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NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN
WEST COAST ECO-REGION

1. Introduction

1.2. Scope

The West Coast Eco-region covers the entire west coast of India, spreading along the five states of Kerala, Karnataka, Goa, Maharashtra and Gujarat including the Lakshadweep Islands, with a coastal length of 3446 km. The west coast consists of diversified ecosystem types, culture and profession with different activities including fishing, industrial, agricultural, tourism etc. The vicinity of the sea has given rise to a few major ports, and many fishing harbours. This area has many small rivers, originating along the Western Ghats eventually joining the sea resulting in many backwaters and estuaries, which are rich in biota. The life activities of the common inhabitants are centered around these estuaries and the coast.

1.3. Objectives

The National biodiversity is the wealth of the nation. The developmental activities along the coast and other regions pose severe threat to the existing living resources. The impacts of technological advancement and industrialisation, modernisation in culture etc. are reflected in the changes in lifestyles and in resource use patterns, resulting in erosion of the biological diversity. Hence the available national living resources traditional knowledge and the indigenous practices should be conserved before it is too late. Furthermore, the multi scale impacts from industries and changes in policies etc., will sometimes question the ownership of the national natural resources. In this respect the NBSAP is planned to conserve and document all the available resources, the major threats they are facing and an action plan to protect these national treasures.

1.4. Contents

This Strategy and Action Plan report gives an overview of the existing scenario of the West Coast, with reference to the types of habitats, major groups of biota, major activities and their impact on the resources, the change in resource use patterns etc. This is followed by an outline of the process adapted to achieve the required information for the Strategy and Action Plan. Further identifying the threats, actions required and the institutions capable of handling the action plan with required human resource development are also documented.

1.5. Methodology

The first step of SAP was the meeting with the Working group members. A detailed discussion was carried out to take up the task in a systematic way, this discussion provided ways for further actions to achieve the goals. Involving the participation of the local government bodies; institutes; NGOs; individuals; students, researchers, public and different stakeholders along the coast. Direct interviews, questionnaires, secondary sources, and primary data collection were some of the methods adopted for gathering information for the preparation of this document.

- To initiate the activities of west coast eco-regions the first meeting of west coast region working group met on the 26th August 2000 at Mangalore wherein, the members were briefed about the salient features and responsibilities of the committee in drawing up the Biodiversity Strategy Action plan. The full day meeting gave an opportunity to have an overall picture of the problems of biodiversity conservation (identification, assessment & the problems).
- The Coordinator arranged a subsequent meeting in Mumbai inviting various stakeholders, scientists, from around Mumbai. The meeting was held at Central Institute of Fisheries Education, Versova, to gather

information and to have interaction along this part of the coast. The meeting also generated good discussions and the inputs were very valuable.

- On 29th November 2000, during the state level Biodiversity workshop held at the Indian Institute of Science, Bangalore. The National Biodiversity aspects of the west coast eco- region was highlighted for the benefit of various participants and sought their information and suggestion for the action plan.
- On 16th December 2000, a one day workshop on biodiversity with special reference to coastal and Western Ghats was held during the National Symposium on Problems & Prospects of the Environment in the New Millennium, about 200 participants were involved with younger generation giving a lot of inputs during the course of interaction.
- Involvement of the district administration and other government officials of the coastal district were initiated during the district committee of Science and Technology. The meeting was held on 2nd January 2001 at Deputy Commissioner's office Dakshina Kannada district. It is also decided to have peoples participation program during June.
- A brainstorm session at a regional level with various fisherman leaders, scientists, administrators and state leaders was held on the 24th March 2001, wherein the Director of Fisheries, Government of Karnataka himself participated. This gave an opportunity to interact with cross sections of fishermen community dealing with different types of fish gathering devices. Each of this group highlighted the merits and demerits of the various fish gathering devices and its implications on benthic biodiversity.
- Problems of the Kerala coastal region was taken up in the regional coastal Biodiversity meeting held on 28th April 2001 at Central Marine Fisheries Research Institute, Kochi. Coastal stretches of Kerala has its own niche as far as the biodiversity is concerned which was apparent with the diverse habitat like mud bank, Pokali field, wadge bank etc. Very useful information and suggestions emerged out of the discussion with various participants.
- A field visit to fishing village to interact with the local communities was organised near Kochi, which was very useful.
- Meeting at BNHS, Mumbai was held on 8th September 2001, on the status of avian fauna and the invasion of alien species into the coast waters.
- 8 and 9th September 2001, a workshop on Environmental Law For Academicians at SDM Law College Mangalore was attended.
- A two day National seminar on Coastal erosion was held in KREC, Surathkal on 7th and 8th September 2001, to discuss and evolve a strategy for preventing the sea erosion along Indian coast, mainly along the Karnataka and Kerala coastline. It is evident that maximum sea erosion was found along the stretches of the Indian coast during the Monsoon.
- On 28th of July 2001, a public hearing with the fisher women and fishing community of Malpe, Karnataka was held, followed by a brief survey on the socio-economic status of these fisher folk families.
- A discussion with the traditional fishermen of the Mattu village was held on 28th July in the evening hours.
- Meeting at Malpe on 18th August .2001 at *Malpe Fisher Women's Co-operative Society Ltd.* where more than 100 members were present including their president, vice president and secretary. Discussions were aimed at the livelihood dependence on fishing, professional diversity among the fisher women and the traditional knowledge amongst women folk.

- Public hearing at/ *Sneha Kunja*, Kumta on 19th September 2001 was organized in order to discuss the local problems to the coastal biodiversity and status of the biodiversity with the association of the Uttar Kannada Coordinator and *SnehaKunja*.
- A Regional Meeting at Goa was organized in association with the *Goa Foundations* on 15th October 2001.
- A regional meeting at Central Salt and Marine Research Institute Bhavnagar, Gujarat on 6th November 2001 was held. Many issues about the Gujarat coastal biodiversity and lacking information on the status of the biodiversity were discussed.
- Some public hearings at Rathanagiri, Malvan regions of the Maharashtra coast are proposed for the next phase along with a few sites along the Gujarat coast.

The complete details of the meetings held and participated are appended. No. 1

2. Profile of the area

2.1. Geographical profile

The West coast has a coastal length of 3446 km, characterized by a varied type of ecosystems/habitats, including a large number of wetlands, backwaters, estuaries and creeks, mangrove vegetation, mud banks, wedge banks, salt pans, salt marshes, lagoon, sea grass beds, corals, small or inaccessible islands and beaches supporting a plethora of flora and faunal attributes including turtles and aquatic birds.

Table 1. States and the geographical distribution of the coastline

State	Coast line (km)	Longitude and latitude	Coastline Continental shelf (sq. km)
Gujarat	1600	Long. 68°00' - 73°00' E Lat. 20°10' - 23°10' N	184
Maharashtra	720	72°10' - 73°10' E 15°52' - 20°10' N	112
Goa	124	73°38' - 74°44' E 15°00' - 15°52' N	10
Karnataka	320	74°00' - 75°00' E 12°45' - 15°00' N	27
Kerala	297.2	75°00' - 77°00' E 9°00' - 12°45' N	40
Lakshadweep	132		4

2.2. Socio-economic profile

The major groups of inhabitants along the coast of Kerala, Karnataka, Goa, Maharashtra coast includes the fishermen community belonging to different religion and castes. The regionalism, culture varies slightly in the state boundaries along the coast restricting particular groups in patches. The Most diversified fishermen community has been observed along the Uttara Kannada coast. They belong to different religions as well as to different subclasses; they are mostly *Kharvi*, *Ambiga*, etc. The fishermen of the Udupi and Mangalore districts mostly fall into the Mogaveera caste, however other caste people also belong to fishing profession. The survey conducted at Malpe showed 90% of the community belonged to fisher folk and only a small population was non-fishing community. The interior of the fishing villages along the coast are mostly undisturbed and only the immediate necessities are utilized by the local inhabitants, who are mostly non-fishermen. Even though the major conglomerations of the fishermen is near the fishing harbours, diffused distribution of them can be observed along the coast carrying out traditional fishing practices

Apart from fisheries, the coastal population has other occupations like agriculture with marginal farmers having paddy and coconut plantations. There are a few coastal areas under the coastal saline paddy fields (called as *Khazans* in Goa, *Gajjanis* in Karnataka and *Chemmen* in Kerala), which are now being converted into aquacultural farms.

2.3. Political profile

The west coast as explained is distributed along the five states. Many of the policies are unevenly implemented along the political territories. Examples include that of Kerala state, which is the first state to ban fishing during the monsoons, where as in Gujarat the monsoon ban is not implemented. The CRZ rule, management of the mangroves, occurrence and distribution of resources etc. vary differently along the different states and regions of the coast.

2.4. Ecological profile

The coastal region includes the intertidal (shore and beach), sub tidal and offshore region. The coastal zone has the highest marine resources, the greatest concentration and diversity of marine life and critical habitats; it also has the most serious threats from the land-based activities.

The important ecosystems types found along this coast are: mangroves, coastal sand dunes, coral reefs, mud banks, rocky shores, gulfs, lagoons, islands, critical habitats, estuaries and backwaters, Marine National Parks and Marine Protected Areas (MPA), salt pans, agricultural lands, fishing harbours, ports, tourist beaches, and pilgrimage sites,

2.4.1. Mangroves

The Mangrove ecosystem, with the conglomeration of halophytic plants supports a variety of biota of marine and estuarine regions. While serving the ecosystem functions at different levels, it also contributes to resource use at various levels, different degrees and for different stakeholders significantly. Mangrove forests serve as a link between terrestrial and marine ecosystems. The energy flow through the nutrients flows from land to sea, and enrichment due to the detritus formation making mangrove ecosystems rich in relation to primary and secondary production. The details of areas of mangrove vegetation spread along the 5 states of the west coast are presented in the table 2.

Table 2. Mangrove forest areas of West Coast

State	Area Sq. km.
Gujarat	260
Maharastra	330
Goa	38
Karnataka	90
Kerala	16
Total mangrove Area in India	6740

(Source: Banerjee and Gosh, 1998)

The mangroves of Gujarat cover the second largest area according to the remote sensing data. The mangroves of Rann of Kachchh, Gujarat are poor along Kori creek. In the Gulf of Kachchh dense mangroves can be observed around the Patre creek, Dibe Kabet, Valsura, Navlakhi and Kandhla. In the Gulf of Khambat, mangroves are distributed along the coast near Mahi, Dhadhar, Narmada, Kim, and Sena Rivers. Scattered mangroves are also present in other areas (RSAM, 1992)

In Goa and Maharastra the mangroves exists in large patches along the Mandovi estuary, Vashista estuary, Kundalika estuary, Dharamtar estuary, Vasai creek, Thane creek and Valitarana creek.

Mangroves of Karnataka cover an area of about 6,000 ha. of which 1000 ha. is in Uttar Kannada district. About 14 species belonging to nine genera are extensively distributed in the district. In the coast of

Karnataka, the mangroves are found along the Kalinadi, Gangavalli and Aghanashini estuaries and at the confluence of Chakra Nadi, Kollur and Haladi rivers near Gangolli (Parnetta, 1993). The mangroves of Karnataka are very sparsely distributed.

The mangroves of Kerala once extending for about 100 sq km. a century ago, has now been reduced to only 17 sq. km. in isolated areas at Kumaragom, Dharmadom, Chettuva, Nadakavu, Pappinisseri, Kunjimangalam, Chateri, Veli etc.

2.4.2. Coral reefs

Coral reefs support a highly diverse and interesting fauna and flora; and are the marine equivalent of the great rainforests of the tropics. They have the highest biodiversity per unit area of any marine ecosystem, and may also sustain fish yields of about 15 tonnes/km². Coral reefs also protect shores from violent wave actions, they consists of atolls, fringing reefs, barrier reefs, patch rays. The major reef beds are found along the following sites. Gulf of Kachchh (patch reefs), Porbunder, Bombay, Ratnagiri, Malvan, Redi, on the west coast Bombay and Goa: Angria bank off Rathangiri, Gaveshani bank off Malpe harbour. The Lakshadweep Archipelago consists of 12 atolls and 3 reefs, which harbour a rich and varied coral fauna.

2.4.3. Coastal sand dunes

Coastal sand dunes are beautiful land features that are often overlooked by coastal property owners, whose homes and lands are buried under them. They are typically formed through the trapping of sand by dune vegetation. The type of vegetation growing on sand dunes has special adaptation characteristics that allow the vegetation to establish, grow and trap sand in the harsh conditions of coastal areas. In the absence of such vegetation, the wind can act on the exposed sand, forming migrating dunes that move back and forth with the wind (Chapman, 1976). Sand dunes support a variety of vegetation and are important in stabilizing the shore environment. With all the required adaptations to inhabit the extreme conditions, fauna are capable of colonizing along the coast.

2.4.4. Benthic biota

Benthic invertebrates and algae, which are associated with mudflats, occupy a special place in the food web by ensuring the link between primary producers and high-level consumers. During the slack water of low tide, millions of crabs flock the intertidal zone. They are the most visible component of a dense and diversified bottom fauna, whose specific composition and abundance are not yet sufficiently known.

2.4.5. Islands

Along the west coast there are many islands associated with the coastal and estuarine areas. The most important are the Lakshadweep islands, Islands off Kochi, Islands off Karwar, small Islands of Goa, a few along Maharashtra, and Coral islands of Gujarat.

The Lakshadweep Archipelago consists of 36 islands with 32km² total area, of which 10 are inhabited. The Islands are grouped into two. The details are given below.

South Canara Islands

- Amindivi islands
- Ameni
- Kalamat
- Chetlet
- Kiltan
- Sibra

Malabar Islands

- Minicoy
- Kavaratti
- Kalpeni (NIO research station)
- Androth
- Bangaram islands (has been occupied by Tourist resort)

2.4.6. Mud Banks

Mud banks are 1-3 m thick patches of turbid waters with high load of suspended and sediments clay bottom, are a unique formation along the west coast (especially Kerala coast). It is a unique habitat where a diverse set of organisms shelter during monsoon.

2.4.7. Critical habitats

The DOD project has identified 11 critical habitats along the Indian coastline, of which the following are situated along the west coast.

- | | | | |
|------|-----------------|-----|---------------------|
| i. | Gulf of Kachchh | iv. | Island off Karwar |
| ii. | Gulf of Kambat | v. | Islands off Kochi |
| iii. | Gulf of Malvan | vi. | Lakshadweep Islands |

2.4.8. Marine Protected Area (MPA)

Along the West coast there are a few protected areas and they include MPA, sanctuaries etc. and are mainly based upon the biodiversity of that particular area.

The Govt. of Gujarat declared a specific area in the Gulf of Kachchh from Okha port to Jodiya in Jamnagar district inclusive of all islands with in the Gulf, as a Marine national park and sanctuary, or *Abhayaranya* which was set up in 1989 with 16289 ha. area

In Maharashtra, Malvan proposed a Marine National Park in 1995 with 2912 ha. area. Malvan was considered as one of the priority areas, as it has a naturally protected coast and the Sindhudurg fort. The diversity of flora and fauna is also high. Due to the geomorphology of this area, sub tidal biodiversity is also rich. Endangered species such as corals and gorgonians are found in this area. (Source: Kothari *et al.* 1989)

Table 3. Protected areas of the Indian mainland with mangrove habitats

State/Union Territory	Status, Name of area and Size (in ha.)
Gujarat	National Park ● Gulf of Kutchchh: 16289
Maharashtra	Sanctuary ● Achra: 100 ● Desgan: 500 ● Malvan: 2912
Goa	Sanctuary ● Charao Island: 100
Karnataka	Sanctuary ● Coondapur: 100
Kerala	Sanctuary ● Ezhimala: 500

Source: www.mangroveindia.org

2.4.6. Tourism

Several beaches of the west coast, especially Kerala and Goa are attracting many international tourists and the tourism industry is budding in at a great speed. Many of the coastal areas are tourism centers and the Karnataka and Goa coasts have been declared as a Special Tourism Area's (STA). Certain pilgrim centres along the coast such as Kanyakumari, Someshwar, Murdeshwar, Gokharna, Hajali, Dwaraka, are attracting devotees.

3. Current range and status of biodiversity

3.1 State of Natural Ecosystems

3.1.1 Mangroves

Of the 65 species belonging to 59 genera and 31 families, the west coast represents 33 species, 24 genera and 19 families (Banerjee and Ghosh, 1998). The backwater-estuarine type of mangroves are found along the west coast, which is characterized by typical funnel shaped estuaries of major rivers or backwaters, creeks and neritic and inlets (Gopal and Krishnamurthy, 1993). Of the total area under mangroves in India, the west coast covers only 12% (Krishnamurthy *et al.*, 1987; Karthiresan, 1995). Among the west coast states, Maharashtra has the most diversified mangrove flora composed of 19 species, followed by Goa and Karnataka. Despite Gujarat having largest mangrove coverage of 37,000 ha. It displays a poor assemblage of only 9 species.

Avicennia alba, *A. marina*, *A. officinalis*, *Rhizophora mucronata*, *R. apiculata*, *Acanthus ilicifolius*, *Sonneretia alba* and *S. apetala* are some of the dominant species found along west coast. Shrubby vegetation including *A. ilicifolius*, *A. marina*, *Salicornia brachiata* and *Sueda* sp. occurs above the high tide mark. Due to the deforestation as well as development activities and domestic exploitation, species of *Nypa* and *Xylocarpus* have become extinct from the west coast, whereas other species like *Ceriops tagal*, *Lumnitzera racemosa*, *Sonneratia apetala* are found only in certain areas (Untawale, 1987). A very distinct discontinuous distribution of mangrove plants has been observed along both the coasts of India due to various factors. The associated floras are plant species that can sustain various levels of salinity in the elevated regions above the spring tidal mark. About 30 terrestrial species are known to grow in these areas. The most common mangrove associates are *Clerodendron inerme*, *Thespesia populnea*, *Pongamia pinnata*, *Sesuvium portulacastrum*, *Myriostachya wightiana*, *Hibiscus tiliaceus*, *Fimbristylis ferruginea*, *Aeluropus lagopoides*, *Cress cretica* etc

3.1.2 Corals

Coral reefs are known to be the most diversified and productive ecosystems among all the marine ecosystems of the tropical zone (Wells, 1998). Coral reefs are often associated with direct economic importance due to the organic and inorganic resources. They also play an important role in protecting the shoreline. The fishery resources of coral reefs are extremely rich and diversified. The associated fauna of the reefs include beautiful molluscs and gastropods. Gujarat has rich heritage of live corals and coral islands in the Gulf of Kachchh. It is these coral islands together with mangrove areas along the Gulf of Kachchh coastline and its islands that support unique and rich ecosystems, which nurture a wide range of aquatic flora and fauna. This includes more than 210 varieties of algae, over 40 varieties of corals, large varieties of coelenterates, 70 types of sponges, 150 types of molluscs, 15 types of echinoderms, 3 types of sea snakes, 2-3 species of sea mammals, over 200 varieties of commercial fishes besides coral fish, 2-3 types of sea turtles, about 90 or more species of water birds, 78 species of terrestrial birds, 8-10 types of mangroves and many others (Chhaya, 1997). It is this vast diversity that prompted James Hornel to call this area "Gods gift from Heaven". It is clear that corals are not exploitable resources, and hence there is no question of harvesting any corals. Their exploitation cause severe destruction of both reef dwelling and reef building organisms. The coral ecosystems provide a good shelter for marine algal growth and diversified seaweed flora is often observed in coral areas. Some of the algae, though in minor scale, are responsible for reef building. There are certain algae that have calcium carbonate deposition and are known as coralline algae. The role of calcareous algae is however, less significant in the Indian Ocean than in the Pacific Ocean. Jagtap (1987) reported 20 meter wide algal ridge on the seaward side of Kavaratti and Agathi Islands, of Lakshadweep. Altogether 82 marine algal species are recorded from the Lakshadweep lagoons with an estimated annual yield of 3645-7598 million tons of fresh weight per year (Subbaramaiah *et al.*, 1979). Rhodophycean species had the maximum number with 39, followed by 33 green and 10 brown algal species.

3.1.3. Sand dune vegetation

There are about 148 species representing 115 genera and 49 families, reported from the east and west coast of India (Untawale, 1980). The west coast has been observed to have more diverse species than the east coast. Along the West coast stretch, a variety of vegetation, about 45 species (Appendix 2) are commonly inhabited

3.1.4 Benthic fauna

Benthic fauna can be divided into two major groups, which are macrofauna and meiofauna. Dominant macrofaunal species recorded from the Goa mangroves were *Modiolus metcalfei*, *Perna viridis*, *Diopatra neapolitina*, *Meretrix casta*, *Papiamalabaricus*, *Cerithidea fluviatilis*, *Diogene custos* and *Glycera alba*. While *Polychaetes* are dominant macrofauna, meiofaunal species belonging to family *Chromadoidae* and *Desmodoridae*, followed by copepods, which are also quite abundant. The upper 2 cm layer of the mangrove sediment harbours 60% of the total meiofauna.

Marine benthic fauna of the Malvan coast (sandy, rocky and marshy area) comprise of 208 species belonging to 172 genera (Parulekar, 1981). The faunal species displayed diversified composition of several groups including 9 corals, 2 sponges, 2 sea pens, 18 sea anemones, 49 polychaete worms, 5 stomatopods, 5 isopods, 2 crab species, 5 prawns, 5 baranacles, 1 insect, 4 limpets, 10 top shell, 8 whelk, 11 spire shells, 3 sea hare, 3 mussels, 3 edible oyster, one pearl oyster, 11 clams, 3 echinoderms and 2 mud skipper species. There is also a chain of rocky islets towards the south extending up to Vengurla Rock Islands, which harbour a very good biota up to 15-20 m depth

3.1.4. Woodborers

Woodborers of India are represented by about 26 species belonging to class Crustacea and Mollusca (Turner and Santhakumaran, 1989). Biodeterioration of mangrove wood is severe along the Indian coast, species such as *Dicyathifer manni*, *Lyrodus pedicellatus*, *Banka rochi*, *B. campanellata*, *Nausitora heldlevi*, *N. dunlopei*, *Bactrosophorus* sp., *Martesia* spp., *Lignopholus chengi* cause severe damage to the woods.

3.1.5. Sea weeds

There are several commercially important seaweed species such as *Sargassum* spp., *Gracilaria* spp. etc. reported from the Gujarat and other coastal sites of the west coast. Some of the rare and endangered genera such as *Acetabularia*, *Neomeris*, *Halimeda* have also been reported from Gulf of Kachchh region.

3.1.6. Algae.

A total of 48 species belonging to 30 genera are reported from the central west coast of India. Altogether 73 marine algal species are recorded from Malvan. Among these, 23 were *Chlorophyceae*, 17 *Phaeophyceae* and 33 *Rhodophyceae* members.

Marine algae in the mangrove environment are either floating or attached to the sea floor and mangrove bark or pneumatophores. Little is known about the algae associated with mangrove regions. There are a few reports on the distribution of algae in mangrove (Jagtap, 1986).

3.1.7. Reptiles

Marine turtles and sea snakes are the important reptiles. Along the west coast a few studies have been carried out on the status of the marine and coastal reptiles.

Along the west coast, the crocodile (*Crocodilus palustris*) is found only in Goa mangroves. Among the reptiles, 21 snakes, 4 lizards, 5 turtles and 1 crocodile species are recorded (Deshmukh, 1994) from the Maharashtra coast.

3.1.8. Birds

Birds use the Sea both for breeding and feeding. There are two main groups of birds, seabirds and water birds. Although somewhat arbitrary, in this context seabirds are those that use marine waters as a food source for most of the year, while water birds are those that feed on or over inter-tidal areas, often for only a part of the year, but the sea is important for both of these groups. Birds are associated with the coastal wetlands, estuaries and backwaters, mangroves, corals and other coastal habitats.

The west coast has some very important habitats for migratory or resident bird species, pelagic and coastal migrants and wintering species that inhabit or travel by coastal areas. Several sites have been identified as IBA's along the west coast. These include the Marine National Park, Salt pans of Bhavnager, and Mahi River Estuary from Gujarat, Kole wetlands from Kerala and Illhas wetlands from Goa.

Prioritised list of IBA's along the west coast are given in table 3.

Table 4. Prioritised list of IBA

Site name	District	Criterion
Flamingo City	Kachchh, Gujarat	A1, A3
Mahi River Estuary	Kheda, Gujarat	A1, A3
Kole	Malapuram, Kerala	A1, A4 (i), A4 (iii)
Pitti Bird Sanctuary	Pitti, Lakshadweep	A4 (i)

Source: MISTNET, 2001. Vol.2 No. 1

Mangrove forest provides good shelter, food and breeding ground for the resident and migratory birds. About 177 species of birds are found in the mangrove forests of India (Mukherjee, 1975; Samant, 1986). Kingfishers, herons, storks, sea eagles, kites, etc. are the dominant and common birds observed. A total of 121 bird species were recorded from mangroves and adjacent areas (Ali and Ripley, 1983a, 1983b; Samant, 1986). Out of these, 66 species are resident and local migrants, 234 true migrants, 28 resident with migratory populations and only 3 are vagrant or occasional strays. Extensive mudflats in the Gujarat coasts attract birds like pelicans.

3.1.9. Mammals

There is very limited information on the Marine/coastal mammals of the west coast.

3.1.10. Islands

Lakshadweep archipelago. The Lakshadweep group of islands is formed of typical coral atolls and harbours a significant number of coral species, associated fauna and ornamental fishes. The rich biodiversity of this region includes 105 coral species, along with 78 seaweed species, 6 sea grasses, 91 sponges and 18 boring sponges (Bakus, 1994).

Karwar Region. The sub tidal areas of the island are rich in sea urchin, *Cuypraea*. The Amadalli muddy shore is known for the living fossil *Lingula* sp. Because of the lagoons and sheltered bays of Karwar coast, the intertidal and subtidal zones are rich in Biodiversity

3.1.11. Biodiversity Rich Special Areas

3.1.11.1. Maharashtra Coast

In order to identify and survey the potential sites for the creation of Marine Protected Area's along the Maharashtra coast, the Government of Maharashtra awarded a Maharashtra Forestry Project to the National Institute of Oceanography. The project surveyed 37 sites, coming out with 10 biodiversity rich sites, out of which only 6 sites are being suggested to be declared as Marine Protected Areas. Details are given below.

Venguria Rock-Malvan. Consists of a group of rocky islets and extend up to Malvan rock forming a chain of exposed and submerged rocks for about 1km north northeastward of Tipti region. There is a high amount of marine fauna, mainly coral, jellyfishes, gargonians and major species of seaweeds. This site is also good for fishing, with high productivity and diversity.

Achara-Deogad-Vijaydurg. Achara is a marine station with substantial mangroves, which extends a distance of 5km from the mouth of the Devgad River. Eleven mangrove species are distributed along this stretch of the estuary. Achara mangroves are considered as "sacred" since the land belongs to Shri Rameshwar. Economically important seaweed species *Monostroma oxyspermum* is also found in the mangrove forest, with the avifauna and intertidal fauna also being very rich and diverse.

Purangad-Ratnagiri. The river at Purangadh has extensive amounts of mangroves, with 9 species of mangroves identified. Ratnagiri (open coast) has a long sandy beach with rocky outcrops towards the north. This area has extensive fauna and flora coverage at different zones. An interpretation center to enhance mangrove awareness for conservation, a nursery for afforestation and two observation towers have been erected in this area.

Mumbra-Diva. An area near Thane, that displays well preserved mangrove patches existing in an otherwise polluted area. This area supports good mangrove vegetation with less human impact compared to other areas of Mumbai, therefore this area requires immediate protection.

Calaba. Is a highly populated area of southern Mumbai, which protrudes into the Arabian Sea. Although Mumbai is one of the most polluted coasts, this area exhibits a diversified and luxuriant flora and fauna. 64 marine algal species have been identified.

Vikroli. Lies towards the western banks of the Thane Creek, it is considered as a special reference to the conservation and management of mangrove forests by private ownership. It has about 1750 ha. of mangrove vegetation, of which 1700 ha. is currently preserved.

3.1.11.2. Gujarat Coast

Gulf of Kachchh is an important biodiversity site especially its coral reserve. It is also known as the breeding ground for the Lesser Flamingo, a nesting place for Great Indian bustard, *Choriotis nigriceps* and a wintering area for waders, pelicans and ducks. The Pirotan Islands and submerged reefs display corals,

giant sea anemones, sea cucumbers, gorgonians, etc. The Gulf of Kachchh is also very rich in marine algal biodiversity and biomass.

3.2. State of agricultural ecosystems

The fishery and other related industries are attracting many of the coastal inhabitants, resulting in the dwindling in agricultural practices to a greater extent. Some of the indigenous salt tolerant varieties of rice are being cultivated in small areas of different parts of Kerala, Karnataka, Goa and Maharashtra.

4.0. Statement of problems relating to biodiversity

4.1. Causes of loss of biodiversity

The major threats to the coastal biota are the human activities, which are anthropogenic rather than the natural. These activities range from small scale utilisation for ones livelihood to commercial utilisation for mega industrial purposes. At different levels these activities are magnified stressing the coastal habitats to various degrees. The immediate gains from the coastal and marine resources are exploited through unplanned and unsustainable way of developmental activities. Many of the coastal areas are locations for large scale industrial operations, and major ports and harbours. The anthropogenic activities exert enormous pressure on the coastal system, as the activities are far beyond the carrying capacity of the area. As a consequence, the public amenities are being lost some local fish population are at risk; the biological diversity is threatened or mostly seriously challenged. The major activities being carried out along the west coast include industrial expansions, intensive aquaculture, which has been exerting adverse effects since two decades on the mangroves (the pharmaceuticals used in aquaculture also pose serious problems on the natural biota); wetland reclamation due to population expansion; beach tourism activities etc.

Industrial activities and their discharges cause serious problems to biodiversity and the environment. These activities are predominant at certain regions along the coast of Kerala, Karnataka, Goa, Northern Maharashtra and Gujarat

4.1.1. Chemical alterations

Sewage, organic pollutants (persistent), heavy metals, radionucleiees, petroleum hydrocarbon, polycyclic aromatic hydrocarbons (PAH), synthetic organic compounds, nutrients (eutrophication), contaminant sediments are some of the major pollutants, which are released by various industries, causing adverse effects on the coastal biota.

4.1.2. Physical alterations

The basic integrity of the whole physical communities or physical structure of coral reefs, seaweeds, mangroves are very important. Many coastal communities are dependant on these physical habitats. Any alternations in the physical environment inevitably result in loss of biodiversity through species extinction, reduction in genetic diversity within species, due to lower population size and resultant *genetic bottleneck effect*.

Sea wall constructions, shoreline alterations, intertidal and sub tidal alterations, mineral & sediment extraction, sand mining, wetland alterations (agriculture), landscaping are the major physical processes, which add to the habitat destruction problems. Others include nutrient fluxes due to agrochemicals and fertilizers.

4.1.3. Biological Alterations:

Result from accidental or deliberate movement of organisms in land based or near shore aquaculture operations (pathogens from cage reared fish and introduction of exotic species), invasion of alien species etc., results in alterations and shifts in the original biota.

Algal toxins. From Unseasonal monospecies bloom resulting in the release of different types of toxins, e.g. PSP, AMP, etc.

4.1.4. Stressed habitats

4.1.4.1. Mangroves.

Changes in geomorphology, environmental and hydrological conditions affect the distribution and survival of mangroves. Excessive resource consumption of fuel and fodder by the coastal stakeholders, industrial effluent discharges to the mangrove areas, aquacultural and agricultural encroachments all have serious effects to mangrove distribution and survival.

4.1.4.2. Coral reefs.

Heavy industrialisation, large-scale coastal land developments, dredging and pollutants including sewage and oil, effect coastal areas especially coral reefs. Removal of grazing fishes, by trapping or netting can upset the delicate balance between a healthy reef and one dominated by large macro algae. Siltation can kill corals or reduce their growth rate, whilst the increase in nutrients through land run-off and sewage pollution affects the corals competition balance. Oil spillages shift the benthic fauna from corals to filter feeders, therefore affecting coral breeding. Tourism if not regulated can also have a negative effect to coral reefs.

4.2 Root causes of the loss of biodiversity

The root causes of loss of biodiversity are multidimensional. The biodiversity of many of the coastal ecosystems are threatened by many industrial activities, including aquaculture, drainage, siltation and pollution.

4.2.1. Anthropogenic alterations

Excessive exploitation of the intertidal biota for different purposes: impact of land based activities; habitation; tourism, coastal industrial discharges, sewage disposal; dumping litter/plastic materials and other insensitive human activities add up resulting in degeneration/alterations in the natural living resources.

Unabated industrial expansion along this part has put immense stress on the coastal waters. There are a number of big industries producing cement, marine chemicals, petrochemicals and textiles along the coast and many coral mining activities for their raw material and it is noted that the coral mining has destroyed vast stretches of benthic organisms. South Gujarat coast is one of the most industrialized coastal belts of India.

4.2.2. Maritime operations

Dredging, port and harbour development, ballast water release etc are also responsible for the habitat destruction/modification resulting in changes in composition of the living resources.

4.2.3. Over fishing

Due to uncontrolled fishing activities, which are mainly caused by increased numbers of fishing trawlers has resulted in many species being fished beyond the sustainable yield. As fishing shifts from subsistence to commercial occupations, mechanisation of the crafts gets prime importance. Various promotional policies of the Centre and State Governments financial assistance from World Bank and other Financial Institutions on liberal conditions were responsible for rapid increase in numbers of mechanised units. The lucrative returns from fishing at initial stages prompted entrepreneurs to invest in mechanised trawling units. Due to the additional units in the inshore waters, heavy competition amongst different types of units has occurred, as they have to share common fishing grounds. The exploitation of high priced resources like prawns and cephalopods has been increasing, therefore threatening the extinction of these resources, especially in the near shore waters. The increase in numbers of fishing units is going on unchecked and with the profit motive, entrepreneurs will carry on increasing their units. As long as existing units continue to earn sustainable profits more and more units will be drawn to join the fishing activity.

4.2.4. Aquaculture

When the Government of India recognized the economic potential of shrimp culture; it prioritised it as 'extreme focus sector', resulting in the huge expansion of fish farming activities. Unregulated construction of farms and construction by conversion of paddy fields caused many problems. Shrimp farming reduced crop farmers of precious rice fields, and the seepage produced effected adjacent agricultural lands, by

making them unfit for cultivation. With the policy of liberalisation, farmed shrimp culture has become one of the blooming industries. India has an estimated brackish water area of about 12,00,000 ha. along the coastline. The aquaculture industry has taken a leap through the induction of new technologies. However, this sudden development lacked environmental management. Expansion of brackish water aquaculture units and their intensive farm practices has put severe stress on the surrounding environment in general. Some of the issues related to brackish water aquaculture industry and its impacts to the coastal environment in general can be enumerated as follows:

- a. Aquaculture involves storage of large amounts of saline water on land. This can cause dispersion of salts in and around the farms, thereby making them saline and unfit for any other purposes. In some cases large-scale aquaculture units located far beyond the coastal regulation zone, which requires seawater to be pumped well inside the hinterland, have the potential for ground water contamination.
- b. Large quantities of freshwater are required for scientific aquaculture farms in order to dilute seawater to acquire brackish water quality. This results in converting fresh water into saline, the abstraction of ground water could result in lowering of water table and salinisation of fresh water.
- c. Some aquaculture farming operations involve the use of highly nutritious palletised feed. Shrimps do not consume all feed and therefore it reaches the bottom. Such unconsumed feed chemicals and antibiotics as well as excreta cause pollution of water and may also lead to eutrophication in the natural water bodies.
- d. Many aquaculture farms sow the naturally available shrimp/prawn as their seeds. According to reports it estimates for every one kilogram of tiger shrimp larvae collected, about 10 kilograms of other varieties of fish and shrimps are killed. This has severe implications to biodiversity of the area.

4.2.5. Sand mining

Large scale sand mining along the coast is an ongoing event, which disturbs biodiversity and the area become prone to erosion. This is a major threat along many parts of the coast causing severe problems to the intertidal biota. The uncontrolled sand mining activities will lead to severe damages along the coast.

4.2.6. Shell mining

Extensive shell mining practices have been observed from the backwaters from October to June, with many families being solely dependent on this. There is no stock assessment data on the shellfish resources, species available and details of the status of the resource exploitation. These activities are practiced in the river systems, further studies are recommended.

The continuous shell mining may destroy the bottom fauna, and uncontrolled exploitation may affect the breeding, hence a study on breeding season, may help to protect the resources to a certain level.

Shellfisheries in this area principally consist of wild scallops in offshore areas and wild mussels and cockles from inter tidal zones of coastal areas and estuaries.

Inshore and inter tidal shellfish harvesting - In addition to the impact of scallop dredging (outlined above), the harvesting of shellfish in intertidal and shallow coastal waters may also result in effects on non-target benthic organisms.

4.2.7. Coastal construction activities

The construction of barrage to reduce sea erosion will have an impact on the sub tidal area of the seaward barrage, in time there would be a shift in dominance / suppression of deposit feeding communities or a reduction in hard bottom communities. The barrage construction at a coastal area will also result in the loss of inter tidal bird feeding habitats.

4.2.8. Disposal of wastes

Domestic and urban sewage, industrial waste discharges and other solid waste dumping exert heavy stress on the coastal environment and biota. The nature and composition of these wastes vary at different locations depending on the hinterland activity in addition to the coastal.

Evaluation of sewage sludge disposal on spatial and temporal variability of the organisms in the heterogeneous environment of coast is complicated by the influence of natural factors and other anthropogenic activities.

The nature, quantity and frequency of disposal of dredged material, as well as the nature of the receiving environment, will determine the response of benthic communities, and other inhabitants.

4.2.9. Oil rig operation and oil pollution

The coasts and the estuaries are affected at different levels because of the refineries and oil transfer facilities. There are evidences of reductions in species such as limpets and barnacles and increases in the abundance of algae in the vicinity of refinery outfalls from different parts of the world.

4.2.10. Ship breaking

Ship breaking is an important activity along west coast especially in the Gujarat state. For example, Alang (a small coastal town) in Gujarat houses the world's largest ship breaking yard. 45,000 workers break down about 200 ships in this yard every year. Ship breaking activities, which are prevalent along the coast, cause numerous hazards for the coastal and marine environments. Ship breaking releases a large number of dangerous pollutants including toxic waste, oil, waste metals etc. into the water and seabed. Although most oil is removed before the ship is scrapped, sand that is used to mop up the remaining oil is discharged into the sea. High concentrations of oil and grease (alters DO levels) found in the coastal waters and chock the marine life. Adding to the stress of coastal waters is the organic load released into the sea from human habitats that have little or no sanitary facilities, which in turn increases, the BOD.

4.2.11. Tourism

The impacts associated with the tourism include environmental, social and cultural. These can be listed as in the table 4.

Table 4. Impacts of Tourism

Environmental impacts	<ul style="list-style-type: none"> ▪ increased waste ▪ Excessive use of resources ▪ Habitat destruction ▪ Construction ▪ Landscaping
Social / cultural impacts	<ul style="list-style-type: none"> ▪ Loss of traditional values and way of life ▪ Artificial culture promoted for tourists ▪ Increased antisocial behavior ▪ Resource alienation

- | |
|---|
| <ul style="list-style-type: none">▪ Cultural revival▪ Economic changes |
|---|

4.2.12. Port and Harbour activities

Though many of the activities including the harbours and ports along the coast are very important for the economy and overall development of the nation. However at some level care should be taken for the sustainable use of the natural habitats for the long-term benefits. Lack of awareness and operational problems, accidental spills of industrial raw materials cause serious damage to the ecosystem supporting them.

4.2.13. Dredging and mineral mining

These sea based activities are also responsible for the destruction of the habitats. Many cases the minor disturbances in the food chain cause serious imbalances in the ecosystem function.

4.2.14. Retting zones

Many locations in the middle and upper stretches of estuaries serve as coconut retting grounds, where extremely poor environmental conditions prevail, resulting in low faunal diversity (severe in the Kerala coast).

4.2.15. Surface transport

Backwaters are used to transport oil, chemicals, toxic materials by barges, pipelines, public transport, mining, waste disposal, mariculture, recreation, reclamation for agriculture and residential development. Domestic and industrial effluents discharged from urban habitation and industries have led to instances of fish kills, degradation of benthic biota and a general decline in the natural carrying capacity of the systems.

5. Major actors and their current roles relevant to biodiversity

5.1. Governmental

Many of the government bodies are responsible for conservational works through the policies and legal frame works. The Ministry of Environment and Fisheries (MoEF), Ministry of Ports and harbour, Ministry of Fisheries (Central and State), Department of Tourism, Ministry mining and geology etc., are responsible for the coastal resource management.

5.1.1. Available policies and legal frameworks for fisheries & coastal conservation

These include measures taken by the Government to deal with a few of the environmental problems of fisheries, with the view for sustaining fisheries development and simultaneously ensuring environmental protection, the approach to coastal fisheries and aquaculture development has been orientated towards mitigating adverse effects on the resource availability, the environment and those engaged in the fishing activities.

5.1.1.1 Central Government agencies

- a. The Marine Fishing Regulation Act (MFRA), 1978 states that 3-6 nautical miles from the coastline should be reserved for the operation of traditional fishing, and beyond this zone for mechanized fishing. The MFRA prohibits fishing by deep-sea fishing vessels within the terrestrial waters of India and stipulates measures for conservation and sustainable development of marine fisheries within terrestrial waters by restricting the type of fishing, fishing gear or craft, period of fishing, mesh size etc.
- b. The Environmental Protection Act, 1986 prohibiting the conversion of reserve forests, mangroves, wetlands, mudflats etc. for coastal aquaculture and beach development
- c. From May 1987, the Indian Government banned bull trawling within the Indian EEZ, and no permits have been issued chartering this type of vessel.
- d. The declaration of coastal stretches as Coastal Regulation Zone's (CRZ). 1991 is the most important decision of the coastal management.
- e. The Indian Fisheries Act, 1897 regulates the fishing of pearl oysters and collection of certain types of shells in vulnerable areas through licensing. The export of silver pomfret below 300gm size and sea cucumber of less than 9cm are also banned
- f. Other important government policies include; Wildlife (Protection) Act, 1972, the Aquaculture Authority Bill 1997, Marine Regulation Act, Merchant Shipping Act, MPEDA Act, Coast Guard Acts and Central and State Pollution Control Boards.

5.1.1.2. State Government agencies

- a. The Kerala Marine Fisheries Regulation Act, 1980, and subsequent amendments imposes a number of restrictions, including the banning of fishing during June-August, limiting the number of trawlers and boats fishing within the state, regulation of mesh size to about 35mm for cod-end of a trawl net and banning of trawling during the monsoon months. Which is similarly found in other states too.
- b. A closed fishing season is being observed by a number of State Governments during the breeding seasons (monsoon) of certain fish types.

5.1.1.3. Local administrative agencies.

These include *Mandal panchayath*, *Taluk panchayath*, Block developmental and District administration.

5.1.1.4. Others

- a. The Department of Ocean Development (Government of India) has prepared draft notification containing the details of regulatory and preventative measures relevant to the coastal zone, exercising the powers conferred under section 3(1) and 3(2)(v) of the Environmental (Protection) Act, 1986. This draft notification has been circulated to all the state governments seeking the views of all concerned about the sustained use of the Indian seas. Coastal areas which serve as breeding and nursery grounds of various species of finfish and shellfish, areas of high genetic diversity, mud banks, mussel beds, estuaries and mangroves are likely to fall under the purview of the proposed Ocean Regulation Zone Notification (ORZ

- I). Opinions are required from various marine sectors including marine biologists and fisheries experts, NGOs, progressive fishermen before decision on the draft notification by states is taken.
- b. The FAO has recommended the formulation of a global Code of Conduct for Responsible Fisheries, which was unanimously adopted in October 1995 at the FAO conference. The code provides a necessary framework for national and international efforts to ensure sustainable exploitation of aquatic living resources in harmony with the environment. It is currently the most important international instrument devised for wholesale management of living aquatic resources

5.2 Fishing communities

These include traditional, mechanised, near shore and deep-sea fishing groups, profession based cooperative societies, Boat Owners Associations (including different types) etc. Fisherman's organisations throughout the country have undertaken awareness campaigns for educating fishermen on resulting damage from uncontrolled and over exploitation of coastal waters. A number of programmes for craft development, provision of financial incentives in the form of subsidy for motorisation of traditional crafts, introduction of offshore pelagic crafts for exploiting the under-exploited pelagic fishing resources etc have also been taken up.

5.3 Local communities.

Fishing communities, marginal farmers, small traders (sand and shell removing communities), agricultural labourers, daily wagers who work in the fishing activities, as well as fish traders can be involved in the protection and enhancement of biodiversity.

5.4 Donors.

A few of the coastal areas are managed by the private donor agencies, which involve a variety of different conservation practices.

5.5 Industry and corporate sector.

Shore based small scale and heavy industries, harbour and port authorities are also involved in small scale conservation works.

6. Ongoing biodiversity related initiatives

6.1. Governmental

Introduction of Fishing holiday, mesh size regulation, CRZ notification, ORZ document, Restriction of the Capacity (HP) of the mechanized trawlers etc, are a few of the important decisions that the Government of India has introduced for the sustainable management of coastal resources.

6.1.1 Policy and Legal framework

There are many ongoing biodiversity initiatives being carried out, these include:

- a. Biodiversity bill 2000, which has to be finalised.
- b. The Central Government has introduced a scheme of patrolling designated waters monitoring fishing activities. 30 crafts fitted with communication equipment were to be introduced by the end of the 8th Five Year Plan (1996).
- c. Steps have also been taken to upgrade technology for sustainable development of coastal aquaculture with the support of the Fisheries Research Institutes of the Indian Council of Agricultural Research (ICAR), the FOA/UNDP and the World Bank.

6.1.1. Administrative

Registration and Licensing for the fishing boats, has been introduced to help regulate over fishing of the coastal waters.

6.1.2. Programs and Schemes

a. NIO, NIOT, CMFRI, NEERI, CIFE, CES, various Universities, CMSRI etc., are having in house, sponsored and centrally funded projects, wherein biodiversity related components are directly or indirectly involved.

b. DOD has a major role in the survey and assessment of marine living resources. It is also responsible for protection and conservation of marine environments. Under the ICMAM project, a GIS based information system for critical habitats gathering the database, which is very significant for biodiversity.

c. Fishery survey of India under the ministry of Agriculture is responsible for survey and assessment of marine fishing resources in the EEZ along the Indian coast. During exploratory survey, one of the objectives was to identify the biodiversity. They are building up species inventory of marine fishery resources under different sponsored programs such as Marine Living Resource Programs (sponsored by Department of Ocean Development). They are also undertaking inventory of deep-sea crustaceans, Molluscs and Finfishes, the biology of perch in Quilon bank and Wadge bank are also being undertaken. Bioresource Inventory Program includes plans for implementation of marine bioresources inventories, which are currently being finalized. The areas include:

- Marine botany-Sea weeds and Mangroves,
- Marine Microbiology- Actinomycetes, fungi, protozoa
- Plankton – phyto and zooplankton
- Porifera and coelentrata
- Other marine vertebrates.
- Effects of dredging on benthic fauna.

d. The Government of Kerala, Department of Fisheries has an autonomous society, called "Fishing Resource Management Society", which is undertaking major projects such as:

- Mangrove afforestation programme for the conservation of natural nurseries of prawns and other fishes.
- Surveys, assessments and the preparations of a bibliography on endangered fishes of Kerala.
- Impact assessment of the trawling ban imposed during the monsoon season.
- Preparation of a fisheries master plan for Kerala, by appointing a expert committee
- Drafting Aquarian reforms with regard access rights, ownership of fishing assets and rights of first scale fish caught by fishermen.
- A project for the conservation and management of the endangered fish, *Masheer*.

This society plays a significant role in formulating and implementing Biodiversity conservation. The initiations can be strengthened and new interventions could be added, for the implementation of the program. (Sponsored by ICAR).

e. Department of Ecology, Environment & Forests, has a number of projects being implemented including mangrove afforestation, degraded mangrove regeneration, and Green wall formation etc.

f. The Central Marine Fisheries Research Institute. Is a central agency under ICAR, which has several branches at different regions. Many fishery oriented inhouse, sponsored, centrally sponsored research projects are being undertaken all along the west coast.

6.1.3. Economic/social sectors

Various kinds of subsidies for fuels and fishing equipments are implemented by the government. Fishery developmental activities: Financial assistance to fisherwomen, traditional fisher folks etc.

6.2. NGO's

Some of the NGOs based near the coast are involved in the coastal zone protection against pollution, resource conservation (vigilant against sand and shell removal from the beach) and management through enforcement of discharge limit (both quality and quantity of the industrial effluents). Some of the legal documents regarding CRZ and other coastal acts have been translated into local languages for the benefit of public by different NGO's.

6.3. Communities and Peoples Movements

Communities are involved at different levels along the west coast, for the enhancement of the quality of the local environment.

7. Gap Analyses

7.1. Gaps in information

7.1.1. Lack of updated data on many of the coastal biotic resources

The complete information on the Intertidal organisms, seaweeds, reptiles, birds (migratory and resident), marine mammals etc. is lacking. Though information on the above is available, many times it is patchy and restricted to certain states or regions. The status of pollution on biota at different levels is not available. For comparison of biodiversity loss or gain, these are insufficient data over different time schedule (e.g. the data on the fishery resources, their exact breeding ground is not available).

7.1.2. Insufficient data

Insufficient data on the pollutants especially on the types and quantity of Petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAH), synthetic organic compounds reaching the coastal waters.

7.1.3. Lack of knowledge about the alien species from the ballistic waters

7.1.4. Information on the breeding grounds of the commercially important species of fishes.

7.1.5. Data on the encroached coastal areas for aquaculture, agricultural, marine salt works, and industrial purposes.

7.1.6. Lack of information about the coastal policies and acts for coastal inhabitants, b this is due to the lack of understanding, improper approach by the authorities, unavailability of the information in local language and illiteracy among the coastal population.

7.2. Gaps in Vision

7.2.1. The major constraints on small-scale fisheries sector are the lack of satisfactory information on economic and social aspects on communities who are directly dependent, inadequate markets, high costs of new technologies and social and cultural impediments to the adoption of new technologies.

7.2.2. Technological improvements applied to limit resources in certain cases have lead to an uneven acquisition of the technology, which only benefits a select few.

7.2.3. Lack of initiative programs for the development of value added product of lesser economic value (by-catch).

7.2.4. Both biological and sociological researches are lacking which are required to make sure that the new and appropriate technologies are relevant to stakeholders needs and abilities and to promote their understanding and acceptance of measures.

7.2.5. Inappropriate developmental programmes along the coast (long term effects on the ecosystem is overlooked). Which includes the development of the harbours along the pristine biodiversity rich areas (e.g. proposed Tadadi project)

7.2.6. Major constraints identified in coastal management are:

- a. Conflicts among the different users of coastal resources, especially traditional fishing and mechanized trawlers, local fishermen and interstate or international fishing vessels. Mechanised Trawlers and the indigenous fishing groups; indigenous and traditional fishermen; national and international trawlers have different approaches for the coastal resources
- b. Destruction or modification of coastal areas, such as wetland, mangroves etc., for commercial or residential purposes.
- c. Uncontrolled discharge of urban sewage, industrial effluents resulting in pollution.
- d. Lack of co-ordination between different government departments and implementing agencies.
- e. Dealing with insufficient or lack of data: Many of the difficulties in making any management decision is the usual lack of information on which the decision is being made, (the paucity of accurate information concerning marine resources has caused serious problems in the past). Management can only apply environmental protection measures when there is a complete knowledge of the resources, their relationship between the stress and environmental response and the stakeholders needs.
- f. Conflicts between different users of the same stock/catchment area within the coastal zone.

7.2.7. Anthropology and Indigenous knowledge (IK) – Anthropological methods have been used by the dominant paradigms of western scientific conservation to access IK in a highly extractive manner. Modernist Anthropology views IK (one of the hallmarks of the indigenous ecology) as a nonpolitical and non economic resource, which can be extracted from local communities, translated into western technology, and assessed by scientific criteria. Far from being non-economic and apolitical, IK like biodiversity is a resource, which is typically extracted and manipulated, with the gains resulting from this manipulation rarely returning to the original source

7.3. Gaps in policy and legal structure

7.3.1. Obscure regulations

Government regulations are inadequate to ensure conservation.

7.3.2. Lack of government attention and overall awareness

Insufficient *tools* for the implementation of regulations. Insensitive attitude towards nature conservation.

7.3.4. Inadequate manpower and logistics in the Government departments for the policy implementation.

7.3.5. Lack of coordination of inter ministerial departments in the legal issues.

MoEF in many cases fail to analyse the implications of the new projects along the coast and permissions have been granted to many of the MNCs inspite of the local agitations.

7.3.6. Coordination between the interministerial policies and activities of the Central and State Governments.

7.3.7. Pollution Control Board is not very strict in monitoring the effluent discharge and quality due to lack of manpower and training.

7.3.8. Monsoon ban requires a uniform or staggered. Currently GOI has introduced uniform monsoon ban along the west coast, but along northern part of the west coast monsoon arrival is delayed by about 10-15 days; needs more scrutiny to arrive at specific recommendations.

7.4. Gaps in institutional and human capacity

7.4.1. Though there are institutions, aimed at coastal research works, there are gaps in the interaction between different institutions.

7.4.2. Gaps in understanding between central and state ministry

7.4.3. Many institutes have stopped the recruitment of the new scientists, which leads to lacunae in the transfer of the experiences gained by the senior scientist to the younger generations resulting in gaps in human capacity building.

7.4.4. The Classical taxonomical works are not encouraged because of the applied research works and hence there are very few expert taxonomists for different coastal and marine groups.

7.4.5. The standard referrals for many of the coastal biota are not available, which leads to improper identification of some species.

8. Major Strategies

The strategies have to combine several interlocking initiatives, which may include different social levels and within government.

8.1. Gaps in Information

8.1.1. Information banks and data banks for the environmental management

Collection of the primary data and the secondary data, generation on the major living resources. Interrelating existing data and training for the efficacy.

8.1.2.

Delineation of breeding grounds of the major commercial fisheries: Strictly time bound. Central and state fisheries departments, major fisheries research institutions, fishery survey of India (FSI) need to concentrate on time bound program to identify and delineate the breeding ground of major commercial fisheries.

8.1.3.

Updating the intertidal resources all along the west coast – delineation of *sites* for protection and immediate actions.

8.1.4

Strict Enforcement of the effluent discharge levels and quality by the pollution control board.

8.1.5.

Integrated Coastal Zone management (ICZM) - ICZM should consider, coordinate and integrate the interests of all appropriate economic sectors involved in utilization of coastal resources, which will solve the problems that exist between the various user groups in the coastal resources. Remediation and Abatement technologies. Persuading the industries to adopt latest technologies.

8.1.6.

Utilisation of the full potentials of the coast guards in the coastal protection by training and involvement.

8.1.7. *Strategies* for mangrove conservation

For the effective management of mangroves and related ecosystems the following strategies are outlined:

- a. Identification of severity of threats from anthropogenic/industrial activities to priorities sensitive areas.
- b. Demarcations of mangrove areas for conservation activities.
- c. Regeneration of the degraded mangroves
- d. Prevention of effluent discharge along these areas.
- e. Cultural and socio-economic issues – Alternate source of fuel wood for the coastal communities.
- e. Capacity building
- f. Forest management through the Forest Department.

8.2.

8.2.1. Fishery

a. Monsoon fishing: (Fishing during the breeding season destructs the resource regeneration and hence reduction in the fishery resource. Suitable measures should be taken up for controlling the fishing during the monsoon and the breeding season.

Proper framework should be set for the protection of the breeding grounds against destruction.

b. Optimum sustainable yield: The In the days of declining natural stocks, steps are needed to sustainable management of the living resources so that they get chance to regenerate and thus prevent collapse. For effective management strategies, the industry needs to respect regulations voluntarily as sufficient logistics and manpower may not be there with the government to enforce them.

c. Fisheries should aim at fulfilling the social goals by making best use of resources in the overall interest of the society. Important step in this regard will include taking steps in the operating efficiencies of the fishing units where some kinds of regulations may be necessary to prevent excess pumping of money in the units.

- d. The fishery management should create situation of Optimum Sustainable Yield (OSY) which should comprise of a set of parameters including techno-economic efficiency of the fishing units; conservation of the fish stocks; balance in export and domestic needs.; equitable distribution of income among different strata of fishermen; development of shore based facilities for different regions; balancing the interests of mechanised and non mechanised sectors; rational use of input resources and protection of interest of producers and end users.
- e. For evolving proper coastal zone management practices and for the planning of a rational and reasonable exploitation and utilization of coastal resources and to practice responsible fisheries, data on the fish stock density, availability, movement and other basic scientific details need to be made available to the fishing communities. The remote sensing information and satellite data could be transferred to the different stakeholders without any time lag. This will also help in resource modeling.
- f. Use modified fishing gear to reduce the proportion of juvenile fish/ shrimps per catch. Development of value added fishery products from the landed catches of low-value fishes in the domestic market.
- g. A nation wide awareness programme on the judicious exploitation and conservation of the coastal zone resources and particularly amongst fisher folk would help planning and development of fisheries as an environment friendly sustainable fishing activity

8.2.2 Tourism expansion

For the economic growth of the country the tourism is promoted all along the coastal stretches without the proper guidelines for the environmental safety, coastal stability, geological and geographic locations which resulted in the destruction of the habitats. The tourism expansion should be set up with proper regulatory guidelines and coastal tourism should be considered as a special case with due consideration or the environmental issues. Both central and state governments may introduce a responsible tourism practice.

8.2.3.

Prevention of activities causing coastal pollution, such as waste/wastewater disposal in the vicinity of coral reefs and sea grass beds for maintaining an ecological balance and for sustainable utilization of the available living resource.

8.2.4.

Technological capabilities for monitoring and controlling pollution along the coast.

8.2.5.

Multi-disciplinary research and development efforts for enhancing production without damaging natural stocks and the environment.

8.2.6. Biodiversity as a valuable resource

The economic values of biodiversity can be divided into (i) aesthetic and (ii) technological. In the former, tourist attractions like beaches, corals, historical monuments, geological heritages etc are the main resources. In the latter, commercial utilisation of the resources.

(i) A number of coastal areas along the Maharashtra are rich in marine biodiversity and have unique flora and fauna that needs to be preserved. These localities can serve as centers for ecotourism, recreation, education and research. The flora and fauna can be maintained as Germplasm preservation centres'.

8.2.7. Strategies for Indigenous and Traditional knowledge

Gaps in Anthropology and Indigenous knowledge (IK) – Anthropological methods have been used by the dominant paradigms of western scientific conservation to access IK in a highly extractive manner. Modernist Anthropology views IK (one of the hallmarks of the indigenous ecology) as a nonpolitical and non economic resource, which can be extracted from local communities, translated into western technology, and assessed by scientific criteria. But far from being non-economic and apolitical, IK is like biodiversity, a resource, which is typically extracted and manipulated: the gains resulting from this manipulation rarely return to the original source

8.2.8. Biodiversity inventory, Research and education

8.2.9. Awareness and Capacity building

This is one of the major areas needed for the planning and implementation of the coastal zone management effectively for making the responsible involvement of the coastal stakeholders in the decision making and implementation process.

8.2.10.

Benefit sharing and issues of common property at different levels should be considered for the planning regulations on the stakeholder's dependency of the coast.

9. Required actions to fill gaps and enhance/strengthen the ongoing measures

9.1. Actions to conserve and sustainable use natural ecosystems, and plans for habitat protection

9.1.1. Habitat protection (Sea erosion and sea wall erection)

- a. Instead of Sea wall erection alternates such as beach nourishment, natural vegetation, vertical dykes etc., are suggested as better alternatives, which along with shore stabilization will protect the breeding grounds of the marine turtles as well as the intertidal biota.
- b. Alternatives of the interest like the substitute plantation cover as well as discontinuous construction barrage with corridors for the fauna and flora to invade into the land ward or visa-versa.
- c. Other recommendations are appended (Appendix.1, Meeting no. 11)
- d. The marine turtle breeding grounds should be identified prior to any sea wall construction activities.
- e. Interministerial cooperation for action in implementing the acts and policies of the coastal management need to be streamlined for better enforcement of the activities, law and policies (sand and shell mining controlled by the Department of Mines and Geology, coastal environment by the DoEn.: Port and Harbour by surface transport and DoEn)

9.1.2. Fishing activities

- a. Cooperation and understanding between different fishermen's unions adopting different types of fishing methods is very essential to safeguard the resources as well as avoid conflicts. The traditional fishermen and the mechanised fishing operators should follow the responsible fishery policies and maintain harmonious practices.
- b. It is suggested to observe OSY instead of MSY or MEY (Maximum sustainable Yield and Maximum Economic Yield). The OSY will ensure the fishery resources for future.
- c. Programs should be aimed at JOINT COASTAL RESOURCE (FIHSERY) MANANGEMENT – where the local inhabitants, experts, local *panchayath* and the governmental organisations will be involved.
- d. A fishery management committee is proposed through the networking of the fisher folks and the outlines for the organisation are given in the flowchart 1.
- e. The formation of an Indian Code for Responsible and Safe Fishing, Aquaculture and Export (ICORSFAE) should be given priority. It should be a combined effort of the Government of India, the State Governments, the MPEDA, various boat owner associations, fisherman trade unions, shrimp farmers and seafood exporters associations and other representatives of the workers in these units. Numerous research organizations should also be involved. Such an initiative will create conservation attempts of the endangered species, selective fishing of the commercial fishery.
- f. The Department of Fisheries and NGOs should initiate measures to translate Code of Conduct for Responsible Fisheries (CCRF) into regional respective state languages. Simplified and illustrated versions providing the essence of the CCRF should be distributed at the coastal *panchayat* level. Fishery Department Extension Services in all the maritime states should mobilize a variety of communication aids to get the message of the CCRF cross in the fishing villages.
- g. Agencies like the Marine Products Export Development Agency (MPEDA) play a major role, especially as they are the only agency with a legally mandated role of management (though technically only for the offshore and deep sea) and funds to finance such initiatives. Therefore, the initiative should be taken to ensure that all fishing vessels, aquaculture units and exporting firms registered within the MPEDA Act, are made aware of the implications of CCRF. Technical and financial assistance should be offered in making necessary changes in their operations to meet the needs of the CCRF requirements.
- h. Active involvement of FSI regarding deep sea fishing operations.
- i. Formation of the fishermen group drawing representatives from different sectors of fishing groups (traditional, mechanised, offshore trawlers, etc.), which can decide about the extent, quantity, and duration of the fishing activities.
- j. Fishery resource management Society as an autonomous body of Department of fishery, in the line of the success story of Kerala state is recommended along the other coastal states.
- k. Fisheries colleges along the maritime states should incorporate the conservation strategy and responsible fishery in their curriculum and extension division and actively involve into sensitizing the coastal communities (through ICAR)

9.1.3. Aquaculture

- l. Encouraging traditional aquaculture along the coast without destruction of the mangrove areas, estuarine productive zones, and other coastal habitats, which are the breeding/resting /feeding sites of the migratory species/juveniles.
- m. Precautions during the seed collection and introduction – The farmer should be considered to procure selected seeds without destructing the other species.

9.1.4. Mangroves

- a. Strengthen and develop existing institutions and information systems and establish standardized regional databases and procedures for collection, collation, retrieval and dissemination of information related to mangroves. (collaboration with ISRO, other research institutions, Universities and Forest department).
- b. Regeneration of the degraded mangroves to be carried out by the NGOs with the coastal community participation.
- c. Joint Mangrove Forest Management programs in the line of JFM practiced in some states with coastal local community involvement (both genders participated)

9.1.5. Coastal Tourism

- a. Strict enforcement of the CRZ rules for permanent structures (resorts, hotel industries)
- b. Sustainable Tourism Management (STM) practice within the carrying capacity of each locations of tourist attraction, local administrative bodies should evolve the policy. The coastal tourism should be economically viable, socially accepted and environmentally sustainable.
- c. STM plans need to be w3holastic in their approach and take into account various competing elements such as land use, maintaining environmental standards and involvement of different sectors of the stakeholders.
- d. Local community involvement in managing the tourism: Locals will only support sustainable tourism, if they benefit from it. Local involvement in the management stage will increase the efficiency. Local community involvement would be through the appointment of 'Community tourism liaison officer', who will represent the views of local people.
- e. Local Culture: The needs of indigenus population should not be ignored and they should have the right to choose whether to invite tourism onto their land.
- f. Local employment: The most direct way of benefiting local community is to employ as many as local residents as possible in tourism related services. The tourism department (Central and State) should also aim at planning a framework for responsible tourism practices.

9.1.6. Critical habitats

- a. The biodiversity status of the identified critical habitats should be evaluated at priority by the DOD for the management of these habitats through research institutions.
- b. A buffer zone also should be delineated around the Critical Habitats in order to maintain the ecosystem health by preventing expansion of industrial activities near these sites.

9.1.7. Offshore Fishery Resources

- a. Offshore Biotic Resources need to be surveyed, as since International Indian Ocean Expedition, no authentic data is available about the present wealth of this region. Through international/national funding, similar task to be undertaken.

9.1.8. Shore, Intertidal and Benthic Biota

- a. Sand and shell mining should be controlled effectively by a single agency – (Department of Mines and Geology and Environment)
- b. Sand dune vegetation establishment through the participation of local communities, NGOs and school children.
- c. By involving educational and research institutions, an updated database of the intertidal biota as well as the pollution impacts need to be generated. This also will help in Bioprospecting.
- d. Human resource development in the form of Training the manpower in taxonomical aspects.
- e. Interrelating the data obtained by the different research projects from different central/state/international agencies for generating the wholistic database, modeling and for management of the resources. – A separate cell with DOD, DoEn, DBT, DST, ICAR and CSIR division be formed.
- f. Wherever necessary the ongoing projects could be updated/deviated/modified to gather necessary information for the biodiversity conservation and management.

9.1.9. Maritime activities

- a. Strict vigilance by the Port and Harbour authorities, coast guards regarding the vessels arriving from the international waters to minimize the hazardous/toxic waste in the coastal and marine waters.
- b. Dredging operations and the dumping of the dredged materials should be restricted to areas, which can hold the pollution without stressing the biota (protecting the productive benthic areas). Similarly the mining activities should be regulated.
- c. An appropriate and effective disaster management cell along the coast to protect the coastal biota from oil spills and other disasters.
- d. Quantitative and qualitative scientific data on the point and nonpoint source of discharges of Petroleum Hydrocarbons, PAHs, synthetic organic compounds and *algal toxins* need to be generated through National laboratories, and Universities.
- e. Vigilance of industrial discharge levels – the pollution control boards should make logistic arrangements by recognising educational institutions and/or research laboratories.

9.1.10. Protection of habitats for rare and endangered species

The biodiversity rich areas as well as regions important for certain rare species should be conserved irrespective of the industrial demands.

- a. Policy for the Marine Mammals and amphibians should be set up. Their habitat types should be identified, and then the protection can be suggested to that, areas with priority.
 - b. The following sites are identified to be protected or considered in to conservation activities with priority. Coral Patches of Vizhinjam (15km²) along Kerala; Tadadi, Aghanashini backwaters, Coondapur along Karnataka; the *Ghajjanis* along Goa and Malvan-Sindudurg, Colaba, Vikroli, Alibhag along Maharashtra.
- Sites along Gujarat and Lakshadweep need to be identified.
- c. Malabar upwelling area: All regulations under the wildlife protection act 1972 and any other prohibition/regulation deemed necessary in the course of future fisheries and allied activities should be strictly enforced and implemented for sustainable marine fisheries development and management.
 - d. Irrespective of the state boundaries the coastal stretches harbouring rare and endangered species need to be protected as 'protected areas' by interstate authorities for which a national apex body in the form of West Coast Ecoregion Authority (**WECERA**) is proposed.

9.1.11. Biodiversity Inventory, Research and Education

- a. With authentic taxonomists, University level inventory managers, Ph.D. level coordinators. With the help of college students for inventory preparation and Bioprospecting, for all the groups. National institutes like NCL (PUNE), ITRC (Lucknow), NIO, CMFRI should take up the responsibility.
- b. Biodiversity literacy – NGOs, Universities and national institutes should provide the resources for the target-oriented awareness among different target groups.
- c. Inhouse management of the biodiversity information. Building the framework for computerized and public management of biodiversity information.

d. Germplasm Preservation centres at different regions of the west coast aiming at different groups of biota. The involvement and cooperation of the experts through the Government and non-governmental agencies. The germplasm of the indigenous species/varieties should be preserved with the involvement of local knowledgeable people.

9.1.12. Training and Awareness programs

- a. Awareness camps to evoke the public participation in the resource conservation programs.
- b. Sensitising the coastal population regarding the biodiversity through dance, drama, skits, stage plays, placards, etc.
- c. Training the trainers for conducting training to the different stakeholders. CEE in collaboration with universities and colleges could take up the responsibility.
- d. The responsibilities of the coast guards, forest officers (mangroves) and other related agents should be made aware of their responsibilities through adequate training for taking the public into confidence for their responsibilities.

9.1.13. Involving Women in the Biodiversity conservation programs

- a. Coastal resource management training for the womenfolk through NGOs, Women groups, *Mahila Mandals* etc.,
- b. Special training to the Fisherwomen for the economic sustainability through the value added products prepared from the by-catch. CIFT, CMFRI, CIFE
- c. Alternative income generation through seaweed culture, traditional aquaculture etc. (Central Marine salt Research Institute and CMFRI)
- d. The traditional knowledge of the Women should be encouraged more and made to practice

9.1.14. Equity and Benefit sharing

- a. The outcome of Bioprospecting through the traditional knowledge of the fisher folks should be shared during the monetary gain.

9.1.15. Participation of the immediate local community

- a. Encouraging locals to build up plans for the management of the ecosystem.

9.1.16. Documentation of the Traditional Knowledge and Indigenous practices

- a. Nutritional and the medicinal values of the biota known to the communities should be documented and the hidden wisdom to be recorded and practiced for conservation.
- b. The traditional forecasting of the location of the fishing grounds, varieties, catch availability should be recorded and the validity to be confirmed.

Fig: The proposed Fishery Management Committee

