

WEST COAST ECOREGIONAL BIODIVERSITY STRATEGY AND ACTION PLAN



PREPARED UNDER

NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN
INDIA

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Contents

CHAPTERS		P
		ageS
1.	INTRODUCTION	1 - 5
	1.1 Biological diversity and Conservation	
	1.2 Methodology	
2.	WEST COAST – A PROFILE	6 - 12
	2.1 Geographical Profile	
	2.2 Socio-economic Profile	
	2.3 Ecological Profile	
3.	CURRENT STATUS OF BIODIVERSITY	13 -19
	3.1 State of Natural Ecosystems	
	3.2 State of Agricultural Ecosystems	
4.	<u>Statement of Problems Relating to Biodiversity</u>	20 - 30
	4.1 Causes for Loss of Biodiversity	
	4.2 Root Causes for Loss of Biodiversity	
	4.3 Natural Causes	
5.	MAJOR ACTORS AND THEIR CURRENT ROLES RELEVANT TO BIODIVERSITY	31 - 34
	5.1 Governmental	
	5.2 Fishing Communities	
	5.3 Local Communities	
	5.4 Industry and Corporate Sector	
	5.5 Research Institutes, NGOs and Individuals	
	5.6 Coast Guard and Navy	
6.	ONGOING BIODIVERSITY RELATED INITIATIVES	35 - 37
	6.1 Governmental	
	6.2 NGO's	
	6.3 Communities and People's Movements	
7.	GAP ANALYSES	38 - 42
	7.1 Gaps in Information	
	7.2 Gaps in Vision	

- 7.3 Gaps in Policy and Legal Structure
- 7.4 Gaps in Institutional and Human Capacity

8. **MAJOR STRATEGIES AND ACTION PLAN** **43 - 60**

- 8.1 Redefinition of Coastal Zone for Biodiversity Protection
- 8.2 Creation of Coastal Biodiversity Authority
- 8.3 Arresting Further loss of Habitat and Biodiversity
- 8.4 Biodiversity Inventorying – Data Banks on Coastal Resources – GIS-Based
- 8.5 Awareness, Education and Training
- 8.6 Alternate Livelihood
- 8.7 Integration of Activities of Line Agencies on Marine Biodiversity
- 8.8 Equity and Empowerment of Women to Involve in Conservation Exercises/works
- 8.9 Identification of Indicators of Changes of Biological diversity

REFERENCES **61 – 62**

APPENDIXES

Content of Tables, Figures and Appendixes

Tables

Table 1.	States and the geographical distribution of the coastline
Table 2.	Mangrove Forest Area of West coast
Table 3.	Protected Areas of Indian Mainland with mangrove habitats
Table 4.	Prioritised list of IBA's
Table 5.	Impact of Tourism
Table 6.	Details of tanker terminals related to Ports along West coast

Figures and Maps

Figure 1.	Map showing Exclusive economic zone, territorial waters of India
Figure 2.	Fishing harbours of West coast

Appendixes

Appendix 1.	Process adapted including details of meetings and public hearings.
Appendix 2.	Geologically important sites along the west coast
Appendix 3. Criteria for IBA	
Appendix 4.	Short Note on Coastal Regulation Zone
Appendix 5.	More on aquaculture (UNEP newsletter)
Appendix 6.	Mangroves survive oil spill (Newspaper- Article)
Appendix 7.	Ongoing Biodiversity related Projects
Appendix 8.	Community and peoples movements

1. Introduction

1.1 Biological Diversity and Conservation

Biodiversity encompasses the entire variety of life on earth from the microorganisms to the mammals and includes species, genetic variations within species, ecosystem within which species occur and the whole of the natural world from commonplace to highly endangered species.

Biodiversity conservation is similar to the idea of nature conservation, but it places specific emphasis on threatened habitats and species. It also implies that in addition to ecological social, cultural and economic values are important in conservation planning. The United Nations conference on Environment and development held at Rio de Janeiro in 1992, and known as the Earth Summit, resulted in the Convention on Biological Diversity (CBD). Agenda 21, a global action plan for the 21st century, was another important result, aim to bring about more sustainable development in the coming years, with the developments respecting environment.

India, with rich biodiversity decided to draw an action plan for the conservation of the biological diversity with the major thrust on the participatory approach. As a part the National Biodiversity Strategy and Action Plan, the West Coast was identified as one of the major ecoregions for formulating with its own action plans for the conservation.

The West Coast Eco-region covers the west coast of India, spreading along five states namely, Kerala, Karnataka, Goa, Maharashtra, Gujarat and Lakshadweep Islands, with a total coastal stretch of 3446 km. This coastal stretch is characterized by diversified ecosystems, culture and profession at diversity. The vicinity of the sea has given rise to a few major ports, and many fishing harbors. This area has many small rivers, originating along the Western Ghats eventually joining the sea resulting in many backwaters and estuaries, which harbor rich biota. The life activities of the communities are centered on the coast and these estuaries. The coastal inhabitants are occupied with different activities such as fishing, aquaculture, saltpan works, industries, tourism and agricultural practices.

Biological diversity of regions 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, modernisations in culture etc. are reflected in the changes in lifestyles, resource use patterns and results in erosion of cultural and biological diversity. Hence the available national living resources traditional knowledge and the indigenous practices should be documented and 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 there is an outlined necessity of planning to conserve and document all the available resources, the major threats they are facing and an action plan to protect these natural national assets.

The current report gives an overview of the present scenario of the West Coast, with reference to the types of habitats, major groups of biota, major anthropogenic activities and their pressure on natural resources, the change in resource use patterns over the years. Brief presentation of methods adapted and evolved to achieve the required information and to complete above-mentioned objectives to draw the outlines for the Strategy and Action Plan. Further identifying the threats, actions required and the suitable institutions for the implementation of the action plan with required human resource development are also documented.

The West Coast action plan aims and targets to:

- ☞ Identify and develop action plans for most fragile habitats, ecologically sensitive and species currently under threat
- ☞ Improved access and co-ordination of biodiversity database
- ☞ Increase public awareness and action by involving key sectors
- ☞ To promote local biodiversity action plans as to promote local people participation in each action plan

1.2. Methodology

Inputs from public meetings, expert opinions from various documented and personal sources and available published works and literatures were made use to highlight current existing status of the coastal environment. With these existing information and detailed discussion with the working group members, a prioritised strategy and action plan is drawn for the west coast ecoregion.

The first step of approach to a SAP was a meeting with the Working group members. A detailed discussion was carried out to take up the task in a systematic way, which, provided

ways for further actions to achieve the goals. This involved the participation of the local government bodies; institutes; NGOs; individuals; students, researchers, public and different stakeholders along the coast. Direct interviews with the coastal dwellers, experts, through questionnaires, secondary sources of information either by the published research works, the news paper articles, booklets, and primary data collected on some aspects of coastal biological diversity were some of the key methods employed as to gather information for the preparation of this document.

The lists of the meetings, public hearings and other programs have been presented in detail in Appendix-1.

- The first meeting of west coast region working group was held on the 26th August 2000 at Mangalore, wherein members were briefed about the salient features and responsibilities of the committee in drawing up Biodiversity Strategy and Action Plan. This full day meeting gave an opportunity to have overall picture of the current problems of biodiversity conservation (identification, assessment of the problems).
- Coordinator of the project arranged a subsequent meeting in Mumbai inviting various stakeholders, scientists, from in and around Mumbai. The meeting venue was Central Institute of Fisheries Education, Versova, as to gather information on biodiversity of that region and to initiate public participation along this part of the coast. This meeting generated good fruitful discussions and inputs.
- On 29th November 2000, during the state level Biodiversity workshop held at the Indian Institute of Science, Bangalore, National Biodiversity aspects of the west coast eco- region was highlighted for the benefit of various participants and sought their information and suggestion for formulating the action plan.
- One-day workshop was held On 16th December 2000. On the eve of National Symposium on Problems & Prospects of the Environment in the New Millennium held in Mangalore University. The major focus was on biodiversity with special reference to coast and Western Ghats. About 200 participants were involved with younger generation giving useful inputs during the course of interaction.
- Involvement of the district, local administration and other government officials of coastal district were initiated during the district committee of Science and Technology. Meeting was held on 2nd January 2001 at Deputy Commissioner's office of Dakshina Kannada district.

- A brainstorm session at regional level with various fishermen leaders, scientists, administrators and state leaders was held on 24th March 2001, wherein the Director of Fisheries, Government of Karnataka himself also 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 various fish gathering devices and its implications on benthic biodiversity.
- Problems of Kerala coast 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 mainly, mud bank, Pokkali fields, etc. Very useful information and suggestions emerged out of the discussion with various participants.
- A field visit was organised, to a nearby fishing village of Kochi as to interact with the local communities, which was very useful.
- Meeting at Bombay Natural History Society (BNHS), Mumbai was held during 8th September 2001, on the status of avian fauna and invasion of alien species into the coastal waters through ballast waters.
- 8th and 9th September 2001, a workshop on Environmental Law for Academicians at Sri Dharmasthala Manjunatheswara Law College, Mangalore was attended.
- Two-day National Seminar on Coastal Erosion was held at Karnataka Regional Engineering College, Surathkal on 7th and 8th September 2001, to discuss and evolve a strategy for preventing coastal erosion along Karnataka and Kerala coastline. It is evident that maximum erosion was found during the Monsoon.
- On 28th of July 2001, a participatory meeting with the fisher women and fishing communities of Malpe. (Karnataka) was held, followed by a brief survey on the socio-economic status of these fisher folk families.
- Discussion with the traditional fisher folks of Mattu village near Udipi was held on 28th July in the evening hours.
- Meeting 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 their traditional ecological knowledge.
- Public hearing at *Sneha Kunja*, (an NGO) Kumta on 19th September 2001 was organized in order to discuss the local problems of coastal biodiversity and status of biodiversity in

association with Uttara Kannada BSAP Coordinator and *Sneha Kunj* (an NGO) founded by late Dr. Kusuma Soraba.

- Regional Meeting at Goa was organized in collaboration with the *Goa Foundations* (an NGO) on 15th October 2001.
- Subsequent meeting at Central Salt and Marine Algal Research Institute Bhavnagar, Gujarat on 6th November 2001 was organised. Many issues related to Gujarat coastal biodiversity and information lacking on the status of the biodiversity were discussed.
- Public hearings at Okha, Poshitra, Bet Dwarka, and Dwarka villages of Gujarat coast were held on 10th and 11th August 2002.
- Meeting with different stakeholders, government officials and NGOs of Lakshadweep islands was held on 20th to 21st of October 2002

Many meetings with the working group members were held along Kochi, Goa and Mumbai on different occasions so as to consolidate the information gathered by the public meetings and opinion inputs.



2. West Coast - A Profile

2.1. Geographical profile

West coast of India has a coastal length of 3446 km, spread as Northwest and Southwest coast characterized by island, gulfs and lake ecosystems. Within these there are varied types of habitats, including a large number of wetlands, backwaters, estuaries and creeks, mangrove vegetation, sand dunes, mud banks, wedge banks, salt pans, salt marshes, lagoon, sea grass beds, corals, small or inaccessible islands and coastal beaches, which supports a plethora of flora and faunal attributes including turtles and aquatic birds. Rich deltas are found along east coast, since most of the west flowing rivers have a short course and there is little sediment load from them to build significant deltas on their own. Headlands, bays and lagoons modify the somewhat straight coastline along west coast at regular intervals. These are evidence of frequent oscillations in levels due to neotectonics as to changes in sea level (more details - appendix 2)

Table 1. States and the geographical distribution of the coastline

State	Coast line (km)	Longitude and latitude
Gujarat	1600	Long. 68°00' - 73°00' E Lat. 20°10' - 23°10' N
Maharashtra	720	72°10' - 73°10' E 15°52' - 20°10' N
Goa	104	73°38' - 74°44' E 15°00' - 15°52' N
Karnataka	300	74°00' - 75°00' E 12°45' - 15°00' N
Kerala	590	75°00' - 77° 00' E 9°00' - 12°45' N
Lakshadweep	132	71°00' - 74°00' E 8°-12° - 13°N

2.1.1. Islands

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

The Lakshadweep Archipelago consists of 36 islands with 32 km² total area, of which 10 are inhabited. These Islands are grouped into two, as South Canara Islands and Malabar islands. These Islands support rich coral atolls.

South Canara Islands

Amindivi islands

Ameni

Kalamat

Chetlet

Kiltan

Malabar Islands

Minicoy

Kavarati

Kalpeni (NIO research station)

Androth

Bangaram islands (occupied by Tourist resort)

2.1.2. Other Habitats

Mud Banks

Mud banks are special formations of 1-3 m thick patches of high load of suspended sediments and clay bottom extending to several kilometers into the sea along the coast, where minimum wave action is found. These unique formations are found along the Kerala coast especially during monsoon season. This is a unique habitat where a diverse set of organisms shelter during monsoon. They are mainly formed by the process of siltation along with many other factors. Formation of mudbanks is a fascinating phenomenon of the Kerala - Karnataka coast (Murty, 1999). It is locally called as *Chaakara* in Malayalam meaning something that creates calmness. All the mud banks are formed with the coastline as a part of their boundary and invariably soon after summer. Most of the mud banks are short lived for a month or two. Soon rains start, the river flowing through the steep Western Ghats discharge huge volumes of sediment and decaying organic matter together with freshwaters to the near shore waters.

Mudflats are found extensively along Gujarat southern coast and northern Gujarat coast is fringed by tidal flat. The shoreline of Gulf of Kachchh has extensive mud flats and mangroves. Intertidal mudflats of gulf comprise of soft clay mud.

Eddy Currents and Upwelling

Upwelling is the most important hydrographical phenomenon in the Arabian sea. It starts at the southern tip of the west coast by the end of May or early June and continues northwards with time (Madhupratap, 2001).

Lake Ecosystems

The lake ecosystem of West coast is very distinct from that of East coast. The Vembanad lake ecosystem of Kerala coast supports rich biota. The *Pokkali* fields are also spread along this stretch.

2.2. Socio-economic profile

The major groups of inhabitants along Kerala, Karnataka, Goa, Maharashtra coast includes the fisherfolk community belonging to different religion and castes. The regionalism, culture varies slightly in the state boundaries along the coast restricting particular groups in patches. Most diversified fisherfolk 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 fisherfolk of the Udipi 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- fishers. Even though the major conglomerations of the fisherfolk are 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 cultivations. There are a few coastal areas under the coastal saline paddy fields (called as *Kbazans* in Goa, *Gajjanis* in Karnataka and *Chemmen* in Kerala), which are now being converted into aquacultural farms.

2.3. 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.

The important ecosystems, major components of the ecosystem and habitat types found along this coast are: mangroves, coastal sand dunes, coral reefs, mud banks, rocky shores, gulfs, lagoons, islands, critical habitats, estuaries, backwaters, and the ecologically sensitive areas declared as Marine National Parks and Marine Protected Areas (MPA). In addition the manmade (altered) ecosystems include saltpans, agricultural lands, fishing harbours and ports.

2.3.1. Mangroves

Mangroves are the characteristic littoral plant formations of the tropical and subtropical sheltered coastlines and are at the interface between land and the sea. Importance of mangroves stems from their pivotal role in both terrestrial and aquatic production, and by many amenities provided within and beyond its boundaries. 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 supply at different levels to stakeholders significantly. Mangrove forests serve as a biocatalytic link between terrestrial and marine ecosystems. The energy flow through nutrient supply from land to sea, and enrichment due to the detritus formation making these ecosystems rich in relation to primary and secondary production. Worldwide, mangrove forests are coming under increasing pressure as a result of population growth in coastal regions and expanding (non-forest based) economic activities in mangroves such as shrimp farming (FAO, 1994).

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.		
Banerjee and Mangroves of the second according to the		Gujarat	260	Gujarat cover largest area remote sensing	(Source: Gosh, 1998)
		Maharashtra	330		
		Goa	38		
		Karnataka	90		
		Kerala	16		
		Total Mangrove Area in India	6740		

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 Khambhat, mangroves are distributed along the coast near Mahi, Dhadhar, Narmada, Kim, and Sone Rivers. Scattered mangroves are also present in other areas (RSAM, 1992)

In Goa and Maharashtra the mangroves exist in large patches along the Mandovi estuary (Goa), Vashista estuary, Kundalika estuary, Dharamtar estuary, Vasai creek, Thane creek and Valitarana creek (Maharashtra).

Mangroves of Karnataka cover an area of about 6,000 ha. of which 1000 ha. is in Uttar Kannada district (Rao, 2001). About 14 species belonging to 9 genera are extensively distributed in the district. In the coast of Karnataka, the mangroves are found along Kalinadi, Gangavalli and Aghanashini estuaries and at the confluence of Chakra Nadi, Kollur and Haladi rivers near Gangolli (Parnetta, 1993).

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, and Veli.

2.3.2. Coral reefs

Coral is the complex form of association and is a super organism. It develops well in the tropical seas and cannot develop in the waters having temperatures below 10°C. Coral reefs support a highly diverse and interesting fauna and flora; and are the marine equivalent of the great rainforests of the tropics (Talbot, 1995). 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 consist of atolls, fringing reefs, barrier reefs and patch reefs.

Subcontinent of India occupies a large area of tropical Indian Ocean, but it has a scant growth of coral reefs along its coasts. Several factors limit reef development here, chief among them being the turbid waters stirred by monsoonal systems, freshwater runoff from rivers, and a heavy human population and developmental pressure along the entire coastline (Bakus et al., 2000). It is believed that the west coast of India was too turbid for the corals to thrive, but there have been reports on the reef building corals and scattered reefs along the coast. Intense siltation and heavy wave action along this coast presumably makes it difficult for branching corals to survive.

The reef beds are found along west coast are; Gulf of Kachchh (patch reefs), Porbunder, Mumbai, Angria bank off Rathangiri, Malwan, Redi and Gaveshani bank off Malpe harbour. The Lakshadweep Archipelago consists of 12 atolls and 3 reefs, which harbour a rich and varied coral fauna.

2.3.3. Coastal sand dunes

Coastal sand dunes are beautiful land features that are often overlooked by coastal property owners. 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. There are reports on undisturbed patches of sand dunes along Karnataka coast (Arun, 2002).

2.3.4. Special Habitats

Critical habitats

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

- i. Gulf of Kachchh
- ii. Gulf of Kambaat
- iii. Gulf of Malwan
- iv. Island off Karwar
- v. Islands off Kochi
- vi. Lakshadweep Islands

Marine Protected Area (MPA)

Along the West coast there are a few protected areas, these include MPA and sanctuaries, and are mainly protected for their characteristic biodiversity and other features 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.

Along Maharastra coast, Malwan region was proposed as Marine National Park in 1995 with 2912 ha. area. Malwan 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. (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	<u>National Park</u> <ul style="list-style-type: none">• Gulf of Kachchh: 16289
Maharastra	<u>Sanctuary</u> <ul style="list-style-type: none">• Achra: 100• Desgan: 500• Malwan: 2912
Goa	<u>Sanctuary</u> <ul style="list-style-type: none">• Charao Island: 100
Karnataka	<u>Sanctuary</u> <ul style="list-style-type: none">• Kundapura: 100
Kerala	<u>Sanctuary</u> <ul style="list-style-type: none">• Ezhimala: 500

Source: www.mangroveindia.org



3. Current Status of Biodiversity

3.1. State of natural ecosystems

As explained in the previous section the west coast of India harbour a rich and varied type of life forms, either associated with or forming a specialized ecosystem by themselves. The sand dunes, corals, benthos, mangrove and their associated flora and fauna, intertidal biota are some of the important organisms are found in their own specialized ecosystems (e.g. corals). Hence, current status of the important biomes and biota are discussed here.

3.1.1. Mangroves

Of the total area under mangroves in India, the west coast covers only 12% (Krishnamurthy et al., 1987; Kathiresan, 1995) and out of a total 65 species belonging to 59 genera and 31 families, the west coast represents 33 species, 24 genera and 19 families (Banerjee and Ghosh, 1998). Generally 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). Among the five 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 with 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. Deforestation due to developmental activities such as industrialization, aquacultural expansions and domestic exploitation, species of *Nypa* and *Xylocarpus* have become extinct from the west coast, whereas other species such as *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 influence of various factors. The associated floras are those 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 associated in these areas. The most common mangrove associates are *Clerodendron inerme*, *Thespesia prulnea*, *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 from harsh currents. 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 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). *Rhodophyceae* represented by maximum number species i.e. 39, followed by green algae with 33 species and brown algae with 10 species.

The reefs of Gulf of Kachchh face severe anthropogenic pressure including heavy oil tanker traffic (with pipelines running through the reefs), large-scale trawling, mining corals for

construction and commercial fishery and industrial waste discharges. Sedimentation levels are high due to coastal development and mangrove degradation with water visibility typically less than 1m. Satellite images have revealed the existence of live corals in this region. Discovered by the Gujarat Ecological Society (GES), the live corals were found at a depth of 25 m off the northern coast of Gulf of Kachchh. This recently discovered colony of corals has to be preserved by putting a check on industrial activities along the adjacent coast. Port based development would also pose danger to the newly growing corals in the area (Down To Earth, May 15th, 2000, page 11).

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 assemblages than the east coast. Along the west coast stretch, a variety of dune vegetation is commonly inhabited. Impacts of tourism extension, sea erosion and other developmental activities result in dwindling of these specialized biomes.

3.1.4. Benthic fauna

Benthic fauna can be divided into two major groups; macrofauna and meiofauna. Dominant macrofaunal species recorded from the Goa mangroves were *Modiolus metcalfei*, *Perna viridis*, *Diopatra neapolitina*, *Meretrix casta*, *Papiamalabaricus*, *Cerithidea fluvialtilis*, *Diogene custos* and *Glycera alba*. While *Polychaetes* are dominant macrofauna, meiofaunal species belonging to family *Chromadoidea* 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 Malwan 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 barnacles, 1 insect, 4 limpets, 10 top shell, 8 whelk, 11 spire shells, 3 sea hare, 3 mussels, 3 edible oyster, 1 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.

Various studies have clearly established a direct link between benthic biomass and demersal fishery as benthos offer trophic support to all demersal fisheries. Complete knowledge of

bottom fauna is very essential for the determination and development of demersal fisheries of any area. Impacts of deep sea fishing result in habitat fragmentation of these organisms.

3.1.5. Sea weeds and Algae

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

3.1.6. 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 marine and coastal reptiles. Olive Ridley turtles (*Lepidochelys olivacea*) every year come to nest along 20 km stretch of beach between Pavyoli and Kottopuzha estuary (45 km north of Calicut.)

Along the west coast, the crocodile, *Crocodilus palustris* is found only in mangroves of Goa. Among the reptiles, 21 snakes, 4 lizards, 5 turtles and 1 crocodile species are recorded (Deshmukh, 1994) from the Maharashtra coast. Along Gujarat coast 3 species of turtles, 4 species of snakes have been identified (Inputs from public meeting).

Along the Konkan belt, four species of turtles are known to occur. Of these Olive ridley (*Lepidochelys olivacea*) is more common. However near Malwan, green turtle (*Chelonia mydas*) is commonly noticed. The turtle population needs to be thoroughly assessed in area especially like Bagmandala (Raigad), Mithbav and Karh (Sindhudurga). Along Karnataka coast, breeding grounds are encountered along Mangalore, Kundapura, and Karwar region.

3.1.7. Birds

Birds use the sea both for feeding and breeding. 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.

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 IBAs along the west coast. These include the Marine National Park, Saltpans of Bhavnagar, and Mahi River estuary from Gujarat, Kole wetlands from Kerala and Illhas wetlands from Goa. Prioritised list of IBAs along the west coast are given in table 3.

Nearly 2 million water birds of various species make their home in winter and then back to colder northern climes by April. Requests have been made from NGOs for protecting this site by declaring as Ramsar Site as it is being a host of such large conglomeration of international birds. (Indian Express News, 2nd June 2002, *Thane Creek to become official bird sanctuary*)

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)

* Appended (No. 3)

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 and 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 and 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 Gujarat coasts attract pelicans.

3.1.8. Mammals

There is very limited information on the Marine/coastal mammals of the west coast. More details are needed on the mammals such as Otter and fishing cats.

3.1.9. Island Biota

Though there are several small - medium sized islands, the current status of biodiversity is still not documented.

Lakshadweep archipelago

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).

Islands off Gulf of Kachchh

There are 42 islands with 33 having coral reefs and 20 islands are fringed with mangroves along Gulf of Kachchh coast. Bural - Chank, Kalubhar, Paga, Chandri, Narara, and Pirotan are the largest islands with coral reefs in the Gulf of Kachchh. Biological diversity of the area is attributed to the varied habitats, which support over 103 species algae, 7 species of mangroves, about 301 coastal flora, about 74 species of sponges, 52 species of soft and hard corals, 4 species of sea anemones, 193 species of fishes, 27 species of prawns, 21 species of crabs, 200 species of mollusks, 3 species of turtles, 4 species of snakes and 5 five species of mammals and about 200 species of birds. Colorful sponges and corals, reef fishes, prawns, lobster, pearl oyster, window pane oyster, sea horse, giant sea anemone, sea hare, puffer fish, shark, cat fish, ray fish, star fish, sea urchin, *Sabella*, *Bonelia*, Dugongs, sea turtles and dolphins are important marine life in these area (inputs from Gujarat meeting)

Karwar Region

Sub tidal areas of the island are rich in sea urchin, *Cypraea*. 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.

3.2. State of agricultural ecosystems

The fishery and other related industries are attracting many of the coastal inhabitants, resulting in the dwindling of agricultural practices to a greater extent. Along some parts of the western coast there are small patches of agricultural practices being carried out. Examples includes growing indigenous salt tolerant varieties of rice are small areas of

different parts of Kerala (*Pokkali*), Karnataka (*Khajanis*), Goa (*Gazani*) and Maharashtra (Personal communication with the local).

Pokkali fields along the Kerala coast are being characteristics of growing indigenous rice varieties and extend throughout the coast in patches. These fields are found along Ernakulam, Trichur, Alleppy and Kottayam. This is a traditional system of alternative cropping of prawns and Pokkali paddy. This practice is dying slowly.

In the coastal regions of Kachchh, agricultural workers consist of 70% of total. The problems of salinity ingress will impacts on agriculture affecting a large section of coastal population; further natural calamities enhance the disaster scenario.

Due to the increasing demands for the coastal areas and the natural amenities/facilities the coasts provide attracts the entrepreneurs to invest on these fragile but rich coastal areas ignoring the social, cultural and indigenous bonding with the ecosystem.



4. Statement of Problems Relating to Biodiversity

4.1. Causes for loss of biodiversity

All the ecosystems are exposed to gradual changes in climate, nutrient loading, habitat fragmentation or biotic exploitation. Nature responds to the gradual changes in a smooth way. External conditions such as climate, inputs of nutrient or toxic chemicals, ground water reduction, habitat fragmentation, harvest or loss of species diversity often change ecosystems gradually, even linearly with time.

The major threats to the coastal biota are anthropogenic rather than 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 pressure exerted is far beyond the carrying capacity of the area. Consequently, the public amenities are being lost some local fish population are at risk; the biological diversity is threatened or seriously challenged. Other major activity being carried out along west coast include 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, Persistent Organic Pollutants (POPs), heavy metals, radionuclides, 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. POPs, which persist in the environment and travel long distance through ocean and wind currents, have long been associated with currents, have long been associated with serious health effects, ranging from growth retardation in children to genetic defects in living organism. POPs include organochlorine pesticides, furans, Dioxins etc. Major sources of heavy metals are mining, smelting, urban settlements and industrial compounds.

Sewage related problems all over the world have a great deal in common. Historically the seas have been considered as the sinks and the notion has not been changed till date.

4.1.2. Physical alterations

The basic integrity of the whole 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 construction, shoreline alteration, intertidal and sub tidal alteration, mineral and sediment extraction, sand mining, wetland alteration (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. Accidental transport of various exotics or non-indigenous species from large tankers and other ships on international routes is one of the major threats of exotics to the coastal waters. The colonization patterns and resultant impact on the existing diversity of organisms is not clearly known.

4.1.4. Important Ecosystems under Stress

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 inhabitants, industrial effluent discharges to the mangrove areas, aquacultural and agricultural encroachments and their discharges have serious effects on mangrove distribution and survival.

Coral reefs

Heavy industrialization, large-scale coastal land developments, dredging activities, release of sewage and pollutants including sewage and oil, impacts of climate change etc., effect coral reefs as well as coastal areas in general. 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. Amazing beauty of corals attracts the tourists and the unregulated extension of tourists exerts pressure on these fragile ecosystems threatening their survival. The loss caused to ecosystem is irreparable or if repairable will take a long time period.

Many coastal families around Gulf of Kachchh are engaged in collection of shell and corals from the reef area for the preparation of ornaments and items of display.

4.2. Root causes for 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 kinds of human activities such as, refuse from the industrial activities, aquaculture wastes, drainage discharges, siltation and pollution.

4.2.1. Anthropogenic alterations

Excessive exploitation of the intertidal biota for different purposes (e.g. sea weeds for fodder, oysters as food, sand dunes for different purposes etc.); 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. Over fishing

Fish has been serving as the critical input in the food basket of developing countries to meet the nutrient requirements. Contributing sustainability to foreign exchange earnings, fisheries and aquaculture are being recognized as important tools for development of small scale farming communities across the world. At the same time, increasing pressure on natural resources is making it necessary to work for alternatives and diversification in different sectors of fisheries. Marine fisheries operation during the pre-independence days used to be carried out at subsistence level, almost exclusively by the traditional fishers. Today the fisheries sector has attained the status of a capital-intensive industry. Attained by more fishing activities with additional people and large fleets. Fisheries offer an important source of protein, employment, and foreign exchange. Technology has had a major impact on pelagic fishing. Pelagic trawls, and purse seines have revolutionized the capture of schooling groups such as Clupeids, Scombrids and Carangids.

Annual average landing of small pelagics along west coast of India increased from 0.20 million tonnes during 1950-54 to 0.76 million tonnes during 1991-95. This remunerable increase was possible due to the mechanization of fishing vessels and introduction of trawlers and synthetic filaments in 1960's, introduction of purse seines in the mid 70's and motorisation of traditional crafts in 1980's. The mechanized, motorized and non - motorised vessel contributed 53%, 27% and 20% of the landings of the small pelagics during 1991 - 95 (Data from CMFRI, Mangalore).

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 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, such as prawns and cephalopods has been increasing, therefore threatening the extinction of these resources, especially in 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. Deep sea trawling affects the bottom fauna. Fishers are looking into the demersal fishing, as there is a decline in the pelagic fishery resources.

4.2.3. 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. Many potential mangrove areas have been destroyed for the purpose of aquacultural expansion. 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 (appendix No. 5), 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 result in conversion of 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 (lead to drug resistant pathogens) 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.
- e. There will be an exchange of water with natural habitats and this untreated exchange with the natural water bodies will deteriorate the water quality and deterioration of the natural habitats. Abandoned farms are not suitable for further shrimp farming.

4.2.4. 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. Some of the coastal areas along Kerala the Governmental control has successfully practiced against sand mining (Inputs from Prof. R. Damodaran).

Mineral rich sand mining: Kerala State Govt. very recently approved a new policy that allows joint venture exploration of the abundant mineral rich sand found along the coast, mainly in Kollam district. Several private companies have been lobbying the govt. to open the 23 km stretch of coastal land from Neendakara in Kollam district and Koyamkulam in Alapuzha district for mineral exploitation. This tsretch has high concentration of precious minerals such as limonite, rutile and monazite. Kerala State Industrial Developmental

Corporation would be the nodal agency looking after allotments to joint venture companies (The Times of India, 9th Oct. 2002).

4.2.5. Shell mining

Extensive shell mining (live and dead as well as the geological deposits) 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. Every year, 4-5 lakh tons of shells of *Elorita cyprioides* are being mined for the sustenance of the white cement industry along Kerala coast.

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 coast 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, the harvesting of shellfish in intertidal and shallow coastal waters may also result in effects on non-target benthic organisms.

4.2.6. 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, and loss of breeding and recruitment of intertidal fauna.

4.2.7. Disposal of wastes (Sewage)

One of the major concerning problems to the coastal habitats is sewage. The sources are being domestic, urban and industrial refuses. There are two kinds of wastes, namely solid waste and wastewater. Major problems arising from these are the introduction of the pollutants from different sources namely non-point and point sources. The heavy metals, pesticides and many other toxic and hazardous wastes are being discharged to the coastal

waters as natural sinks (unregulated). The nature and composition of these wastes vary at different locations depending on the hinterland activities 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.

Recently the incidence of effluent pipeline burst from Tata chemicals Ltd. damaged more than 7000 mangrove trees and rare marine plants and animals (See Appendix - 6) along Gujarat coast.

4.2.8. Oil Spills and Shipping

The western part of the Indian Exclusive Economic Zone, i.e., the Arabian Sea adjoining the peninsular India, forms the main international route for oil tankers originating from the Gulf. It has been estimated that some 450 mt. of crude oil is transported annually along this route, involving approximately 2500 laden tankers. Considering the large volume of oil transported and increased ocean traffic, the probability of tanker accidents is high. Oil rig operation and oil pollution. Coastal areas 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. Incidences of oil spills have threatened the local fauna and flora. Important examples include oil spill from Bombay High in 1993, affecting more than 5 km stretch near Raigad.

4.2.9. Ship breaking

Ship breaking is an important activity along west coast especially in 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, 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 choke 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 biological oxygen demand.

4.2.10. 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 ▪ Cultural revival ▪ Economic changes

Though the Ecotourism has been promoted since 1992 Earth Summit focusing on sustainable development, the exact concept of the practice is not understood well by the tourism industry and tour operators.

4.2.11. Port and harbour activities

Though many of the activities including harbours and ports along the coast are very important for the economy and overall development of the nation. The fishing harbours of the west coast are given in figure 2. However at some level care has to 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.

Table: 6. Details of tanker terminals related to Ports along West coast

Port	Function of Concern
Gulf of Kutch	Ship to ship transfer
Port Kandla	Single point Mooring Buoy
Bombay (Offshore)	Ship to ship transfer
Bombay	Refinery/Depot
Marmagoa	Marine Terminal
Mangalore	Marine Terminal
Cochin	Marine Terminal

Marine bio-invasion

Bio-invasion refers to introduction of an alien organism into an ecosystem. Growing number of invasive species introduced through increased travel and trades poses severe threats to marine biodiversity. Without additional safeguards, it is almost inevitable that increased international trade will also increase the rates at which alien species are introduced into domestic water. Two main pathways of marine bio-invasion are; intentional - for aquacultural gain or unintentional through a ship's ballast water discharge and fouling of ship hulls.

Cargo ships moving worldwide keep ballasting and de-ballasting seawater to and from various ports. In the process live organisms as part of the ballast water are introduced at the new port, causing marine bio-invasion. According to International Maritime Organisation (IMO)-London, shipping transfers more than 10 billion tonnes of ballast water around the globe each year. This itself indicates the scale & pace at which this problem is multiplying all over the world. The invaded species can cause deleterious effects to local flora and fauna through their toxigenic, proliferative and over competitive characteristics.

Though the research in India is still in nascent stage, one species viz. *Mytilopsis sallei* (black striped mussel) has been found to have invaded and established on a large scale at Mumbai and Vishakapatnam ports. This species is a native of tropical and sub tropical Atlantic waters and is believed to have invaded the Indian waters sometime during 1960's. There are over 18 species of animals and plants documented along the Indian coast as those that might have got invaded and established (for more details see; Anil, et al. 2002). In addition to introduction, the threat of its dispersal to neighboring environments, especially the precious coral reefs of Andaman & Nicobar and Lakshadweep islands poses a serious challenge.

Average 5000 ships call in Mumbai port alone and receive approximately 2 million tonnes of ballast water each year. Indian coastlines are falling prey to the harmful marine bio-invasion through ballast water.

4.2.12. 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.

4.2.13. 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 Kerala coast). Retting activities discharge nutrients to the coastal waters resulting in eutrophication and reduction in dissolved oxygen and increase in biological oxygen demand and turbidity. This results in a overall disturbance in the natural habitat conditions of the waters.

4.3. Natural Causes

Though natural variations are results of the anthropogenic modifications of the nature over the historical periods, it is opined that climate changes are major disturbance. Especially global warming, the increase in sea temperature result in increased bleaching of corals and may also result in a shift in the natural community structure. Cyclones and hurricanes are rare in the West coast of India compared to the East coast (175 cyclones in the last 100 years along the east coast; only 31 in the west coast during the same period. Data Source - <http://www.nic.in:80/dod/>)

Serious coastal erosion problems are also experienced in the western part of India due to intense monsoonal activity. In the state of Karnataka, nearly 0.2 metric ton of sand material is lost per year due to monsoons and resultant sand drift.



5. Major Actors and Their Current Roles Relevant to Biodiversity

5.1. Governmental

Many of the government agencies are responsible for conservational works through policies and legal frame works. Ministry of Environment and Forests (MoEF), Ministry of surface transport, Department of Tourism, Ministry of Mining and Geology Department of Ocean Development (DOD) etc., are responsible for the coastal resource management. The Government has formulated several policies and legal frame works for conservation.

5.1.1. Variable policies and legal frameworks for fisheries and 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 resource availability, environment and those engaged in fishing activities.

Central Government agencies

The national laws governing coastal zone related issues are as follows:

- a. **Merchant Shipping Act, 1954:** Deals with prevention and control of pollution arising from ships and offshore oil platform
- b. **Wildlife (Protection) Act, 1972:** Deals with protection and conservation of marine life and establishment of marine parks, sanctuaries etc.
- c. **Water Act, 1974:** Deals with control of marine pollution and land based sources.
- d. **Maritime Zone Act, 1974:** Defines various maritime zones like territorial waters, Exclusive Economic Zone and the continental shelf.
- e. **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.

- f. **The Environmental Protection Act, 1986** prohibiting the conversion of reserve forests, mangroves, wetlands, mudflats etc. for coastal aquaculture and beach development
- g. From May 1987, the Indian Government banned bull trawling within the Indian EEZ, and no permits have been issued chartering this type of vessel.
- h. The declaration of coastal stretches as **Coastal Regulation Zone's (CRZ)**. 1991 is the most important decision for the coastal management. For regulating development activities, the coastal stretches within 500m of high tide line on the landward side are classified into 4 categories namely, CRZ1, CRZII, CRZIII and CRZ IV (Details appended; No. 4).
- i. **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
- j. **Aquaculture Bill 1997**: Banned commercial aquaculture firms (excluding traditional and improved traditional farms) in the coastal areas and ordered the govt. to establish a regulatory authority to monitor the implementation of its order and for further regulation of such firms.
- k. Other important government policies include; Wildlife (Protection) Act, 1972, Marine Regulation Act, Merchant Shipping Act, MPEDA Act, Coast Guard Acts and Central and State Pollution Control Boards.

State Government agencies (other state acts)

- 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.

International

National legislation and frameworks for use of marine diversity need to be in accordance with international law. The international community deals with control over marine biodiversity through;

- a. United Nations Convention on the Law of Sea (UNCLOS)
- b. Convention on Biological Diversity (CBD)
- c. Trade-Related Aspects of Intellectual property Rights (TRIPS) and many other agreements.

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 fisherfolk 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 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. Fish co-operatives. Fishermen organisations throughout the country have undertaken awareness campaigns for educating fisherfolk 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 are involved in the protection and enhancement of biodiversity. Many groups of local communities in patches have been working for the cause of conservation of mangroves, guarding the turtle nesting grounds against preys (Biju Kumar, 2001).

5.4. Industry and corporate sector

Shore based small scale and heavy industries; harbour and port authorities are also involved in small-scale conservation works. The involvement of corporate sector in the conservational works is very limited in India unlike many other countries.

5.5. Research Institutes, NGOs and Individuals

A lot of research on various aspects of coastal ecosystem status has been researched in research institutes, universities, and colleges. Many NGOs and individuals concerned with coastal ecosystem health and ecological diversity have been working with coastal related research problems making contributions in various aspects including conservations and inventorying of the biological diversity.

5.6. Coastguard and Navy

Peacetime duties of Coastguard and Navy include protection of the sea and the coastal area especially from illegal activities. Coastguard operations are more varied ranging from surveillance through pollution control to prevention of poaching, and are generally carried out closer to the continental shores, where biodiversity and the threats to its sustainability are highest. Besides Coast guard also is concerned with surveillance of critical coastal marine ecosystem and the EEZ. They therefore have a great role to play in monitoring and evaluation of the state of Biodiversity.



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:

- Biodiversity bill 2000
- 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.
- Current NBSAP process

6.1.2. Administrative

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

6.1.3. Programs and Schemes

- a. NIO, NIOT, CMFRI, NEERI (Appendix 7), CIFE, CES, various Universities, CMSRI etc., are having in house, sponsored and centrally funded projects, wherein, biodiversity related components are directly or indirectly involved.

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. **National facility for Integrated Coastal and Marine Area Management (ICMAM).**

Since the ICMAM related activities are long term in nature, DOD is

establishing a National facility on ICMAM in the new National Institute of Ocean Technology campus to undertake the above activities on a long-term basis. Besides regular long-term training programmes on preparation of ICMAM plans and an information system needed for the management of critical habitats, it will also undertake all other ICMAM related activities like determination of use classification of coastal waters and water quality criteria for different uses of sea, determination of no impact zone for developmental activities in critical habitats, etc. DOD also envisions ICMAM to become a regional training centre on for South Asian countries and implement international coastal zone programmes.

- b. 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 Wedge 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 trawling on benthic fauna

- c. 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).

- d. Department of Ecology, Environment and Forests, has a number of projects being implemented including mangrove afforestation, degraded mangrove regeneration, and Green wall formation etc.
- e. The Central Marine Fisheries Research Institute. Is a central agency under ICAR, which has several branches at different regions. Many fisheries oriented in-house, sponsored, and centrally sponsored research projects are being undertaken all along the west coast.

6.1.4. Economic/social sectors

The government implements various kinds of subsidies for fuels and fishing equipments. Fishery developmental activities: Financial assistance to fisherwomen, traditional fisher folks etc.

6.2. NGO

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

Several initiatives have been taken up from the coastal communities, especially the traditional fishermen to prevent habitat loss due to the developmental activities. Further many of the protests and movements have not yielded in the results of protection of the environment, due to several interfering factors (political, conflicts between stakeholders etc.). A few examples, which have taken wide publicity, are appended (No. 8).



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).

Information on the indigenous practices, data on their relevance to the conservation practices is not well documented.

Data on harvested non-target organisms-quantum and quality

Impacts of trawling on bottom fauna

Information on impacts of alien species on the natural biota

7.1.2. Insufficient data

Insufficient data on the pollutants especially on the types and quantity of chemicals and oil, Petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAH), synthetic organic compounds reaching the coastal waters. Persistent Organic Chemicals (POP), which are currently considered as the most hazardous reaching even up to the Polar Regions and suspected pollutants.

7.1.3. Lack of knowledge about the alien species

Introduction and impacts on the natural environment and information on the ballast water and hull. One of the major areas of concerns along the coast is the invasion of exotics through ballast waters. Except for Gujarat coast there is no evidence of deballasting the ships' tank before reaching the port/harbour.

7.1.4. Lack of information on the recruitment, spawning and breeding grounds of the commercially important species of fishes and others species

7.1.5. Data on conversion of 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. National fishing policy - the national fishing policy raises conflicts between various internal groups of resource users, such as large scale, industrialised, artisanal, traditional fishers etc.

Lack of central ministry is one of the biggest loopholes. Several organisations are involved in the fishing sectors, in additions other ministries are also involved for the management of the coastal resources. Due to a lack in the vision in the government policies and co-ordination and implementation of the agenda there arises several conflicts between the resource uses. The political interferences many a times overrule the national interests neglecting the ecological significance of natural resources.

7.2.2. 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.

7.2.3. Lack of initiative programs for the development of value added product from low coast raw materials (e.g. by-catch) and lack of governmental initiatives/supports for practicing traditional knowledge base.

7.2.4. An integrated approach in biological and sociological research, so as to get a holistic measure of the impacts/benefits/needs and acceptance of new and appropriate technologies by the stakeholders and interest groups is lacking, which is very much 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. Inclusion of environmental costs in developmental programmes along the coast such as expansion of tourism, aquaculture, industrial developments, expansion of ports and harbours etc., (where long term effects on the ecosystem is generally overlooked) is lacking (e.g. setting up of harbours along the pristine and biodiversity rich areas (e.g. proposed Tadri project) without proper EIA.

7.2.6. Lack of developing a vision for the sharing of common properties. Major constraints identified in coastal management are;

- a.* Conflicts among the different users of coastal resources, especially traditional fishing and mechanized trawlers, local fishers and interstate or international fishing vessels. Mechanised trawlers and the indigenous fishing groups; indigenous and traditional fishers; national and international trawlers have different approaches for the coastal resources. Lack of an effective Fishing Regulation Act
- 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 and Inadequate manpower and logistics

Though government regulations are adequate to ensure conservation, rational use of resources and conservation but attempts for the strict implementation are inadequate.

Government department's lack of adequate manpower and inadequacy of tools and logistics to implement nature conservation

7.3.2. Lack of coordination of inter-ministerial departments in the legal issues

MoEF in many cases fail to analyze implications of new projects along the coast and permissions have been granted to many of MNCs inspite of local agitations. Non-transparent, and non-receptive attitude to incorporate ground realities even after receiving healthy comments on EPA and CRZ regulations

7.3.2. Coordination between the inter-ministerial policies and activities of the Central and State Governments

7.3.4. Effective measures have been taken by pollution control board policies for monitoring and implementing safety standards but Pollution Control Board is not very strict in monitoring the effluent discharge and quality due to lack of manpower and training.

7.3.5. Ensure generation of more data to take appropriate decision on trawl ban, all along the western coast

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. Lack of coordinated effort in coastal research by maritime universities, research institutes, CSIR, ICAR and other research organizations

7.4.2. 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.

7.4.3. Lack of emphasis on taxonomical research leads to death of expertise in taxonomy. Classical taxonomists, who could do qualitative identification of marine and coastal, are not encouraged because of the applied research works and hence there are very few expert taxonomists for different coastal and marine groups.

7.4.4. Lack of central reference point to authenticate the identification of coastal species





NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN
WEST COAST ECOREGION

Section -8

**Major Strategies and Action
Plan**

8. Major Strategies and Action Plan

Considering the unique features of the west coast, demographic pressures, and current development, there is a need to create specific legal regimes for the west coast. There is a need to undertake studies to determine the special features prior to further developments. The strategies have to combine several interlocking initiatives, which may include different social levels and within government sectors.

Strategies and the Action Plans

The action plans are grouped into 7 major categories as opined by the Working Group (WG).

- 1. Arresting further loss of habitat and biodiversity**
- 2. Biodiversity inventorying – Data Banks on Coastal resources-GIS based**
- 3. Awareness, Education and Training**
- 4. Alternate Livelihood**
- 5. Integration of the activities of line agencies on marine biodiversity**
- 6. Equity and empowerment for women to involve in conservation exercises**
- 7. Identification of indicators of changes of biological diversity**

The details of each of these are provided in the following sections. In addition to the above, recommendations on defining the coastal zone and setting up of Coastal Zone Authority (CZA) are discussed.

8.1. Redefinition of coastal zone for biodiversity protection

At present the extent of coastal zone is variously defined. Ecologically it is up to supra littoral zone. Environmentally it is up to the farthest point where the tide reaches. According to LOICZ it is 200 m elevation inland. According to CRZ it is 500 m beyond high tide mark. All these definitions have particular objectives but not necessarily in terms of conservation of biodiversity.

- Within the framework of CRZ, it is proposed that a width beyond high tide line upto landward limit of distribution of organisms of sea origin be declared as biodiversity conservation zone where activities inimical to sustainability of biodiversity would not be permitted. These zones could also be used as biodiversity conservation units at local levels.

8.2. Creation of Coastal Biodiversity Authority (CBA)

At present there are agencies to collect information on marine fisheries coastal habitats, tourism developments and a number of other activities that affect coastal zone. The WG members felt that none of these agencies consider biodiversity issues with the credence they deserve. Even the proposed biodiversity bill gives allowance for only one member to represent marine and coastal issues. The WG members, while recognizing competence and the integrity of such agencies still felt that the concerns of biodiversity are diluted because of other over riding concerns. Hence they propose the creation of CBA which will primarily and with a focus, deal with biodiversity related issues in the coastal zone.

The WG agrees that CBA should be composed of members from line agencies, coastal states, academics and public. The WG recommends that nuclear groups be established at village and community levels that would provide relevant inputs to CBA. **The proposed composition of CBA shall be;**

- One member each from MoEF, DOD, and one member each from maritime states, besides a minimum of 7 experts from NGOs and other 5 marine research institutes such as NIO, CMFRI, ZSI, BSI, and FSI. Such an authority should collect information on the biodiversity, maintain database, and identify the sensitive habitats. It should also have powers for clearance of any coastal-based developmental activities. Should able to resolve conflicts between state/regional boundaries.

8.3. Arresting further loss of habitat and biodiversity

8.3.1. Strategy 1

- a. **Protecting the existing biodiversity rich and ecologically sensitive areas by declaring as protected areas (P.A.)**

Criteria for declaring the sensitive and biodiversity rich areas should be defined and based on the criteria the sites for conservations should be notified as P.A.

Definition of criteria of Protected Areas

At present the protected areas in India are quite large and include vast geographical areas often with more than one ecosystem. This approach however neglects smaller areas which are much richer in biodiversity and heavily impacted. Some smaller sites could also be the home to endemic species or rare ones. Some sites may also harbor unique species in the region. Such sites are not covered under protected areas network simply because they are smaller in extent.

The WG felt that a reassessment of sensitive and biodiversity rich areas along the coast should be made taking into considerations views expressed above.

- The WG proposes that uniqueness in biodiversity abundance, traditional biodiversity uses and not the geographical extent or isolation should be the primary criterion. The WG also recommends that generation of primary data should be included while evaluating the suitability of any one site for declaration as protected area.

The generation of primary data should satisfy;

- Statistically valid number of surveys
- Comprehensive listing of flora and fauna and their presence and abundance
- Detailed documentation of historical usages
- Assessment of susceptibility to natural and man-made impacts

A few areas to be given high priority are the following;

- ♦ Vizhinjam (15km²) along Kerala for coral patches
- ♦ Coondapur (for mangroves)
- ♦ Tadadi and Aghanashini backwaters along Karnataka for the rich biological diversity
- ♦ Vembanad lake of Kerala coast
- ♦ *Ghazanis, Pokkali* fields and other traditional agricultural practices along the coast
- ♦ Ratnagiri, Malwan and Sindhurg, Raigad coastal area along Maharashtra and Gulf of Kachchh along Gujarat.

Time Duration – Within 3 years

Priority - Very High

Buffer zones around protected areas

The current practice of having protected areas in the marine environment does not provide for any buffer zone. For e.g. the national marine park in the Gulf of Kachchh has all coral reefs as protected but not the waterways between them. Any impact like oil spill that occurs in the waterways will affect the coral reef ecosystem yet the offender would not be legally liable. This becomes more critical in the marine system where the water currents can transport pollutants over vast areas.

- Hence, the WG recommends creation of buffer zones at least of 50% radius of the core zone in all protective areas.

b. Mangrove Conservation

Redefinition of mangrove habitat size under CRZ-1

The current CRZ-1 includes mangroves in all water bodies subjected to tidal action and does not define the density of mangrove trees in such habitats. While the conservation concern under this classification is welcome, quite often sporadic presence and patchy distribution of mangrove plants at some sites prohibits any activity including sustenance livelihoods.

- The WG therefore recommends that if a mangrove patch is to derive benefit CRZ protection, it should be of a size of at least 1 hectare, with more than 50% canopy cover. The WG also considers that patches below this size, while enjoying CRZ1 protection, may be opened for non-destructive commercial and recreational activities.

Identification of threat and restoration

- Identification of severity of threats from anthropogenic/industrial activities to prioritise sensitive areas and to prevent effluent discharge along these areas. Regeneration of the degraded mangroves should be initiated immediately in order to increase the mangrove cover. As a part of the conservation programme the socio-economic issues of the locals should be evaluated for assessing the severity of the threat caused by them, and alternate source of fuel for the coastal communities should be initiated preferably with subsidized coasts.

Strengthening of Institutional capacity

- 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, and other research institutions such as NIO, Universities and Forest department).

8.3.2. Strategy 2

Participatory management of coastal habitats and their biodiversity

The current practice of biodiversity management resides on policy formulation by MoEF based on data generated by academic institutions and research laboratories. While the quality of this procedure cannot be disputed, there are however three short comings to this approach.

1. They are too site specific
 2. Monitoring mechanisms are never built-in so that the impacts of policies can never be truly understood or appreciated
 3. This delineates local population from decision making or even evaluating their own biodiversity changes.
- The WG recommends that the monitoring and management of biodiversity should be done at multiple levels. It recommends creation of nuclear bodies at several locations along the coast and training in methods of biodiversity monitoring. These nuclear groups should also be enabled with necessary physical, infrastructural and intellectual capabilities to record changes in habitat properties and their constituent biodiversity components. The higher level in this hierarchy will then have the responsibility of analysing these data and recommending appropriate management strategies.

The WG agrees that this is somewhat similar to JFM but is a distinct improvement in the following respects

1. Networking of a large number of coastal marine habitat monitoring groups
2. Capacity building at multiple levels
3. Development of databases for various components
4. Decentralization of responsibilities and initiatives to local groups and their empowerment
5. Establishment of a long term monitoring set up for the entire West coast

8.3.3. Strategy 3

Minimising Over exploitation and wasteful by-catch

Revision of existing fishing regulations and innovative implementation

At present the fishery sector in India is regulated by outdated rules and regulations both at the central and state levels. Most of these are irrelevant to present situation and issues.

- The WG recommends a revision of all fishery related rules and their integration into a new Fishing Regulation Act and creation of mechanisms for its implementation. This would provide more effectiveness in implementation.
- The WG considers that the gap in understanding of the issues is too vast between policy framers and policy users. It recommends that steps should be taken to translate all these acts and recommend practices into regional languages, supplemented by graphical illustrations. The WG recommends that a large number of innovative measures be employed in the extension services of state fisheries department, so that the rules are understood by most stakeholders and adhered to in letter and spirit.
- The WG recommends that integration and framing of FRA should be done by committee consisting of representatives from Central and State Fisheries Departments and Agencies, and also representatives from user groups so that the gaps in policy framers can be identified and suitably addressed at the initial stage itself.

Regulation of over capitalization

One of the main causes for loss of marine biodiversity is intensive exploitative practice evidenced by non-adherence to code of responsible fishing that includes measures for conservation, sustainability and equitability. The dwindling yields have also lead to over capitalization in certain sectors in order to increase the economic returns in short time. The follow up of this is a fast depletion of natural stocks, degradation of coastal habitats and the attendant socio economic issues including non-repayment of loans.

- The WG recommends careful studies of the capital investments both in public and private sectors, in marine fisheries sector and regulate this as a function of harvestable marine fish stocks and the socio economic needs of the coastal communities

Uniform ban on monsoon trawling

Monsoon is the period when most marine fishes reproduce and the juveniles come inshore for feeding. Trawling in inshore waters, often with very fine mesh, destroys breeding stocks and juveniles. Several States have proposed ban on monsoon trawling but the periods of effective ban are not the same between the states. This defeats the very purpose since trawler owners and fishermen migrate to adjacent States and continue fishing legally.

- The WG proposes that the ban on monsoon mechanised and motorised fishing along the west coast be made uniform over the entire monsoon period.

Stock assessment of non-conventional and deep-sea fishery resources

If one looks at the yield from marine fishery sector, it will become apparent the yields along the west coast are stagnant for last several years and they are close to the optimum yields estimated from several different models. It is expected that irrespective of the developments in coastal Mariculture, demand for captured fishes would increase.

- Fishery has to change from open access mode to regulated with a well-organised monitoring, control and surveillance (MCS) system.

Value addition to by-catch

In the case of high value targeted fisheries, the quantum of by-catch generated is substantial. These are converted into fishmeal, animal feed etc.

8.3.4. Strategy 4

Biodiversity management and conflict resolution by zoning for activities

The biodiversity along the coast is threatened to varying degrees by variety of developmental and recreational activities, as this cannot be wished away in the name of conservation, the next best alternative would be adopting a zonal plan (informed partitioning) which would provide for various activities, yet enable an effective monitoring and management. This practice has been in vogue in some countries and has been generally successful. Besides being a tool for conflict resolution, the zoning pattern would also help regulate unplanned excessive developmental activities on the coast (e.g. development of new ports when existing adjacent old ports could be upgraded to serve the purpose)

- Drawing from the concept of CRZ, the WG recommends a zoning plan for various activities should be evolved for the west coast. Such a plan will take into account the current status of biodiversity and their uses, possible impacts of developmental activities, economics of biodiversity losses and environmental audits.

8.3.5. Strategy 5

Suitable control measures for coastal constructions and other developmental activities which cause damage to the habitats

Developmental activities and EIA procedures

Most of the developmental activities on the west coast need an EIA study. While a separate commissioned paper examines the ways and means of strengthening the EIA procedures, the WG felt that follow-up of the post-project activities and impacts are quite critical.

- Accordingly, the WG recommends pre and post project environmental audit/status reports of every project should be prepared every 3 years after the project becomes operational. (The term projects here include new industries and ports. Instead of establishing the new ports, expansion of existing ports should be thought of wherever possible. E.g., proposed Tadadi port in Karnataka coast can be stopped by expansion of the nearby Karwar and Mangalore ports)
- Controlling the damage caused to habitats (e.g., destruction of turtle breeding/nesting grounds) by activities such as sea wall erection, sand mining, shell mining, port activities, expansion of the ports and harbours, dredging and ship breaking

Control of beach erosion

The current practice of constructing sea walls to contain beach erosion at many places is unacceptable and not a biodiversity friendly action. The disadvantages are many: it is not aesthetic, alters long shore currents and modifies habitat properties, causes habitat loss in many places, fragments some habitats, deprives nesting grounds of future and prevents access to the beach and the estuaries needed by marine organisms for breeding and rearing of their young.

- The WG recommends that present practice of constructing sea walls be stopped forth with or at least modified with suitable expert engineering technology to maximise the

effect of energy dissipation. Where needed, alternative technologies that minimize impacts on habitats should be identified and applied. Ecofriendly method of controlling erosion by replanting sand dune vegetation, beach nourishment, and alternative ecofriendly engineering technologies should be adapted to minimise the severity of the coastal erosion.

Evaluation of impacts of mining activities

Commercial mining for inorganic resources like shells, corals and sands is being done at many places on the assumption that removal of dead material is not a threat to biodiversity. In some cases it is even argued that shells and corals washed on the beaches, if not recovered would be taken back to the sea, and hence there is no harm in collecting them. While it can be admitted that mining inorganic resources could be permitted, uncontrolled mining practices could harm the habitats and indirectly the biodiversity.

- Recognizing this threat, the WG recommends the commercial mining of shells should be regulated taking into account-
 - a. The rate of replenishment in case of resources like molluscs and
 - b. The impacts on other biota because of removal of some components from the habitat as well mining per se.
- Hence, the WG recommends actions that would evaluate such impacts. WG also recommends mining activities near protected or sensitive habitats should not be permitted.

A threat, the magnitude of which is as yet unperceived is **deep-sea mining for polymetallic nodules**. This would destroy not only benthic habitats but also affect pelagic habitats since the mining rejects would be released on the surface. Environmental impact assessment studies have been conducted recently by simulation experiments. These need to be reinforced with more data from benthic and pelagic habitats.

Another potential raw material for **mining is cold nutrient rich deep waters** for use in OTEC plants. While it has been advocated that the cold water brought up can be used for increasing productivity, impact of release of several thousand tones of cold water on the surface is not known. The WG recommends that impact assessment studies should be conducted before any mining from deep sea is envisaged.

Port activities

Operations at the Ports should be suitably controlled without harming the coastal resources. Disaster management protocols should be in place at all ports to address eventualities such as accidental spilling of chemicals and other materials while loading and unloading.

Expansion of ports and harbours should satisfy the EIA criteria. Setting up of the new harbours or ports should undergo strict EIA and can be initiated only if it is unavoidable. Other activities such as dredging and ship breaking should be monitored for the environmental damage. Efficient tools for the pollution abatement and recycling of the goods should be adopted.

Aquaculture

The WG during the first meeting discussed extensively the issues concerned with coastal aquaculture. Some of the members felt that the Aquaculture Bill, in its present form is inadequate to safeguard the interests of coastal biodiversity and the well being of coastal ecosystems.

- The WG recommends that the aquaculture practice along the coast should be regulated on a basis that it does not affect carrying capacity of the system and the waste generated is not adversely affecting the biodiversity at its vicinity. And aquaculture practicing at high biodiversity areas should be carefully avoided.

Effluent management in coastal systems

The marine waters are recipients of industrial and sewage effluents. Seawaters has a certain amount of assimilative capacity but in the recent years the quantity of effluents released into seawater grossly exceeds this.

- In order to contain the impact of pollution on biodiversity, the WG recommends-
 - a. Compulsory pre-treatment of all effluents
 - b. Development of dispersal models for each pollutant in order to determine upper levels of dispersal
 - c. Site-specific, carrying capacity models for multiple types of effluents

In almost all cases only major inorganic effluents such as metals or organic ones like oil are considered. The effluents may quite often contain persistent organic molecules, which will affect the life history of marine organisms for generations to come.

- The WG recommends setting up of proper effluents treatment plants for all effluents into the sea. Further, it recommends strict vigilance by the state pollution control boards for effluent quality control. In addition, NGOs also should be involved in taking care of the coast against hazardous effluents.

Tourism management

Tourism, especially its new form of ecotourism is being promoted as ecofriendly and no risk to biodiversity. While most tourism practices are non-invasive, their impacts on biodiversity are mostly indirect, caused by habitat reclamation, pollution excess demand on local resources and over crowding. At present the tourism on the west coast is confined to very small stretches but is being planned to add more sites to tourism. Key concern with regard to safeguarding the coastal biodiversity should be focused on the Special Tourism Area (STA) along the Coast.

- In this context the WG proposes that:
 - a. Tourism should be treated as an industry and proper EIA should be carried out before clearance is given.
 - b. Carrying capacity of each site should be evaluated prior to delineating an area for tourism along the coast
 - c. Provision for rotation of tourist zones should be incorporated in the tourist development plans
 - d. Awareness of the value of habitat and biodiversity conservation should be built into all tourism activities
 - e. Local community participation in the sustainable tourism operation should be made mandatory.

8.3.6. Strategy 6

Invasion of exotic species and GMOs

Introduction of alien species into natural habitats occurs in two ways, in the first it is accidental, quite often brought in by ballast water or shipment of commercial marine products. In the second instance the introduction is intentional, either as bio-control agents or for their ability to grow and reproduce faster than the native species (aquaculture). Creation and introduction of GMOs also qualify as invasive alien species.

In most of these cases ecological damages are perceived only by hindsight. Considering the gravity of the havoc the exotic species and GMOs can play with the natural ecosystems and recognizing their mode of entry,

- The WG recommends:
 - a. Site-specific monitoring studies should be carried out where exotic species have already invaded to understand their impact on the local biota and ecosystem functions.
 - b. Sites near ports and coastal aquaculture farms should be intensively monitored for alien species and GMOs
 - c. Precautionary approaches (biosafety) in handling, transport and maintenance of GMOs should be strictly enforced.

As the fate or impacts of GMOs in the marine environment are little known and as measures to contain the damages that might be caused by them are particularly unknown in India, WG strongly feels creation of a marine biosafety unit or an institution/ inspectorate is a must.

Institutes - Suitable expert agency or scientists in the field of exotic's research should further coordinate this project. E.g. CMFRI, ZSI, BSI

Priority - High

Time Schedule: Immediate

8.4. Biodiversity inventorying - Databanks on Coastal resources - GIS based

8.4.1. Strategy 1

Authenticated inventory of the coastal biota

As issue that repeatedly came up in all WG meetings was that our knowledge of the marine biodiversity is quite inadequate. Even the relevant materials prepared by ZSI and BSI do recognize these lacunae. By relative estimates, it is possible to conclude that the current inventory of marine biodiversity would be only ¼ of the actual potential. This situation is a

result of lack of detailed surveys, lack of adequate taxonomies and lack of centralized data banks where such information can be stored.

➤ The WG recommends:

- a. Surveys and inventories of coastal marine biodiversity to be completed at the earliest
- b. Taxonomic expertise for each group be developed along with the mechanisms to retain the trained manpower
- c. Establishment of authentication centers and reference collections in maritime institutions and universities
- d. Provision of incentives for taxonomy as job opportunities, better recognition at national levels to be promoted
- e. Retrieval of taxonomic data bases from assorted sources like reports, thesis and miscellaneous publications and synthesize them into a centralized electronic database.
- f. Electronic documentations of individual groups of organisms and distribution to user agencies
- g. Taxonomical expertise gained by the senior scientists should be utilised for training the younger generation to prevent a gap in the knowledge.

Suitable institute should be recognized with expert scientific staff. E.g., National Institute of Oceanography (NIO), CMFRI, Centre for Marine Living Resource and Ecology (CMLRE), and universities and colleges located near the coast.

The operation will be in the project mode by the above mentioned institutes

Priority should be to the following groups:

Corals and coral reef fauna
Algae and Sea-grasses
Annelids

Molluscs, Crustaceans, Echinoderms
Fin-fishes

Time frame - Should be taken up immediately and completed in five years.

8.4.2. Strategy 2

Community Inventories of Biodiversity

While the measures proposed to strengthen taxonomic expertise would help to complete the inventories at a national level, for a day-to-day management of marine resources at

local levels, a different kind of expertise needs to be developed. This should be in the form of Para taxonomy for individuals and communities.

- WG recommends:
 - a. Taxonomic knowledge at basic levels to community members be imparted so that changes, loss or decline bio-piracy and invasion by exotic species are monitored and appropriate interventions are initiated.
 - b. Community inventories of biodiversity are maintained so that traditional knowledge rights can be protected.
 - c. Biodiversity information centres at village and *taluka* levels be established to create awareness

8.4.3. Strategy 3

Setting of Biodiversity Museums for coastal resources

Ex situ conservation

While protected areas offered possibilities of *in situ* conservation, certain endangered species need to be brought under *ex situ* conservation as well because of the continuing loss of their habitats and the longer periods needed to restore these habitats conducive to their survival. Candidates include some mangrove plants, marine mammals like dugong, some *Protochordates* like *Balanoglossus* etc. The WG recommends *ex situ* conservation of such rare and threatened species by establishing large aquaria and /or gene banks

Priority: High

Institutes: CMFRI is already running an in-house project and can be promoted with additional funding.

8.5. Awareness, Education and Training

8.5.1. Strategy 1

Sensitizing stakeholders

Action plans and conservation of biodiversity can be successful only to the extent that concerned stakeholders are sensitized of their roles and responsibilities. This becomes

critical not only in the implementation phase but also in the follow up, especially when personnel involved in education and implementation are rotated or transferred.

- Recognizing that creation of awareness is vital, the WG recommends:
 - a. Conducting awareness programmes for coastal communities on the values of biodiversity
 - b. Sensitising policy makers on the intricacies of evaluating the economics of biodiversity and ecosystem conservation
 - c. Awareness and training courses for enforcement agencies (Wild life wardens, Customs, Police, Navy, Coast Guard) in identification of biodiversity components, especially those under schedule I
 - d. Guidelines and training on ecotourism, sustainable tourism and responsible behaviour for tourist operators and tourists
 - e. Special awareness to corporate sector on biodiversity valuation and conservation and their role in it.
 - f. Training programs at school level on biodiversity and conservation
 - g. Periodic check of the issues with all the agencies associated with the above areas

The institutes involved with the environmental educational programs should take initiatives and run these programs with the assistance from related government agencies

8.6. Alternate Livelihood

8.6.1. Strategy 1

To minimise the dependency on the limited coastal resources, alternate livelihoods are recommended

The most important cause of biodiversity loss is over-harvest and/or unsustainable harvest practices and resource utilization practices. Eradication of these causes would be possible only by promoting alternative means of income generation.

- Towards this objective WG recommends:
 - a. Identification of destructive resource harvest practices
 - b. Understanding the underlying socio economic compulsions

- c. Preparation and promotion of a list of alternate livelihoods which do not rely on local biodiversity
- d. Training to local population in the practice of choosing alternate livelihood
- e. Formation of local self-help groups for biodiversity and habitat conservation
- f. Employing biodiversity wardens from the local communities for the prevention of;
 - i. Poaching of Mangrove forests
 - ii. Removal of bottom fauna by dredging
 - iii. Destruction of the nesting grounds/nest of turtles
 - iv. Effluent and solid waste discharge in the coastal habitat. s

Institutes: Local NGOs, CMFRI, NIO, CIFE, and other fishery/coastal related institutes may be approached to outline the alternatives for minimization of resource exploitation

8.7. Integration of activities of line agencies on marine biodiversity

Currently MoEF is funding most of the projects on marine biodiversity. However quite often projects that have a direct or indirect bearing on biodiversity are funded by DOD, DST, Dept. of Space, Foreign Donor Agencies and other International Bodies.

- The WG recommends a cross-sectoral mechanism whereby all biodiversity related projects are managed by a co-ordinated way. While discussing this, the WG also noted the need to compile important findings from previous projects and disseminate them as consolidated status reports. The WG also recommends that the abstracts or summaries of all project reports should be posted in appropriate websites.

The findings of these projects may have direct or indirect bearing on the conservation strategy of biodiversity. Hence a cross-sectoral mechanisms to use the outcome of these projects

8.8. Equity and empowerment of women to involve in conservation exercises/works

One of the basic principles of NBSAP is to enable women play a determinant role in biodiversity conservation and management.

- The WG discussed this at length and taking recognition of the current extent of involvement of women and the constraints behind it, a multi-tiered approach is recommends
 - a. Creation of awareness on the issues of biodiversity
 - b. Education in management strategies
 - c. Induction of women into decision making forum
 - d. Enabling economic independence through constitution of Self Help Groups and Co-operatives

- This is a process that would take several years to reach its logical end.

8.9. Identification of indicators of changes of biological diversity

Abundance and distribution of biological components undergo natural variations on time scales ranging from diel through tidal and lunar to annual cycles. Changes in densities of some organisms are much more of ecological value since they indicate that the ecosystem experiences unusual or even non-reversible effects. A case in point is the proliferation of the crown-of-thorns starfish in the coral reefs, which has a drastic impact on the survival of the corals. The proliferation by itself is an effect of factors that altered the densities of its own predator (triton shells). Monitoring such key species would provide early warning signals of the impending changes.

While the case of crown-of-thorns is one such example with coral reefs, such indicators are much less known from other systems. It is essential that a set of indicators be identified for each ecosystem and their changes included as one of the parameters in long term monitoring projects. The indicators would ideally recognize component changes, structural changes and process changes. Besides these scientific/ biological indicators, there is also a need to identify socio-economic indicators that would have a bearing on the intensity and patterns of biodiversity uses.


