Scott (1989).
- Kalametiya Kalapuwa Sanctuary: two brackish lagoons fringed with mangrove; very important for water birds; site account in Scott (1989).
- Honduwa Island.

There are site accounts for several of these areas in IUCN (1990).

### **International and Regional Initiatives Relating to MPAs**

#### ***World Heritage Convention***

The following countries are party to the World Heritage Convention: Bangladesh, In-

dia, Sri Lanka, Maldives (and possibly the Chagos Archipelago through the UK).

The only marine World Heritage Site in the region is the Sundarbans National Park in India. It has been recommended that the Chagos Archipelago should be nominated.

### ***Ramsar Convention***

The following countries are party to the Ramsar Convention: Bangladesh, India, Sri Lanka.

There is one marine Ramsar site (Chilka Lake, India), and two other coastal areas (Sundarbans, Bangladesh and Bundala, Sri Lanka). Several other sites have been proposed for India, including Point Calimere, Khijadia and the Gulf of Kutch.

### ***MARPOL***

No areas in the region have been identified under MARPOL.

### ***UNESCO Man and the Biosphere Programme***

The following countries have national MAB committees: Bangladesh, India, Sri Lanka.

No marine biosphere reserves have been designated in the region but a number have been proposed for India, including the Gulf of Kutch, Gulf of Mannar, Chilka Lake and the Sundarbans (Scott 1989). There is a biosphere reserve in the Nicobar Islands but this is not part of the MAB programme (Pernetta 1993c).

### ***UNEP Regional Seas Programme***

A Regional Seas Programme was established in 1983 for the South Asian Seas Region (which covers Pakistan, India, Bangladesh, Sri Lanka and the Maldives) but there is no Convention or Action Plan yet. A number of preliminary country studies have been produced such as

**Table 10.2 Number of MPAs in Biogeographic Zones of the Central Indian Ocean Marine Region**

<i>Biogeographic Zone</i>	<i>Number of MPAs</i>
I. Western Indian Ocean	4 <sup>a</sup>
II. Eastern Indian Ocean	8
III. Northern Bay of Bengal	2
IV. East Bay of Bengal	1
V. The Central Indian Ocean	0
Total	15

IUCN/UNEP (1985) and the 1993 reports used in this review.

### ***Other***

Relatively few regional initiatives are underway in this region, apart from the fact that the whole area lies within the Indian Ocean Whale Sanctuary. Research into fisheries management issues is being carried out in the Bay of Bengal through cooperation by FAO and other agencies.

### **Assessment of Representation of Biogeographic Zones within MPAs**

The degree to which MPAs in the Central Indian Ocean Marine Region represent the biogeographic regions identified is discussed below. This assessment considers only those 15 protected areas recorded as including a subtidal component. There are an additional 34 protected areas which include terrestrial coastal and in some instances intertidal features.

Most MPAs are located in the Eastern Indian Ocean biogeographic zone, that includes eight MPAs. Four of these are located around Sri Lanka and four along east the coast of India. There are four MPAs covering three separate sites along the west coast of India in the Western In-

dian Ocean zone. There is one MPA in the East Bay of Bengal, Wandur Marine National Park, which is located in the Andaman Islands. There are two MPAs in the Northern Bay of Bengal zone, (Sundarbans NP and Bhitarkanika Wildlife Sanctuary in India).

A more detailed analysis would be required to determine whether the existing MPAs effectively conserve a representative range of the habitat and ecosystem types within each of the zones that are represented. However, even without such an analysis it is clear that there are some major gaps.

Four of the six countries or territories in the region (Bangladesh, Maldives, Myanmar and the Chagos Archipelago) have no subtidal MPAs (although Bangladesh has two coastal land protected areas that include intertidal features). The atoll groups of the Laccadive-Chagos chain and the coast of Myanmar are also not represented. There is only one MPA in the Andaman and Nicobar island group.

Rodgers and Panwar (1988) assess representation of the coast and island biogeographic zones in protected areas in India. Protected areas on the coast cover 2.4 percent of the country (two National Parks and 17 other protected areas), and island protected areas cover 0.3 percent of the country (six National Parks and 100 other protected areas), mainly in the Andaman Islands. The Laccadives and Nicobars have poor coverage. However, there is no assessment of MPAs as such by these authors.

## PRIORITY AREAS AND RECOMMENDATIONS

### National Priorities for the Establishment and Management of MPAs

Recommendations are given in the Corbett Action Plan for Protected Areas in the Indo-

Malayan Realm (Thorsell 1985). Most sets of recommendations stress the global and regional importance of the coral reefs of the Maldives, the Chagos Archipelago and Laccadives and the coastal wetlands of India, Bangladesh and Myanmar. Several areas need at least bilateral conservation action, such as the Sundarbans (India and Bangladesh), the Gulf of Mannar and Palk Bay (India and Sri Lanka) and the eastern Indian Ocean atoll systems (India, Maldives, the Chagos Archipelago).

The following areas have been identified on the basis of existing and available information by Sue Wells (see Map 10). Dwivedi, Singh, and Ivan (1994) provided a subsequent review of priorities. The recommendations have not yet been reviewed by government authorities in the countries concerned.

### *Bangladesh*

Recommendations for future action in the coastal and marine environment are given in Pernetta (1993b). The priority areas for marine biodiversity conservation are given below.

#### Proposed new MPAs:

- \ The Sundarbans: Primarily important for mangroves and associated fauna and flora; there are several existing protected areas that include intertidal habitat and may include subtidal habitat; the area is an important breeding and nursery area for a range of marine species and should be a priority for a MPA.
- \ Naaf Estuary islands (and adjacent areas including Teknaf Peninsula and Chakaria Sundarbans): Supports a small stand of mangroves with the only population of crab-eating macaques in the country; site accounts for some areas in Scott (1989).
- \ Jinjiradwip and surrounding marine areas: Important for coral reefs, winter-

ing ground for wildfowl, turtle nesting beach; site account in Scott (1989); recommended for protection in the Corbett Action Plan. The mudflats on the northwest and southeast coasts are important for waterfowl, with the highest priority being Nijhum Dweep (site account in Scott; 1989).

Existing MPAs that require management support:

There are no existing MPAs.

### ***British Indian Ocean Territory (the Chagos Archipelago)***

Proposed new MPAs:

This is the largest, most pristine and possibly most diverse expanse of reef in the Indian Ocean.

Existing MPAs that require management support:

There are no existing MPAs.

### ***India***

A proposal for a protected areas network has been drawn up by the Wildlife Institute of India (Rodgers and Panwar 1988). Many new sites are recommended for protection, others for expansion, and others for improved management, with the aim that five percent of each biogeographic province should be protected. This would result in 18 parks and 40 protected areas for islands, and seven parks and 32 protected areas for coasts. These and other recommendations for future action in the coastal and marine environment are given in Pernetta (1993c). The more important areas for marine biodiversity conservation are listed below.

Proposed new MPAs:

- \ Gulf of Khambhat Wildlife Sanctuary: Important for mangroves, shorebirds, green and olive Ridley turtle

nesting beaches; site account in Scott (1989).

- \ Kundapur Wildlife Sanctuary and estuaries of Karnataka coast: Mangroves and shorebirds; site account in Scott (1989).
- \ Chilka Lake Wildlife Sanctuary Extension (see above): Proposed extension to the existing Sanctuary to include Nanda Island and important turtle nesting beaches.
- \ Point Calimere National Park (see above): Existing coastal terrestrial Sanctuary is proposed to be upgraded to National Park, with the extension to include turtle nesting beaches and possible designation of adjacent marine areas as a Ramsar site.
- \ Kazhiveli Wildlife Sanctuary: Mangroves, waterfowl; one of the last high quality lagoon and estuarine systems on the east coast of India; recommended as a Biosphere Reserve.
- \ Sundarbans: There is an existing National Park (see above) that includes intertidal and estuarine areas, as well as terrestrial features. The area is an important breeding and nursery area for a range of marine species and should be a priority for sustainable management of the entire marine environment. This could be achieved through the establishment of a large, integrated multiple-use MPA.
- \ Lakshadweep Archipelago (Laccadives): Management is urgently needed in this area. Improved protection for nesting turtles is recommended for the Indian part of the Indus delta.

Existing MPAs that require management support:

- \ Bhitar Kanika Wildlife Sanctuary (see below): To be extended to include turtle nesting beaches; management support is required.
- \ Gulf of Kutch: Improved management of existing Marine Sanctuary and Ma-

rine Park, particularly in the southern part; the main threats are cutting of mangroves, exploitation of shells, algae and oysters, dredging and pollution from salt industries and shipping; coral reefs reportedly reduced in area by nearly 50 percent and the mangroves by about 20 percent over the last 10–15 years. The main requirements are to control commercial fishing, identify and control sources of pollution, plan for sustainable tourism development, evolve effective guidelines for planning and managing the marine national park, and to involve the local community (see below).

- \ Gulf of Mannar National Park: Prior to declaration of the park, reefs in the area had undergone noticeable deterioration, possibly as a result of increased water turbidity from coral mining; management measures need to be improved, particularly to control dugong exploitation (probably the most important area in the region for dugong), and ban coral mining (see below).
- \ Malvan Sanctuary (see below): One of the least disturbed areas on the west coast of India.

### ***Andaman and Nicobar Island (India)***

#### **Proposed new MPAs:**

- \ Andaman and Nicobar Islands: These islands include coral reefs, important nesting beaches for leatherback, hawksbill, olive Ridley and green turtles; dugong and saltwater crocodiles. A number of sites already receive some protection but this is mostly for coastal land areas only. Further protection is needed for dugong. Proposals for the protected area system that relate to the marine environment include (Rodgers and Panwar 1988; Pande and Singh 1991):
  - Upgrading of some sanctuaries to Park status: Narcondam Island; North

Reef Island; South Sentinel Island; Barren Island; and all islets in the west coast Shearme group, the northern Landfall group, and the east coast Table-Brush group

- Little Andamans: 300 square kilometer National Park proposed for southwestern half of island to include turtle nesting beaches and coconut crabs
- Little Nicobar with surrounding islets: proposed as a National Park
- Great Nicobar: northern area (north of Casuarina Bay-Dogma River and Mt Thullier) to be a wildlife sanctuary
- Extension of Mount Harriet National Park to include a marine area.

There are also proposals for amalgamating some of the tiny individual island sanctuaries into ten larger units for more efficient administration; for bringing a larger area of mangroves into the protected area network; and for creating a number of other protected areas. Highest priorities relating to MPAs are as follows (Pande and Singh 1991):

- Creation of North Andaman Peninsula Wildlife Sanctuary
- Creation of a sanctuary in West Rutland to act as a buffer for the Marine National Park
- Establishment of Little Andaman National Park (see above)
- Upgrading of South Sentinel Wildlife Sanctuary (see above) to National Park
- Extension of Button I. National Park (see above) to include Outram I. and surrounding waters
- Upgrading of Narcondam Wildlife Sanctuary (see above) to National Park
- Upgrading of North Reef Wildlife Sanctuary (see above) to National Park
- Establishment of Great Nicobar Wildlife Sanctuary (see above)
- Establishment of Little Nicobar National Park (see above).



Existing MPAs that require management support:

- \ Wandur Marine National Park: Possibly the least disturbed group of islands and the richest coral reefs in the Andamans; four turtle species; dugong; mangroves; site description in UNEP/IUCN (1988) and Pande and Singh (1991).

### **Maldives**

Numerous recommendations have been produced for the Maldives (see Pernetta 1993d; UNEP/IUCN 1988), and many of these are now outdated, irrelevant or impractical within the current socioeconomic and development context of the country. The National Environment Action Plan (which was not available for consultation for this report) has established a program of activities, and recommendations for MPAs must fit in with these. Given the global importance of the Maldives for marine biodiversity, this area should, however, be represented in any global network of MPAs.

### **Myanmar**

Proposed new MPAs:

In the 1980s, and under the Corbett Action Plan (Thorsell 1985), a number of marine areas were recommended for protection (UNEP/IUCN 1988):

- \ Moscos Island Wildlife Sanctuary: Coral reefs, turtle nesting; extension recommended to create a marine reserve; site accounts in UNEP/IUCN (1988) and Scott (1989); recommended for protection in Corbett Action Plan.
- \ Thamihla Kyun Wildlife Sanctuary: Formerly a major green and olive Ridley turtle nesting site; extension recommended to create a marine reserve; recommended for protection in Corbett Action Plan; site account in Scott (1989).

- \ Lampi Island and adjacent areas of the Mergui Archipelago: Coral reefs, some turtle nesting; proposed as a marine park to be managed in conjunction with proposed Pakchan Nature Reserve for mangroves; site account in UNEP/IUCN (1988) and Scott (1989).
- \ Irrawaddy Delta: There are many Reserved Forests in southern part of the delta but no marine protected areas; protection needed for mangroves, turtles, estuarine crocodiles, waterfowl; three sites proposed as Wildlife Sanctuaries: Meinmahla Kyun, Kadonlay Kyun (also recommended for protection in Corbett Action Plan), Letkokken Islands; all are small estuarine islands, surrounded by shallow water with mudflats, mangroves and crocodiles; site account in Scott (1989).
- \ Sittang Estuary and Gulf of Martaban: Important estuarine system with a large area of mudflats; site account in Scott (1989).
- \ Central Tenasserim coast and northern Mergui Archipelago: Large area of bays, estuaries, mudflats, mangroves, some reefs, turtles, estuarine crocodile; site account in Scott (1989).

Existing MPAs that require management support:

There are no existing MPAs in Myanmar.

### **Sri Lanka**

Priorities for coastal and marine conservation and management have been identified in a recent report *Coastal 2000* (Olsen and others 1992) and a large number of coastal and marine sites have been recommended for some form of protection (Pernetta 1993e). A recent initiative is the development of SAM plans that will promote local involvement in marine resources management for sites of ecological and economic importance. Two SAM projects have recently been initiated:

- Hikkaduwa Area: A number of recommendations and management proposals have been made for improved management of this area (Pernetta 1993e).
- Rekawa Lagoon: Important for mangroves, lagoon, fish and shrimp fishery; adjacent area is a turtle sanctuary (established under a project run by the UK-based society Care for the Wild).

Sites that appear to be of highest priority (Pernetta 1993e) are listed below.

**Proposed new MPAs:**

- \ Puttalam Lagoon, Dutch Bay and Portugal Bay areas: Important for coastal wetlands, seagrasses, mangroves, water birds, turtles, dugong; includes Karaitivu and Kalpitiya lagoons; site account in Scott (1989).
- \ Negombo Lagoon: Mangroves and seagrass beds; site account in Scott (1989).
- \ Jaffna Peninsula and Lagoon area: Many important coastal wetland areas; details in Pernetta (1993e) and Scott (1989).
- \ Palk Bay and Gulf of Mannar: Including Adam's Bridge area wetlands and coral reefs; details of sites in Pernetta (1993e) and Scott (1989).
- \ Basses Reef: Recommended as a marine sanctuary; site account in UNEP/IUCN (1988).
- \ Rekawa Lagoon: SAM site (see above).

**Existing MPAs that require management support:**

- \ Hikkaduwa Marine Sanctuary (see above)
- \ Bar Reef: Research under way and management plan being developed with SAREC funding

Other areas recommended for protection and listed in Pernetta (1993e) include:

- Unawatuna Reefs: Recommended as an MPA
- Polhena Reef: Recommended as a marine sanctuary
- Thenaddi Bay, Vandeloos Bay, Pasekudah and Kalkudah Bay area: Reefs, coastal wetlands, mangroves; recommended for protection; site account in UNEP/IUCN (1988) and Scott (1989)
- Pigeon Island
- Muthurajawela Swamp: Mangroves; site account in Scott (1989)

The Corbett Action Plan recommends protection of waters adjacent to Wilpattu National Park. Scott (1989) lists numerous other wetland areas as being of significance.

**Regional Priorities for the Establishment and Management of MPAs**

The areas outlined have been selected as regional priorities for the establishment and improved management of MPAs protection using the criteria outlined in the introduction to this report (see Map 10). Priorities were identified in a report prepared for IUCN-CNPPA by Dwivedi, Singh, and Ivan (1994). These areas provide broad biogeographic and geographic coverage of most areas and represent a range of different ecosystem types. In selecting the areas the necessity of support from national governments has been recognized and where possible preference has been given to areas where the concerned Government has expressed interest in marine biodiversity conservation and action is already underway.

Insufficient information has been available to recommend any areas in Myanmar. Gathering the data to make such recommendations should be a high priority.

## Proposed new MPAs:

\ Maldives Atolls (Maldives): The Maldives form the central and largest section of the Laccadive-Chagos chain, which extends southward from India to the centre of the Indian Ocean. As noted previously, the islands support a diverse coral assemblage, with possibly the greatest diversity of reefs in the western Indian Ocean (Pernetta 1994d). A number of sites have been proposed for the establishment of MPAs (see Pernetta 1994d). Although it has not been possible to identify a specific site for the establishment of a MPA, the islands should be a high priority for marine biodiversity conservation.

\ Palk Bay and the Gulf of Mannar (Sri Lanka): Palk Bay and the Gulf of Mannar are located off the southeast Indian coastline and the northeast coast of Sri Lanka. The area is shared between these two countries (the Indian component is dealt with below; see the Gulf of Mannar Marine National Park). The region has 96 species of corals from 36 genera; corals in this area are much more diverse than those further north, with highest diversity around Adam's bridge and the Gulf of Mannar (Pernetta 1993c). Coral development in Palk Bay is inhibited by turbidity and turbulent seas for much of the year. Extensive sea-grass beds are present in Palk Bay and the Gulf of Mannar and these are important for dugong, which are now increasingly rare. The absence of large metropolitan cities and industries have helped to keep the rich fauna and flora relatively undisturbed; due to shallow waters and rocky bottom it has not become a major shipping lane. The area is rich in mollusk resources that are exploited for commercial purposes. Corals are also mined for liming. The bay supports a fishery

of small pelagic fish that are used for making fish meal. This fishery needs sustainable management and conservation. The area is also important for scientific research by universities and institutes in both India and Sri Lanka. The establishment of an MPA to include the Sri Lankan component of this area is recommended. Cooperation between the governments of India and Sri Lanka would facilitate the management of this area as a complete ecological unit.

\ Lakshadweep Archipelago (India): The Lakshadweep (Laccadive) Archipelago lies on the northern part of the Laccadive-Chagos Ridge and is the second largest group of atolls in the Indian Ocean. The archipelago includes about 25 islands of which nine are inhabited. Corals from nine genera have been recorded; in a few places corals have been degraded but they remain healthy on several islands (Agatti, Bangaram, Kadamat and Chetlat). Dolphins, three species of marine turtle and five species of seabirds are present (Dwivedi, Singh, and Ivan 1994). The main threats appear to be sand mining for civil works and over exploitation of bait fish used for catching tuna. The local population depends essentially on tuna fishing and although the local administration is keen to support the establishment of a marine national park, there is some reservation among local fishermen. Provision must be made for traditional fishing to secure public support for the establishment of an MPA.

\ Sundarbans (Bangladesh, India): The Sundarbans is a vast complex of intertidal and estuarine areas situated on the border of India and Bangladesh where the Ganges Brahmaputra and Meghna rivers converge in the Bengal Basin. About 65 percent of the Sundarbans lies in Bangladesh and 35 per-

cent in India. The area includes the most extensive areas of mangrove present in India (constituting more than 60 percent of the area of mangroves remaining in India) (Dwivedi, Singh, and Ivan 1994). A total of 32 mangrove species and 10 seagrass species have been recorded (Dwivedi, Singh, and Ivan 1994). The area provides nursery grounds for many species of fish and invertebrates, including exploited species such as tiger prawns. Its productivity plays a major role in supporting fisheries along the east coast of India (Dwivedi, Singh, and Ivan 1994). Marine turtles, dolphins, estuarine crocodiles and seabirds are also present. The Sundarbans are threatened by the impacts of sewage and industrial pollution, that have resulted in mangrove mortality and the threats to other species. The Sundarbans has been identified as being of high conservation priority for the governments of India and Bangladesh. India has established the Sundarbans National Park while Bangladesh has established a forest reserve and three wildlife sanctuaries. These areas are not managed to effectively conserve marine resources and biodiversity. Given the area's importance it is recommended that MPAs be established in India and Bangladesh to provide for integrated management of marine resources and protection of rare and endangered species.

\ Malvan Sanctuary (India): Malvan is one of the very few relatively undisturbed locations along the western coast of India. The nearest major city is Bombay, which is about 400 kilometers away, and the area is largely free from the effects of pollution. The sanctuary includes coral (eight species), mangroves, seagrasses and turtle

nesting beaches. Surrounding areas support a commercial trawl fishery. Initial planning for a National Park has commenced. The development of a MPA has the support of the government of Maharashtra and the national government (Dwivedi, Singh, and Ivan 1994) and should be implemented.

\ The Chagos Archipelago (British Indian Ocean Territory, United Kingdom): This is the largest, most pristine and possibly most diverse expanse of reef in the Indian Ocean. There are no existing MPAs although the inaccessibility of the area provides some measure of protection. Several sites have been recommended for special protection: Nelson Island for green turtles and frigate birds; the small islands of the Great Chagos Bank and the northern atolls. The whole area has been recommended as a World Heritage Site. An organization has been established dedicated to the protection of the Chagos Archipelago environment (Friends of the Chagos), and a research program on the marine environment of the area is being established through the University of Warwick (UK).

Existing MPAs that require management support:

\ Gulf of Mannar Marine National Park (India): A description of this area is provided above (see Palk Bay and Gulf of Mannar). The Gulf of Mannar Marine National Park was established in 1980 to include 21 islands and the surrounding five kilometers of sea. Support for management of this area is urgently required. Cooperation between the governments of India and Sri Lanka would facilitate the management of this area as a complete ecological unit.

\ Gulf of Kutch Marine Sanctuary and Marine National Park (India): The Gulf of Kutch is a large inlet of the Arabian Sea, covering approximately 7,350 square kilometers and with a maximum depth of about 60 meters. Most of the Gulf is criss-crossed with mangrove-lined creeks, the intertidal zone being sandy or muddy, or of exposed limestone. Numerous islands are present and most of these support fringing reefs, although these are of low diversity with 44 species recorded (UNEP/IUCN 1988). The two existing MPAs are 45,792 hectares and 16,289 hectares respectively and lie on the southern shore. They include a complex of fringing reefs backed by mud and sand flats, coastal marsh and mangrove forest (Pernetta 1993c). Mangroves, corals, sponges, mollusks, fish, algae, seabirds and marine mammals are all present, although they are increasingly threatened by development on the coast. These threats include the discharge of brine from saltworks and effluents from industrial activities into the park area, land filling, cutting of mangroves and dumping from ships. Management support for the existing MPAs is urgently required. To be effective, this must be implemented within the context of management of all uses in the adjacent land and sea areas.

\ Wandur Marine National Park (Andaman and Nicobar Group of Islands—India): The Andaman and Nicobar islands are located between the Bay of Bengal and the Andaman Sea. The northern-most island, Land Fall, is located 190 kilometers from Myanmar while the most southerly, Great Nicobar, is 160 kilometers from Sumatra (Indonesia). The two island groups stretch for about 700 kilometers and include 572 islands, islets

and rocks with an area of 8,240 square kilometers. The islands are known for their rich fauna and flora (Dwivedi, Singh, and Ivan 1994). The Andaman group of islands has 27 mangrove species recorded; 64 seaweed species, three seagrass species; the Nicobar group has 27 species of mangroves 105 species of seaweed, and seven species of sea grasses. The islands also support a diverse assemblage of algae, invertebrates and fish (Dwivedi, Singh, and Ivan 1994). The Wandoor Marine National Park was established in 1983 off the west coast of South Andaman island mainly to provide protection for five species of sea turtles (leatherback, Olive Ridley, green, hawksbill and loggerhead), coral reefs and associated marine life. The impacts of fishing (although illegal) and tourism activities are the primary threats to the park. The amalgamation of the park with some of the smaller island sanctuaries would provide a more effective basis for management. Expansion and effective management of the park is recommended.

\ Bhitarkanika Wildlife Sanctuary (India): This area is situated on Kanika Island in the Brahmani-Baitarani delta on the Orissa coast about 144 kilometers from Bhubaneswar. The area receives freshwater input from eight rivers (Bramhani, Batitarni, Baitarni, Dhamra, Patsala, Mahipura, Hansua, Nansina) and is also subject to a tidal influence from the sea that is 12 kilometers away. The existing Sanctuary is well protected by virtue of being surrounded by this river system. Mangroves, saltwater crocodiles, and marine turtles are found within the reserve. The area provides nursery grounds for marine animals including tiger prawns and fish, and is of global

significance for nesting Olive Ridley turtles (Dwivedi, Singh, and Ivan 1994). A Wildlife Sanctuary was declared in 1975. This area requires management support.

### **Other Recommendations**

The recommendations below draw on a report prepared for IUCN-CNPPA by Dwivedi, Singh, and Ivna (1994).

#### ***Developing an Effective System of MPAs in the Central Indian Ocean***

The threats facing marine environments of the Central Indian Ocean are many and well documented (see Pernetta 1993a,b,c,d). These threats include:

- pollution, including direct sewage disposal, discharges from shipping, industrial waste, sediment and nutrient runoff
- land reclamation and coastal construction
- coral mining
- overfishing
- cutting of mangroves for fuel and aquaculture development
- uncontrolled tourism development
- sea level rise.

While some marine environments have been subject to minimal pressure and remain in good condition (particularly some of the offshore islands and atolls), others are under increasing pressure and are becoming heavily degraded.

Although recognition of the need for marine conservation in the region has increased, the degree of national activity in addressing these threats varies greatly. Sri Lanka has established a coastal zone management program, similar initiatives are underway or planned for parts of India and Bangladesh, while the Maldives has developed a National Environmental Action plan.

Although these initiatives are encouraging and should be supported, there has been less activity to establish and manage marine protected areas. A total of 15 protected areas with a subtidal component have been identified in this report. There are an additional 33 coastal protected areas that include coastal land and intertidal features. Only two of the six countries or territories in the region (India and Sri Lanka) have established MPAs. The major marine biogeographic subdivisions are poorly represented by these existing MPAs; one of the five zones has no MPAs (the Central Indian Ocean), while only a small proportion of the other zones has been protected.

Although a detailed assessment of management of existing MPAs could not be carried out for this report, available information suggests that, with some exceptions, the level of management of most areas is low.

Available information suggests that most of the existing conservation measures have been made under forestry or fisheries legislation. Legislation specifically for establishing protected areas in the marine environment is not well developed, neither are the legal frameworks for development of national MPA systems.

Marine resource management is a specialized subject matter and requires particular skills. Conservation in the region has been focussed on terrestrial issues and there is comparatively much less expertise in marine resource management. The institutions with responsibility for management of MPAs, which are often forestry agencies, require assistance to develop the management expertise to effectively carry out this task. Further, such institutions have insufficient resources in terms of funds, equipment and trained personnel to effectively manage even the few MPAs that have been established. As a high priority, management institutions must be considerably strengthened through the provision of additional staff, training, equipment and funding in or-

der for them to be able to manage MPAs effectively.

Effective management requires data for planning, monitoring and reviewing management activities. Many marine areas in the region are not well studied, very few are effectively monitored. There is a need for more management orientated research and monitoring and closer cooperation between scientists and managers in identifying research priorities and developing research programs that meet management needs.

The development of effective national MPA systems would also be assisted by identifying clear institutional responsibilities for MPAs and mechanisms for coordination of agencies with responsibilities relevant to the marine environment.

Mobilization of the support and commitment of local communities will be important to achieving effective MPA implementation. In the Central Indian Ocean local communities rely on the marine environment for food and income. Marine resource use is the only source of livelihood for many people. Success has been achieved in some instances where local populations recognize that it lies in their interests to conserve marine biodiversity. Failures commonly result where local people are not supportive or actively oppose MPAs. Addressing the need to gain local support will require:

- Participation and representation of local people in the planning and decisionmaking process in establishing and managing MPAs
- Ensuring that MPAs provide tangible financial and social benefits to local communities
- Recognition of and addressing the need to provide for the livelihoods of local people
- Developing mechanisms for effective ongoing cooperation and communication with local communities.

Important lessons can be learned from the Special Area Management project for Sri Lanka, which is supported by the Natural Resources and Environment Policy Project of USAID and implemented through the University of Rhode Island Coastal Resources Management Project. A summary of the lessons learned, extracted from a recent paper by White and Samarakoon (1994) are attached in the Appendix.

Some of the most serious pressures facing marine environments are generated by activities on the land. It is likely that the MPAs will only achieve their objectives if they are part of programs for overall coastal zone planning and management. The development and implementation of such programs within all countries in the region should be a high priority.

#### **APPENDIX. LESSONS LEARNED FROM THE SPECIAL AREA MANAGEMENT FOR COASTAL RESOURCES PROJECT, SRI LANKA**

The following discussion is from White and Samarakoon (1994).

The Special Area Management (SAM) project for Sri Lanka is being carried out by the Natural Resources and Environmental Policy Project of USAID through the University of Rhode Island and its Coastal Resources Management Project. The project applies Special Area Management as a means to achieve resource management within a defined geographical area. The basic premise of SAM is that it is possible to organize local communities to manage their natural resources and that they will continue to do so if they perceive that they derive tangible benefits from such management.

Two sites have been selected for the project: Hikkaduwa Marine Sanctuary, an area that is heavily used for tourism; and Rekawa Lagoon, an area that supports tradi-

tional lagoon and offshore fishing, small scale agriculture, coral mining and has potential for tourism development. The purpose of SAM in both sites is to resolve competing demands on resources by planning for optimal and sustainable use.

As planning and development of these two projects proceeds, there are a number of fundamental lessons that have been learned and that may have some wider applicability, particularly as relates to MPAs in other countries in the Central Indian Ocean and to other regions of the world. These are outlined below:

*The SAM process must be open, participatory and work toward consensus.* All planning meetings must allow a free expression of felt needs whether the participants are small-scale fishermen or national agency managers. In the end, the government and nongovernment groups must work together and continue to have open dialogue during the planning and implementation process.

*Decisions must be clear and well documented.* Because of the number of different interest groups involved, any binding decisions must be very clearly communicated and abided by. Otherwise mistrust will grow and goodwill will be lost.

*National government agencies must understand and accept the process.* Although this should be achieved in the beginning, it may not happen until the SAM process has proceeded through several stages. In reality, the SAM process is one of learning for all involved for the duration of the program.

*Stakeholder groups must be equally represented in the management process.* In the case of Hikkaduwa, stakeholders include fishermen, tourist boat operators and hoteliers among others who have a stake in the resources of beaches, coral reefs and clean marine waters. Because each has a slightly different perspective on how the resource can best serve their needs, planning and management needs to be by consensus of all groups.

*Implementation results should be apparent within three years.* Timing is critical to maintain the interest and participation of stakeholders and government alike. If results are not forthcoming within a reasonable time, all concerned lose interest.

*Monitoring and feedback of results makes the program tangible.* Monitoring should be started at the beginning of a SAM planning and implementation process so that changes over time are recorded and understood by all concerned. In this manner, positive results will reinforce participation and further change efforts.

*In Sri Lanka, cooperative management is a more appropriate concept than community based management for coastal resources.* The national and local governments are inherently part of any management efforts for coastal resources in Sri Lanka. It is best to realize that community efforts alone may not work without the support and joint participation of government.

*Community groups can make the difference in success or failure.* In contrast to the role of government that is required, the enduring efforts of the community groups are also critical and can make the difference for sustainable success. In Rekawa for example, no amount of government effort has stopped coral mining. This can only come when communities decide it is not in their best interest to continue.

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