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Prof. L. KANNAN, M.Sc., Ph.D., D.Sc., F.S.B.,
Professor of Marine Biology
&
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15.09.2002

To
Shri Ashis Kothari
Coordinator
Kalpavriksh
Apartment 5 Shree Dutta Krupa
908 Deccan Gymkhana
Pune – 411 004.

Sir,

Sub: National Biodiversity Strategy and Action Plan – East coast – Submission of final report – reg.
Ref: Moen& F D.No. No. J-22018/25/99-CSC (BC), dt. 11.08.2000

Please find enclosed our final report on "East coast eco-region Biodiversity Strategy and Action Plan". As per your direction (vide your letter No. CONS/VA/9/1079 dt. June 10, 2002), the draft action plans were circulated to all the working group members and necessary corrections / modifications have been carried out in the final report as suggested by them.

I have already submitted to you the Utilization Certificate duly signed by the University authorities. Hence, I request you to kindly release the final installment of Rs. 40,517.00 to settle the entire account with the University.

Your early action in this matter is highly solicited.

Thanking you,

Yours faithfully,

(L. KANNAN)

Encl: Final Report (Hard copy & CD)

Copy to: 1) Dr. Sarat Babu, Addition Director, MoEn & F
2) Dr. M.V.M. Wafar, Sr. Scientist, NIO
3) Dr. Vibha Ajuja, Member – Secretary, NBSAP

UTILIZATION CERTIFICATE

1.	Title of the project/ scheme	:	National Biodiversity Strategy and Action Plan – East Coast Eco-Region
2.	Name of the organisation and Principal Investigator	:	CAS in Marine Biology Annamalai University **Dr. L. Kannan**
3.	Department of Environment letter No. and date of sanctioning the project	:	MoEn& F D.O.No.J-22018/25/99-CSC(BC) 11.08.2000
4.	Amount brought forward from the previous financial year quoting Dept. of Environment's letter No. and date of which the authority to carry forward the said amount was given	:	-
5.	Amount received from the Dept. of Environment(Please give No. and dates of sanctions showing the amount paid)	:	No. and date of sanction Amount 1) 16.11.2000 Rs. 1,99,600.00 2) 05.12.2001 Rs. 99,800.00 3) 06.06.2002 Rs. 59,820.00 **Total** **Rs. 3,59,220.00**
6.	Total amount that was available for expenditure (including commitments) incurred	:	Rs. 3,59,220.00
7.	Actual expenditure incurred	:	Rs. 3,99,737.00
8.	Unspent balance refunded if any (please give details of cheque No. etc.)	:	-
9.	Balance amount available at the end of the financial year	:	Rs. (-) 40,517.00

10. Amount allowed to be carried forward to the next financial year (vide letter No. and date) : -

Certified that the expenditure of **Rs. 3,99,737.00** (Rupees ***three lakhs ninety nine thousand seven hundred and thirty seven*** only) mentioned against column 7 was actually incurred on the project/ scheme for the purpose for which it was sanctioned.

Date : 24.06.2002

Signature of
Principal Investigator

Signature of
Head of the Department

DIRECTOR
CENTRE OF ADVANCED STUDY
IN MARINE BIOLOGY
ANNAMALAI UNIVERSITY
PARANGIPETTAI — 608 502.

Registrar i/c
Annamalai University
Counter signature of
Accounts Officer/
Registrar

OUR REF. NO.

ACCEPTED AND COUNTERSIGNED

Date:

COMPETENT AUTHORITY
DEPARTMENT OF ENVIRONMENT



EAST COAST ECO-REGION BIODIVERSITY STRATEGY AND ACTION PLAN



PREPARED UNDER

THE NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN - INDIA



Prof. L. KANNAN, *M.Sc., Ph.D., D.Sc., F.S.B.,*
Co-ordinator



Centre of Advanced Study in Marine Biology
ANNAMALAI UNIVERSITY
Parangipettai – 608 502
Tamil Nadu, INDIA
2002

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Tamil Nadu, INDIA
2002

NBSAP EXECUTING AGENCY	:	Ministry of Environment and Forests, Government of India
NBSAP FUNDING AGENCY	:	United Nations Development Programme (UNDP) / Global Environmental Facility
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NBSAP ADMINISTRATIVE AGENCY	:	Biotech Consortium India Ltd.
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ABOUT NBSAP

The National Biodiversity Strategy and Action Plan (NBSAP), a project of Union Ministry of Environment and Forests (MoEn&F) aims to produce a series of planning documents dealing with the conservation of India's biodiversity, sustainable use of its biological resources, and equity including in decisions regarding access to such resources and the benefits accruing from them. The project is funded by the Global Environment Facility through United Nations Development Programme (UNDP). A unique aspect of the project is that its technical execution is by a Technical and Policy Core Group (TPCG) being coordinated by an NGO Kalpavriksh, and its administrative coordination is by Biotech Consortium India Ltd.

The NBSAP process has included extremely widespread consultation across the country and across all sectors of society, involving tens of thousands of people. It aims to produce not one national action plan, but 18 local (substate) plans, 33 state and union territory plans, 10 ecoregional (interstate) plans, and 13 thematic plans. All these will coalesce into a national plan but will also remain independent for implementation purposes. In addition, over 30 thematic papers have been commissioned on a variety of topics related to biodiversity.

Within this overall process, one of the eco-regional action plans is on **"East coast Eco-region Biodiversity Strategy and Action Plan"**, which has been drafted by Dr. L. Kannan, Coordinator and the Working Group consisting of persons experienced in the field.

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INTRODUCTION

Marine Biodiversity

The total number of named species of organisms is about 1.4 million (Wilson,1988). Of these, about 2,50,000 are vascular plants and bryophytes, 44,000 are vertebrate animals and 7,50,000 are insects. There are reports stating that over 50 million species may exist if we take into account the biodiversity of microorganisms and invertebrates. But, in reality, it is very difficult to estimate the exact number of organisms that actually exist because many individual groups such as fungi, nematodes, mites and bacteria are poorly known. This includes marine biodiversity also especially the deep sea biodiversity (Ray,1988).

Estimated number of species in the world and their scarcity (Otto T. Solbrig, 1993)

Group	Total number of species	Number of species identified	Percentage of the identified over the total	Number of scarce species	Percentage of scarce species identified
Mammals, reptiles and amphibians	15.210	14.484	95	728	5
Birds	9.225	9.040	98	683	8
Fish	21.000	19.056	90	472	3
Plants	480.000	322.311	67	-	-
Insects	30000.000	751.000	3	895	<1
Other invertebrates and microorganisms	3000.000	276.594	9	530	<1
Total	33525.435	1392.485	4	-	-

Much of the world's wealth of biodiversity is found in highly diverse marine and coastal habitats. The pelagic water column and wealthy benthic marine environment are the dwelling places for millions of species including mammals, reptiles, fish and invertebrates like crustaceans, molluscs and worms. The marine ecosystems such as estuaries, coral reefs, marshes, mangrove forests and seagrass beds are all characterized by high biological productivity and any erosion into the species diversity of these areas would

signal a decline in productivity; of course with detrimental consequences for coastal communities.

Marine and coastal ecosystems provide a wide range of important food resources and critically important services to human beings. Their ecological functions include storing and cycling of nutrients, regulation of water balance, protection against erosion due to currents and waves and most importantly filtering the pollutants. In addition, regulation of climate through the oceans and photosynthetic pump, removal of primary green house gas from the atmosphere and production of one third to one half of global oxygen characterize the coastal areas.

The coastal ecosystems act as nurseries and feeding grounds for many coastal and pelagic species, important for human consumption. Ingredients for food, cosmetics, industrial chemicals and dyes are also provided with by marine species especially plants (seaweeds and seagrasses). It is also well known that marine organisms produce previously unknown bioactive compounds, including antiviral and antitumour agents which have very great medical potential. Marine biodiversity is also thought to produce new enzymes for industrial biotechnological applications, environmental technologies, adhesives and other industrial compounds. Exploitation of marine living resources, even of single stocks, is therefore a biodiversity issue.

The economic and life saving value of biodiversity is receiving more understanding and attention and at the same time, denudation of the habitats (rich in biological diversity) such as tropical rain forests, wetlands and coastal ecosystems is also continuing alarmingly. The present population is consuming directly or indirectly 40% of the energy fixed on land as food and the percentage exceeds 50% when the production of the ocean is included (Swaminathan,1991).

Through human induced changes, people affect biodiversity in both direct and indirect ways. Use of renewable natural resources especially in extractive industries such

as forestry and fisheries, usually involves decrease in species diversity as stocks are depleted and unwanted species are introduced. IUCN has calculated that if current trends and destructive practices continue, we may lose up to one quarter of the world species by the year 2050.

Categories of fundamental human factors contributing to the erosion of biological diversity (Otto T. Solbrig, 1993)

Factor	Example of impact on conservation
Population growth	Demographic pressure
Poverty	Hunger, deforestation, trading of species in danger of extinction, lack of popular support
Bad perception	Desire of quick results and negation of failures in the long term
Anthropocentralism	Absence of support for non-utilitarian causes
Cultural transitions	Unsustained management of resources during colonization and quick social changes
Economy	Absence of planning as a result of the internatilization of markets and the erratic price of goods
Implementation of policies	Social crisis, wars, corruption, non-fulfillment of law

Scope of the Strategy and Action Plan

Strategy and action plan for the east coast eco-region has been prepared as part of the National Biodiversity Strategy and Action Plan programme through "participatory planning process involving all major stakeholders" as originally proposed in the project document signed by the Government of India and United Nations Development Programme. The action plan has been prepared to establish important strategies to fill the existing gaps in coastal and marine biodiversity management and to enhance and strengthen the ongoing measures and to recommend suitable action plans to achieve the above said goals and to protect / conserve the coastal and marine biodiversity of India in general and its east coast in particular.

Objectives of the NBSAP – East coast eco-region

The present task was undertaken with the following prime objectives to bring out the:

i) current range

ii) current status

iii) problems

iv) root causes of loss

v) gaps in various aspects, and

vi) major strategies to fill the gaps,

with regard to coastal and marine biodiversity of the east coast of India and to recommend suitable action plans.

Methodology

Assessing existing reports and action plans: Collection of existing literature dealing with various aspects of conservation, management and strategy and action plans was made and the same was utilized to assess the priority issues, gaps and current range and status of the coastal and marine biodiversity of the east coast eco-region.

Collection of data using questionnaires: Suitable questionnaires were prepared for data collection from the Andaman and Nicobar islands, West Bengal, Orissa, Andhra Pradesh, Tamil Nadu and Pondicherry states. A separate questionnaire in local language (Tamil) was also prepared so as to get inputs from the common public of Tamil Nadu and Pondicherry states. Considerable number of respondents gave their inputs which were utilized in compiling the document.

Collection of inputs from the east-coast working group members: Inputs were collected from the working group members of the east coast eco-region on their chosen field of expertise and geological area.

NBSAP – East coast working group meetings: Separate working group meetings and brain-storming sessions for Tamil Nadu and Pondicherry, Andhra Pradesh and Orissa states were conducted and two more meetings for Tamil and Pondicherry states were also conducted for obtaining inputs and suggestions for preparing the document. In the workshops, wide representation was given to cover all the sectors viz. research organizations, governmental and non governmental organizations, women organizations, naturalists, fisherfolk, school and college students, teachers, research scholars and common public of the society.

Interactive meetings: Many personal interactive meetings were conducted all along the east coast from West Bengal to southern most tip of Tamil Nadu, the Kanyakumari. In these meetings, the co-ordinator and several working group members of the states concerned held discussions with the fisherfolk and common public of the coastal areas so as to collect inputs.

Boat rally: A boat rally was conducted in the Vellar estuary, Tamil Nadu to popularize the National Biodiversity and Action Plan and also to emphasise the coastal and marine biodiversity conservation.

Nature Camps: Many nature camps were conducted for the school children in the Great Nicobar and Tamil Nadu. At the camps, classes were conducted to educate the pupils about the importance of marine resources and the imperative need for conservation.

Awareness camps: Awareness camps were conducted to the fisherfolk of Campbell Bay, Great Nicobar island and Tamil Nadu. They were educated about the importance of mangroves and coral reefs and the need for their conservation. Awareness was also created to use standard mesh – size fishing nets for fishing and to leave the juveniles back into the water, as a measure of sustainable utilization of aquatic resources.

Besides these, the co-ordinator and other working group members participated in several meetings, workshops and conferences and delivered lectures to school, college and university students as well as common public, popularized the NBSAP concepts and gathered inputs for drafting the document.

CURRENT RANGE OF COASTAL AND MARINE BIODIVERSITY OF INDIA

India is endowed with a long and varied coastline of nearly 7500 km, under 53 coastal districts of 10 maritime states and 6 union territories including the Andaman, Nicobar and Lakshadweep islands. Nearly 50% (420 million according to 1991 census) of the country's population resides in these areas. About 340 communities are primarily occupied in marine and coastal fisheries. Its Exclusive Economic Zone (EEZ) stands over 2 million km^2 .

The coastal mangrove forests protect the coast from erosion and flooding while the coral reefs serve the purpose of adding to the high productivity in coastal waters. In the recent past, due to very high density of human settlements, industrial and navigational needs and also by pollution, major development projects (for ports and industries), land reclamation and over-exploitation of living and non living coastal resources, there is erosion into the coastal, marine biodiversity. Hence, coastal and marine protected areas are important not only for nature protection but also for conservation of critical and economic resources of the coastal states. IUCN's (1990) report on "Threatened protected areas of the world" indicates five protected areas of India as endangered which includes the Gulf of Kutchch Marine National Park (Gujarat state).

Humankind shares with all other species the genetic heritage and numerous ecological linkages that form the context within which human societies have developed a complex set of psychological, ethical and spiritual values about biodiversity. The very conditions that make living possible for all the species will also promote and sustain the existence of current and future generations of human kind since they are dependent on biological diversity for food, shelter and health.

Human activity is severely degrading the biological diversity of coastal area in particular through profound modifications of its habitats and ecosystems. An equal

understanding of structural functioning of the ecosystems can provide the scientific basis to improve the human ability to predict the responses to the environmental changes and to prevent damages to the ecosystems, as well as to better understand the processes that must be maintained so as to insure sustainable benefits. In this line, conserving the coastal, marine ecosystems requires an extended understanding of the patterns and processes that control their biodiversity. If development is production and conservation is maintenance of the means of production – both are necessary for human survival and well being.

Many of the changes occurring in the coastal margins are closely linked, requiring integrated studies of biotic and abiotic interactions. Many shoreline features such as mangroves, coral reefs, mud-flats, marshes, lagoons, dunes, deltas and estuaries are inherently unstable, with their status of dynamic equilibrium maintained by both biological and physico-chemical processes. Coastal plains and seas include the most taxonomically rich and productive ecosystems on the earth. They account for nearly 25% of global plant growth. Coastal mangrove forests are 20 times more productive, coral reefs are about 15 times and the coastal shelf area is about 5 times. These enhanced rates of primary production result in abundant varieties of life forms, including many commercially important species. Coastal and shelf areas yield over 90% of the total marine catch of fish and shellfish.

PROFILE OF THE STUDY AREA - EAST COAST OF INDIA

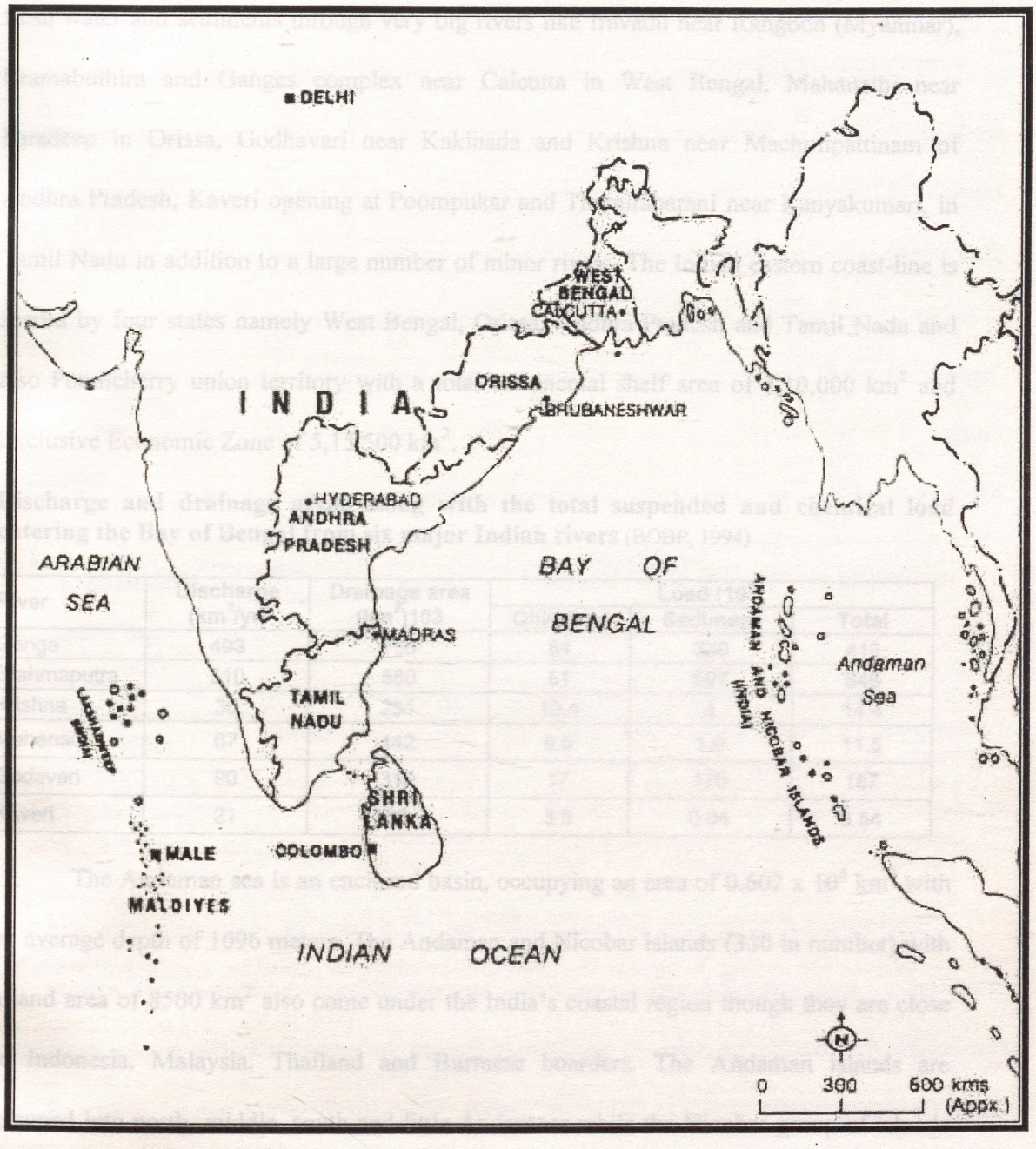
Geographical profile

The east coast of India extends from the West Bengal north, on the east bordering Bangladesh to Kanyakumari on the south. It is 2545 km in length covering 21 districts in the states of West Bengal, Orissa, Andhra Pradesh, Tamil Nadu and Pondicherry with a population of 130 million. Five major and many minor ports and fish landing centers are situated along this coast and the well known sandy beaches occur at Digha, Puri, Gopalpur, Waltair, Chennai, Pondicherry, Rameswaram, Kanyakumari and Covelong which are the well known tourist spots of repute and are also of great historical and religious significance.

Profiles of major Indian States on the East cost (BOBP, 1994)

West Bengal	
Length of coastline	157 km
District (population in millions)	24 Parganas, North and South (10.7); Calcutta (4.4) and Midnapore (8.4)
Ecologically sensitive areas	1. Tiger reserve 2. Crocodile breeding and rearing sites 3. Sajinakhali bird sanctuary 4. Mangrove forest of Sundarbans
Places of special interest	1. Beaches of Digha, Bakkhali and Sagar island 2. Pilgrim centre at Sagar Island
Ports	Calcutta and Haldia
ORISSA	
Length of coastline	476 km
District (population in millions)	Balasore (2.3), Cuttack (4.6), Puri (2.9) and Ganjam (2.7).
Ecologically sensitive areas	1. Chilika, the largest brackish water lake in Asia 2. Bhitarkanika Wild Life Sanctuary 3. Mangrove forests of Brahmani and Baitarani delta 4. Bird Sanctuary of Nalbana Island 5. Danghmal crocodile site 6. Satbhya turtle rookery
Ports	Paradwip and Aryapalli near Gopalpur
Fishing activities	1. No. of Fishing villages – 329 2. Marine Fishermen – 521,439 3. Fish landing centers – 62 4. Area under brackishwater farming (ha) – 1500 5. No. of crafts Traditional – 10,579, Mechanized – 674 6. Fishing harbour – Dhamara

ANDHRA PRADESH	
Length of coastline	476 km
District (population in millions)	Srikakulam (2.0), Vishakhapatnam (2.6), East Godavari (3.8), West Godavari (2.90), Krishna (3.0), Guntur (3.4) and Prakasam (2.3)
Ecologically sensitive areas	1. Mangrove forest areas at Nizampatnam, Pandipora, Machilipatnam and Coringa Island
Places of special interest	1. Sriharikota Satellite Launching Station 2. Pilgrim centers at Kollapatnam and Antarvedi
Ports	Vishakhapatnam, Kakinada, Machilipatnam, Bheemunipatnam, Narsapur, Krishnapatnam, Vadarevu and Kalingapatnam.
Fishing activities	1. No. of Fishing villages – 409 2. Marine Fishermen – 606,796 3. Fish landing centers – 379 4. Area under brackishwater farming (ha) – 1000 5. No. of crafts Traditional – 57,458 Mechanized – 1,009 6. Fishing harbours – Vishakhapatnam, Kakinada, Nizampatnam and Bharanapada
TAMIL NADU	
Length of coastline	938 km
District (population in millions)	Madras (3.3), South Arcot (4.2), Chidambaranar (1.4), Thanjavur (4.0), Pudukkottai (1.2), Ramanathapuram (1.0) and Kanniyakumari (1.40).
Ecologically sensitive areas	1. Mangrove forest area at Pichavaram near Parangipettai (Porto Novo) 2. Bird sanctuary and wildlife and forest conservation zone near Point Calimere 3. Oyster beds near Point Calimere 4. Coral reef near Mandapam 5. Shell fishing area within Tuticorin harbour 6. Sanctuary for coastal fauna at Kurusadai Island 7. Sponge beds at Manoli and Putti Islands 8. Windowpane shell fisheries at Point Calimere
Ports	Madras, Tuticorin, Cuddalore and Nagapattinam
Fishing activities	1. No. of Fishing villages – 449 2. Marine Fishermen – 520,90 3. Fish landing centers – 343 4. Area under brackishwater farming (ha) – 100 5. No. of crafts Traditional – 39,367 Mechanized – 2514 6. Fishing harbours – Cuddalore, Tuticorin, Madras, Nagapattinam and Pazhaiyar



Map showing the east cost eco-region

The Bay of Bengal enclosed by the east coast of India on its west and Burma (Myanmar), Thailand and Malaysia bordering on the east, receives enormous amounts of fresh water and sediments through very big rivers like Iravathi near Rangoon (Myanmar), Bramabuthira and Ganges complex near Calcutta in West Bengal, Mahanathi near Paradeep in Orissa, Godhavari near Kakinada and Krishna near Machulipattinam of Andhra Pradesh, Kaveri opening at Poompukar and Thamirabarani near Kanyakumari, in Tamil Nadu in addition to a large number of minor rivers. The Indian eastern coast-line is shared by four states namely West Bengal, Orissa, Andhra Pradesh and Tamil Nadu and also Pondicherry union territory with a total continental shelf area of 1,10,000 km^2 and Exclusive Economic Zone of 5,15,500 km^2.

Discharge and drainage areas along with the total suspended and chemical load entering the Bay of Bengal from six major Indian rivers (BOBP, 1994)

River	Discharge (km^2/yr)	Drainage area (km^2)103	Load ($10^{6/}$)		
			Chemical	Sediment	Total
Ganga	493	750	84	329	413
Brahmaputra	510	580	51	597	648
Krishna	30	251	10.4	4	14.4
Mahanadi	67	142	9.6	1.9	11.5
Godavari	90	310	17	170	187
Kaveri	21	88	3.5	0.04	3.54

The Andaman sea is an enclosed basin, occupying an area of 0.602 x 10^6 km^2 with an average depth of 1096 meters. The Andaman and Nicobar islands (350 in number) with a land area of 8500 km^2 also come under the India's coastal region though they are close to Indonesia, Malaysia, Thailand and Burmese boarders. The Andaman islands are grouped into north, middle, south and little Andamans while the Nicobar group of islands occur far south. The Andaman group covers 6500 km^2 (with 325 islands of which 21 are inhabited) while the Nicobar group covers 1900 km^2 (with 25 islands of which 12 are inhabited). The total coastline of this region is about 2000 km. The continental shelf of Andaman and Nicobar region has an area of 35000 km^2 and is considered to be the abode

of the India's richest tropical coral reef ecosystem comparable to any tropical rain forest in productivity and diversity.

Ecological profile

Climate of the Indian east coast region in general ranges from subtropical to tropical conditions, characterized by high temperatures (up to 40°C) and medium annual rainfall (1200mm). Both the southwest (May-September) and northeast (October-December) monsoons influence the rainfall in these islands. The Andaman-Nicobar region is rather unique since it is close to the Indo-Malaya archipelago and is considered as the "faunistic centre" from which other subdivisions like Indo-west Pacific have derived their fauna.

Meteorological parameters of the coastal states of the Bay of Bengal (BOBP, 1994)

Parameters	West Bengal		Orissa	Andhra pradesh	Tamil Nadu
	Kakdwip coast	Contai-Digha coast			
Salinity (‰)	15-27	20-30	18-35	18-33	31
Temp. (C°)	25-35	22-37	10-43	20-30	27-30
Relative humidity (%)	80-92	Upto 70	61-81	60-75	-
Total rain fall (mm/year)	1722	2000	995-1914	1000-1500	900
Wind velocity (km/hr)	-	3.0-16.6	7.7-17.7 (70 - 120 in stormy weather)	-	5-10 (100 - 200 in stormy weather)

The exponential growth of population, the rapid pace of industrialization and urbanization and increasing use of fertilizers and pesticides in agriculture are mainly responsible for causing pollution in the Bay of Bengal. Industrial activities are the main cause for heavy metal pollution. In ocean waters, river runoff is the natural source of metals, which includes some toxic metals like cadmium, mercury and arsenic. Besides this, about 78,000 tonnes (BOBP, 1994) of pesticides are used in India every year, of which one third is by Andhra Pradesh and it is also estimated that bout 25% of these substances finally reach the sea and 0.1 % of the total quantity used is bio-accumulated in marine biota (Qasim and Sengupta, 1992).

Heavy metals in sediments of various estuaries of India's east coast and in the Bay of Bengal (in ppm) (BOBP, 1994)

Source of sediments	Manganese	Nickel	Copper	Zinc	Chromium	Lead	Cadmium
Kaveri estuary							
a. bed	1310	379	33	75	229	38	1.8
b. sediment	1968	379	55	347	246	38	3.4
Ganges estuary	732	49	44	151	98	32	-
Krishna estuary	6978	149	69	1482	174	4	-
Godavari estuary	1294	91	119	-	128	5	-
Narmada estuary	1077	81	136	140	-	-	-
Tapti estuary	1125	70	128	125	-	-	-
Southeast coast of India	337	-	17	62	138	53	2.7
Bay of Bengal	529	64	26	-	84	-	-
For Comparison Baltic Sea, Europe (average pre-industrial sediments)	600	41	46	115	51	19	0.3

Profile of the important / ecologically sensitive areas along the east coast of India

Sunderban Mangroves (West Bengal)

Area (sq km)	4264 (lat. 21°32' – 22°40'; long. 88°85' – 89° 00')
Ecological significance	The Sunerbans (which means "beautiful forests") account for over 10% of the mangrove forests in the world, making them the largest single mangrove unit globally. They cover an area of 12000 sq km of which approximately one third lies in India and the rest occurs along the Bangladesh coast. It is the largest mangrove forest in India which consists of diversified mangrove flora including some endangered species
Flora and Fauna	A total of 69 floral species have been recorded which includes 34 species of true mangroves. Fauna of this area include 250 species of fishes, 8 species of amphibians, 57 species of reptiles, 161 species of birds and 40 species of mammals besides several other benthic organisms
Socio-economics	Timber extraction, honey collection, fire wood and fodder collection and rich local fishery
Conservation status	World Heritage Site, Biosphere Reserve for preservation of mangrove genetic resources, Royal Bengal Tiger project site, protection site for salt water crocodiles

Bhitarkanika Mangroves (Orissa)

Area (sq km)	195 (lat. 20°04' – 20°08'; long. 86°45' – 87° 05')
Ecological significance	One of the pristine mangrove environment of India which is also second largest in India
Flora and Fauna	Forest contains 60 species of mangrove plants including halophytes, with medicinal value. Unique estuarine crocodiles and white crocodiles inhabit here. The "living fossil" blue blooded horse shoe crabs (*Limulus*) are found in the mud flats. Diversified birds (150 species) are also found here
Socio-economics	Fishing and brackishwater prawn farming are the major income sources. Honey collection and grass basket making are major occupations. Scope for eco-tourism: "Bagagahana" and "Crocodile Sanctuary"
Conservation status	Wildlife sanctuary, National park, protecting important birds, estuarine crocodiles and horse shoe crabs (*Limulus*)

Coringa Mangroves (Andhra Pradesh)

Area (sq km)	200
Flora and Fauna	42 species of flora and 244 species of fauna have been identified from the mangrove area of Coringa
Socio-economics	Traditional fishing and large scale aquaculture activities fetch lakhs of rupees to the local people
Conservation status	Coringa wild life sanctuary is situated in the mangrove forest

Pitchavaram Mangroves (Tamil Nadu)

Area	1100 ha (lat. 11°27' N; long. 79°47' E)
Ecological significance	The Pitchavaram mangroves consist of 51 islets, which are traversed by numerous creeks, gullies, channels and canals; mostly covered by forest stands and the rest by mudflats, sandy flats and salty soils. In this mangroves, waterways comprise about 40% and forests, 50% of the total area. The remaining 10% is sand flats, mud flats and oyster beds
Flora and Fauna	There are 94 species of phytoplankton, 61 species of mangroves, 95 species of zooplankton, 197 species of fishes, 36 species of crabs and 177 species of birds. Of the 177 species, 110 species (55%) are aquatic and the remainder, terrestrial. Among the 110 species of aquatic birds, 52% are 'true migrants', 35% are 'local migrants' and the remaining 13%, 'residents'
Socio-economics	The profession of majority of the people in the villages around the mangroves is fishing. There are about 1700 families dwelling in these villages and they employ nearly 500 canoes for fishing and keeping about 1500 cattle
Conservation status	Protected area

Muthupettai Mangroves (Tamil Nadu)

Area (sq km)	68.03 (lat. 10°46' N; long. 79°51E)
Ecological significance	The vegetation of Muthupet comes under littoral and tidal swamp forest category. This forest comprises dense woody trees, shrubs and succulent herbs, dispersed in varying proportions based on the tidal inundation and fresh water availability
Flora and Fauna	Mangroves and associates include 61 plant species, 6 species of seagrasses, 10 species of seaweeds and 6 species of hydrophytes. The fauna includes 14 species of crustaceans, 18 species of mollusks and 73 species of fishes. Occurrence of oyster beds on the merged land pockets is noteworthy
Socio-economics	There are about 3000 families living in eleven villages around these mangrove forest. In these villages, about 35 – 40% of the people are fishermen. They are using 150 large wodden dug-out canoes for fishing. Others are farmers who depend on cultivation of paddy, groundnut etc. There are about 5000 goats and 1500 oxen kept by these people
Conservation status	Protected area

Chilika Lake (Orissa)

Area (sq km)	740 (summer) and 1165 (rainy) (lat. 19°28' – 19°54'; long. 85°06' – 85° 35')
Ecological significance	Largest brackishwater lake in Asia. Feeding and nesting ground for a large variety of wintering water fowl.
Flora and Fauna	706 species of phyto-diversity with 9 endemic species. There are 800 species of fauna with the unique and endangered species of Dolphin, *Oryphaena* sp.
Socio-economics	More than 12, 363 fishermen families are living in 132 villages. It is a major white prawn harvesting centre and major landing centre for many commercially important fishes and shellfishes
Conservation status	Due to its rich biodiversity, it has been designated as "Ramsar Site". Nalabana island within the lagoon has been notified as "Bird Sanctuary".

Pulicat Lake (Tamil Nadu and Andhra Pradesh)

Area (sq km)	350 (lat. 13°24' – 13°47'; long. 80°02' – 80° 16')
Ecological significance	One of the important brackishwater lagoons of India and one of the major wetlands
Flora and Fauna	Nearly about 160 species of fishes and about 60 thousand migrant water birds, belonging to 50 species have been recorded besides several other floral elements like seagrasses and seaweeds and faunal components excepting aquatic mammals
Socio-economics	This lagoon has an average penaeid prawn production of about 500tonnes/year. An average of 40 to 50 thousand fisherfolk are living in 52 villages around the lagoon for their economic development
Conservation status	An important wetland of India and is awaiting recognition as Ramsar site

Point Calimere Wild life and Bird Sanctuary (including Vedaranyam salt swamp, Tamil Nadu)

Area (sq km)	377 (lat. 10°18' N; long. 79° 51'E)
Ecological significance	The sanctuary may be divided into three divisions: the tropical dry evergreeen forest at Point Calimere, the Great Vedaranyam Swamp and the mangrove forsts of Talaignayar reserve forests. Most of the swamp area has been altered and made into a series of "salt ponds". The existing unaltered habitats are named according to their nature as intertidal and seasonal tidal habitats. The salinity of waters in the various habitas fluctuate widely, ranging between 10 and 242‰. Such a widely fluctuating environment offers suitable niches for different floral and faunal species
Flora and Fauna	The wild life sanctuary has 317 plant species of 86 families. From the different habitats, macrobenthos species such as protozoans, polychaetes, chironomid larvae, ephydrid pupae, ephydrid larvae, ostracods, apseudes, amphipods, molluscs, insects and beetles have been reported. A total of 233 species of birds have been recorded. Of these, 39 species are shore birds, 10 species are ducks, 4 species are egrets, 20 species are raptors, 5 species are gulls and 11 species are terns
Socio-economics	A total of 1000 people are working in the salt industries, producing 2 lakh tonnes of salt every year. Besides this, fishing is carried out in the entire swamp area including the area under the salt industry. In addition to fishing in the swamp area, large scale fishing is done from the adjoining sea by engaging over 500 trawlers
Conservation status	Wild life and bird sanctuary

Gulf of Mannar Biosphere Reserve and Coral reefs of the Palk Bay (Tamil Nadu)

Area (sq km)	10,500 (lat. 8°35' – 9°25'; long. 78°8' – 79° 30')
Ecological significance	Predominant coral reef ecosystem supported by seagrass and mangrove ecosystems with an estimated benthic gross production of 7.3 gC/m^2/day, in addition to phytoplankton, seagrass and seaweed production.
Flora and Fauna	Flora consists of 126 species of phytoplankton, 160 species of seaweeds, 13 species of seagrasses, 13 species of mangroves and 28 species of other flowering plants. The faunal components comprise 91 species of zooplankton, 108 species of sponges, 14 species of gorgonids, 119 species of polycheates, 70 species of crustaceans, 96 species of echinoderms, 263 species of molluscs, 6 species of pearl oysters, 5 species of chanks, 4 species of sea turtles, 10 species of mammals, 117 species of corals and 450 species of finfishes.
Coral reefs	The Palk Bay reef is 25 – 30 km long, 200 m wide and centered between 9°17' N and 79°15' E. The Mannar Barrier reef is 140 km long and 25 km wide between Pamban and Tuticorin (lat. 8°47' – 9°15'; long. 78°12' – 79°14')
Socio-economics	The average annual income of a fisherfolk household in this region is Rs. 19,700/= within the range of Rs. 5,846 to 43,230. The annual per capita income of a fisherman is Rs. 3,943/= which is far less than that of the state average of Rs. 4428. There are about 90 fishing villages along the Gulf of Mannar with 35,000 active fisherfolk and 70% of the working population is involved in direct fishing, 21% in fishing related activities and 9% in various other activities
Conservation status	Marine Biosphere Reserve and National Marine Park

Great Nicobar Biosphere Reserve (The Nicobar)

Area (sq km)	885 (lat. 6°45' - 7° 15'; long. 93° 38' and 93° 55')
Ecological significance	The island has several biotopes – seascapes, estuaries, backwaters, inland freshwaters, seashores, coasts, valleys, slopes and hill tops and supports several endemic floral and faunal species. Because of its isolation and limited size and the restrictions imposed by physical barriers, a unique and highly fragile ecosystem of plant and animal communities has developed in these islands which is different from those found in continental areas.
Flora and Fauna	Flora includes 119 species of phytoplankton, 32 species of seaweeds, 8 species of seagrasses, 12 species of mangroves and the fauna includes 60 species of zooplankton, 9 species of ichthyoplankton, 13 species of bivalves, 41 species of gastropods, 2 species of nudibranchs and 2 species of cephalopods, 43 species of brachyuran crabs, 18 species of hermit crabs, 3 species of lobsters and 7 species of shrimps, 3 species of starfish, 4 species of brittle star, 5 species of sea urchins and 19 species of sea cucumbers, 101 species of finfishes, 21 species of benthic polychaetes, 6 groups of sponges, 2 families of coral boring polychaetes, 3 genera of sipunculids and 6 species of coral boring bivalves (as per recent survey)
Coral reefs	In the Nicobar islands, of the 42 genera identified, 39 are hermatypic. (Although the full extent of the coral diversity is still not known, 68 coral species belonging to 31 genera have been found in the Andamans). Coral reefs of Andaman and Nicobar islands are protected mainly in Mahatma Gandhi, Rani Jhansi and Nandur Marine National Parks and Great Nicobar Biosphere Reserve
Socio-economics	Local people and settlers collect minor forest products and only a very few people are dependent on fisheries. Coconut and areca nut are the major income source for the people.
Conservation status	Marine Biosphere Reserve which supports several endemics that have evolved locally or have survived only because of the geographical isolation and protective barriers against invaders

CURRENT STATUS OF COASTAL AND MARINE BIODIVERSITY OF EAST COAST OF INDIA

Seaweeds

Seaweeds or marine macro-algae form one of the important marine living resources. They belong to three main classes of algae viz. Chlorophyceae (green algae), Phaeophyceae (brown algae) and Rhodophyceae (red algae). They occur in the intertidal and subtidal zones of the sea and also in brackish water environments. They grow on rocks, stones, pebbles, dead corals, and other substrates and also as epiphytes on seagrasses.

Seaweed resources of the east coast of India

Coastal States	Seaweeds				
	Orders	Families	Genera	Species	Production (Ton / Year)
TamilNadu	15	45	428	302	90,000
Andra Pradesh	14	29	51	79	-
Orissa *	1	2	3	6	-
West Bengal	3	4	5	6	-
Andaman and Nicobar Islands	8	25	40	64	-

** Information available only for Chilika Lake*

It has been recorded that 806 species of seaweeds exist along the Indian coast, of which, 487 species belong to Rhodophyceae, 186 to Phaeophyceae and 133 to Chrolophyceae (Krishnamurthy, 1991). The surveys carried out so far along the east and west coasts of India and Lakshadweep and Andaman and Nicobar islands clearly show the impressive diversity and abundance of seaweed resources of our country and the total standing crop of the seaweeds is approximately 77,000 tonnes (wet). Over-exploitation of seaweeds of commercial importance for the seaweed industry and destruction of habitats due to various activities such as coral mining, trawl fishing, construction of jetties and dumping of municipal garbage are considered to be the two important causes for the loss of seaweed biodiversity in India.

Seagrasses

Seagrasses are the submerged marine angiosperms growing well in tidal and subtidal areas of all seas except the polar regions. Seagrasses have a well developed creeping rhizome, bearing branched or un-branched roots at each node and erect shoot bearing several foliage leaves. They are not true grasses of the family, Poaceae which has only terrestrial grasses but belong to two related families of monocots viz. Hydocharitaceae and Potamogetonaceae and are successfully adapted to the saline environment.

Seagrasses have a high growth rate, producing organic matter about 300 – 600 g dry wt. / m^2 / year which excludes root production (Thayer *et al.*, 1975). They serve as sediment traps besides stabilizing the bottom sediments, thereby improving the water quality. Seagrasses are also involved in cycling of nutrients in their environment and provide food and shelter for diverse groups of organisms and act as a nursery ground for many fishes of commercial importance. Thus, they play a vital role in the fisheries production of any region in which they exist.

As it has been stated by Das (1996), geographic distribution of the seagrasses is well known in southeast Asian countires as well as in Australian and Caribbean coasts. Areas where seagrass records are scarce include parts of south America, Africa and Indian subcontinent. There are 13 genera and 58 species of seagrasses distributed throughout the world. In India, there are 6 genera and 14 species and all of them have been reported from the east coast. Species of the genera *Halophila* and *Halodule* are found distributed throughout the east coast. From the Palk Bay region, 6 genera of seagrasses with 11 species have been recorded whereas 13 species from the Gulf of Mannar and 9 species from the Andaman and Nicobar islands have also been recorded.

Distribution of seagrasses along the east coast (Kannan *et al.*, 1999)

S. No.	Species	Coromandel coast	Palk Bay and Gulf of Mannar	Andaman and Nicobar islands
1	*Enhalus acoroides*	X	✓	✓
2.	*Halophila beccarii*	✓	✓	X
3.	*H. decipiens*	X	✓	X
4.	*H. ovalis*	✓	✓	✓
5.	*H. ovalis sub.sp. ramamurthiana*	✓	X	X
6.	*H. ovata*	✓	✓	✓
7.	*H. stipulacea*	X	✓	X
8.	*Thalassia hemprichii*	X	✓	✓
9.	*Cymodocea rotundata*	X	✓	✓
10.	*C. serrulata*	X	✓	✓
11.	*Halodule pinifolia*	✓	✓	✓
12.	*H. uninervis*	✓	✓	✓
13.	*H. wrightii*	✓	✓	X
14.	*Syringodium isoetifolium*	X	✓	✓

✓ denotes presence of species x denotes absence of species

Fishing on seagrass beds using mechanised boats causes heavy damage to the seagrass beds. The seagrass sites of the Palk Bay and Gulf of Mannar (eg. Kattumavadi, Kottaipattinam, Manora, Manamelkudi, Mandapam, etc.). are the key fishing and fish landing areas and hence the possibility of protecting and conserving the seagrass meadows in these regions appears to be remote.

Mangroves

Mangroves are tropical and subtropical swampy forests comprising trees of many unrelated genera that share the common ability to grow in saline, coastal environments. They are important as "coastal stabilizers" and "shelter belt areas". These formations protect the coasts and the landward areas from erosion and cyclonic destruction to some extent. They mainly function as the most ideal spawning, breeding and nursery grounds for nearshore and estuarine organisms like fishes, crabs, prawns, molluscs etc. which include some commercially important species of *Mugil, Hilsa, Lates, Scylla, Meretrix* and *Penaeaus*. Apart from this, the mangrove forests of India have importance from the point of view of wild life, recreation and education. 'Project tiger' of Sunderbans and 'Crocodile sanctuary' in the Mahanadi delta are some examples for this.

The mangroves of India comprise 69 species excluding saltmarshes and other associated species, under 42 genera and 27 families. Of these, 20 mangroves species are either rare or endemic, but none of them entered into the red data book (Kathiresan, NBSAP inputs).

Survey estimates of the mangrove forests of the east coast of India (in km^2)

States / Union Territories	Sidhu (1963)	Blasco (1977)	Govt. of India
Tamil Nadu	26	15	150
Andhra Pradesh	184	100	200
Orissa	120	50	150
West Bengal	4189	2000	4200
Andaman & Nciobar	1152	1000	1190
Total	5671	3165	5890

The total area covered by mangrove forests in India is estimated to be approximately 4,250 sq km (Krishnamoorthy, 1997). The deltaic environs of India's east coast support extensive mangrove forests as a result of a general intertidal slope and heavy siltation. The largest stretch of mangroves in the country is in West Bengal, where the Sundarbans cover an area of about 4200 sq km. The Andaman and Nicobar islands located in the northeast Indian Ocean, account for an additional 1190 sq km. In addition, a considerable area of mangroves exists in the states of Orissa, Andhra Pradesh and Tamil Nadu.

The mangrove ecosystems are rich in biodiversity for the reason that they are open and dynamic ecosystems with widely fluctuating physico-chemical and other environmental conditions and hence harbouring a plethora of genetically diverse organisms of terrestrial, estuarine and marine habitats. In India, totally, 1854 species of flora and fauna have been reported from the mangrove environs; of which, 412 are floral species and 1442 are faunal species, contributing 23% and 77% respectively.

Floral and faunal species reported from the mangroves of India (Kathiresan and Rajendran, 2000)

S. No.	Group	No. Species
Flora		
1.	Bacteria	36
2.	Fungi	84
3.	Algae	206
4.	Seagrasses	3*
5.	Mangroves	35
6.	Mangrove Associated Flora	48
Total no. of floral species		412
Fauna		
1.	Zooplankton	107
2.	Prawns and shrimps	48
3.	Crabs	82
4.	Molluscs	136
5.	Other Benthos	230
6.	Finfish	341
7.	Birds	378
8.	Reptiles	42
9.	Amphibians	22
10.	Mammals	56
Total no. of faunal species		1442
Total number of floral and faunal species		1854

** corrected as 3 species instead of 11 species*

Coral Reefs

The taxonomic status of coral reef flora and fauna is similar to that of diverse terrestrial habitats including tropical rain forests where new birds and mammals continue to be recognized and thousands of species of insects and other invertebrate organisms await discovery and description. Coral reefs provide a complex habitat for a variety of fishes (shell and finfishes) and benthic organisms with a vast array of ecological niches and thus represent a highly productive natural ecosystem. Over the last few decades, degradation of coral community has become a world-wide phenomenon as indicated by loss of species diversity and decrease in coral cover and fishery resources due to over-exploitation of living resources in addition to non-living resources. Coral reef destruction due to spiny star fish invasion has also increased at an alarming rate. So, such a

combination of short and long-term physical and biological disturbances and over-exploitation of resources can change the reef community dramatically.

A total of 199 species of scleractinian fauna belonging to 71 genera are hitherto recorded in India, including the Lakshadweep, Gulf of Kutchch, Palk Bay and Gulf of Mannar and Andaman and Nicobar islands. Of these, 155 species belong to hermatypes and 44 species belong to ahermatypes. A recent study conduced by the Zoological Survey of India (Chennai) at Port Blair reveals that the total number of species of scleratinian corals may increase up to 265 species (Venkatraman, NBSAP inputs).

The coral reef formation in Tamil Nadu is chiefly confined to the Gulf of Mannar and Palk Bay. A marine national park has been established on both sides of Mandapam Peninsula along the southern coast of Tamil Nadu to protect these coral reefs which are facing severe ecological threats due to tourism, industry and port development activities, in addition to over-exploitation of colourful ornamental shells.

In the Gulf of Mannar, the coral reefs extend from Rameswaram to Tuticorin port covering a distance of 140 km with an estimated formation of 100 sq. km. Reefs are not continuous but are mainly found around 20 small islands at a maximum depth of 6 meters.

Reefs of the Palk Bay are only 30 km in length along the northern part of the Mandapam peninsula in the east-west direction, occurring about 200 m away from the shore, in patches. Sedimentation in the shoreward side influences the distribution of corals in general. The outer side of the reef contains ramose corals while the inner side has massive corals with large polyps and 94 species of corals belonging to 37 genera have been recorded from this region (BOBP, 1994). The corals have been mined from earliest times for lime and morter. In the past few decades, licensed mining has also been taking place for industrial purposes. Nearly 15,000 tonnes of corals (living and dead) are said to be removed around Tuticorin area. Such coral removals have resulted in the reduction of productive coral habitats. Over-exploitation has damaged and destroyed the coral reefs in

many sites. Even if the mining is stopped now, it may take another three decades for reasonable re-colonization.

Area estimates (km^2) of coral reefs, seaweeds, seagrasses etc. in India (DOD&SAC, 1997)

Category	Gujrat	Tamil Nadu	Lakshadweep Islands	Andaman & Nicobar Islands
Reef flat	148.4	64.9	136.5	795.7
Sand over reef	11.8	12.0	7.3	73.3
Mud over reef	117.1	-	-	8.4
Coralline shelf	-	-	230.9	45.0
Coral heads	-	-	6.8	17.5
Live coral platform	-	-	43.3	-
Algae	53.8	0.4	0.4	-
Seaweeds	-	-	0.7	-
Seagrass	-	-	10.9	-
Reef vegetation	112.1	13.3	-	8.9
Vegetation over sand	17.0	3.6	0.4	10.5
Lagoon	-	0.1	322.8	-
Total	**460.2**	**94.3**	**816.1**	**959.3**

There are about 50 fishing villages in the marine park area of the Gulf of Mannar and are involved in reef fishery, pearl fishery, ornamental shell trade, illegal mining of corals, harvesting sea cucumbers, trapping of sea turtles and dugongs (seacow) for human consumption and large scale chank fishery. The average annual fishery landing from the Gulf of Mannar is around 50,000 tonnes of demarsal fishery and 35,000 tonnes of pelagic fishery in the 33 landing centres bordering the park area. Actually, intense trawl fishing in this area and use of gill nets for lobster fishery are damaging the reefs in the marine park area.

Fish and Fisheries

Day (1889) described 1418 species of fish under 342 genera from the British India. Subsequently, 275 species were added by the R.I.M.S. investigator from the deep waters. Talwar (1991) reported 2546 species of fish belonging to 969 genera, 254 families and 40 orders. The Indian fish populations represent 11.72 percent of species, 23.96 percent of genera, 57 percent of families and 80 percent of orders of the global fishes. The Indian fish

fauna is divided into two classes viz. Chondrichythyes and Osteichthyes. The Chondrichthyes (those with cartilaginous skeleton) is represented by 131 species under 67 genera, 28 families and 10 orders in the Indian region. These fishes (sharks, skates and rays) form one of the important commercial fisheries in India. The annual average landing of the Indian Chondrichthyes is 33442 tonnes. The Indian Osteichthyes (those with bony skeleton) are represented by 2415 species belonging to 902 genera, 226 families and 30 orders.

Number of species of fishes endemic to India (Barman, 1998)

S.No.	Order	Family	Genera (No.)	Species (No.)
1	Anguilliformes	Ophichthidae	1	1
2	Clupeiformes	Clupeidae	2	2
3	Cypriniformes	Cyprinidae	22	97
		Parapsilorhynchidae	1	3
		Balioridae	6	46
		Cobitidae	4	8
4	Siluriformes	Bagridae	5	10
		Siluridae	3	3
		Schibeidae	6	6
		Sisoridae	7	21
		Clariidae	2	3
		Olyridae	1	1
5	Cyprinodontiformes	Hemiramphidae	2	2
		Horaichthyidae	1	1
		Synbranchidae	1	2
		Chandidae	1	1
		Nandidae	1	1
		Cichlidae	1	1
		Gobiidae	7	9
		Eleotrididae	1	1
		Mastacembelidae	1	1
		Chaudhuriidae	1	2
6	Tetraodontiformes	Tetraodontidae	1	1
	Total 6	**23**	**78**	**223**

The marine fish production in India during 1999 has been provisionally estimated at 2.42 million tonnes (mt) which is 9.3% less compared to 2.67 mt of 1998. The pelagic fish group forms 52.9% of the total landings whereas demarsal finfish, crustaceans and molluscs together contribute 47.1%. The landings by mechanized modern units account

for 65% of the production, while the traditional units, 35%, (Kurup *et al.,* 2000). The crustacean landings of 3,99,570 t in 1999 contributed 16.5% towards the country's total marine fish landings. Group-wise contribution of crustaceans amounted to 41.43% by penaeid prawns, 38.67% by nonpenaeids, 0.52% by lobsters, 6.89% by crabs and 12.49% by stomatopods. However, the landings of 1999 suffered a decline of 19.79% over the previous year.

Birds

India offers a variety of habitats which range from the snowcapped Himalayan ranges to the vast deserts in the Thar, from the lush tropical rain forests of the Western and Eastern Ghats and the northeastern states to the equally diverse coral reefs along its (India's) coastline and around its islands and from the waterlogged wealth of its freshwater and saline wetlands to the rich variety of forest types, scrubs and grasslands, its rich plains and river valleys. Considering such a vast diversity of habitats, it is of no wonder that it offers home for about 1200 species of birds.

Fossil records show that on an average, only one bird species becomes extinct every 100 years. During the last 200 years, the rate of extinction has been at least 40 times greater than this. The main causes for such extinctions are habitat loss and habitat degradation. In India, there are 76 species of birds threatened with extinction (Important Bird Area sites– BNHS).

About 176 species, contained in 106 genera, 39 families and 11 orders are endemic to Indian subcontinent. Many of them are spill overs to Pakistan, Nepal, Bhutan, Bangladesh, Myanmar and Sri Lanka. Many species are relictual and 50 species and 11 genera are endemic to India exclusively. Besides, 106 endemic species of the subcontinent also occur in India (Saha, 1998).

Endemic bird areas in India (coastal) with the list of restricted range bird species found in them (IBA – BNHS)

	Andaman Islands	
1.	Andaman Serpent Eagle	*Spilornis elgini*
2.	Nicobar Scrubfowl	*Megapodius nicobariensis*
3.	Andaman Crake	*Rallina canningi*
4.	Andaman Wood Pigeon	*Columba palumboides*
5.	Andaman Cuckoo-dove	*Macropygia rufipennis*
6.	Andaman Hawk-owl	*Ninox affinis*
7.	Narcondam Hornbill	*Aceros narcondami*
8.	Andaman Woodpecker	*Dryocopus hodgei*
9.	Andaman Drongo	*Dicrurus andamensis*
10.	Andaman Treepie	*Dendrocitta bayleyi*
11.	White-headed Starling	*Sturnus erythropygius*
	Nicobar Islands	
12.	Nicobar Serpent-eagle	*Spilornis minimus*
13.	Nicobar Sparrowhawk	*Accipiter butleri*
14.	Nicobar Scrubfowl	*Megapodius nicobariensis*
15.	Andaman Wood Pigeon	*Columba palumboides*
16.	Andaman Cuckoo-dove	*Macropygia rufipennis*
17.	Nicobar Parakeet	*Psittacula caniceps*
18.	Andaman Hawk-owl	*Ninox affinis*
19.	Nicobar Bulbul	*Hypsipetes nicobariensis*
20.	White-headed Starling	*Sturnus erythropygius*

Reptiles

Marine reptiles of India include turtles, crocodiles and sea snakes. Of the 12 living turtle families, only 2 families are marine which include 8 species, of which, 5 are found along the Indian coastline viz. *Dermochelys coriacea* (leather back sea turtle), *Chelonia mydas* (green turtle), *Eretmochelys imbricata* (Hawksbill), *Caretta caretta* (Loggerhead sea turtle) and *Lepidochelys olivacea* (Olive ridley). Three species of crocodiles are found in the subcontinent viz. saltwater crocodile (*Crocodylus porosus*) mugger (*Crocodylus palustirs*) and Gharial (*Gavialis gangeticus*). There are about 20 species of sea snakes reported from India.

Threats to the endemic reptiles in India (Zoos' print, 1998)

Nature of Threat	No. of species	Percentage
Habitat loss	105	45
Habitat fragmentation	22	9.5
Human interference	63	27.7
Trade	8	3.5
Hunting	2	0.9
Others	32	13.8

Mammals

One of the most fascinating features of the Indian biodiversity is its mammalian fauna, which encompasses species as large as whales, elephants, rhinoceroses and tigers and as small as shrews, mice and bats. Most of the writers use the term 'marine mammal' to include members of five different mammalian groups viz. cetaceans (whales, dolphins, and porpoises), sirenians (manatees and dugongs), pinnipeds (sea lions, walruses, and seals), marine and seaotters and the polar bears.

Marine mammals of India and world (Agrawal, 1998)

Order	Families		Genera		Species	
	India	World	India	World	India	World
Carnivora	7	11	33	129	55	271
Cetacea	6	10	21	41	29	78
Sirenia	1	2	1	3	1	5

Number of endangered species of mammals in India (Agrawal, 1998)

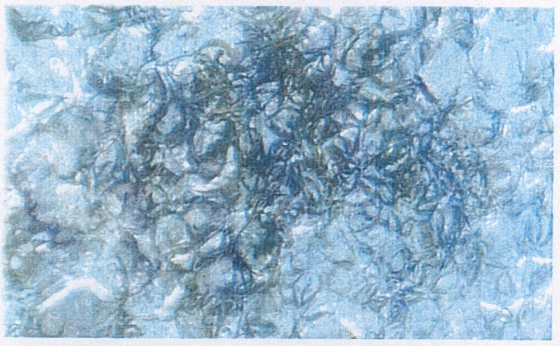
Order	Total no. of known species from India	No. of endangered species (as per Wildlife Act, 1972 schedules I – IV)			
		I	II	III	IV
Cetacea	29	3	26	-	-
Carnivora	55	28+(1)	21+(4)	-	6+(1)
Sirenia	1	1	-	-	-

(Figures within brackets denote subspecies)

MARINE BIODIVERSITY ALONG THE EAST COST



Seaweeds



Seagrasses



Seagrass - animal association



Mangroves along the channel



Dense mangroves

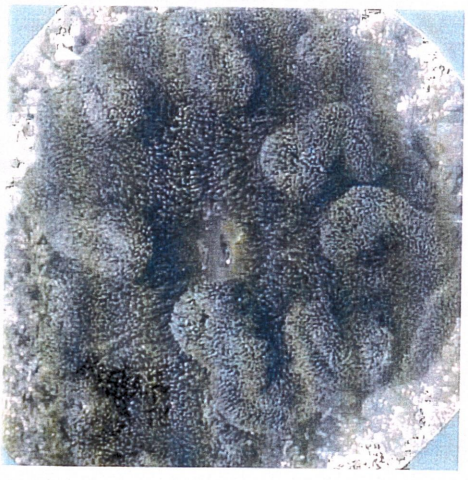


Mangrove with viviparous seedlings

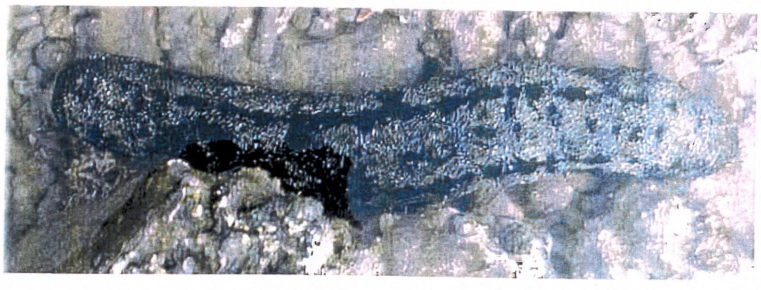
MARINE BIODIVERSITY ALONG THE EAST COST



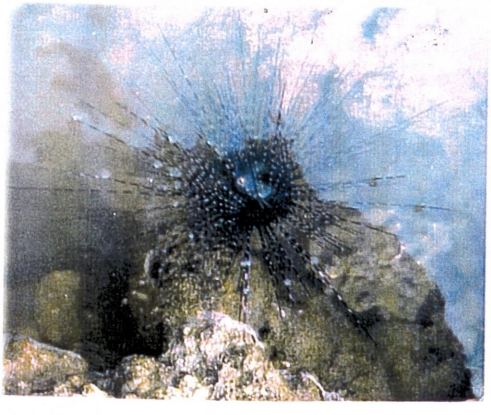
Corals



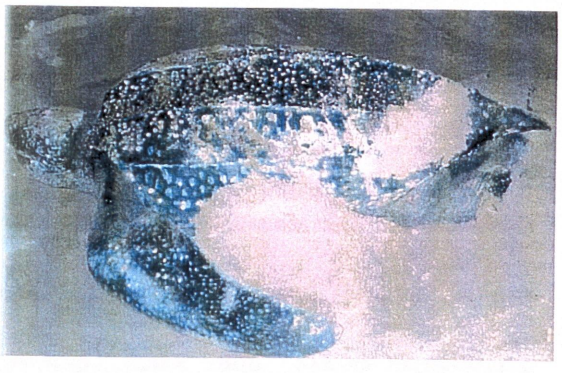
Sea anemone



Sea cucumber



Sea urchin



Sea turtle

STATEMENT OF PROBLEMS RELATING TO COASTAL AND MARINE BIODIVERSITY OF EAST COAST OF INDIA

Major direct threats to the marine and coastal biodiversity are many and are interrelated. Some of the important threats are habitat destruction and conversion, introduction of exotic species, monoculture, pollution, hunting and poaching, over-exploitation and global changes. All these factors singly or combinedly cause erosion into the coastal marine biodiversity. The documented endangered marine life includes 8 species of marine mammals, 5 species of turtles, 1 species of hemichordata, 3 species of cephalochordata, 6 species of echinoderms, 2 species of xiophosurans, 15 species of molluscs, 10 species of crabs and 1 species in each of echiuroids and brachiopods (Ministry of External Affairs, 1996). The mangrove experts in India have found that out of the 52 species of marine fish dwelling in the mangrove area, 9 are vulnerable and 2 are endangered and out of the 41 invertebrates, 4 are vulnerable and only one species is critically endangered (Kathiresan, NBSAP inputs).

Habitat destruction and conversion

Coastal ecosystems continue to deteriorate with heavy harvesting or are altered for other uses. Encroachment of critical habitats viz. mangroves, swamp areas etc. is the main problem for habitat loss and fragmentation.

Progressive reclamation of the Sunderbans over the last 150 years has resulted in the loss of substantial masses of mangrove forest and several faunal species, especially along the northern limits. Silanjan Bhattacharyya (1998) reports that the turn of this (last) century, the Sunderbans has lost some of its remarkable wild fauna such as Javan Rhinos (*Rhinoceros saundicus*), wild buffalos, swamp deers and marsh crocodiles. Likewise,tigers, estuarine crocodiles and many species of turtles and terrapins were pushed to the brink of extinction mainly because of deterioration and destruction of their habitats along with indiscriminate hunting.

Conversion of mangrove areas into shrimp and prawn culture farms is yet another important activity for marine habitat loss. In Andhra Pradesh alone, various kinds of wetlands have been converted for shrimp aquaculture which grew exponentially from around 8,000 hectares in 1991-92 to about 53,000 hectares in 1994-95 (Vivekanandan and Johan Kurien, 1998). In addition, the loss of major ecological functions such as sediment trapping and shoreline protection serves to underscore the unsustainability of mangrove conversion as an attempt to increase food production.

Venkataramajujam *et al.* (1981) have reported that in Tuticorin, the coral *Acropora formosa* fragments (Challi) are extensively collected from this region alone, by operating about 30 boats which remove an annual 80000m^3 of reef derived materials. In addition, massive corals are collected to the extent of about 30000m^3 per year or 15,000 tonnes and are used as building materials. Such a rapid loss of coral reefs in the Gulf of Mannar area would definitely exert pressure on this ecosystem and ultimately would reduce the fishery potential of the area.

Dredging is done periodically in the shallow areas of marine ports. This is especially true in the old harbour of Tuticorin. There is also plan to dredge the Pamban channel near Mandapam in order to facilitate the movement of small cargo vessels. It is not known how much of siltation problem will be there to cause damage to corals and seagrasses around the islands in the Gulf of Mannar.

The mangroves serve as a wildlife sanctuary especially in Sundarbans, Orissa and Bay islands. The wildlife like tigers, crocodiles, snakes etc. save the mangroves in these places. Some times, the wildlife may pose problem to the mangroves. For instance, in the Andamans, spotted deer population, in the absence of carnivores, increases and it causes grazing loss of mangroves.

There has been a considerable decline in the freshwater fishes of India in general and food and game fishes in particular. This is mainly due to indiscriminate fishing /

exploitation and habitat alteration like dynamiting of rivers, construction of dams across rivers, over utilization of water, cutting down of forests, mismanaged farm lands and erosion, pollution by factory chemicals, etc.

Introduction of exotic species

The introduction of exotic organisms, whether intentional or accidental, has tended to reduce biodiversity between regions. Introduction of alien species to an environment in which they are not native is largely due to the accidental transport of species from one harbour to another in the ballast waters of ocean going ships. This can upset predator-prey relationship. Some times, in the absence of predators, the introduced species may supplement native species and cause previously unknown diseases by new pathogens.

Prosopis sp. competes rarely with back mangroves in few sites like Muthupettai in Tamil Nadu.

In Cochin backwaters, where most of the mangroves have been destroyed, a water fern, *Salvinia* sp. has practically occupied the entire backwaters due to its tremendous vegetative growth. This has clogged the waterways and also reduced the fishery resources of the region.

In the recent past, there have been some attempts to introduce the exotic fish species viz. European seabass and Gilthead Seabream for cage culture in the Andaman waters.

Until recently, before the trade restrictions, there has been a considerable import of exotic species of family Psittacidae and Phasianidae. Macaeow, Coccatoe, Lory, Pheasants, Cocatil, etc. are well represented exotic species in captivity (Saha, 1998). These exotics will certainly compete with the local birds for their nesting areas and this will cause serious threat to the local bird biodiversity.

Mono-culture

In general, the mangrove afforestation programme that involves mainly *Avicennia* spp. is being implemented in India. These species that are growing like weeds do not allow other species to grow luxuriantly.

Nalylor *et al.* (2000) have estimated a reduction of fish biomass of about 434 g for every kg of farmed shrimp. This is the best example for the monoculture practice to show how the shrimp culture makes its impact on the local biodiversity . This is mainly because of the habitat conversion, nutrient rich outlets etc.

Pollution

The coastal zone receives wastes generated by landbased activities including sewage, sediments and industrial effluents. Agricultural chemicals notably fertilizers and pesticides also contribute to the degradation of the quality of coastal waters.

One of the important causes for the accelerated degradation of mangroves and other wetland ecosystems has been aquaculture with its high inputs of organic matter, fish feed, and the artificial partitioning of the water bodies. Although returns are high at least on the short term, the culture of fish in natural wetlands has aggravated the problems of eutrophication and siltation and impeded water circulation (WWF, 1992). This is not to undermine the economic importance of aquaculture in which great strides have been made in India, leading to virtually a "Blue Revolution" in states such as Andhra Pradesh where the activity has brought prosperity to millions of people. Fishery scientists are, however, concerned about the use of unnecessarily high quantities of organic manures, fertilizers, antibiotics and other inputs by the aquaculturists to increase production. Much of these find their way into natural wetlands through aquacultural runoff.

In the Chilika lake, noise pollution from the increasing number of motorboats keeps the fish away, thereby affecting the fishery. "Heavy plying of motorboats has made

much of the lake too noisy for breeding" says a fisherman, not without a grain of truth (Manas Mishra, 1998).

In Tuticorin, there are a number of chemical industries including fertilizers, copper smelting and alkali chemicals which let out either untreated or partially treated effluents into the coastal waters of the Gulf of Mannar. These effluents may cause not only mortality among the plant and animal populations which get exposed to the chemicals but also accumulation of chemicals in the seafood.

The thermal power plant which lies close to the coast in Tuticorin dumps thermal effluents along the coast besides a lot of fly ash washing into the coastal waters. This has caused not only an elevation of temperature but also inorganic nutrients of the nearby waters. This in turn has resulted in enhanced primary productivity by triggering algal growth. Such local productivity, inspite of its appearance as a good prospect, has resulted not only in siltation but also clogging of the coastal waters adjacent to the power plant and killed what was once a rich shellfish ground (Kumaraguru, 2000).

The main rouets of marine transport of oil from the Gulf countries are across the Arabian sea. One of these is through the Mozambique Channel around South Africa to the Western Hemisphere, while the other is around Sri Lanka across the southern Bay of Bengal through Malacca Strait to the Far East and Japan. This coupled with the increasing emphasis on offshore oil exploration in many countries (eg. oil exploration in and around the Krishna river delta and Kaveri basin)of the region, makes the northern Indian Ocean very vulnerable to oil pollution. It has been calculated that at any one time, the amount of floating tar in the surface layers of the Arabian Sea would be about 3,700 tonnes while along the tanker route across the southern Bay of Bengal, it would amount to 1,100 tonnes. This agrees well with the intensity of tanker traffic and the volume of oil transported through the two areas (UNDP, 1985).

Hunting and poaching

The royal Bengal tiger (*Panthera tigris*) is the best known example for hunting and poaching. After the ban on tiger shooting and the commencement of project tiger, its population has increased substantially. However, in recent times, poaching this species for skin and bones has proved to be a major threat to its existence.

In Chilika Lake, 15,000 – 20,000 waterfowl are killed by poachers every year.

The Andaman and Nicobar islands have diverse marine wealth including commercially important fishes. Illegal collections of such species have increased considerably, particularly by the people from neighbouring countries like Myanmar and Thailand. This kind of poaching is for seacucumbers, corals, coral reef fishes, ornamental shells, saltwater crocodiles, seaturtles and endemic birds of the islands.

Over-exploitation

Because of proximity to land, the living resources found in the coastal zone are heavily exploited, often beyond rates at which these can regenerate.

Of the world marine fish stocks for which data is available, 44% are fully or heavily exploited, 16% are over-exploited, 6% are depleted and 3% are very slowly recovering (FAO, 1991).

In the Tuticorin and Gulf of Mannar regions, commercially important sea cucumbers viz. *Holothuria spinifera* and *H. scabra* have been collected indiscriminately by the local fisherfolk.

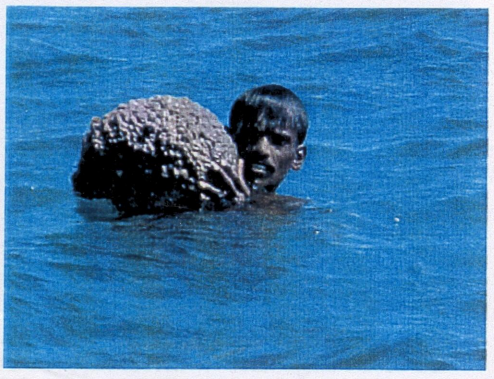
Shell collections in the coral reef environs of the Gulf of Mannar, Andaman and Nicobar islands and estuaries like Vellar (Tamil Nadu) lead to a large scale destruction of molluscan biodiversity especially that of *Umbonium, Chicoriu,* etc.

The large scale fishing carried out during the monsoon and postmonsoon seasons in the important bird habitats and in several other unnoticed areas has a bearing on the

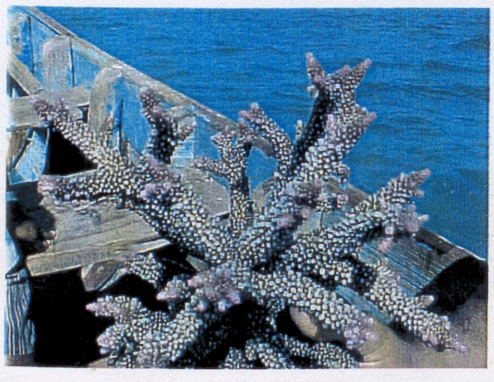
CAUSES FOR MARINE BIODIVERSITY LOSS



Seaweed collection



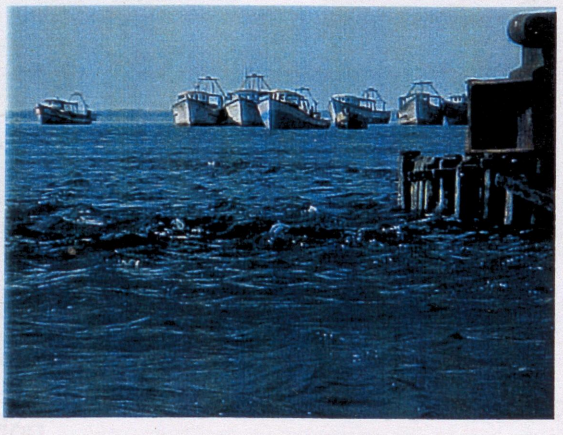
Coral collection



Live coral destruction

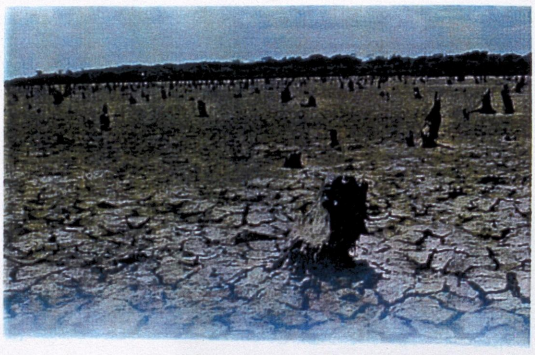


Coastal development

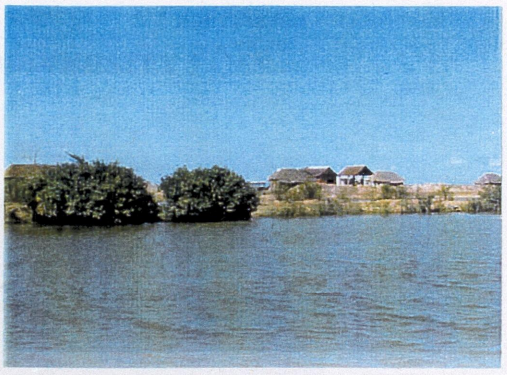


Boat operations

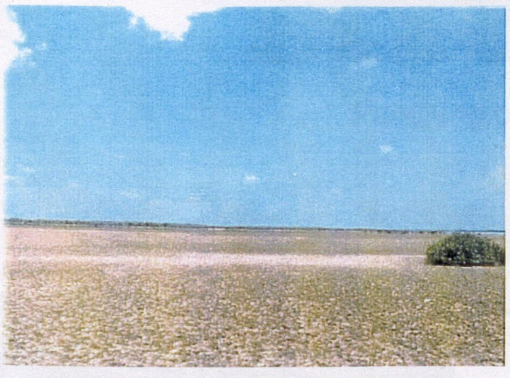
- CAUSES FOR MARINE BIODIVERSITY LOSS



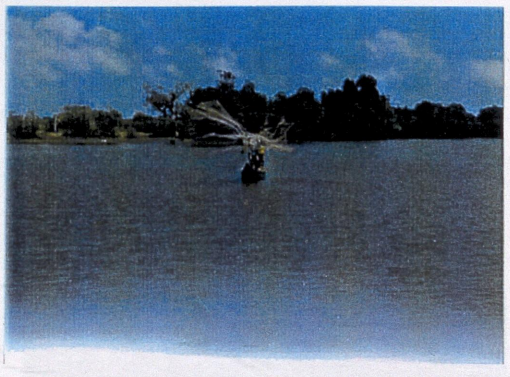
Mangrove deforestation



Developments in mangrove area



Mangrove loss due to low water inundation



Fishing in mangrove area using nets with inappropriate mesh size

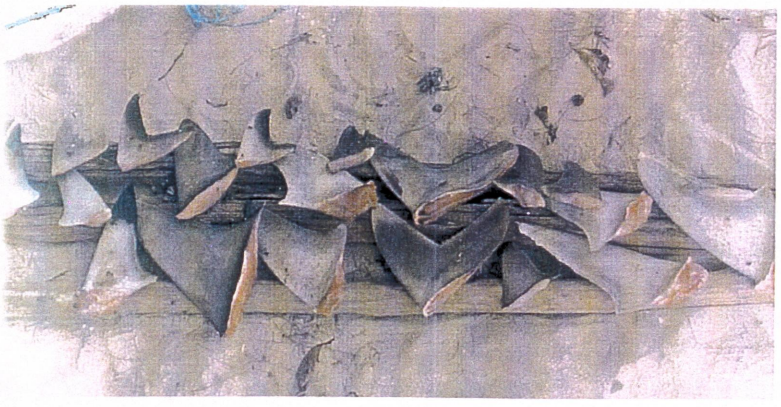


Fish hunting



Exploitation of rare fish species

CAUSES FOR MARINE BIODIVERSITY LOSS



Poaching of sharks for fins





Exploitation of molluscan shells for ornamental purposes





avifauna of the areas in the form of disturbance to the foraging birds by reducing the available food organisms, besides hunting.

Global changes

Superimposed on the human induced threats to coral reefs are anomalous occurrences of prolonged high sea surface temperatures, as witnessed during 1997 – 1998 El Nino event. The mortality because of bleaching as documented during this extreme event was unprecedented in the past 3000 years.

The increasing concentration of carbon dioxide in the air has been shown to decrease the extent to which corals can produce chalk or calcium carbonate (Kleypas *et al.* 1999). It is also predicted that the calcification rate of reef – dominated communities including corals, calcareous algae, crustaceans, gastropods and echinoderms may decrease by as much as 21% from the pre-industrial period to the time when Co_2 is expected to double its concentration in 2065.

Other causes

The increasing tourism is said to be exerting pressure on the foraging birds in the form of disturbances and other pollution related problems in the important bird sanctuaries like Point Calimere wildlife and bird sanctuary.

ROOT CAUSES OF THE LOSS IN COASTAL AND MARINE BIODIVERSITY OF THE EAST COAST OF INDIA

Unsustainable development

Increased use of large quantum of chemical fertilizers for higher crop yield by the farmers has paved the way for the deterioration of water quality of the marine environment and wetlands through draining of the agricultural wastes into these areas.

Likewise, use of nets with improper mesh sizes in the marine environment has caused heavy loss to the juveniles and endangered marine life. Further, usage of such nets for fishing collects enormous quantities of trash fish. This trash fish sometimes exceeds the main fishery in some fishing zones.

Clearing of mangrove forests and conversion of wetlands for aquaculture will lead to the heavy loss of habitats for the naturally existing organisms. Collection of wild seeds for aquaculture will cause ecosystem imbalance in the marine environment. In addition to this, usage of large quantities of synthetic feeds in aquaculture may lead to some adverse effects on the coastal marine biodiversity of that area.

Alienation of citizens from natural resources

As the people around the important critical habitats often find their agricultural practices non-profitable, they either knowingly or unknowingly, to meet their daily needs, take up to hunting of birds and other wildlife around them.

Social, political and economic inequities

Fortunately or unfortunately, most of the biologically critical areas are rural in nature. So, there is every possibility for the pervading of social and economic prejudices. This sort of discrimination drives the people to get accustomed to evil practices of killing wildlife, birds and other fauna for their benefits.

Ethical and / or moral changes of citizens

Lower economic status and unlettered nature of the people deprive them of healthy moral characters.These take them to cause any type of damage or loss to the coastal marine biodiversity.

Inappropriate or contradictory policies and laws

Coastal Regulation Zone has many contradictory points over the implementation of the same. The uniform application of the no-development zone and the distance barrier throughout the coasts of India is unscrupulous, since the tidal effect varies from coast to coast. So also, the geomorphology of the coast is also not the same in all the places. Likewise in the draft notification dated 5.8.1999, the government has permitted the development of petroleum and natural gas industry which would have more impacts on the coasts. But, restraints are imposed on tourism and required constructions, which are comparably non polluting (Jacon,1999).

Over-centralization of decision-making

Formulation of strategies and execution of the programmes by the bureaucrats sans people's involvement and end up with failure.

Lack of administrative co-ordination

One of the important problems faced in the implementation of programmes related to marine biodiversity conservation is lack of administrative co-ordination among different government agencies such as Zoological Survey of India, Botanical Survey of India, Fisheries Survey of India, State Fisheries Department, State Forest Department etc. which are either directly or indirectly involved in conservation activities. Sharing the data and expertise available with them and taking lesser time to mobilize things for implementation of conservation programmes will help a great deal.

MAJOR ACTORS IN THE REGION
(East Coast of India)

Dr. Abhijit Mitra (WWF Nature – India) Department of Marine Science University of Calcutta, 56B, Belgachia Road, Calcutta – 700 037 (W.B.).	Studies on Marine Fauna and Pollution
Dr. S. Ajmal Kahan, Professor CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on Crustaceans
Dr. Amalesh Choudhury Secretary S.D. Marine Biological Research Institute Sagar Island, 24 pgs (s), W.B. 743 373.	Studies on Floral and faunal aspects of Sundarban Mangroves
Dr. P. Anantharaman, Lecturer CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Studies on Seaweeds & Benthic diatoms
Shri H. Andrews Madras Crocodile Bank, Post Bag No. 4 Mamallapuram, Tamil Nadu 603 104	Crocodile Conservation
Dr. S. Antonay Fernando, Professor CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Studies on benthic organisms
Dr. Arul Department of Biotechnology School of Life sciences, Pondicherry University Kalapet, Pondicherry – 605 014.	Research on Marine Biotechnology
Ms. Asha Scientist Tuticorin Research Centre of CMFRI Tuticorin, Tamil Nadu	Sea cucumber culture
Dr. T. Balasubramanian, Professor CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Marine Pollution studies
Dr. L. K. Banerjee Deputy Director & ENVIS in-charge Botanical Survey of India p-8, Barbourne road Calcutta – 700 001	Floral aspects of the Bay of Bengal (east coast)
Shri D. Basu Wildlife Preservation Organisation Uttar Pradesh Forest Department Turtle Breeding Centre, P.O. Saranath, Varanasi 221 007	Crocodile Conservation

Dr. Biwash Pandev Wide Life Institute of India Post Box No. 18, Chandrabani, Dehra Dun – 248 001, Uttaranchal State (working in Kohir Matha Coast of Orissa).	Studies on Sea Turtles
Dr. V.S.K. Chennubhotla Scientist CMFRI – Reaserach Centre Vishakhapatnam – 500 003	Studies on Seaweeds & seagrasses
Chilika Lake Development Authority Orissa	Chilika lake management
Shri B. C. Choudhury Wild Life Institute of India, P.O Box 18, Chandrabani, Dehradun 248 001	Crocodile Conservation
CPR Environmental Education Centre No. 1. Eldams Road, Alwarpet Chennai – 600 018	Environmental education and awareness
Director (Research and Development) Global Village, Manora, Sarabendra Raja pattinam, Pattukkottai Taluk, Thanjavur Dt., Tamil Nadu	Creation of awareness on coastal and marine biodiversity by establishing marine biodiversity park
Field Centre M. S. Swaminathan Research Foundation Muthupettai, Nagapattinam Dt, Tamil Nadu	Creation of awareness on mangroves & afforestation
French Institute P. Box No. 33 Pondicherry – 605 001	Coastal vegetation studies including mangroves
Dr. V. D. Gaikward Associate Professor Dept. of Fish Hydrography College of fisheries, Ratnagiri-415-612	Studies on Polychaetes Taxonomy
Dr. M. Ganesan Scientist CSMCRI – Marine Algal research Centre Mandapam Camp – 623 519, Tamil Nadu	Research on Seaweeds
Indian Society for Wildlife Research Mr. Tathagata Bhattacharya, 122B, Southern Avenue 3rd Floor Calcutta – 700 091	Scientific research / Survey
Dr. R. Jayalakshmi, Lecturer CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on marine microbiology
Dr. M. Kalaiselvam, Lecturer CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Aquatic Animal Health Management

Dr. N. Kaliaperumal Officer –in-charge CMFRI – Regional Centre Marine Fisheries – 623 520, Tamil Nadu	Research on Marine and coastal vegetation
Dr. L. Kannan, Professor of Marine Biology & Direcdtor – Research Annamalai University Annamalainagar – 608 002, Tamil Nadu	Research on Marine Botany & Biodiversity
Dr. T. Kannupandi, Professor CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Studies on Crustacean Biology
Shri S. Kar Government of Orrisa (Wildlife Wing) C/o Chief Wildlife Warden (Orissa), 7 – Saheed Nagar, Bhubaneswar 751 007.	Crocodile Conservation
Dr. K. Kathiresan, Reader CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on Mangroves
Dr. (Mrs.) P.S. Lyla, Lecturer CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on Stomatopods and Amphipods
Madras Crocodile Bank Trust (MCBT) Post Bag – 4, Mamallapuram – 603 104	Crocodile breading & Coral reef research
National Fishworkers' Forum Valiathura Trivandrum – 695 008	Coastal ecology & livelihoods of traditional fishworkers
Dr. (Mrs.) Olivia J. Fernando, Reader CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on Polycheates
Dr. R.C. Panigrahi Department of Marine sciences Berhampur University Berhampur – 760 007, Orissa	Research on Marine flora and fauna
Dr. P. Perumal, Lecturer CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on Zooplankton
Dr. A. Purushothaman, Reader CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on Microbiology
Mr. Rabi Mohanty, Secretary Antyodaaya Research and Action Group (ARAG) Gamhapur P.O. Redhua Via Balibar, Jagatsinghpur District – 754 104	Studies in Bhitarkanika Sanctuary

Dr. S. Rajagopal, Reader CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Aquaculture studies
Dr. V. Ramaiyan, Professor CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Fisheries research
Dr. A.V. Raman Dept. of Zoology Andhra University Waltair – 530.004	Research on Eco- Biology of Mangroves
Dr. M.P. Ramanujam Department of Botany Centre for Post Graduate Studies Lawspett, Pondicherry – 605 008	Studies on Coastal plants
Dr. C.A.N. Rao Zoological Survey of India Berhampur- 760 001	Studies on Estuarine ecology
Dr. D.V. Rao Zoological Survey of India Port Blair – 744 101	Studies on Fish diversity
Prof. R. Regnasamy CAS in Botany, University of Madras Giuindy Campus, Chennai – 600 025, Tamil Nadu	Seaweed research
Salim Ali School of Environmental Studies Ponciherry University Pondicherry – 605 014	Studies on ecology of mangroves and bird habitats
Dr. K. Sampath Society for Environmental Education and Conservaiton, 2/71, 5th Cross Kanakasabai Nagar Chidambaram – 608 001, Tamil Nadu	Conservation of birds
Dr. P. Sampathkumar, Lecturer CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on Phytoplankton
Dr. RK. Sastry Officer-in-charge, Zoological Survey of India Port Blair – 744 101	Research on Echinoderm ecology, taxonomy, diversity and conservation
Dr. Sathapathy, College of Fisheries Orissa University of Agriculture and Technology, Rangailunda, Berhampur – 760 007, Orissa	Fisheries
Scientific Society for Ecosphere Awreness Ms. S. Hyma Singh, Secretary Aripaka Village Sabbavaram Mandal, Vishakhapatnam – 531 035	Environmental education

Mr. S. Senthilkumar Butterflies Biotech & Director – Youth Service 9, Kamala Illam, PWD Bungalow road, Muthupet – 614 704, Tamil Nadu	Environmental Awareness creation
Dr. A. Shanmugam, Lecturer CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on Molluscs
Shri Vijaya Kumar Department of Bioscieces, Saurashtra University, Rajkot 360 005.	Crocodile Conservation
Shri L.A.K. Singh Government of Orissa (Wildlife Wing) Similipal Tiger Reserve Khairi Jashipur, Orissa – 757 091	Crocodile Conservation
Dr. B. Srikrishnadass Fisheries College, Tuticorin – 628 008 Tamil Nadu	Research on Ecology and Biology of Polychaetes
Dr. M. Srinivasan, Reader CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on Fisheries & Seasnakes
Dr. P. Subramanian Department of Animal Science Bharathidasan University Trichirapalli – 620 024, Tamil Nadu	Studies on Benthic fauna, plankton & crustaceans
Dr. An. Subramanian, Professor CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Research on Marine Pollution
Dr. R. Sounderapandian, Lecturer CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Nutrition Studies
M. S. Swaminathan Research Foundation III cross street, Tramani, Chennai – 600 113	Biodiversity and Environmental awareness related programmes
Dr. N. Veerapan, Reader CAS in Marine Biology Parangipettai – 608 502, Tamil Nadu	Studies on Fish parasites
Dr. K. Venkataraman Scientist, ZSI – Marine Biological Station 100, Santhom High Road, Chennai – 600 028.	Studies on Coral reefs and associated fauna
Wild life Warden Gulf of Mannar Marine Biosphere Reserve Ramanathapuram-623 503, Tamil Nadu	Protection and conservation of Marine organisms
Wild life Warden Nagapattinam, Tamil Nadu	Protection and conservation of Marine organisms and Marine Nature Club activity
Dr. S. Yogamurthy Department of Future Studies Pondicherry University Kalapet, Pondicherry – 605 014	Marine fauna studies

(and also Fisheries department, Forest department, Wildlife department, Pollution Control Board etc. of coastal states concerned)

ONGOING COASTAL AND MARINE BIODIVERSITY CONSERVATION RELATED INITIATIVES IN THE EAST COAST OF INDIA

Agency	Area and Activity	Action
Ministry of Environment and Forests, Govt.of India	Orissa Social Forestry Project	Coastal forestation
Department of Ocean Development, Govt. of India	Samudrika (filed Laboratory), Orissa	Preservation and cutlure of horse shoe crabs in Chandipur shore
Government of Orissa	Awards for enviornmental conservation and protection	The Orissa State Government have instituted "Prakruti Mitra" and Prakruti Bandhu" awards for outstanding contribution in the field of environment conservation and protection
Ministry of Environment and Forests, Govt. of India	Orissa	Mangrove genetic resource centre
	East coast of India	Database and wetsite creation for coastal and marine biodiversity
	'Care & Share' scheme for mangroves	This is a Joint Forest Management approach to develop degraded forest area through co-operative society in which women represent 30% of members
Ministry of Environment & Forests, Govt. of India	Tamilnadu coast	Application of remote sensing techniques to wetland ecology
Department of Ocean Development, Govt.of India	Gulf of Mannar Biosphere Reserve	Conservation of seagrass ecosystem
Department of Ocean Development – ICMAM	Pitchavaram (East Coast)	GIS Based Information System
Department of Ocean Development – ICMAM	Gulf of Mannar Biosphere Reserve	GIS Based Information System - Collection of data on bacteria
Indian Council of Forest Research & Education, Dehradun	Tamil Nadu	Invigoration of mangrove seedings in nursery for efficient performance in the field
Tamil Nadu State Council for Science & Technology	Cuddalore (East Coast)	Assessing the quality of the atmosphere, water and sediment and its impact on biota
Department of Ocean Development, Govt. of India	East Coast	Pesticide levels in the edible fishes
Ministry of Environment & Forests, Govt. of India	Gulf of Mannar Biosphere Reserve	Monitoring coral reef health with reference to microbial diseases
Ministry of Environment & Forests, Govt. of India	East Coast eco-region	National Biodiversity Strategy and Action Plan preparation
Department of Ocean Development, Govt. of India	Tamil Nadu	Biodiversity and molecular taxonomy of some commercially important marine organisms
Ministry of Environment & Forests, Govt. of India	Tamil Nadu	Taxonomy of Molluscs

Ministry of Environment & Forests, Govt. of India	Great Nicobar	Assessment of marine biological resources of the Great Nicobar Biosphere Reserve and its ecology
CSIR, New Delhi	Gulf of Mannar	Screening of marine microbes for bioactive compounds
Tamil Nadu State Council for Science & Technology	Tamil Nadu	Resource estimation of stomatopods and popularizing the same as valuable seafood and technology development for production of chitosan from stomatopods
Ministry of Environment & Forests, New Delhi	Tamil Nadu	Conservation and development of mangroves in degrading areas with participation of local community
Department of Ocean Development, Govt. of India (OSTC)	---	Biology and biodiversity of sea fans of Indian waters
Department of Ocean Development, Govt. of India (OSTC)	---	Biology of Sea horses
Department of Ocean Development, Govt. of India (OSTC)	Parangipettai (east coast)	Investigations on the eggs and larvae of the fin and shell fishes
UGC, New Delhi	Tamil Nadu coast	Insect infection in dried fishes
UGC, New Delhi	Vellar Estuary (East Coast)	Pilot scale cultivation of some economically important seaweeds
Department of Ocean Development, Govt. of India (OSTC)	East & west coasts of India	Faunal biodiversity and sediment dynamics of mangrove systems
Tamil Nadu State Council for Science & Technology	Uppanar Estuary, Cuddalore (East Coast)	Assessing the environmental quality
Ministry of Environment & Forests, Govt. of India	Palk Bay	Evaluation of the bioresources through conjunctive use of a conventional ground surveys and satellite remote sensing
Dept. of Biotechnology, Govt. of India	East and west coasts of India	Digitized inventory of marine bio-resources- Seagrasses
Department of Ocean Development, Govt. of India (OSTC)	---	Studies on the biology of marine mammals and shore birds using chemical studies and DNA methods
Dept. of Biotechnology, Govt. of India, New Delhi	East and west coasts of India	Digitized Inventory of Marine bioresources -Microbes
Chilika Banchao Andolan ("Let live Chilika")	Chilika lake, Orissa	Eco-preservation and land/water tenure systems

GAP ANALYSIS

Gaps in information

a) Urgent need for a more scientific means of acquiring and disseminating data for proper utilization by resource users and decision – makers.

b) Detailed quantitative baseline studies of temporal and spatial abundance of aquatic resources

c) Quantitative measures of physico-chemcial correlates, for determining biogeographic zones

d) Studies on indicator species

e) Quantification of the role of aquatic ecosystems and their components

f) Information available regarding the coastal biodiversity is lying scattered in different institutions as grey literature and the key actors like government agencies should use it while formulating the biodiversity polices.

g) There are enormous gaps in knowledge concerning the status of marine mammals of the east coast of India. There are no population estimates of marine mammals especially those of dugongs and other endangered species.

h) Incidental kills of marine fauna need to be documented and the species, thus killed with crafts and gears involved, should also be recorded. Stomach contents of animals of such incidental kills should also be studied because such data are lacking.

i) Lack of consistent studies on population dynamics for most of the marine reptile species preclude confident statements or even inference of reduction in population.

Gaps in vision

The inherent value of biodiversity is multidimensional and vast which has not been properly evaluated and this has made the policy makers lack in vision in the areas concerned. Moreover, most of the actor authorities who are non-professionals are

entrusted to look into the matter of biodiversity conservation and they fail miserably in implementing the programmes.

Allowing more and more people to settle in the coastal areas with the increase in the number of fishermen settlements is posing serious threats to the coastal marine biodiversity and its habitats. Settlements and the resultant population increase in the coastal regions can become an acute problem in a decade or two.

Except some (Sundarbans, Chilika lake, Gulf of Mannar etc.), other coastal ecosystems have not been studied systematically and projected for conservation on a long-term basis by the state agencies or institutions.

In the case of conservation programmes / projects, the work is undertaken till the aid is received from the funding agency and thereafter, it is discontinued as no local government fund is made available to continue the valuable, long term, result oriented programmes. This is true in the context of coastal and marine biodiversity conservation programme also and this could be visualized as a gap in vision.

Gaps in policy and legal structure

Wild life protection Act 1972 - Coral reef species and reef dwelling fishes are not included in the schedules of the wildlife protection act. Further, there seems to be no restriction on the coral collections from the reefs outside the protected area.

Convention on International Trade in Endangered Species of wild flora and fauna (CITES) - CITES has some coral reef fishes listed on its appendices. Information for these species from the Andaman Nicobar islands is far from complete because of lack of data on coral reef fishes (Krishna Kumar, 1997). Some coral genera have been listed like Milleporidae, order: Athecate (Fire corals) and Tubiporidae, Order: Stlolonifera (Organ Pipe Corals). This would of course, in principle covers all the species of these genera.

Convention on Biological diversity: It does not provide any explicit rights either to nations or people, regarding the vast store of genetic material or knowledge transferred abroad prior to 1993.

Strict enforcement of laws and policies is the need of the hour pertaining to habitat protection, sustainable use and biodiversity conservation.

To achieve this, the following are essential.

1) Policy to support the use of selected habitats rather than whole area
2) Identification of specific responsibilities in implementing and enforcing the rules and regulations
3) Clear guidelines and policies for conservation of biodiversity in aquatic ecosystems
4) Development of financial schemes that would sustain various management and scientific activities
5) Clear and concurrent pollicies that would coordinate and integrate efforts on biodiversity conservation, environmental protection and aquatic resources use
6) Most of the state government policies, laws and legal structures reflect those of the Central Government. These are adopted in similar form and have not been moulded as per the requirement, feasibility and effectiveness depending upon the local problems.

Gaps in institution and human capacity

Management institutions for biodiversity conservation need to be built up primarily upon data and information gathered through basic and applied research. Such institutions should concentrate on the following.

a) Baseline data collection to document extent and conditions of different marine habitats

b) Monitoring programmes for detecting early effects of disturbances

c) Measures to deduce major degradation sources (pollution etc.) using indicators

d) Measures to detect changes due to natural and anthropogenic pressures

e) Information collection on economic and social values

f) Ensuring active involvement of people

g) Rehabilitation and restoration technology use in conservation programmes

h) Capacity building

i) Financial sustainability

The scientific working groups and experts on coastal, marine biodiversity have not established effective links for exchange of information with the government agencies concerned. This gap should be plugged forthwith.

People's empowerment

The goal of conservation of nature and natural resources can not be achieved by the government alone. Thus, for the success of any conservation activity, the people should be roped in and entrusted some powers to make it a people's movement. Such types of conservation activities have not emerged yet at several places in India.

Gender & equity

Global Assembly on Women and the Environment, Miami, 4 – 8 November 1991 declared that 'too few women have been involved in decision making with regard to policies, programmes or funding for the environment, despite the international target of 30% of women in leadership positions by 1995, and equal representation by women and men by the year 2000'. But even after 2001, women are not given much priorities in environmental related programmes in India and in the whole of Asia. This is contradictory to their achievements in relevant fields.

For example, in Andhra Pradesh, Vasanth Kanibera observed the desperate environmental and social situation around her. The degradation of productive land has led to the erosion of topsoil and the choking of water drainage was causing salinity problem, loss of food crops and increasing unemployment in the villages. Led by Vasanth Kanibera, village-level groups decided to pool their limited resources, collectively lease degraded lands and renew them through traditional farming. As no bank would lend the women farmers any money, a development society offered an initial loan. The project grew to the strength of 400 women in 20 villages and, in three years, 700 acres of land had been restored to productive use. More land is being improved every year. The women make sure that there is no loss of topsoil, reduction in crop diversity or waste of rainwater (Paul Ress, 1992).

One of the major constrains being faced by women is that no organized sector is coming forward to give any loan facility or financial support to them to undertake such environment related works.

International issues

Most of the open sea habitats lie beyond territorial limits. For this reason, it is urgent to have an international agreement by including countries with fishing fleets from outside the region for effective conservation. Moreover, the present methods for oil pollution control and still others are currently practised only in coastal waters and these should be extended to the offshore areas also.

For the effective conservation of gharial and saltwater crocodiles which straddle international borders (notably the population of gharial along the Narayani, Gandak and Karnali Girwa Rivers and that of the saltwater crocodile in Sunderbans), cooperation of Nepal and Bangladesh is necessary (Madras Crocodile Bank inputs).

Most of the coastal bird species visiting India are from several countries. An appreciable populations of 350 species, out of 1200 species of birds recorded in India are migratory in nature. They migrate to India, especially, the east coast from the Siberian part of Russia and from some other counties. So conservation strategies should be evolved and structured involving all the countries concerned.

Indigenous knowledge

Indigenous knowledge of people of coastal communities is rich. This has not been utilized properly for formulating different coastal, marine biodiversity conservation programmes.

Indigenous knowledge of people especially those who are dwelling in the mangrove, coral-reef, lagoon, island and other important coastal zone areas should be made use of for formulating policies and action plans with regard to local resource utilization and conservation programmes.

MAJOR STRATEGIES TO FILL GAPS AND TO ENHANCE / STRENGTHEN THE ONGOING MEASURES

1. Protection of the gene bank and the genetic biodiversity in the mangrove and coral reefs areas
2. Creating centralized facility for biomonitoring, inventorying and catalouging the flora and fauna of the east coast
3. Establishment of Marine Biodiversity Board in each coastal state and union territory (Pondicherry and Andaman and Nicobar)
4. Undertaking eco-friendly and small scale projects to provide alternate source of energy and gainful employment to the local communities living around identified sites of threats to coastal biodiversity
5. Preparation of illustrated field guides on marine biodiversity of each coastal state and union territory
6. Protection and conservation of endangered, threatened and endemic species by suitable *in-situ* and *ex-situ* methods
7. Protection of eco-sensitive areas such as:
   a) Gahirmatha coast in Orissa which is the breeding site for the leather back turtles
   b) Paradeep mangroves with flora and fauna which are still in pristine condition
   c) Bhitarkanika mangrove area in Orissa where only the "living fossil" horse shoe crab (*Limulus*) and the estuarine crocodile exist
   d) The coastal lagoons of Chilika lake in Orissa, Pulicat lake in Andhra Pradesh and the Muthupettai lagoon in Tamil Nadu
8. Measures to protect the coral reefs and associated organisms of the National Marine Park in the Gulf of Mannar from intensive human activities

9. Preservation of genetic diversity of the Pitchavaram mangrove area which is at present free from pollution but suffers from anthropogenic pressure

10. Establishment of a permanent bio-monitoring Centre in each coastal state for regular monitoring of water quality, toxic pollutants and toxic algal blooms employing standardized methodologies with a centralized database facility

11. Protection of the breeding sites and the nursery areas of fish and shellfish and undertaking sea ranching programmes by rearing the young ones of the threatended and commercially important species at appropriate sites as measures towards protection of biodiversity and prevention from extinction

12. Conserving the seagrass ecosystems of the Palk Bay and Gulf of Mannar, which are the feeding and nursery grounds for innumerable animals including the seacow (*Dugong*).

13. More effective implementation of laws and taking stringent action against those who violate the laws of biodiversity conservation.

ACTION REQUIRED TO FILL - UP GAPS AND TO ENHANCE / STRENGTHEN THE ONGOING MEASURES

The need for action

Domesticated and wild species of plants, animals and microorganisms provide basic materials for food, clothing, medicine, housing and major industries. Further, these species are also linked within complex ecosystems that provide ecological services to humanity such as maintaining soil fertility and water quality. Loss of biodiversity, particularly in threatened ecosystems like islands, wetlands and coral reefs, is usually irreversible. Continued widespread loss of biodiversity is critical to the activities of every country and sector of society. Hence, biodiversity conservation based on sound scientific information and filed data is very essential for posterity and sustainable utilization and this ultimately depends upon the political, cultural and ethical issues.

Direct threats to biodiversity are due to:

i. Fragmentation or loss of natural habitats

ii. Over-exploitation of useful species

iii. Ecological imbalance due to human activities

iv. Pollution of the environment through different sources

v. Regional climate changes

The underlying causes for the above are the patterns of land use practices, population growth, poverty, inappropriate development projects, urbanization and urban consumer demands, under development of rural areas, dependence on limited number of varieties of plants and animals and lack of awareness, scientific knowledge and information.

Hence, action is needed to fill-up the existing gaps in biodiversity conservation and to enhance and strengthen the ongoing measures.

ACTION PLANS

Action 1: Setting up of Interstate Ecoregional Biodiversity Committee

Category: High priority, long term

Details:

Constitution of an Interstate Ecoregional Biodiversity Committee , independent in nature, is essential because coastal and marine biodiversity concerns go beyond the state boundaries and they are serious enough to be tackled. Examples: issues such as migration of fish across state boundaries, fishing pressures alternating between states, situation where extensive destruction of habitats might affect population in the adjacent states, etc.

The Interstate Ecoregional Biodiversity Committee can be constituted by including all the four east coast maritime states viz. West Bengal, Orissa, Andhra Pradesh and Tamil Nadu and also Pondicherry and Andaman and Nicobar union territories. Chairman of each State Biodiversity Board and the Member Secretary of the Coastal Zone Management Authority of each state can be included as committee members along with some marine biologists, NGOs and fisherfolk associations. The committee can be headed by each state on rotation basis. This committee can meet at regular intervals to discuss the current biodiversity issues of the ecoregion, to analyze the coastal development activities taking place in the ecoregion and interstate issues and suggest necessary time bound actions for the respective states for implementation to conserve biodiversity. Provision can be made for creation of such a committee in the proposed Biological Diversity Bill.

Responsibility: Central Government and State Governments of the east coast states

Time frame: One year to set up the committee

Resources required: Financial support for establishing the committee and its functioning.

Action 2: Expert Centres for Taxonomic Stuides on Marine Biodiversity (ECTIMB)

Category: High priority, medium – term

Details: There is an urgent need to establish taxonomic study and capacity training centres for varied groups of flora and fauna along the east coast, each specializing in selected biotopes (such as Bitarkanika, Krishna mouth, Pitchavaram and Sundarbans for mangrove flora and fauna; dry coastal sand strands and rocky flora and fauna for Tamil Nadu, Andhra Pradesh and Orissa coasts; and the Gulf of Mannar for hard and soft coral species and their associated flora and fauna) since such specific area oriented studies are generally not undertaken by government agencies. These centres will also serve as data collection, reference and display centres. Each centre thus will serve for educational and research purposes through their data bases. These centres must be involved in regular sampling and identification of species and computerization of all comparable, valid data in order to establish a scientific database in addition to holding a reference collection. They will prepare audio-visual aids and documentaries for education, tourism, training and research purposes. These centres can also be involved in identifying and locating endemic and endangered species, by involving experts and parataxonomists on the local flora and fauna and can propose the policy and legal steps necessary to protect and conserve such species and their habitats. These centres must provide training for those interested, on continuing basis, and will thus help,

i) in assessing the state of our knowledge about marine biodiversity along the east coast of India through continuous monitoring and collection

ii) in developing taxonomic capability through hand and field guides for use in education, research and tourism

iii) in locating the endemic and endangered species and their protection and

iv) to prepare non-technical literatures for common man to initiate awareness on the conservation of biodiversity

A comprehensive inventory for generating information can be prepared on each selected site and in every major sensitive ecosystem like corals, mangroves, mudflats etc.

The best initiative is to evolve a standardized format for species characteristics and identification and thus, the collected information should be stored as computerized inputs. These regional centres will enjoy full autonomy and will receive financial support for such specialized inventory efforts (through video and digital databases), for holding regional reference collections as well as for housing the materials of the inventory sites for long term use and reference. Each centre can also prepare a centralized register of described species and also impart capacity training on taxonomic methodologies through basic and refresher courses and workshops, with the help of field guides and hand books. For this, the expertise of retired experts can be utilized.

Responsibility: Central government through the Ministry of Environment and Forests / Department of Ocean Development

Time frame: Within 2 years of finalization of Biodiversity Strategy and Action Plan (first year for identifying the centres and experts and the second year for the establishment of the centres)

Resources required: To be finalized by each Identified Expert Centre for Taxonomic Identification of Marine Biodiversity (ECTIMB).

Action 3: Maintenance of local community level biodiversity register for coastal and marine biodiversity

Category: Medium priority, long term

Details: Local community level biodiversity register for coastal and marine biodiversity can be prepared and maintained by the local communities (eg. fisherfolk) themselves, with the help of the college / university departments concerned, through scientific

documentation. Information in such registers can be updated periodically and made available to all those interested local people and scientists who can suggest some measures to problems related to biodiversity conservation. Benefits should be shared equally.

Responsibility: To maintain such registers, the local communities, colleges, universities and other academic institutes have to be provided with adequate funds by the State and Central Governments.

Time frame: One year

Resources required: As required by the local communities, colleges and universities

Action 4: A permanent monitoring team (to collect data on coastal and marine biodiversity and related parameters by adopting standardized methodology) is to be formed, along with a centralized documentation facility for each coastal state

Category: Medium priority, long term

Details: We need to prepare scientific databases on a continuing basis with regard to coastal and marine biodiversity, water quality, soil characteristics and the impacts of climate and sea level changes and pollution. A permanent monitoring team can be formed under the aegis of a national facility (DOD) involving also the National Institute of Oceanography which is already provided with a centralized documentation facility. This team should also involve the local people after imparting some basic training to them in monitoring methods.

Responsibility: Central Government / State Government

Time frame: One year to form such a team

Resources required: To be finalized by the team after it is set up by the Central or State Government

Action 5: Regulatory measures on the indiscriminate harvest of seaweeds

Category: Medium priority, long term

Details: In Mandapam area alone (in Tamil Nadu state), nearly 1,200 people (70% are women and 30% are men and children) are involved in indiscriminate exploitation of seaweeds and this consequently had led to the loss of seaweed biomass and biodiversity especially of species of *Gracilaria*, *Gelidiella* and *Sargassum*. Moreover, such intensive collections will also affect 'inter alia' the coral reef ecosystem and its associated biodiversity of this area. Such collections especially during the reproductive phase of the seaweeds, will seriously result in the elimination of seaweed juveniles and consequently causing loss of biodiversity and biomass of many species. To control this large scale destruction, a closed season for seaweed collection (as practiced for fishery) has to be introduced and a total ban on seaweed collection in fragile ecosystems such as coral reefs has to be introduced.

Responsibility: Central and State Governments of the east coast states, through the proposed Ecoregional Biodiversity Committee.

Time frame: One year to prepare the seaweed calendar to assess the reproductive phase and announce the closed season

Resources required: Scientific manpower to prepare immediately a seaweed calendar through seaweed phenology studies.

Action 6: A National Level Standing Committee for Seagrass Conservation in the east and west coasts and islands of India.

Time frame: High priority, long term

Details: Seagrass meadows are highly productive ecosystems and economically very valuable as they are the nesting and breeding grounds for a variety of commercially important shell and finfishes. Further, seagrasses support innumerable numbers of micro and macro algal epiphytes and epizoites. The natural and demographic pressures exerted

on these ecosystems during the last decade led to their large-scale destruction, and to the loss of associated species like dugongs and green turtles. Seagrasses have invariably been neglected in priorities for protection in our country and have been given much less (research) importance compared to mangroves and coral reefs. Hence, it is highly essential to set up a National level Standing Committee for Seagrass Conservation which can help formulate and implement different programmes pertaining to seagrass biodiversity, with special reference to species & habitat conservation, evaluation & monitoring, sustainable uses, constraints, awareness, training and education. Thus, the committee will help to undertake studies so as to promote research on seagrass ecosystem of the east and west coasts including Lakshadweep and Andaman and Nicobar islands for conservation and protection.

Responsibility: Central Government through the Ministry of Environment and Forests.

Time frame: One year to set up the committee

Resources required: To be implemented by the Ministry of Environment and Forests, Government of India

Action 7: Conservation of mangrove biodiversity through alternate livelihoods under IRDP

Category: High priority, long term

Details: Plans should be drawn for a more effective approach to balance protected area restrictions with opportunities for sustainable use or other economic activities so that the local population will take direct interest and extend their co-operation in conservation efforts (In the protected areas, normally all forms of resource use – sustainable or otherwise, are excluded).

All mangrove forests have already been notified as protected areas. However, they are still facing continuing destruction due to over-exploitation of potentially renewable resources. If resource utilization, both economic and subsistent, is consistent with

conservation of the natural system, society can receive both direct economic benefits and a variety of natural services. A wide array of products ranging from fuel wood, timber, fish, tannin, fodder for livestock and honey are all obtained from various species existing in the mangrove ecosystem. Actions must aim at providing the local people (around the protected mangrove areas) with alternate sources of fuel energy and fodder and also for protecting their hygienic condition and water quality. These could be done through integrated rural development programmes as follows:

Each village must be provided with a community cattle shed so that all the cattle can be housed there. Protected toilets can be constructed with a sewage plant and sewage farm where fodder grass can be grown to provide fodder to the cattle. This would help prevent the cattle from freely grazing on mangrove plants (one of the major causes for mangrove destruction) and let mangroves to flourish. Gobar gas (bio gas) units can also be established, making use of the cattle dung, for production of methane gas which can meet the needs of local people for cooking purposes, thus preventing the local people from collecting fuel wood from mangroves, thus assuring the protection of mangrove species. The construction of toilets will help maintain the hygienic condition in the village (otherwise, people use the open areas near water sheds as open latrines). This will also help curb the contamination of water by human excrements. It should be noted that there should not be any cattle shed or construction of toilets within the mangrove swamps.

For the above purpose, plans must be drawn at Village Panchayat level and Panchayat Union levels or groups of village level, surrounding the mangrove area.

Responsibility: The model plan for a model village could be drawn and a co-ordinated effort must be undertaken by the State Governments together with the villagers including women (and those who are most dependant on the coastal/ marine resources), NGOs and educational institutions to help in the successful operation of these community oriented,

integrated projects by creating awareness. This can be the ideal way for conservation rather than preventing people from resource use which has proved ineffective already.

Time frame: One year to identify the model village and another year for executing the project under IRDP.

Resources required: Central / state governments can provide one time grant to the villages to set up such units. National / State Biodiversity Boards concerned can monitor the programme.

Action 8: Resource conservation through small scale development projects within and around the mangrove areas

Category: High priority, long term

Details: *Nypa* palms can provide many useful products to local people living near the mangrove areas especially in Andaman and Nicobar islands. Its leaves, juice or sap and the fruit can be used for a wide variety of cottage industries and for commercial purposes.

A most important commercial product of *Nypa* is sugar, produced from its sap. The sap can also be used for vinegar and alcohol production. Sugar / alcohol production from *Nypa* palms offers several advantages over sugarcane production, like:

i) inexpensive crushing mills

ii) no begasse (waste from crushing mills) disposal problems

iii) unlike sugarcane, *Nypa* palm does not compete with other crops in plain agriculture lands

iv) continuous production (once planted, *Nypa* palms do not require replanting) which means it is not labour intensive, a problem encountered in sugarcane

Thus, potential of the *Nypa* palm to benefit humans is very great and the maximum economic benefits can be obtained only if such resources are protected against over-use, misuse or abuse.

Responsibility: A model plan could be drawn for each village / group of villages as the case may be and a co-ordinated effort through forest department concerned must be undertaken by the State Governments together with the help of the villagers including women and the banking sector should help in the successful operation of small scale development projects. Such projects can also be thought of for using other mangrove plant resources.

Time frame: One year to identify the model villages and setting up of such small scale industries for sugar / alcohol production

Resources required: Bank loans to set up such small scale sugar / alcohol production industries

Action 9: Demarcation of fishing zones for non-mechanized and mechanized fishing boats in critical habitats like mangroves, coral reefs and seagrass beds under CRZ - I

Category: High priority, long term

Details: This kind of demarcation will help save the adults (of shell, finfish etc.) from boat injuries and the juveniles from death. Operation of mechanized boats closer to the mangrove vegetation will uproot the seedlings by the propellers, injure the stilt roots and cause mechanical stress to the aerial parts like buds, flowers and young fruits, thereby disturbing the spread of mangrove vegetation. Similarly, boat operations in coral reef areas may break the delicate corals and cause injuries to them. The propellers of mechanized boats can also uproot the seagrasses, thereby destroying the feeding grounds of many marine animals. To avoid this, both the mechanized and non-mechanized boats can be allowed for fishing only in the deeper parts demarcated in the mangrove channels, coral reefs and seagrass environs so that boat operations will not hinder in any way these bioresources.

Responsibility: Central Government and State Government of the east coast states through full community mobilization and empowerment.

Time frame: One year to demarcate the depths for fishing in mangrove, coral and seagrass areas.

Resources required: Scientific manpower to make demarcations in mangrove, coral reef and seagrass areas

Action 10: Establishment of breeding centres for commercially imporatant ornamental fishes.

Category: Medium priority, long term

Details: To provide alternate livelihood and gainful employment as additional economic benefit for the fisherfolk, large numbers of breeding centres for ornamental fishes such as *Amphiprion nigripes* (Black-footed clown fish), *Chelmon rostratus* (Copper band Butterfly fish) and *Pterois volitans* (Lion fish) can be established at various places along the coast. The ornamental fishes are in great demand and have very high export value. This will be very promising for community development and for obtaining economic benefits by proper and rational utilization of marine resources. However, it should be noted that the species selected for breeding should be studied thoroughly (their collection from wild should be minimal, that too, after obtaining permission from the government departments concerned). It is also necessary to undertake social impact assessment over a period of time and build in equity safeguards so as to ensure that the major benefits of this actually go to the small fisherfolk.

Responsibility: State Fisheries Department of respective areas can help in establishing the breeding centres. Marine Product Export Development Authority may create export facilities for such ornamental fishes through appropriate marketing strategies.

Time frame: One to two years to establish such breeding centres and for creating export facilities

Resources required: Financial support to start breeding centres.

***Action 11*: Formation of youth and women eco-clubs in fisherman and salt-swamp worker communities**

Category: Medium priority, long term

Details: Departments such as fisheries, forests and wildlife can initiate action by providing grants to the youth and women of fisher community and salt swamp workers to start eco-clubs. This will help a great deal to create awareness among the fisherfolk and salt swamp workers. This will also create a custodian like feeling in them for bioresources conservation and the information will automatically be passed on to the next and future generations. These eco-clubs can address problems relating to understanding and tackling of critical issues of land/water/fisheries tenure, access to the seas etc., by the government and communities coming together.

Responsibility: State Government of the east coast states

Time frame: One year to form the eco – clubs

Resources required: Regular grants to the youth and women eco-clubs to start and conduct the clubs and sustain their activities.

***Action 12*: Creation of Community Based Marine Biodiversity Protection Group (CBMBPG)**

Category: Medium priority, long term

Details: Community based marine biodiversity protection groups can be formed by associating all the panchayats around the critical habitats to be identified along the coast. These groups can take care of the critical sites and must initiate necessary protection action with the help of forest, fisheries and police officials. The economic wealth derived from such critical habitats can be shared equally by all the families of the villages concerned. The CBMBPG can be formed under the headship of a person chosen by all the adults of the local community including women, with a local Fisheries Department

official, panchayat heads of the villages around such critical habitats, local NGOs and representatives of biology departments of local schools / colleges, as members. This will be very much helpful to know the destructive practices / activities taking place locally and curb them so as to ensure local biodiversity protection.

Responsibility: Fisherfolk associations, gram sabhas and panchayats, with help from the State Governments of the east coast states to form CBMBPGs.

Time frame: Two years to form the groups

Resources required: For organizational expenditure

Action 13: Identification of highly disturbed / degraded sites for inclusion under Protected Areas

Category: High priority, long term

Details: From the past experience that we had in the Krusadai island, Gulf of Mannar Biosphere Reserve, it is very essential to formulate regulations to restrict or permit collection of marine biological materials. The Krusadai island, once known as a "Biologists' Paradise" due its very rich biodiversity has now become highly degraded due to unauthorized and unskilled extensive, intensive and indiscriminate collections of many highly precious and valuable biological specimens by a number of colleges, university departments and academic and research institutions. Such biologically very rich but now highly threatened valuable habitats should be brought under Protected Areas where botanical and zoological collections by teaching and research institutions should be totally banned, though students and researchers may be allowed to visit these areas for compiling photographic and videographic records for their studies and for reference. Specific species of research importance may be allowed to be collected in strictly restricted numbers by the technically skilled persons during peak seasons of growth on prior permission and under staff supervisor of the government. This will help increase the biodiversity without disturbance, thereby sustaining such biologically high risk areas.

Responsibility: Central and State Governments (through U.G.C., NCERT, SCERT, DOD, DoEn, Directorates of School Education & College Education, Universities etc.)

Time frame: One year to identify and declare the Protected Areas in the coastal states

Resources required: Necessary funding from the Ministry of Environment and Forests to identify the disturbed areas and to bring them under 'Protected Areas' cover.

Action 14: Levying heavy tax (Environmental Protection Tax) on materials prepared by using biologically non-degradable substances

Category: High priority, long term

Details: Heavy tax on materials prepared by using biologically non-degradable substances like plastics, PVC etc. can be levied and the revenue earned can be used for environmental and biodiversity conservation programmes. This high taxation procedure will also reduce the bulk purchase of such materials, thereby reducing pollution. Further, fines can be collected from those who are dumping / disposing such materials along the coast or into the sea.

Responsibility: Central Government and State Government of the east coast states

Time frame: One year for introducing such taxation procedures

Resources required: ----

Action 15: Ecotourism and Awareness Creation

Fact: Conservation of coral reefs of the Gulf of Mannar and the Andaman & Nicobar islands by protecting the water quality in these regions can help the breeding grounds of many fish species which in turn will lead to high fishery production in the EEZ on a sustainable yield basis. In addition to promoting eco-tourism and educational research, awareness programmes for school children, public and fisherfolk underlining the urgent need for protecting the coral reefs for sustained fish production must be conducted.

Category: Medium priority, medium term

Details: Centres for eco-tourism and awareness creation among the school children, fisherfolk and the public have to be established at suitably selected places along the east coast so as to protect the coral reef and other ecosystems from further deterioration and towards sustainable utilization of resources.

Such centres can be established at the following places.

S.No.	Place	State	Ecosystem
1.	Mandapam (Gulf of Mannar)	Tamil Nadu	Coral reef
2.	Pitchavaram	Tamil Nadu	Mangroves
3.	Muthupettai	Tamil Nadu	Lagoon & mangroves
4.	Pulicate lake	Tamil Nadu / Andhra Pradesh	Coastal wetland
5.	Kakinada	Andhra Pradesh	Coringa mangroves
6.	Gahirmatha	Orissa	Turtle nesting ground
7.	Bhitarkanika	Orissa	Mangroves and salt marsh grass
8.	Chilika	Orissa	Coastal wetland
9.	Sundarbans	West Bengal	Mangroves
10.	Wandoor	The Andaman	Corals and mangroves
11.	Galathea	Great Nicobar	Estuary with crocodiles
12.	Indira Point	Great Nicobar	Turtle nesting ground

Gradually, these centers can build full capability amongst the local communities for effective and efficient handling of ecotourism. Educated unemployed youth from the local communities can be trained, as tourist guides and also for policing, to help the tourists, in addition to creating awareness. Each such centre can have members drawn from local communities, fisheries department, forest department, wildlife department, educational / institutions and NGOs.

Responsibility: Ministry of Environment and Forests, Government of India & State governments through their tourism departments

Time frame: One year to establish such centres

Resources required: -----

<u>Action 16</u>: 'Project Dugong' to conserve the endangered species of dugongs and their ecosystem

Category: High priority, long term

Details: 'Project Dugong' (like 'Project Tiger') can be initiated through which these endangered species could be effectively protected from extinction. This project can be introduced in two important areas viz. Dugong Bay in Andaman and Nicobar islands and specific sites in the Gulf of Mannar and Palk Bay in Tamil Nadu, by announcing these sites as dugong reserves. The project can be operated in three parts viz. i) Banning of trawl fishing in these sites so as to prevent the accidental killing of existing population; ii) Ecosystem development in which large scale seagrass transplantations can be carried out at these sites so as to increase the feeding grounds for the dugong population and, iii) To undertake captive breeding of these species and sea-ranching of the same. Cloning can possibly be tried to rear the organisms in more numbers since the female dugongs become sexually mature only after 10 to 17 years and have a 13 – months pregnancy. It can give birth only to one calf at a time and usually a gap of at least three years exists before it conceives again. Such reduced and very low reproductive potential is also an important cause for the decline of its population.

Responsibility: WWF / World Bank / UNDP-GEF / Government of India for funding these programmes. Department of Environment and Forests of the states concerned can identify the sites and monitor the overall programme. The Centre of Advanced Study in Marine Biology, Annamalai University can carry out large scale seagrass transplantation programme in selected sites and the Central Marine Fisheries Research Institute can be engaged for developing breeding technology and sea-ranching.

Time frame: Two years, first year to select the sites and to announce the dugong reserves and second year to start large scale seagrass transplantation and breeding experiments.

Resources required: Adequate funding to the Department of Environment and Forests of the states concerned to establish autonomous authorities, Centre of Advanced Study in Marine Biology, Annamalai University and CMFRI through major research projects.

Action 17: International co-operation in monitoring marine pollution in the Indian Ocean region

Category: Long term, medium priority

Detail: Most important aspect of any marine pollution study is to examine the physical processes occurring in the recipient water body. The nature of pollutants discharged in to the water body, their dispersion, mixing, residence time, bioaccumulation and eventual transport of these pollutants from the discharging points depend on the dynamics of any coastal water body. Possibly, pollutants released by one country can have their ultimate effect on the coastline of another country. To predict the ultimate fate of the pollutants, the factors which determine the dynamics of the recipient water and its neighbourhood must be known spatially and temporarily over a certain period. This is highly required for Indian Ocean region which is particularly influenced by both south west and north east monsoons and has large tidal variations (UNEP, 1985). A "mussel-watch" type of programme (more preferably oyster tissue monitoring) is essential for monitoring several dangerous pollutants. Some efforts are in progress in some countries of this region. As barnacles can tolerate wide range of salinity and dilution, this arthropod may be brought under the set of "indicator organisms" after a rigorous scientific exercise on its tissue system. These efforts should be coordinated and intensified through international programme. Towards this goal, the Indian Ocean member countries with the involvement of their respective National Pollution Control Boards can jointly set up an Indian Ocean Regional Co-operation Committee. This committee can monitor the ocean in selected sites to predict the pollution and suggest remedial measures

Responsibility: Indian Ocean member countries must create a common fund for monitoring the " Indian Ocean health".

Time frame: One year to set up the co-operation committee and to create a general fund for identifying the areas in the Indian Ocean region for monitoring.

Resources required: Can be met from the general fund of Indian Ocean member countries.

Action 18 : Preparation of Coastal Resources Atlas of India

Category: High priority

Details: Coastal resources atlas is an essential tool in contingency planning and decision making for the utilization of coastal resources and the management of environment. This will serve as the means for delineating marine and coastal areas of sensitivity that could be managed by surveying and systematic mapping of the coastal zone, proper exploitation and management of resources and to prevent environmental degradation. Besides, such an atlas will also provide logistic information for effective surveillance of coastal waters and areas.

There is an urgent need therefore, for the preparation of Coastal Resources Atlases of India for effective marine environmental study and for classifying coastal zones into sub-zones with specified primary uses as fishing, tourism/ recreation, port/harbour, industries, waste discharge/dumping, mining / oil exploration, conservation etc. Keeping in view of the above, the National Hydrographic Office (Dehra Dun) which has a field infrastructure of six surveying vessels and equipped with latest surveying equipment as well as system software with qualified cartographic experts, can be invited to process all the available coastal resource information and to prepare the coastal resources atlas both as maps and in digital format.

Responsibility: Department of Ocean Development/ Ministry of Environment and Forests for funding the above programme

Time frame: One year to assess the institutional capacity to undertake such programme and another three to four years to work out and finalize the coastal resources atlas of India.

Resource required: As required by the National Hydrographic Office and 1/3 of the total funding may be collected from the maritime states.

Action 19: Translation of government acts/rules and regulations in the local / regional languages

Category: Long term, high priority

Details: It must be made mandatory for the governments of coastal states concerned to prepare and make available all environment related acts/ rules and regulations and their periodic amendments in the local / regional languages for public use. At present, it is felt by people that it is very difficult to get the full set of acts / rules and regulations from the government offices. Further, they are not available in local languages. These are also causes for the loss of bio-resources since people are not fully aware of what are all included under prevention act, etc. Likewise, several other rules which are related to environment protection are also not clearly known to the common public. So, there is an urgent need to translate the acts such as Coastal Zone Regulation act, the water act, the air act, the forest conservation act, the wildlife protection act, the Indian fisheries act, the Indian ports acts etc. in the local / regional languages for the better understanding of such acts by the industrialists (small scale), fisherfolk and common public who all depend on the natural bioresources.

Responsibility: State Governments concerned

Time frame: One year to translate the above acts in the regional languages by the departments concerned.

Resources required: ---------

Action 20 *: Promotion of fishery practices in the Andaman and Nicobar region*

Category: Long term, medium priority

Details: The Andaman and Nicobar groups of islands have an area of 1,00,000 sq.km. of Exclusive Economic Zone and its fishing resources could be sustainably harvested by encouraging the local people to fish. This will be possible only by establishing provisions in the form of creating facilities for deep-sea fishing, cold storage facility, fish processing industries, by providing more faster and reliable transport facilities to main land and adequate marketing facilities. This would help generate employment for local people and ultimately would reduce the pressure of over-dependence only on island's forest resources. Value addition to fishery products can be done by undertaking onshore processing of fishes. This will create more employment opportunities for women and tribes. Above all, such fishing activities in the sea by the local people will help prevent international poaching of valuable marine resources such as sea cucumbers, ornamental fishes etc. from this area. Moreover, such local fisherfolk could act as filed informers to the officials of the forest department, fisheries department, wildlife department and Coast Guard and this will help control poaching, protect and conserve our coastal resources.

Responsibility: Government of India / Andaman and Nicobar Administration

Time frame: Two to three years to promote increased fishery practices among the local people of this region

Resource required: ----------

Action 21*: Quota allocation to the fishing vessels and use of resources through proper assessment of their values considering economical and cultural aspects*

Category: Medium priority and medium term

Details: This kind of restriction shall help reduce the fishing pressure in the sea and the conflicts arising thereof. Fishing vessels shall not undermine the effectiveness of conservation

Responsibility: Fisheries departments of states concerned has to formulate the rules and to allocate the quota to the fishing vessels considering the capacity of the vessel and the integrity of the ecosystem.

Time frame: One year

Resource required: ----------

Action 22 : Validation of the indigenous fishing practices on regional basis

Category: Medium priority and medium term

Details: This will help understand the performance of particular gear used in traditional fishing practices. The loss and gain due to the existing practice shall be examined for validation for a long term sustainability. If necessary, modification of such gears and fishing practices shall be proposed.

Responsibility: Governments of respective states through fisheries department, involving fishing and research community.

Time frame: Two years

Resource required: ----------

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Annexure - I

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Annexure – II

CROSS REFERENCING OF EAST COAST ECO-REGION STRATEGIES AND ACTIONS TO RELEVANT GOVERNMENT DEPARTMENT / AGENCY

Strategy and Action Plan	Government Department / Agency
Action 1	Ministry of Environment and Forests, Government of India and Department of Environment, State Governments concerned
Action 2	Ministry of Environment and Forests / Department of Ocean Development
Action 3	State Forest / Wildlife Department,
Action 4	Department of Ocean Development, Government of India
Action 5	Ministry of Environment and Forests, Government of India
Action 6	Department of Ocean Development / Ministry of Environment and Forests, Government of India
Action 7	Ministry Rural Development, Government of India / State Government
Action 8	State Government through Banking Sector
Action 9	Ministry of Environment and Forests, Government of India
Action 10	State Fisheries Department / Marine Product Export Development Authority
Action 11	State Fisheries and Forest Departments
Action 12	State Governments Concerned
Action 13	Ministry of Environment and Forests / Department of Ocean Development, Government of India
Action 14	Ministry of Environment and Forests, Government of India
Action 15	Ministry of Environment and Forests & Ministry of Tourism, Government of India
Action 16	Ministry of Environment and Forests, Government of India
Action 17	National Pollution Control Board
Action 18	Department of Ocean Development / Ministry of Environment and Forests, Government of India
Action 19	State Information Department
Action 20	Ministry of Agriculture, Government of India
Action 21	State Fisheries Department
Action 22	State Fisheries Department