Coastal and Marine Wetlands in India

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ABSTRACT

Marine and coastal wetlands encompass the enormous variety of marine and coastal species and open sea habitats and ecosystems, and the wealth of ecological processes that support all of these. India has a coastline of 7,516 km of which the mainland accounts for 5,422 km, Lakshadweep coast extends 132 km and Andaman and Nicobar Islands have coastline of 1,962 km. Nearly 250 million people live within a distance of 50 km from the coast. The coast is indented by a number of rivers, which form estuaries at their confluence with the sea. The complex coastal ecosystems comprise of estuaries, lagoons, mangroves, backwaters, salt marshes, mud flats, rocky shores and sandy stretches. Besides, there are three gulf's, one on the East Coast, Gulf of Mannar and two on the West Coast, Gulf of Kachchh and Gulf of Kambath. The two island ecosystems Lakshadweep and Andaman and Nicobar Islands add to the ecosystem diversity in India. Gulf of Mannar, Gulf of Kachchh and the two island ecosystems have rich coral reefs harboring valuable marine biodiversity.

In India, all the 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. The mainland coast of India has two widely separated areas containing reefs: the Gulf of Kutch (=Kachchh) in the northwest, which has some of the most northerly reefs in the world, and Palk Bay and Gulf of Mannar in the southeast. There are patches of reef growth on the West Coast, for example coral reefs at Malvan. The Andaman and Nicobars have fringing reefs around many islands, and a long barrier reef (329 km) 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 Lakshadweep has extensive reefs but these are equally poorly known. Mangrove forms one of the most extraordinary ecological formations occurring almost exclusively in the tropics.

The mangrove ecosystem also protects coastal areas from sea erosion and forms the violent effects of cyclones and tropical storms. The East Coast is endowed with the world’s largest mangrove forest, the Gangetic Sunderbans in West Bengal. The mangrove area in Orissa is nearly 200 km² in extent and its degradation is placed at 20 km² over ten years, as per recent estimates. Andra Pradesh has about 582 km² of mangrove area. The area under mangrove ecosystem in Tamil Nadu is about 225 km². One of the largest and most unspoiled mangrove forests in Tamil Nadu is at Pichavaram in Cuddalore District, extending over an area of 1100 ha. Seagrasses occur in the infratidal and midtidal zones of shallow and sheltered localities of sea, gulf, bays, backwaters and lagoons. They are submerged monocotyledonous plants and adapted to the marine environment for completion of their life cycle under water. They occur along the East and West Coast of India and Andaman and Nicobar Islands. They form a dense meadow on sandy and coral rubble bottoms and sometime in the crevices under water. In India the earlier studies revealed that about 14 species are found along the India coast. The seaweed communities prefer from open shore formation to interdial lagoons, bays, rock pools, and puddles or in creeks and inlets beyond the low tide make along the infralittoral region of the coast. Different species are abundant along the West Coast, Andaman and Nicobar Islands, Lakshadweep and Minicoy. Estuaries are an integral part of coastal environment. They are the outfall regions of the river, making the transitional zone between the fluvial and marine environs. "Estuaries" are semi-enclosed and sheltered coastal bodies of water. As they are semi-enclosed they provide natural harbour for trade and commerce. They are also effective nutrient traps and provide a vital source of natural resources to man and are used for commercial, industrial and recreational purposes. Biodiversity in this ecosystem is very impressive.

Coastal lagoon is a shallow coastal water body separated from the ocean by a barrier, connected at least intermittently to the ocean by one or more restricted inlets and usually oriented parallel to shore. The ocean entrance(s) can at times be closed off by sediment deposition as a result of wave action and littoral drift. A number of lagoons are present on the east and West Coast of India. There are 17 noteworthy lagoons (8 on the east and 9 on the west) along the Indian coasts. The East Coast of India, extending from the international border of India and Bangladesh in the northeast, to Kanyakumari in the south is 2,545 km long. It covers the states of West Bengal, Orissa, Andra Pradesh, and Tamil Nadu. It is over 2 million km² in extent and acts as the recipient of mighty rivers of the subcontinent viz. the Ganga and Brahmaputra. These areas are important for the marine fisheries, serving as they do as nurseries for many species of shellfish and fin fish.

Though human impacts on marine and coastal wetland biodiversity are less understood and publicized than those on its terrestrial counterpart, their potential effects are no less threatening. The
major direct threats to marine and coastal biodiversity can be divided into five interrelated categories: pollution (from land based and other sources), over exploitation of marine living resources, introduction of alien species, habitat degradation caused by coastal development, and global climate change and ozone depletion. The pressure on natural habitats associated with increasing population and economic growth will continue to lead to the loss of biological diversity. Recognition of the scale of problem, the nature of the underlying causes, and the limited resources available to counteract powerful destructive trends will definitely lead to a best way of conserving the Biological Diversity of the Marine Ecosystems of India.

INTRODUCTION:

Marine and coastal wetlands encompass the enormous variety of marine and coastal species and open sea habitats and ecosystems, and the wealth of ecological processes that support all of these. While the total number of described, marine species is smaller than that found on land, scientists are continually discovering new concentrations of diversity. Coastal zone has high biological potential as it serves as feeding, nursery and spawning grounds with rich biodiversity and as an intermediary biotope between marine and freshwater environments. India has a coastline of 7,516 km of which the mainland accounts for 5,422 km, Lakshadweep coast extends 132 km and Andaman and Nicobar Islands have coastline of 1,962 km (Fig. 1). Nearly 250 million people live within a distance of 50 km from the coast.

The Indian mainland coast is divided into two parts: West Coast and East Coast. The West Coast is fronted by the Arabian Sea and the East Coast is fronted by the Bay of Bengal. Other than these mainland coasts, there are three island groups such as Lakshadweep in the south Arabian Sea, Andaman and Nicobar in the eastern Bay of Bengal. The east and west coast are markedly different in their geomorphology. Further, the coastal zone of India also endowed with a very wide range of coastal ecosystems such as estuaries, lagoons, mangroves, backwaters, salt marshes, rocky coasts, sandy stretches and coral reefs which are characterised by unique biotic and abiotic properties and processes. More than half of the Indian coastline is sandy.
The west coast of India is predominantly rocky consisting of silt covered rocky flats or lime stone rocks, often with overhanging cliffs formed of green to black basalt. Sandy areas, rivers, creeks interrupt the rocky coast, and back waters. On the East Coast, small stretches of rocky formations occur along Tamil Nadu and Andhra Pradesh.

Coral reefs form the most dynamic ecosystem providing shelter and nourishment to thousands of marine flora and fauna. In India, all the 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 (Venkataraman et al., 2003). The mainland coast of India has two widely separated areas containing reefs: the Gulf of Kachchh in the northwest, which has some of the most northerly reefs in the world, and Palk Bay and Gulf of Mannar in the southeast. There are patches of reef growth on the West Coast, for example coral reefs at Malvan (Venkataraman, 2003). The Andaman and Nicobars have fringing reefs around many islands, and a long barrier reef (329 km) 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 Lakshadweep has extensive reefs but these are equally poorly known (Venkataraman, 2003).

Mangrove forms one of the most extraordinary ecological formations occurring almost exclusively in the tropics. The mangrove ecosystem also protects coastal areas from sea erosion and forms the violent effects of cyclones and tropical storms. The total area of mangroves in India is estimated as 4,827 km². The East Coast is endowed with the world’s largest mangrove forest, the Gangetic Sunderbans in West Bengal.

The Sunderbans mangroves are of the deltaic type. The 2109 km² area of Sunderbans has 30 of the 50 species of the true mangroves in the world. The mangrove area in Orissa is nearly 200 km² in extent and its degradation is placed at 20 km² over ten years, as per recent estimates. Andhra Pradesh has about 582 km² of mangrove area. The area under mangrove ecosystem in Tamil Nadu is about 225 km². One of the largest and most unspoiled mangrove forests in Tamil Nadu is at Pitchavaram in Cuddalore District, extending over an area of 1100 ha.

Seagrasses occur in the infratidal and midtidal zones of shallow and sheltered localities of sea, gulf, bays, backwaters and lagoons. They are submerged monocotyledonous plants and adapted to the marine environment for completion of their life cycle under water. They occur along the East and West Coast of India and Andaman and Nicobar Islands. They form a dense meadow on sandy and coral rubble bottoms and sometime in the crevices under water. In India the earlier studies revealed that about 14 species are found along the India coast.

The seaweed communities prefer somewhat flat and rocky coastal wetlands that gradually slope towards the sea with marked tidal effect of complete submergence during high tide and successive exposure during low tide. Its distribution extends from open shore formation to intertidal lagoons, bays, rock pools, and puddles or in creeks and inlets beyond the low tide make along the infralittoral region of the coast. Different species are abundant along the West Coast, Andaman and Nicobar Islands, Lakshadweep and Minicoy Islands. Except the places like Chilka, Pamban and Cape Comorin, its occurrence along the East Coast is very scanty (Fig. 2).

Estuaries are an integral part of coastal environment. They are the outfall regions of the river, making the transitional zone between the fluvial and marine environs. “Estuaries” are semi-enclosed and sheltered coastal bodies of water. As they are semi-enclosed they provide natural harbour for trade and commerce (Venkataraman, 2003). They are also effective nutrient traps and provide a vital source of natural resources to man and are used for commercial, industrial and recreational purposes. Biodiversity in this ecosystem is very impressive.

Coastal lagoon is a shallow coastal water body separated from the ocean by a barrier, connected at least intermittently to the ocean by one or more restricted inlets and usually oriented parallel to shore. The ocean entrance(s) can at times be closed off by sediment deposition as a result of wave action and littoral drift. A number of lagoons are present on the east and West Coast of India. There are 17 noteworthy lagoons (8 on the east and 9 on the west) along the Indian coasts. The East Coast of India, extending from the international border of India and Bangladesh in the northeast, to Kanniyakumari in the south is 2,545 km long. It covers the states of West Bengal, Orissa, Andhra Pradesh, and Tamil Nadu. It is over 2 million km² in extent and acts as the recipient of mighty rivers of the subcontinent viz. the Ganga and Brahmputra. These areas are important for the marine fisheries, serving as they do as nurseries for many species of shellfish and fin fish. The fauna of the marine ecosystem is not evenly distributed throughout the oceans. It is estimated that 90 percent of marine species live in about 50 million sq km of the total 352 million sq km. Larvae of many benthic invertebrates represent mesoplankton. Sponges, coelentrates, molluscs and echinoderms have planktonic larvae. Copepods, cladocerans, mysisids, rotifers, chaetognaths, hemichordates and protochordates have planktonic adults.

Pelagic life thus has a tremendous diversity in form and function. Dominant taxa in the nektan are fish represented by about 4000 species in the Indian Ocean, of which about 50% occur in Indian seas.
Majorities of these species occur in coastal water supporting valuable fisheries. About 26 species of snakes belonging to one family Hydrophiidae and five species of sea turtles were reported from seas around India. The seashore offers a veritable feeding and breeding ground for a number of birds. From the available data it has been inferred that there are 12 families, 38 genera and 145 species of seabirds, which occur, in the coastal ecosystem (Venkataraman et al., 2003).

India has a long coastline, of about 8000 km, stretching along ten states and two archipelagos. The coast is indented by a number of rivers, which form estuaries at their confluence with the sea. The complex coastal ecosystems comprise of estuaries, lagoons, mangroves, backwaters, salt marshes, mud flats, rocky shores and sandy stretches. Besides, there are three gulfs, one on the East Coast, Gulf of Mannar and two on the West Coast, Gulf of Kachchh and Gulf of Kambath. The two island ecosystems Lakshadweep and Andaman and Nicobar Islands add to the ecosystem diversity in India. Gulf of Mannar, Gulf of Kachchh and the two island ecosystems have rich coral reefs harboring valuable marine biodiversity.

Though human impacts on marine and coastal biodiversity are less understood and publicized than those on its terrestrial counterpart, their potential effects are no less threatening. The major direct threats to marine and coastal biodiversity can be divided into five interrelated categories: pollution (from land based and other sources), over exploitation of marine living resources, introduction of alien species, habitat degradation caused by coastal development, and global climate change and ozone depletion.

The pressure on natural habitats associated with increasing population and economic growth will continue to lead to the loss of biological diversity. Recognition of the scale of problem, the nature of the underlying causes, and the limited resources available to counteract powerful destructive trends will definitely lead to a best way of conserving the Biological Diversity of the Marine Ecosystems of India.

Coastal and Marine Wetlands in India

Among coastal wetlands estuaries, mangroves and coastal lagoons are biodiversity-rich areas, whereas the other brackish habitats have only a few specialized species. It is generally commented that there is a reduction in the species number in estuaries compared to adjacent seas and in-flowing River system. However, as far as Indian estuaries are concerned the statement is partly true. There is lesser number of species than in the adjacent seas, but the upper riverine ecosystem does not harbor as many species as its estuary. It has been observed that as the distance increases from the sea the number of species decrease. Salinity becomes an important regulating factor.

The marine fauna of India is rich and varied. The coastline encompasses almost all types of
intertidal habitat, from hypersaline and brackish lagoons, estuaries, and coastal marsh and mudflats, to sandy and rocky shores with every degree of exposure and widely varying profile. Subtidal habitats are equally diverse. Each local habitat reflects prevailing environmental factors and is further characterized by its biota. Thus, the marine fauna itself demonstrates gradients of change throughout the Indian coasts.

Much is to be known about the number and types of the species of Flora and Fauna, which live in India. The algae, fungi, ferns, bryophytes and lichens are less well known than flowering plants. For flowering plants, the location and even population size are known for the most threatened species. Invertebrates are generally less well known than the vertebrates. For birds, and now increasingly for reptiles, amphibians and mammals, most species have estimates.

Out of the total 32 animal phyla, 15 are represented by the taxa in the marine ecosystem. They may constitute either migratory or resident species. The former includes pelagic crustaceans, coelentrates (medusae), Cephalopod molluscs, fishes, reptiles, birds and mammals. Amphibians are generally absent in estuaries. The benthic macro fauna comprises resident species of polychaetes, molluscs, sipunculas and mud-burrowing fishes. Among invertebrates, sponges, phoronids and echinoderms generally do not prefer estuarine ecosystem. In India estuarine species diversity seems to be highest in molluscs. About 245 species belonging to 76 genera under 54 families were cataloged. Other important taxa, polychaeta are represented by about 167 species belonging to 97 genera under 38 families. Maximum diversity has been observed in the much-studied Hoogly-Matlah Estuary (West Bengal). Macro organisms and meofauna of Indian estuaries are not properly investigated. Estuarine mud may contain rich variety of bacteria, flagellates, ciliates nematodes, ostracodes, harpacticoid copepods, rotifers, gastrotriches, arachnids and tardigrades.

Free swimmers or nekton are important components of marine biodiversity and constitute important fisheries of the world. The dominant taxa in the nekton are fish, others being crustaceans, molluscs, reptiles and mammals. Out of a total 22,000 species, it has estimated that about 4,000 species occur in the Indian Ocean of which 1,800 species are from the Indian seas. Majority of the nektionic species is found in the coastal waters. It is estimated that 40 species of sharks and 250 species of bony species represented the oceanic fishes (Fig. 3).

Among reptiles, sea snakes and turtles are important and represented worldwide by 50 and seven species respectively. These are generally oceanic forms but majorities of these often swim near to the shore and visit the shore at some part of their life. About 26 species of sea snakes belonging to one family, Hydrophiidae and five species of sea turtles were reported from seas around India. Oceanic islands seem to harbor more reptiles in their marine environment. All the sea snakes and four species of turtles in their marine environment are known from islands of Andaman and Nicobar.

![Image of Diversity of Mollusca, Echinodermata and marine Fishes of India.](image-url)
Nesting sites of an amphibious snake were reported from the shores of North Andaman Islands (Whitaker, 1985). Turtles visit the shore during breeding time to lay their eggs. The shore visit of these turtles especially the Olive Ridley is a spectacular sight on the sandy beach at Gagirmatha near Bitharkanika in Orissa (Venkataraman and Milton, 2003). The Andaman and Nicobar Islands have best nesting beaches for the leatherback, the hawksbill and the green turtle and also the Olive Ridley (Baskar, 1993).

The seashore offers a variable feeding and breeding ground for a number of birds. It is difficult to define precisely the avian component of marine biodiversity. There are some special species, which are exclusively dependent on marine ecosystem, while a few are generalists without much dependence on it. From the available data it has been inferred that there are 12 families, 38 genera and 145 species, which occur in the coastal ecosystem (Venkataraman et al., 2004).

Marine mammals belong to three orders, Sirenia, Cetacea and Carnivora. About 120 species are estimated to occur in World seas and of these 30 are reported from seas around India. But majority of these is oceanic forms and occasionally a few individuals may get stranded on the shore. Sea cow occurs in near shore waters.

**Human Impacts on Marine Wetland Biodiversity:**

Though human impacts on marine and coastal wetland biodiversity are less understood and publicized than those on its terrestrial counterpart, their potential effects are no less threatening. The major direct threats to marine and coastal biodiversity can be divided into five interrelated categories: pollution (from land based and other sources), over exploitation of marine living resources, introduction of alien species, habitat degradation caused by coastal development, and global climate change and ozone depletion.

Some of the harmful human impacts on marine biodiversity stem from ignorance and lack of understanding of the importance of marine biodiversity and how it can be affected. Marine resources and biodiversity have traditionally been undervalued, which puts marine resources on a lower priority level vis-a-vis land biodiversity. Unregulated use of resources, increase demand for the resources and rapidly expanding coastal development put the marine resources at considerable risk.

The belated realization of the need for action after the damage becomes apparent (and often when it is too late) perpetuates this destructive cycle. Communities that depend on marine resources face the long-term challenge of sustainability yet are often confronted with immediate economic hardship. For developing country like India, action is hardly ever preventive, but is usually under taken only after irreversible damage has occurred (Venkataraman, 2003).

**Marine Biodiversity of India**

<table>
<thead>
<tr>
<th>Name of the group</th>
<th>No. of species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algae</td>
<td>425</td>
</tr>
<tr>
<td>Protista</td>
<td></td>
</tr>
<tr>
<td>1. Sarcomastigophora</td>
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</tr>
<tr>
<td>2. Ciliophora</td>
<td>Animalia</td>
</tr>
<tr>
<td>1. Porifera</td>
<td>500</td>
</tr>
<tr>
<td>2. Cnidaria</td>
<td>842</td>
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<tr>
<td>3. Ctenophora</td>
<td>100</td>
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<tr>
<td>4. Platyhelminthes</td>
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<tr>
<td>5. Gastrotricha</td>
<td>98</td>
</tr>
<tr>
<td>6. Kinorhyncha</td>
<td>104</td>
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<tr>
<td>7. Annelida</td>
<td>40</td>
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<tr>
<td>8. Mollusca</td>
<td>3370</td>
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<tr>
<td>9. Bryozoa</td>
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</tr>
<tr>
<td>10. Entoprocta</td>
<td>8</td>
</tr>
<tr>
<td>11. Phoronida</td>
<td>3</td>
</tr>
<tr>
<td>12. Brachiopods</td>
<td>3</td>
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<tr>
<td>13. Arthropoda</td>
<td></td>
</tr>
<tr>
<td>a) Crustacea</td>
<td>2430</td>
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<tr>
<td>b) Pycnogonida</td>
<td>16</td>
</tr>
<tr>
<td>c) Merostomata</td>
<td>2</td>
</tr>
<tr>
<td>14. Sipuncula</td>
<td>35</td>
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<tr>
<td>15. Echiura</td>
<td>43</td>
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<tr>
<td>16. Tardigrada</td>
<td>5</td>
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<td>17. Chaetognatha</td>
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<td>18. Echinodermata</td>
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<td>19. Hemichordata</td>
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<td>20. Chordata</td>
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<td>a) Protochordata</td>
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<tr>
<td>b) Pises</td>
<td>1800</td>
</tr>
<tr>
<td>c) Amphibia</td>
<td>3</td>
</tr>
<tr>
<td>d) Reptiles</td>
<td>31</td>
</tr>
<tr>
<td>e) Aves</td>
<td>45</td>
</tr>
<tr>
<td>f) Mammalia</td>
<td>30</td>
</tr>
</tbody>
</table>

* In estuaries/mangroves.

In the face of this increasing uncertainty, the adoption of a precautionary approach is a sine qua non to the conservation of marine and coastal biodiversity. The precautionary principle, which is now widely recognized as a emerging part of customary international environmental law, requires that no harmful action be undertaken until all the effects on marine and coastal biodiversity have been clearly identified and weighed against the expected benefits. Moreover, this precautionary approach should cover all the activities of past, present and future, bearing in mind the cumulative impact that
these activities combined will have on marine biodiversity.

**Government of India Initiatives:**

Many acts and rules related to coastal and marine activities exist in the country. The following are the important ones. Indian Fisheries Act 1897 and its Amendments 1920 and 1980; Indian Ports Act 1902; Merchant Shipping Act 1974; Wildlife Protection Act 1972; Water (Prevention and Control of Pollution) Act 1974; Indian Coast Guard Act 1974; and Marine Zones of India (Regulation of Fishing by Foreign Vessels) Act 1981 and Environment Protection Act 1986. The CRZ notification also stated that during the interim period till the coastal zone management plans are prepared and approved, all developments and activities within CRZ should not violate the provisions of this notification. Although marine ecosystems have a larger coverage than the other ecosystems these are poorly represented among world’s protected areas. Only 100 of the 1162 National Parks of United Nation List include or adjoin reef ecosystem. In India four out of the 504 protected areas (National Parks 86, Sanctuaries 448 and Biosphere Reserves 7) are with reference to marine ecosystems. There are Gulf of Mannar, Gulf of Kachchh, Marine National Park of Andaman and Nicobar Islands (Mahatma Gandhi Marine National Park) and Rani Jhansi Marine National Park. The protected areas (a total of about 102) of the Andaman and Nicobar Islands cover substantial areas of marine waters also. The Gujarat State Government in 1980 constituted the first Marine Sanctuary in India in the Gulf of Kachchh to cover an area of 456 sq. km, from Okha to Jodiya having a core area of 162.9 sq km. Secondly, Mahatma Gandhi Marine National Park was notified on May 24, 1989 in Andaman and it covers an area of 281.5 sq km.

Consequently, effective research and extension programmes, which are critical to the conservation and management of marine ecosystem, have been given priority. The following institutions under the Government of India are engaged in the research and extension as well as conservation and management of the Marine and Coastal Ecosystems of India: Ministry of Agriculture, Department of Agriculture and Cooperation; Fishery Survey of India, Central Institute of Fisheries, Nautical and Training, Integrated Fisheries project, Central Institute of Coastal Engineering for Fishery, Development of coastal marine fisheries, Development of fisheries harbours, Assistance for strengthening fish marketing infrastructure, Fish Farmers Development Agency, Brakishwater Fish Farmers Development Agency, Deep-sea Fishing, Fisherman welfare schemes, Department of Agriculture Research and Education, Central Marine Fisheries Research Institute, Central Inland capture Fisheries Research Institute, Central Institute of Freshwater Aquaculture, Central Institute of Brackish water Aquaculture, Central Institute of Fisheries Technology, Central Institute of Fisheries Education, National Bureau of Fish Genetic Resources, National Research Centre on Coldwater Fisheries, Ministry Commerce, Ministry of Food Processing Industries, Ministry of Environment and Forests, Zoological Survey of India, Universities such as Annamalai University, Centre of Advanced studies on Marine Biology, Madurai Kamaraj University, Andhra University etc.

Despite the above mentioned acts and regulations marine ecosystems in India are subjected to over-exploitation of their resources. Besides over-exploitation, pollution from land-based sources is another major threat to marine resources. The population influx and increased tourism in some coastal places are responsible for indiscriminate destruction of marine resources. Recent spurt in aquaculture activities increased the demographic pressure and the related environmental manipulation. All the above mentioned reasons leads to biodiversity conservation problems in India which may be reduced by taking examples from other regions of the world where the marine ecosystem is conserved at a larger scale.

**International Agreements for Conservation**

The need to devise methods to manage and protect marine ecosystems and resources became widely recognized internationally during the course of the 1950s and early 1960s. Thus, the World Conference on National Parks (1962) considered the need for protection of coastal and marine areas but the development of practical responses to this need required a legal framework for addressing the sovereignty and jurisdictional rights of nationals to the seabed, beyond the customary three-mile territorial sea. In 1958 three conventions, known collectively as the Geneva Conventions on the Law of the Sea were adopted: the Convention on the Continental Shelf; the Convention on the High Seas; the Convention on Conservation of the Living Resources of the High Seas.

India has signed several international conventions on oceans and related activities. The important one are the following: MARPOL 1973/1978; London Dumping Convention 1972; Convention on Civil Liability for Oil Pollution Damages (CLC 1969) and its Protocol 1976; Fund 1971 and its Protocol 1979 and Convention on Biodiversity (1992). Increasing technical capability to exploit mineral resources on or beneath the seabed and to exploit fishery resources in deep waters led to the long-running Third United Nations Conference of the Law of the Sea, held between 1973 and 1982. During the 1970s there was increasing recognition and mounting concern regarding the regional nature of the environmental problems of the marine living
resources of the world. In 1971, the Convention of Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) was developed, defining wetlands to conclude many coastal marine habitats. In 1972, the Convention for the Protection of the World Cultural and Natural Heritage (known as the World Heritage Convention) was developed to give international recognition to areas ‘of outstanding universal value”; these could include marine areas.

Also in 1972, the Governing Council of the United Nations Environmental Program (UNEP) was set up and given the task of ensuring that emerging environmental problems and adequate consideration by Governments. In 1975, IUCN conducted a conference on Marine Protected Areas in Tokyo. The report of that conference noted increasing pressures upon marine environments and called for the establishment of a well-monitored system of Marine Protected Areas representative of the world’s ecosystems. In 1981, a workshop was organized as part of the UNESCO Division of Marine Science COMAR (Coastal and Marine) Program to consider research and training priorities for coral reef management. An outcome of this workshop, which was held in conjunction with the IV International Coral Reef Symposium, was the publication of the UNESCO Coral Reef Management Handbook. In 1982, the IUCN Commission on National Parks and Protected Areas (CNPPA) organized a series of workshops on the creation and management of marine and coastal protected areas as part of the III Worlds Congress on National Parks held in Bali, Indonesia.

UNESCO organized the First World Biosphere Reserve Congress in Minsk, USSR in 1983. In that meeting it was recognized that the Biosphere Reserve concept is potentially applicable to the marine environment and that an integrated, multiple use Marine Protected Area can confirm to all of the scientific, administrative and social principles that define a Biosphere Reserve under the UNESCO Man and Biosphere (MAB) Program.

In 1987, the World Commission on Environment and Development (WCED) published its report “Our Common Future”, which highlighted the importance of marine conservation. In November of the same year, the General Assembly of the United Nations welcomed the WCED report. At the same time, it adopted the “Environmental Perspective to the year 2000 and Beyond”, which was developed by UNEP in tandem with the WCED report. In 1988 UNEP AND IUCN published the three volume “Coral Reefs of the world”, a global directory of coral reefs prepared by then IUCN Conservation Monitoring Center. These and other publications have highlighted the series threats, which confront marine areas around the world.

All these above-mentioned experiences helped to formulate the marine conservation at a global level at a larger scale.

**Convention on Biological Diversity**

The Convention on Biological Diversity is a legally binding agreement opened for signature at the Earth Summit in Rio de Janeiro in 1992. Over 145 countries are Parties. The Convention’s objectives are the conservation of biological diversity (biodiversity); the sustainable use of biodiversity’s components; and the equitable sharing of benefits derived from genetic resources. The Convention defines biodiversity as ‘the variability among living organisms from all sources, including, interalia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystem’.

Under the Convention, each Party is required to protect components of coastal and marine biodiversity within its national jurisdiction. As defined by the law of the sea, embodied in the United Nations Convention on the Law of the Sea (UNCLOS), coastal States can exercise jurisdictional rights over vast areas of the marine realm, including inland waters, the terrestrial sea, the contiguous zone, the exclusive economic zone (EEZ), and parts of the continental shelf.

Action in the following eight general categories will be critically important in the application of the Biodiversity Convention to the marine and coastal realm. The first five areas are those identified in the Jakarta Mandate (see below). The last three actions aim to support implementation of the Mandate. While these eight areas of action are priorities in most marine and coastal ecosystems, each Party will select or develop its own means of implementation and priorities within these eight areas. The action items are the following: 1. Institute integrated coastal area management (ICAM), including Community-based coastal resource management, and prevention and reduction of pollution from land-based sources; 2. Establish and maintain marine protected areas for conservation and sustainable use; 3. Use fisheries and other marine living resources sustainably; 4. Ensure that mariculture operations are sustainable; 5. Prevent introduction of and control or eradicate harmful alien species; 6. Identify priority components of biodiversity and monitor their status and threats to them; 7. Build capacity to study and share the benefits from marine genetic resources; 8. Take responsibility for transboundary harm and global threats to marine biodiversity.

Action Items 1 to 5 correspond to priorities identified in the Jakarta Mandate adopted by the second Conference of Parties (COP) in 1995. Action
Items 6 through 8 are recommended, as actions needed to support the first five items.

This ambitious set of actions reflects the Biodiversity Convention’s comprehensive approach that seeks conservation and development in every sector that affects biodiversity. Implementing these actions will require major changes in policies and programs in all Parties to the Convention, both developed and developing. Many countries, however, have very limited resources to devote to reshaping policies and institutions for sustainable use and conservation; this is especially true for developing countries.

Conclusion and Strategies for Conservation and Management of Marine Ecosystem

“...The future historians of science may well find that a crisis that was upon us at the end of the 20th century was the extinction of the systematist, the extinction of the naturalist, the extinction of the biogeographer—those who would tell the tales of the potential demise of global marine diversity”.

Carlton (1993)

Thirst for understanding changes in marine biodiversity resulting from human activities, calls for ecological and oceanographic research spanning a broad range of spatial scales, from local to regional, and over approximately long time scales for capturing the dynamics of the system under study. This paper proposes a fundamental change in the approach by which biodiversity is measured and studied in the ocean by emphasizing integrated regional-scale research strategies within an environmentally relevant and socially responsible framework. This is now possible because of recent technological and conceptual advances within the ecological, molecular, and oceanographic sciences. A major goal of this paper is to improve the diversity of life in the sea, in order to improve conservation and management plans.

A well-defined set of biodiversity lessons learnt in other regions of the world is proposed for implementation in several different types of regional-scale marine ecosystems. These ideas will permit meaningful comparisons across different habitats of the causes and consequences of changes in biodiversity due to human activities. This lesson requires significant improvement in taxonomic expertise for identifying marine organisms and documenting their distributions, in knowledge of local and regional natural patterns of biodiversity, and in understanding of the processes that create and maintain these patterns space and time.

Biodiversity Conservation in India can be best managed by the following guidelines:

- Clear understanding of what is valuable
- Application of anthropogenic objectives of maintaining biodiversity so that it is of actual or possible value to humankind.
- Local people priority recognized
- Biodiversity Conservation practised with a precise definition and with clear targets.
- Need for rapid expansion in taxonomy in order to interpret, manage, conserve and use biodiversity sustainable and need to pull together existing data from all sources by forming an information network of all agencies in the country.
- Knowledge about the extent and state of biodiversity is necessary to understand the measures of Biodiversity.
- Priorities for Biodiversity conservation identified to understand what values are important, which genes/species/habitat, how much biodiversity should be conserved and how should biodiversity be conserved.
- To achieve best biodiversity conservation objectives improved methodologies practised for different projects, more effective policy and targeted projects with highest priority.

The pressure on natural habitats associated with increasing population and economic growth will continue to lead to the loss of biological diversity. Recognition of the scale of problem, the nature of the underlying causes, and the limited resources available to counteract powerful destructive trends will definitely lead to a best way of conserving the Biological Diversity of the Marine Ecosystems of India.

REFERENCES