CONSERVATION OF BIODIVERSITY OF THE WEST COAST BETWEEN MUMBAI AND GOA

Prakash Gole

Sponsored by
World Wide Fund For Nature
India

ECOLOGICAL SOCIETY
Pune
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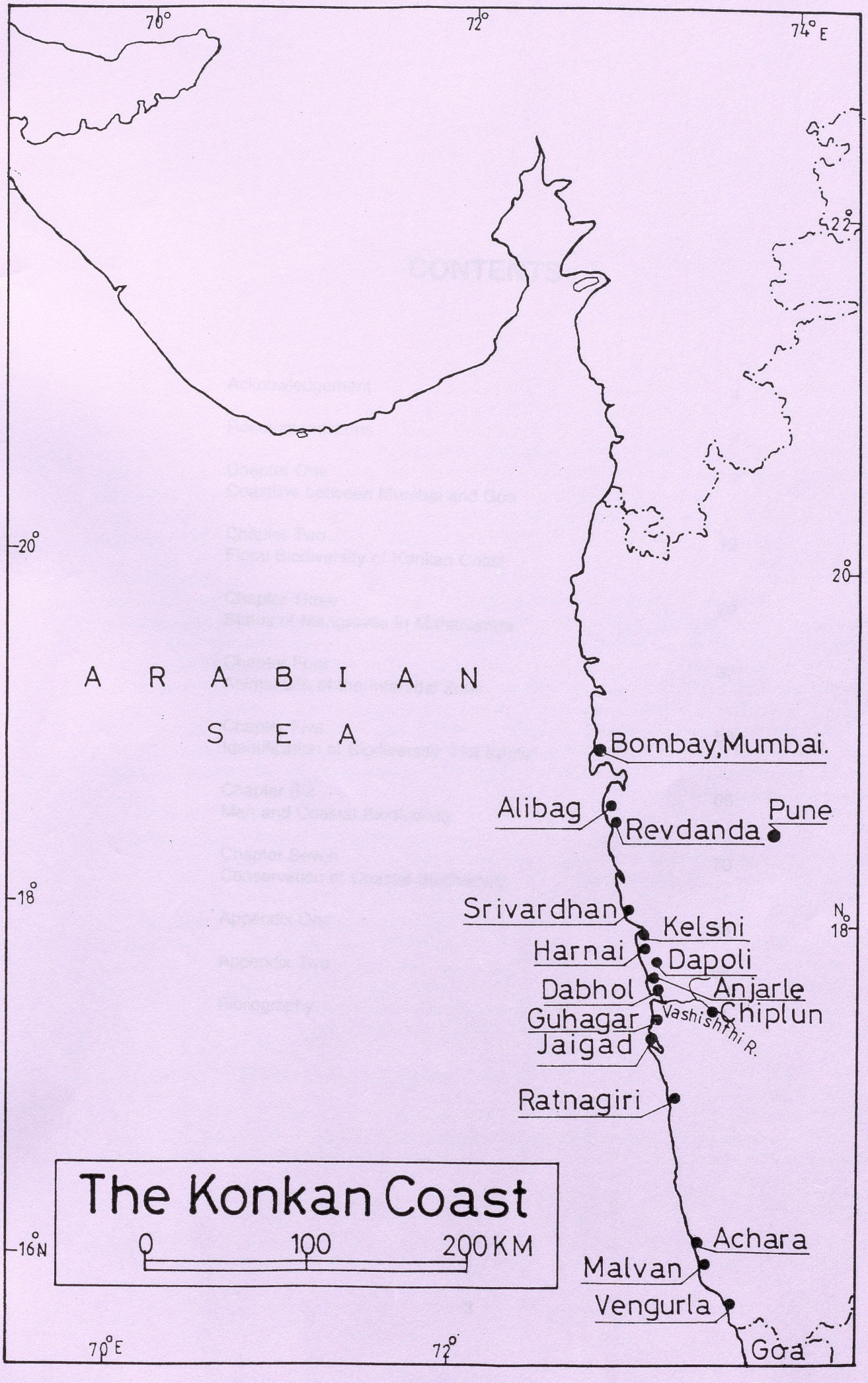
70°
72°
74° E
22°
20°
20°
A R A B I A N
S E A
Bombay, Mumbai.
Alibag
Pune
Revdanda
18°
Srivardhan
Kelshi
N. 18°
Harnai
Dapoli
Dabhol
Anjarle
Guhagar
Chiplun
Vashishthi R.
Jaigad
Ratnagiri
The Konkan Coast
0 100 200 KM
16° N
Achara
Malvan
Vengurla
Goa
70° E
72°

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ACKNOWLEDGEMENT

Help from a number of individuals, NGO's, and official agencies was responsible to see this project through. The very positive attitude of Shri. Samar Singh, Secretary General, WWF-I encouraged us to work hard. The Director of Bombay Natural History Society readily agreed to co-operate in the project and asked his staff to assist whenever their help was needed. In Pune ECOSOC's Chairman Admiral Awati (Retd) took keen interest. Prof. Mahajan assisted by training volunteers in identification of coastal vegetation. Likewise Prof. Joshi of Ratnagiri helped in identifying the intertidal fauna. Both the professors were very generous in providing advice whenever it was asked for. Dr. Ranade' of Ratnagiri helped in identification of fish species. His help was also invaluable in contacting officials and organizing the meetings of citizens. Mrs. Swati Gole assisted us in field work.

Shri. Vishwas Katadare and his team of volunteers from Sahyadri Nisarga Mitra were very helpful in organizing the Orientation Camp, meetings of citizens and carrying out socio-economic survey. Shri. Rajan Indulkar and Mrs. Vaishali Patil of Shramik Sahayog helped a great deal in providing contacts among fishermen and their leaders and organizing socio-economic survey. Shri. Ramesh and Sharad Dhuri of Machchimar Sangh in Malvan were instrumental in organizing the survey in south Konkan. Their support was invaluable in organizing logistics and facilitating movement in that region. Shri. Deolkar of Nath Pai Sevangan also gave valuable information. Shri. Soman of Deogad was helpful in organizing meetings of local people. Shri. Vaishampayan of Panchanadi, Shri. Mahajan of Kolthare, Dr. Dandekar of Dapoli and Shri. Aathwale of Murud also helped us in various ways.

Dr. Sawant, Vice-chancellor, Konkan Agricultural University took keen interest in our work. Dr. Untawale and his colleagues in National Institute of Oceanography, Goa, also assisted a great deal in identification of marine algae.

The officials of Forest, Town Planning and Irrigation Departments of Government of Maharashtra also helped us. We especially like to record the help received from Shri. Gogate, Principal Conservator of Forest (WL), Shri. Limaye, Conservator of Forest and Shri. Puranik, Dy. Conservator of Forest (WL). The Director, Town Planning and his staff provided information on plans covering the Konkan including the coastal zone. The Chief Engineer, Konkan region, Irrigation Department, provided data on river discharge of the Konkan rivers.

Lastly we like to record the hospitality, good nature and keenness to help of the people of Konkan, especially the fishing communities.

We are very glad to wholeheartedly thank all these individuals and organizations who made this work so enjoyable.

Prakash Gole, Sanjay Deshmukh, Sujata Pataskar

RECOMMENDATIONS

1. The presence of the Forest and Wildlife wings of the Forest Department of Government of Maharashtra needs to be strengthened in the Konkan region. To solve the region's peculiar problems their personnel should be specially trained to handle public relations, dissemination of scientific and other important information and peoples' participation in management and decision-making. This is crucial to the conservation of biodiversity.

2. For the proper conservation of biodiversity and the long-term interests of the local people and their culture, five biosphere reserves need to be established. They are: 1) Murud-Janjira-Shreevardhan-Savitri, 2) Suvarnadurg-Jaigad-Sandkhol, 3) Ratnagiri-Purnagad, 4) Vijaydurg-Devgad-Mithbao, and 5) Achra-Malvan. Local people are to be involved in their establishment and management. Before setting them up all relevant scientific and management information about them should reach the people and their pros and cons should be fully debated.

3. To further strengthen biodiversity conservation 12 Areas of Special Scientific Interest should be set up. Again local people should be involved in their management. Collection of specimen for scientific purposes needs to be strictly controlled in these locations.

   Both these categories of Marine Protected Areas should not interfere with traditional activities and occupations of the local people.

4. Hotels, resorts and other recreational activities need to be strictly controlled in marine protected areas. They should be located outside the reserve boundaries and their waste disposal should not pollute soil, streams, rivers and shoreline within the reserves. Only conducted tours under the guidance of qualified wildlife personnel should be allowed in the reserves.

5. To control the ground, air and water discharges of existing industries a monitoring committee consisting of biological and environmental experts, representatives of M S Pollution Control Board, Revenue and Forest Department officials and representatives of residents should be set up. It should have the power to inspect industrial units and recommend and enforce corrective measures.

6. The proposed Hindustan-Oman oil and gas pipeline terminal should be shifted from its present location to a site north of Murud-Janjira. Likewise as Dabhol (Vasishthi) estuary is an area of critical ecological importance no project be set up in it which will affect its character.

7. Fishing in traditional ways, with traditional gear and in low-powered boats should be allowed in marine protected areas (MAP). This is especially to be noted in the Malvan area where the present proposal to create a marine national park has sparked intense opposition. Traditional fishing can be practised in the core area of the proposed Achra-Malvan Biosphere Reserve.

8. High-powered boats and trawlers using purse-seine nets, mopping gear, suction gear and other equipment which is likely to lead to wholesale destruction of marine life should not be allowed to operate in 5-fathom deep shallow sea zone.

9. Activities such as traditional agriculture, low-energy input processing of agricultural and marine produce and non-effluent producing service industries may be allowed in MAPs. For this purpose the MAPs should be properly zoned.

10. Landowners in the Biosphere reserves should be encouraged to keep a part of their land for regeneration of natural forest. The Forest Department may enter into a contractual arrangement with them which allows them a cash incentive for the proper maintenance and quality enhancement of the forest on their lands. Such demonstration activities will not only help biodiversity but will also create a sense of belonging among local people.

11. At specific locations within the biosphere reserves the Forest Department should establish or contract landowners to establish mixed plantations of Tectona grandis, Terminalia alata, T. paniculata, Gmelina arborea, Callophylum innophylum, Wild mango, Thespesia sp. and Acacia sp. for the needs of local people and their traditional activities.

12. The present proposal for the establishment of a marine national park at Malvan should be suitably modified in consultation with local people so that it will form a part of the proposed Achra-Malvan Biosphere Reserve.

13. In the areas of special scientific interest, while traditional, low-intensity activities should be allowed, watch and ward committees consisting of wildlife officials, wildlife wardens should be set up to protect their biodiversity.

14. Similar watch and ward committees need to be set up for the nesting of marine turtles on the following beaches: Murud-Janjira, Velas, Kelshi, Murud (Harnai), Guhagar, Ganapatipule, Ratnagiri, Ganeshgule', Ambolgad, Vijaydurg, Kolewadi, Padavanewadi, Phanasewadi, Mithmumbri, Kunkeshwar, Hindale', Achra, Bhogvewadi, Vayangani, Kelus, Mochemad and Arawali. That marine turtles are protected by law needs to be properly publicised by bringing out coloured posters etc.

15. Mangroves and mudflats in the Kundalika, Mhasala, Savitri, Kelshi, Vasishthi, Bhatye, Vaghotan, Deogad and Achra estuaries should be transferred to the Forest Department for care, maintenance and enhancement of their quality. They should be guarded against contamination. Degraded mangroves should be replanted by involving local communities on contractual basis. Women should especially be involved.

16. The Government should encourage and assist Mumbai and Shivaji universities, the Institute of Science in Mumbai, Taraporwala Aquarium, Agricultural University, Dapoli, College of Fisheries, Ratnagiri, National Institute of Oceanography, Goa, to conduct training and extension programmes of education in coastal biodiversity conservation. They should be aimed at coastal communities, should integrate relevant local knowledge based on experience and should provide local people incentives to guard and protect local biodiversity. NGOs and interested, dedicated individuals should be co-opted in these programmes and their help sought in organizing nature camps, promoting eco-tourism, organizing monitoring activities etc.

17. The state-level committee on the management of wetlands and mangroves should be revived.

18. Transport of wood and timber from the government and private forests outside the region should be strictly controlled.

CHAPTER ONE

THE COASTLINE BETWEEN MUMBAI AND GOA

From the border of Gujrath in the north (about 20° N latitude) to the border of Goa (16° N lat.) the coastline of India forms the part of Maharashtra state which has a long coastline of about 720 kms. The coastline between Mumbai and Goa with a length of about 500 kms is a part of Maharashtra coast. This region of Maharashtra known as the Konkan is narrow (width upto 60 kms only) and hilly and difficult of access over land. The seaboard is characterized by the presence of typical funnel-shaped estuaries at the mouth of small streams rising into the Western Ghats to the east and flowing into the Arabian sea. Western Ghats known as the Sahyadri in Maharashtra allow access to the Konkan region through a few very steep, zigzag roads passing over its crestline at a height of over 1000 meters. The Arabian sea confronts the radiating spurs of the Sahyadri along an indented coastline.

The region may be divided into :

1. North Konkan consisting of Thane dist, Greater Mumbai and Panvel and Karjat Taluks of Raigad dist.

2. Central Konkan (between 18° N and 16° 45' N lat.) consisting of the remaining part of Raigad dist. and northern taluks of Ratnagiri dist.

3. South Konkan consisting of southern Ratnagiri dist. and whole of Sindudurg dist. (between 15° 45' N and 17° 15' N lat.).

The northern Konkan comprises of the river basins of the Vaitarna, the Ulhas and their tributaries; the central Konkan of the river basins of the Patalganga, the Kundalika, the Savitri, the Vasishthi and their tributaries; and the south Konkan is formed of the river basins of the Shastri, the Muchkundi, the Vaghotan, the Achra, the Karli and the Terekhol and their tributaries. These rivers drain into the Arabian sea forming wide estuaries which are navigable for small vessels over a distance of 25 to 50 kms. from the sea.

Formation and Character of the Coastline

The Indian peninsula was once a part of the Gondwanaland from which it started drifting north during the Cretaceous era. At the Cretaceous-Tertiary boundary (about 65 million years ago), the Indian plate began to experience intense volcanic activity due to uplift and pouring of lava over the peneplained surface. The cooling of the lava resulted in layers of the Deccan trap which are clearly seen today in the hills of the Sahyadri. As the downward drift continued the Indian peninsula gradually came under the monsoonal regime. The streams that began to flow from the newly formed mountains were superimposed on the landscape.

Over the years the tract witnessed epirogenic movements, headword erosion, submergence in the sea, recession of the scarp, progradation and retrogression, emergence and lateritization. During the Quaternary the sea level rose and then fell giving rise to drowned valleys and the emergence of offshore islands. The presence of raised beaches, extensive beach rock exposures, dune ridges extending several kilometers inland all point to a fall in the sea level (Wagle 1989). The sea level stabilized about 6000 years ago and has fluctuated only mildly since then (Kale and Rajguru 1988). Older dunes extend 1 to 2 kms inland and are now covered with vegetation. The recently formed dunes are devoid of any vegetation and those that are untouched by waves show that they are a part of the coast where depositional processes are going on. Because of the steep slopes and shallow cover of the soil, almost all rivers flow during and immediately after the monsoon but progressively dry up as the summer approaches. The rivers have developed small terraces on their banks and alluvial fans as they approach the flat lands near the sea. The tidal effect is seen to reach even upto 40 kms in the interior in the rivers such as the Vaitarna, the Amba, the Ulhas and the Vasishthi.

The Climate

The Konkan region experiences a hot and humid maritime climate with plentiful rain during the monsoon months, i.e. June to September. The mean annual temperature ranges from 22° C to 30° C. The range of variation is low because of its proximity to the sea and the wind barrier formed by the cliffs of the Sahyadri. The mean maximum temperatures generally range between 25° C and 35° C and the mean minimum range between 10° C and 27° C. April and May are the hottest months of the year. High humidity and pleasant onshore breezes are characteristic of the coastal low lands. The mean relative humidity at 0830 hrs IST and 1730 hrs IST in the region is generally found to be 80 per cent.

Western Ghats provide the principal geographical barrier in the path of the Arabian sea branch of the south-west monsoon and are responsible for the very heavy rainfall over its crestline (600 to 700 cms per annum). The rainfall decreases from east to west with the mean annual average of 300 cms on the coastline. The region may experience a feeble secondary spell of rainfall (80 to 200 mm with 5 to 10 rainy days) during October-November in association with movements of depressions over the sea.

Soils

The plentiful supply of water received during the monsoon is responsible for silt-laden flows of the rivers. In about a width of 20 km from the coast, soil is formed due to deposits of eroded material brought by the streams from the steep slopes of the Sahyadri. During high tides, seawater inundates the soil deposited along the creeks and increases the contents of soluble salts.

In Raigad dist. soils are sandy clay loam to clay in texture. The depth varies from 45 to 90 cms. The maximum water-holding capacity varies from 46 to 67 p.c. The electrical conductivity is as high as 14.0 mhos/cm. In Ratnagiri and Sindhudurg districts soils are sandy to clay loam in texture with high rates of percolation. The water-holding capacity is low (28 to 44 p.c.). The soil depth varies from 67 to 90 cms. In general, the coastal saline soils of Thane and Raigad districts are fine textured containing high proportions of silt and clay; while those of Ratnagiri and Sindhudurg districts are lighter with a high proportion of sand fraction.

Investigating the Coastline

Standing on the crestline of the Sahyadri and looking west one can see the ground falling at first steeply and then into step-like terraces that undulate right upto the coast. The sea therefore, actually marks the boundary where the radiating spurs of the Sahyadri face the pounding of the waves. The coastline consists of headlands and promontories that jut out into the sea, protected crescent-shaped beaches between two promontories, small, isolated pocket beaches, straight sandy beaches often many kilometers long, estuaries and creeks with their alluvial plains, arcuate

bays, spits, eroded cliffs, wave-cut platforms and rugged sea cliffs that stand like walls bearing the full impact of the waves. The number of beaches on the coastline between Mumbai and Goa can easily run upto 100. The present report is based on investigation in the intertidal zone of 80 beaches of which 48 were sandy and 32 rocky.

Estuaries of the several rivers were also examined. These are places where mangroves are located. Thane and Panvel creeks, the Mhasala and the Shreevardhan creeks, the estuaries of the Kundalika, the Savitri, the Vasishthi, the Vaghotan, the Deogadh, the Achra and the Karli rivers were examined for mangroves.

The character of the beaches was assessed on the basis of their length and breadth, dune vegetation, protective vegetation, variety and number of marine life forms, the variety and extent of intertidal flora and fauna and the variety and number of nesting and wintering bird fauna. The quality of mangroves was assessed on the basis of their length and breadth, floral variety, density of cover and the height of trees.

Biodiversity of the Coast

The Earth Summit in 1992 defines biodiversity in the following manner: "Biological diversity means the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic systems and the ecological complexes of which they are part; this includes diversity within species, between species and of eco-system."

This comprehensive definition covers almost all aspects of biodiversity. It was however, not possible to examine all these aspects in the time available to us. We therefore, restricted ourselves to examining genera/species richness and their extent and abundance covering the intertidal zone. We also examined species richness of eco-systems that support and sustain the intertidal flora and fauna. Such eco-systems included protective and dune vegetation, mangroves along creeks and estuaries, their associated vegetation and forests adjoining them.

As we began listing the species diversity and richness of flora and fauna, the parameters that should be taken into account in assessing biodiversity status became evident. They are :

For sandy and rocky beaches : total length, slope and extent of sand dunes, background protective natural and planted vegetation, number and variety of shells, crabs, marine animals, number and variety of wintering and pelagic birds, presence of the nest of White-bellied sea eagle, extensiveness of different vegetation and animal zones on rocks, number and size of rock pools, presence of rare plants and animals and intensity of human use.

For estuaries : total area covered by mangroves, total area covered by forests on slopes looking over the estuaries, the area covered by mudflats and islands, navigability and the extent of tidal influence.

For mangroves : length and breadth of the mangrove patch, average height of trees, density of tree cover, species variety and intensity of human impact.

Survey Methods

The field work began in October 1996. With the help of tidal time tables days of low tides at places which we wanted to examine were selected. The fieldwork in the intertidal zone was carried out 2-3 days before and after the day of the low tide. Most of the beaches could be visited only once, though confirmatory visits were again paid to beaches where excellent biodiversity was noticed. Algal specimens were collected for identification. Estuaries were examined by boat for mudflats, marshes and mangroves. In some estuaries it was possible to examine mangroves by going around and inside them wherever bunds were available. Mangrove vegetation could be examined at close quarters then. Surface water samples were collected in estuaries for examination.

A socio-economic survey of coastal communities was carried out with the help of a questionnaire on the coast between Bankot and Jaigad and Achara and Malvan. This was entrusted to trained volunteers from the NGOs working with fishermen's communities. The volunteers carried out the survey.

Coastal Communities

In Raigad district fishing is carried on by Bhois, Gabits, Kharvis and Kolis. Bhois are found all over the district. Gabits are mainly from Mahad or Ratnagiri. Kharvis are from Alibag, Mangaon and Mahad. Kolis are from the whole district, a few of them even live in the hills. Sailors and fishermen are mainly Son-Kolis. They are skillful and brave seamen, manly, hard-working and honest. They catch fish both for local use and for the market at Mumbai. When a cargo of fish is landed, it is sorted on the beach, the best taken by women in large baskets to nearest markets. The poor varieties are thrown on the sand to dry and afterwards sold as manure. If sharks are caught their awes are cut, dried and sold for export.

Fishing communities from Ratnagiri and Sindhudurg district consist of Gabits found from Deogad to the Goa frontier and Kolis who reside mainly on the north coast. The men catch fish on the high seas and women sell them fresh, or dry it for the market. Gabits are engaged in carrying goods and passenger traffic also. Kolis are the ancient residents of the coast possessing many forts in the past. Many of them have their own boats, prepare their own nets and value their independence.

The Fishing Industry

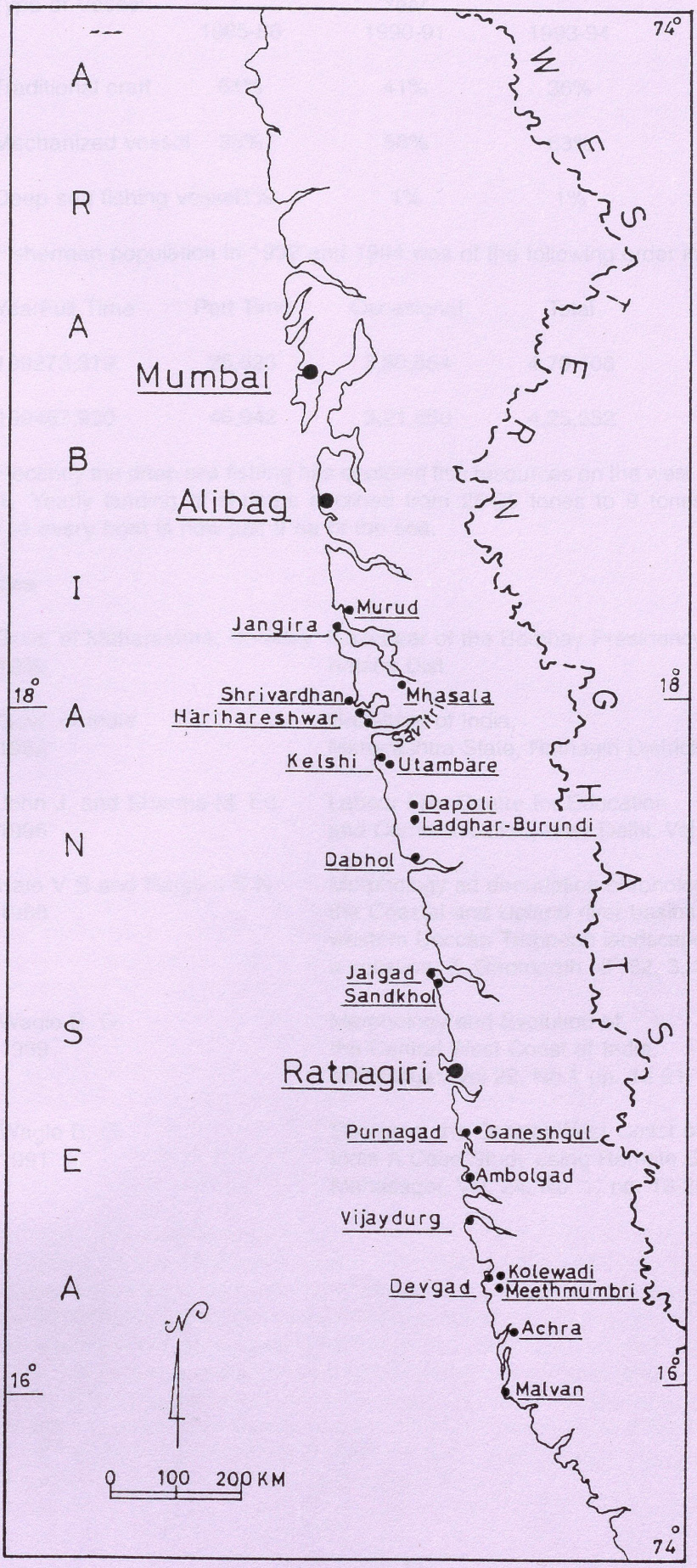
Traditional fishing is a small scale industry in which fishermen pool their resources and catch as well. The catch is divided among the active parties, the owner of the boat gets two shares and the rest divided among the crew. They do not fish during the monsoon. Most of the fish is sold in local market, a small percentage is exported to Mumbai and Pune after processing. The main difficulties in the trade are storage and transport, finance for mechanization and lack of proper marketing facilities.

In Ratnagiri and Sindhudurg there are 119 fishing villages and towns out of which Bankot, Dabhol, Jaigad, Jaitapur, Malvan, Ratnagiri, Vengurla and Vijaydurg are the important fishing centres. In 1958-59 the total fishing community population was about 70,000 with the active fishermen numbering 21000. The traditional fishing boat varies in weight from 4 to 9 1/2 tons with 1 to 2 masts and nets varying in size from 3 to 6 meter in length and 2 to 9 meter in breadth. The types of nets include bag, drift, gill, ghol, wall and cast nets, hooks, lines etc. In 1958 there were about 3700 fishing boats.

The government have several programmes to help the fishing industry through loans and subsidies. Loans are provided to the extent of 95% of the cost of the vessel. This encouraged mechanization and the use of large, mopping nets.

In 1991 the government of India announced an open door policy in India's economic zone offering subsidized fuel, 100 p.c. export permission, trans-shipment at sea and no compulsion to dock in an Indian port. This led to fierce competition from foreign companies who entered into partnership with Indians. In 1993 according to the Ministry of Agriculture, for the whole Indian coast, there were 1,7,752 traditional vessels, 25,467 traditional mechanized vessels and 34,848 mechanized boats. In 1983 there were 68 trawlers capable of fishing in deep sea. Their number increased to 180 in 1990. The percentage of marine fish caught by different sections was as follows :

Coastline Between Mumbai & Goa



Type of Vessel	Year		
	1985-86	1990-91	1993-94
Traditional craft	61%	41%	36%
Mechanized vessel	38%	58%	63%
Deep sea fishing vessel	1%	1%	1%

Fishermen population in 1992 and 1994 was of the following order in Maharashtra :

Year	Full Time	Part Time	Occasional	Total
1992	73,319	25,623	3,80,564	4,79,506
1994	67,930	46,042	3,21,680	4,25,652

Recently the deep sea fishing has depleted fish resources on the west coast between 1985 and 1991. Yearly landing of shrimps declined from 25-35 tones to 9 tones. The fishing area available to every boat is now just 9 ha of the sea.

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CHAPTER TWO

FLORAL BIODIVERSITY OF KONKAN COAST

Sujata Pataskar

Biodiversity of a place / habitat is the variety (Genetic) of the flora and fauna that exists in / on that place symbiotically, commensally, parasitically or independently as ephemerals or perennials, as well as the microflora and microfauna. Seasonally visiting animals and birds also equally contribute to the biodiversity of a habitat. The extent of interrelationships, associations, interdependence amongst the floral and faunal members and the nature and complexity of foodchain and foodweb network established between them are also major parameters or indicators of the biodiversity dynamics.

The aim of the project was to survey and study the biodiversity of the intertidal zone along the Konkan coast and finally identify the hotspots which will be further promoted for their protection and conservation by formatting and devising a suitable management plan. Only the macrofloral biodiversity has been considered here.

The Intertidal Zone

The coast in a transverse section can be broadly distinguished into three zones namely the dunes, the beach and the shoreline or sea. Each of these has its own characteristic floral and faunal composition. The intertidal zone on the coast is the region which lies between the highest high tide mark and the lowest low tide mark. The extent of intertidal zone varies from a few meters to over 1 km depending upon the beach type. The bays or creeks where there is intermixing of fresh river water and saline water are also a part of the intertidal zone.

So, for convenience the floral vegetation in the intertidal zone has been separately studied for the beach flora, the dune or strand vegetation and the mangrove communities in the estuaries. Many a time it was quite surprising to notice that a certain places there was a total absence or very scanty floral growth inspite of the availability of favourable factors as compared to those places which exhibited similar conditions and harboured a luxuriant flora. This needs more investigation.

The season we visited the coasts from Murud (North Konkan) to Redi (Southern most Konkan beach) was between October 1996 to April 1997. It was not an intensive survey as each beach was visited only once and only the occurrence during that particular season was recorded. The major floral forms collected / observed in the given time span and the area covered are described. Some of the commonly occurring genera of algae and angiosperms occur on most of the beaches, varying only in their abundance, density and extent of cover.

The parameters employed to study the floral cover on the beach or strand / dune or (mangroves) estuaries were :

FOR ALGAE :

1. The dimensions or the area of the beach compared to the total area covered by the algae.
2. Density.
3. Comparative abundance of the species (i.e. Dominant, Condominant, Common, Rare etc.)
4. Percentage ratio of common to uncommon species.

FOR MANGROVES :

1. The average height and the canopy spread.
2. The variety or number of species encountered.
3. The area covered by the mangrove patch.

FOR STRAND OR DUNE VEGETATION :

1. The number of species recorded.
2. Associations observed.
3. The extent of spread of *Ipomoea biloba* zone and the genera coexisting along with.
4. The width of dunes penetrating inland.

The Beach

The beach can be categorised into three major types : Sandy, Rocky and Mixed type. The sandy beaches can be subdivided according to colour and texture variation into Muddy sand, Black metallic sand, very Coarse sand comprised of shell pieces, White sand and Golden yellow fine sand. The intertidal zone of a purely sandy beach hardly harbours any algal flora but this sand when forms a layer in rocky pools and crevices can act as a good substratum for algal growth. Very few beaches like Kunkeshwar, Bhatye, Kolewadi showed presence of algae like Enteromorpha, Padina, Ulva on such a substratum, that too towards Northern rocky headlands sides.

Other sandy beaches visited were Guhagar, Velneshwar, Ganeshgulé, Ranpar, Gavkhadi, Vettye, Madban, Padavnewadi, Kolewadi, Deogad, Mithmumbri, Tambaldek, Kunkeshwar, Adhé, Padlé, Achra, Malvan, Tarkarli, Murud, Kelshi, Anjarlé, Vengurla, Ubhadanda, Kelus, Velagar and Shiroda. The sandy beaches at abovesaid locations were devoid of any algal flora because of lack of any firm substratum for rooting but the rocky portion with a sandy substratum lodged good and dense flora at most of these places.

Purely rocky and mixed type of beaches seemed to be ideal for algal growth. Amongst rocky beaches, the beach at Sandkhol towards the southern headland was morphologically weathered with wave cut rocky, uneven platforms, with an intertidal zone of 35-40 mts and backed by steep cliffs. This beach exhibited a dense and luxuriant algal cover with a co-dominance amongst the existing genera. They included *Ulva, Sargassum, Dictyota, Hypnea, Ceramium, Chaetomorpha, Polysiphonia, Clarophora, Gelidium, Gelidiopsis, Grateloupia, Enteromorpha, Padina, Gracillaria* and *Melobasia.*

Rocky wave cut platforms at purnagad were about 3.5-4 kms long with a width of 25-30 mts backed by straight cliffs. Here too, the wave action was vibrant and characteristic pothole formation was seen. Occurrence of peculiar multiple chain of potholes was observed. Other pools, puddles and crevices harboured a good algal cover, though not too dense but in uneven patches. There was no distinct zonation or stratification observed. The algae included mainly *Sargassum, Dictyota, Stoechospermum, Gracillaria, Hypnea, Laurencia, Grateloupia, Acanthophora, Enteromorpha, Cladophora, Chaetomorpha.* Very rare occurrence of Caulerpa seen.

At Ganeshgulé, the southernmost headland was initially bouldary and gradually towards south the rock was wave-cut with patchy algal distribution.

Kolewadi beach was of mixed type with sand bordered rocks towards North and South. Total length of the beach was about 1.5-2 kms and the intertidal zone being 40-50 mts wide. To the South of the Sandy beach, on big boulders was dense, abundant algal growth. Dominating genera were *Caulerpa sertularoides, C. scalpeliformis, C. racemosa var. peltata, Polysiphonia, Gelidium, Gelidiopsis, Padina, Dictyota, Enteromorpha, Acanthophora, Hypnea, Bryopsis, Ceramium* and *Gracillaria.* In the rocky patch of 15 x 800 mts dimension almost 80% was covered with algae. All were exhibiting wild and luxuriant growth. Towards Northern headland of the beach were small rounded boulders scattered uniformly on an area of 20 x 150 mts on which towards the sea side, approximately 5 mts wide belt exhibited *Dictyota, Padina, Sargassum* and *Chaetomorpha.* On the boulders away from the sea, behind the abovesaid 5 mts patch were seen sparse *Ulva* and *Enteromorpha.*

At Mithmumbri, the southward portion of the sandy beach was composed of big boulders with almost horizontal or 0 beach slope. The algal flora recorded was similar to the one found at Purnagad but more frequent occurrence of *Caulerpa racemosa var. peltata* was seen.

Kunkeshwar beach behind the Temple was sandy with very gradual slope and 2-3 small patches of Sabellaria colonies with *Enteromorpha, Ulva* growing alongwith it. Towards north of this sandy beach are flat platforms closely levelled with the adjacent sandy beach, having shallow puddles and crevices with a substratum of sand in between. Algal cover was fairly good (about 60% of the total rocky area) and was more on seaward side. Intertidal zone was 25-30 mts wide. Though the algal cover was fair and variation was less, calcified algal genera viz; *Amphiroa, Jania* and *Cheilosporum* were found in abundance at Kunkeshwar beach.

Murud beach was sandy, very gradually sloping with an intertidal zone of 500 mts and was about 4 kms long. Towards south after 1 km, there was a sudden patchy outgrowth of flat rocks which were irregularly distributed over an area 1.5 km long and 100 mts wide. Rocky patches near village Burundi exhibited maximum biodiversity of both flora and fauna. Algal variety was composed of *Polysiphonia, immature Grateloupia, Gelidium, Enteromorpha, Dictyota, Padina, Gelidiopsis, Ahnfeltia, Hypnea, Lithophyllum, Caulocanthus, Cheilosphorum, Rhizoclonium* and *Gracillaria.* Algal flora occupied about 50% of the rocky surface and the remaining part covered with faunal varieties like Sabellaria, Corals, Sponges and Mytillus beds. Almost 95% of the total rocky patches were densely covered with flora and fauna. The beach was very gradually sloping and the wave action was very mild.

Utambaré-Kelshi beach covers the seaside from the mouth of a narrow river northward to Kelshi. Near the mouth of the estuary were small boulders which gave way to big boulders towards north with flat platforms towards the sea. The platforms near the lighthouse in the bay mouth showed thick and dense algal growth. Inside the bay mouth on small boulders as well as on sand throve *Ulva, Enteromorpha, Padina, Polysiphonia* and on flat rocks towards north was seen *Sargassum, Dictyota, Padina* followed towards land by *Polysiphonia, Cladophora, Ulva, Enteromorpha, Ceramium, Gelidium, Bryopsis, Hypnea* and *Gracillaria.* Total width of this rocky beach was approximately 100 mts out of which 30-40 mts towards the sea were densely covered with algal mat. The rocky stretch was intruded in between transversely by small bay like projections. In the pools and puddles formed in the rocks, each was occupied by a dominating algal genus independently. Sargassum was seen flourishing in stagnant pools as otherwise it is seen adhering to steep or sloping rocks continuously splashed by waves. The sea water was muddy and sublittoral zone was exposed.

To south of Utambaré across the small bay are sandy beaches of Aadhé and Padlé with an intertidal zone of 200 mts, where the sand was brownish muddy and the beach was gradually sloping. After 1-1.5 kms was a projecting jetty-like formation of boulders in the sea. Amongst these rocks were 125-130 stunted Avicennia bushes. After this jetty, towards the south flat rock continues for 0.5 kms. These rocks have shallow round potholes whose peripheral borders are a bit elevated. Not much algal cover was encountered except *Ulva, Enteromorpha, Rhizoclonium, few Gracillaria* and *immature Grateloupia.* These occupied hardly 20% of the total platform area.

Murud-Janjira beach is divided into two parts : partly sandy near the village and partly pure bouldery rocky to the south of the village across a weak bay. Huge boulders were seen away from the sea and flat rock beds towards the sea, like those encountered at Sandkhol. Rocks exposed to wave action were 70% covered with algae like *Sargassum, Dictyota* (two species), *Gracillaria, Grateloupia, Hypnea, Acanthophora, Laurencia* and *Padina* whereas the second stratum slightly away from the sea was comprising of Ulva, Chaetomorpha, Cheilosporum, Jania, Dictyota and Champia. Few pools behind these two algal strata were harbouring Caulerpa racemosa var. peltata. Width of the rocky zone was about 100 mts and the length was about 1 km. Out of these 100 mts, about 20 mts wide belt from the sea side was densely covered with algae. Out of the total area covered by algae almost 50% of it was occupied by *Sargassum, Padina, Dictyota* and *Spatoglossum* collectively. The growth observed was wild and luxuriant with a good variety and number of faunal members dependent on them.

The beach of Shrivardhan was sandy, 2.5 kms long with an intertidal zone of approximately 350-400 mts which was very gradually sloping. Its Northern rocky headland which was composed of big boulders and having a width of about 20 mts and extending northwardly upto 1.5 kms exhibited a good algal cover. Here the *Phaeophyceae* and *Rhodophyceae* members dominated *Chlorophyceae.* These comprised of *Champia, Gracillaria, Dictyota, Hypnea, Grateloupia, Acanthophora, Laurencia, Lithophyllum, Sargassum, Padina, Polysiphonia, Gelidium, Gelidiopsis, Halymenia* and a few *Ulva.* A belt of 15 mts width and about 1 km long was covered with good algal mat and of the overall area covered by algae, about 50% was occupied by *Champia, Gracillaria, Hypnea* and *Gelidium.* Faunal diversity was almost negligible.

The above discussion concludes that the density and variety of algal cover in the inter tidal zone are remarkable at the following beaches :

1. Murud Janjira
2. Shrivardhan
3. Ladghar Burundi
4. Budhal
5. Sandkhol
6. Jakimirya
7. Purnagad
8. Kolewadi
9. Padavanewadi
10. Mithmumbri

The beaches described above have been given different grades to quantify the observed algal biodiversity in terms of highest scores attained by these beaches in the table on the status of beaches. Here, rocky and sandy beaches are assessed separately as the actual algal flora is restricted to rocky beaches than sandy ones. The sandy beaches tend towards higher score because of their length and wide spread intertidal zone which shouldn't misguide the reader about the real status of the beach. As the scoring pattern has been clarified below the table, it is necessary to elaborate the meaning of the terms as they are relative to each other.

Poor status of algal cover is meant by negligible or scanty flora as compared to the total area of the beach as well as occurrence of less than 5 algal genera.

Good algal cover is one where the flora is irregularly scattered in patches and the genera recorded are between 6-9.

Very good algal cover can be described as occurrence of a uniform and fairly dense spread which can be at times discontinuous but occupying about 30-40% area of total beach span. About 10-12 algal genera are encountered.

Excellent cover is the richest and luxuriant algal growth forming a uniform and thick mat on

the substratum, occupying more than 50% area of the total rocky intertidal zone. More than 13 genera are listed.

Dune and Strand Vegetation

In a seashore environment, dunes are irregular, undulating small hilly ranges of sand formed behind a sandy shore. These can occur in one, two, three or multiple rows extending inside upto 1.5-2.0 kms. These dunes have their own characteristic vegetation with a strong, firm and deep penetrating root system which goes down to the water table below as the top soil cover is composed of sand. These extensively spread dunes can therefore, form an independent ecosystem itself.

The dune vegetation to a great extent prevents sand erosion by acting as sand binders and the trees growing on dunes protect the inland vegetation and human settlements from strong winds carrying sand, blowing from the sea.

Sand binders like *Ipomoea biloba, Cyperus sp., Cynodon dactylon, Spinifex squarossus, Lawnia pinnatifida* etc. are seasonal or ephemerals which complete their life cycle in one favourable season and then hibernate underground as the unfavourable season approaches or if there is scarcity of water. As the wind is strong on shores, the mode of seed dispersal is usually anemophilic i.e., carried away by the wind. So the seeds have special modifications and adaptations like light weight, minute size, developing winglike structures etc. Sometimes a multiple seed complex structure formation is seen as in Spinifex, which together is transported from one place to another. Spinifex is a member of family *Poaceae* with a running habit having underground stolons and spiny, thick leaf blades. The seed complex is enveloped by dried spines forming a sphere which when detached from the parent plant, rolls on sand and is carried away by the wind. In case of *Ipomoea* the seeds are expelled forcefully if even slightly disturbed by wind.

On most of the sandy beaches the dunes are delimited by *Ipomoea biloba* towards the extreme seaward side. But at some places like at Tarkarli this position was occupied by *Cynodon dactylon* whereas at Murud near Garambi, this was replaced by *Sesuvium portulaccastrum.* Ipomoea, a creeper which forms a uniform dense cover on crests bears conspicuous violet flowers and have bilobed leaves as its specific name indicates.

Beaches at Guhagar, Ranpar, Ambolgad, Gavkhadi, Vettye, Madban, Deogad, Tambaldek, Mithmumbri, Murud-Kelshi, Kolthare and Shiroda were having extensive *Casuarina equisetifolia* plantation which acted as a wind barrier. These have a width in the range of 0.5-1 km and a length of 0.5-2 kms. Casuarina plantation was predominantly noticed on every bar formation near bay mouths, eg. at Hindale, Deobag, Dabhol creek, Ranpar, Mithbav etc. which helps prevent the sand blocking the bay mouth by binding it, to some extent.

Strand vegetation delimits the beach by forming a thick wall behind the beach. Behind this strand vegetation are other common wild or planted mesophytes. Usually where strand vegetation exists, dune spread is not seen or if present it is negligible. Only one or two crests towards the seaside occurred which hardly bear any vegetation. These strands are normally dominated by *Pandanus sp.* alongwith *Vitex nigundo, Crotolaria sp., Zizyphus sp., Calotropis sp., Vitis trifoliata, Carissa carundus* and *Opuntia.*

Sole dominance of *Pandanus* strand was encountered at Murud, Kelshi — near Utambaré, Padlé and Kasheli.

On some beaches like Anjarlé, Tarkarli, Achra and Ambolgad alongwith *Pandanus, Vitex nigundo, Lantana, Carissa carundus, Zizyphus, Crotolaria, Opuntia* and *Calotropis* were found equally dominating. These plants tend to switchover their habit towards mild xerophytic physiology as the conditions persist.

Behind these crests and strand mesophytic angiosperms make their appearance e.g. *Thespesia populnia, Calophyllum inophyllum, Clerodendron inerme, Pongamia glabra, Euphorbia sp., Erythrina sp.* and *Cocus nucifera*. Though these plants are seen on dunes and crests to grow upto their maximal habit they need soil beneath the sandy layer and cannot survive solely on sand.

Extensive dunes were encountered at Arvi (near Redi), Ubhadanda, Mithmumbri, Garambi (near Murud), Tarkarli, Velneshwar and Achra. Here, alongwith aforesaid vegetation, variation was added by occurrence of plants such as *Acanthus sp., Anacardium occidentale, Cyperus sp., Momordica sp., Eugenia sp., Wedelia sp., Indigofera sp., Desmodium sp., Barleria preonites, Elaeocarpus sp., Sterculia sp., Odina woodier, Flacourtia sp., Achyranthus aspera, Vernonia sineraria, Senecio grahamii, Cassia tora, Ammania bassifera, Teramnus labialis, Wedelia sp., Boehravia diffusa, Ricinus cummunis, Eclipta alba, Acanthospermum hispidum* and *Leucas sp.* These plant representatives were not encountered so frequently as were seen at these places.

More towards South of Konkan i.e., Malwan and southwards, Cashew trees were seen very commonly on dunes. At Arvi, amongst Casuarina was seen *Datura sp.* on the dunes. At Ubhadanda, extensive dunes spread inwardly from the beach till 1-1.5 kms which imparted it an appearance of a desert ecosystem with sparse vegetation cover and dried, stunted herbs and shrubs. Special mention is required for the occurrence of *Caesalpenia crista* on the dunes alongwith *Pandanus*. At Mithmumbri, *Zizyphus sp., Ficus bengalensis, Sterculia urens, Odina woodier, Strychnos nux vomica, Flacourtia sp.* and *Salvadora persica* occurred on dunes alongwith other typical dune flora.

Poaceae members e.g. *Elusine sp., Ergostis sp., Argyreia speciosa, Setaria sp.* and *Celosia sp.* occurred frequently amongst *Ipomoea biloba, Spinifex squarossus, Crotolaria sp.* and *Cyperus sp.* forming crest cover.

Beach length at Ubhadanda near Vengurla was about 3.5-4.0 kms and the dune width about 1.5 kms. At Velagar, beach length was approximated 3-3.5 kms and the dunes extended to a width of 1 km. Casuarina plantation seemed to be quite old as the girth of trunks was quite large and buttresses were formed at the trunk bases.

Dunes at Garambi (Murud) were in 4 rows. The raremost dune towards land showed fair growth of mesophytic strubs and trees like *Vitex nigundo, Thespesia populnia, Urena sp., Tridax procumbens, Clerodendron inerme, Cocos nucifera* etc. which gradually towards seaside was replaced by *Zizyphus sp., Calotropis sp., Crotolaria sp., Indigofera sp.* and *Lantana camera* and finally *Cyperus sp., Ipomoea biloba, Lawnia pinnatifida, Sessuvium portulaccastrum, Cynodon dactylon, Setaria sp., Elusine sp.* and *Spinifex squarossus*. The dune area at Murud was about 75 sq. km.

In most cases, *Ipomoea-Spinifex* association was common where Ipomoea usually dominated. Many a time, *Ipomoea* is patchy, scattered with *Crotolaria sp., Leucas sp., Acanthus sp.* and *Cyperus sp.* evenly distributed. Some times Ipomoea is negligibly present and was replaced by *Sessuvium portulaccastrum* and *Cynodon dactylon*. *Cynodon*, as seen on Tarkarli and Garambi dunes was a bit robust with very strong, pigmented stolon, shorter and swollen nodes and dwarf leaves. *Sessuvium* is a Portulaccaceae member with succulent stolon, reddish due to anthocyanins with oval, thick reddish green succulent leaves. Flowers are solitary, conspicuous and light pink in colour. Both are herbs with a creeping habit.

The status of dune and the strand vegetation is converted into scores for convenience to judge the biodiversity which is given in tabulated form.

The poor status is meant by sparse and patchy *Ipomoea biloba* and *Pandanus* occurrence. The ratio between the total dune span and the area covered by the vegetation is quite large. The number of species found are about 5-8 that too infrequently.

Good dune or strand vegetation is indicated by the presence of noticeable *Ipomoea* or Pandanus cover though not continuous or thick. Atleast 25-30% of span is covered. Along with it about 8-12 species are recorded.

The beach where, about 30-40% of crest / dune area is occupied by *Ipomoea* or *Pandanus* alongwith other floral members forming fairly dense and diversified cover can be classified as having very good dune or strand vegetation. About 12-15 species are recorded.

Excellent dune or strand vegetation is the beach having a continuous *Ipomoea* cover alongwith associated members and a *Pandanus* stretch forming a continuous wall like barrier at the rear of the beach and exhibiting wild growth. More than 15 species are found on these dunes. Occurrence of unusual and uncommon plants also adds to the score.

Estuarine Intertidal Vegetation — Mangroves

Mangroves are the specially adapted plants which grow in brackish water in estuaries on mudflats. These have special physiological and anatomical adaptations to withstand the salinity of water. These require a humid climate with good rainfall and slit or mudflats to anchor. Mangroves also prove to be economically important as they can provide timber, wood for fuel and are used for medicinal purposes by local people. They are of major importance ecologically for they provide breeding places for fish, some crustaceans and other marine / estuarine fauna. Their extensive root and pneumatophore network alongwith rich slit in the mudflats can form a peculiar ecosystem in itself.

Mangroves on West coast are only 25% of total mangroves in India (Deshmukh S. and Chaphekar S. B., 1996). Mangroves on Central west coast i.e. Maharashtra are still in better condition than those on Northern and Southern west coast.

Of all the major estuaries studied, only those are being considered here which still have a good mangrove cover. The parameters employed for the assessment of the status of mangroves in these estuaries were the area covered, average height, the density, number of genera / species, associated mangrove diversity and stress imposed by the local people due to encroachment.

Dabhol creek is one of the richest centres of mangroves. Of the total length of the Vasishthi estuary which is 45 kms, 11 sq. kms area is occupied by the mangrove community. Mangroves seen in dense patches spreading not less than 1 km near villages Navsha, opposite Bhati, near Sakhari, Peve, Humbargar, Pangari, Karur, Isapur, Bhopan and Chiveli. Mangroves in Dabhol creek have an average height of 8-9 mts and a fairly dense forest formation observed. Mangroves at Pangari were studied very closely. The length of the patch being 2.5-3.0 kms and width being 50-60 mts. Very old specimens of *Avicennia marina, Sonneratia acida* and *Rhizophora mucronata* were encountered. From the river mouth good mangrove vegetation starts at a distance of 5-6 kms. Normally *Rhizophora* and *Sonnertia sp.* are seen growing to a height of 4-5 mts but at Pangari they were competing with *Avicennia* which attained height upto 10-12 mts. Total 9 mangrove genera were recorded with 7 mangrove associates.

Mangrove associates are those plants which do grow near mangroves but avoid direct saline conditions and prefer moist soil towards land. So they usually occupy places immediately behind the mangroves towards the land. These are represented by Exoecaria agallocha, Acrostichum aureum, Cyperus sp., Salvadora persica, Derris heterophylla, Clerodendron inerme, Atriplex sp., Caesalpenia sp. and Acanthus ilicifolius. Most of the mangroves and their associates occurred commonly in all creeks studied but with varying density and cover. A separate list of mangroves and mangrove associates is attached alongwith.

Healthy mangroves in Savitri bay were seen near Umroli village, the area covered was 2 km x 1 km. Average height of mangroves was 8-9 mts with a fair density. Sonneratia acida and Avicennia marina attained height of about 12 mts. Almost all genera of mangroves and mangrove

associates were recorded in it. *Lumnitzera racemosa* was encountered here for the first time. Immediately behind these mangroves the hill slopes were completely covered under mango plantation and land near the bank was employed for paddy cultivation. The other side of the river also harboured a fairly dense patch of mangroves. Another mangrove patch was seen before village Shipole which was sparse and stunted as a bund was built across to reclaim the land for agricultural purposes.

In Vaghotan bay, good mangrove habitat was seen at Navanagar and Girye. At Navanagar the diversity was as usual with all common mangrove genera making their appearance but in scattered patches. *Kandelia kandel, Sonneratia alba* were seen flowering. Girye mangroves exhibited excellent density and an average height of 8-9 mts, like those at Pangari in Dabhol creek. In Girye mangroves, *Sonneratia alba, Avicennia marina, A. officinalis* and *Rhizophora mucronata* were found codominating. The mangrove cover in Vaghotan river can be estimated to be about 500 ha. In the bay, the distribution of mangroves is thick and dense but patchy and irregular with many narrow channels running across as compared to those at Umroli and Pangari which are in one or two continuous stretches and are impenetrable.

Mangroves were also found in other locations like Chinchkhari, Jaigad bay, Kolam estuary, Deogad estuary and Karli river but these were found to be of inferior quality and lacking in one or other parameters as compared to the aforesaid mangroves. Though their role and function in their respective environments remains the same but their area cover seems to be dwindling.

The mangrove habitat described in the above three bays, at present shows a healthy picture but the increasing pressure of human needs and the future danger of encroaching industrialisation are going to affect their status severely in coming decades if not protected well.

Of the three major estuaries surveyed for the status of mangroves, Vasishthi was found to harbour excellent mangrove cover as far as the employed parameters are concerned. In geographically protected pockets in the estuary, they exhibit climax formation in terms of average height, the density of the patch, area occupied and the canopy cover. Special attention is needed to the mangroves at Pangari, Peve, Karur, Isapur, Bhopan, Govalkot and Chiveli as any minor alteration in the health of the existing environment would prove dangerous to their present status and indirectly to the faunal members dependent on them and finally to the fishing economics of Dabhol which is well known for its rich fishing grounds.

The mangroves in Savitri which seemed to be in need of protective help from the local people as bunds were seen built across the bay and the mangroves to reclaim the land for agricultural use. Bunds cause death of mangroves for want of saline water and regular periodical and seasonal variation in the micronutrient content in the tidal gush of water. This gradually causes drying up of the trees which was observed near village Shipole. A better condition was seen at Umroli where the mangroves attained an average height 8-9 mts which indicates a healthy growth.

So, a threshold percentage of mangrove has to be decided for each estuary and should be maintained and protected for the betterment of coastal economics.

CHAPTER THREE

STATUS OF MANGROVES IN MAHARASHTRA

Sanjay Deshmukh

Introduction

The Arabian Seaboard is characterised by the presence of typical funnel shaped estuaries at the mouth of the major rivers like the Narmada and the Tapi and other numerous small rivers (Deshmukh, 1990). The variation in mangrove vegetation is superimposed on the geomorphology of the coastal board, nature of the terrain, catchment area and the course of the rivers. The large annual precipitation on the Western coast has also resulted in greater diversity of species, though chiefly in regard to the flora of the Western Ghats close-by. The West coast covers about 13 percent of the mangrove area in the country (Deshmukh, 1995).

Maharashtra State has a 720 km long coastline that is divisible into roughly three types - hills with steep cliffs entering the sea, sandy beaches and mud-flats. Shorelines of mixed nature are also found, e.g., rocky waterfronts and sandy beaches with interspersed rocks, and mud-coloured sandy beaches. According to the nature of the terrain, coastal communities have adopted different land-uses (Chaphekar and Deshmukh, 1996).

The Konkan

The zone on the Western coast of Maharashtra is known traditionally as the Konkan region. It is a narrow terrain with a width of upto 60 km between the Western coast and the ridge of the Sahyadri mountains. The length of the region is 720 km between the states of Gujarat in the North and Goa in the South. This region has five districts, viz., Thane, the urban area of Greater Mumbai, Raigad, Ratnagiri and Sindhudurg.

The most important physical resource of Konkan region is the plentiful supply of water received particularly during the South-west monsoon period. In about a width of 20 km from the coastal line, deep deposits of soil exist due to erosion of the slopes of the Sahyadri and transportation of the eroded material by rapid flowing system down the Ghats. A large number of streams arising in the Sahyadri range join the Arabian Sea in this area. During high tides, salt water of the sea makes an ingress over the soil deposits along the creeks. The mangrove swamp communities dominate these coastal areas inclusive of creeks, estuaries and backwaters along the coast of Maharashtra. There are 58 such creeks in five districts as shown in Figure 1. It can be seen that of these, 9 are in Thane, 3 in the Urban areas of Greater Mumbai, 13 in Raigad, 21 in Ratnagiri and 12 in Sindhudurg district.

Topography

The Topography of the Konkan is hilly in general. All the same the Northern part of Thane and Raigad districts and the major part of Sindhudurg district are flat or comparatively flat or less

undulating. Along the coast, marine land-forms like lagoons, estuaries, mud-flats, marshy areas and sandy beaches are common. Because of the steep slopes and shallow cover of soils, almost all rivers flow in the monsoon and are dry in the summer. The rivers have developed tiny alluvial plains along their banks where their slopes flatten. At the mouth of the river, the tidal effect is seen to reach even upto 40 km in the interior as in the case of the rivers Vaitarna, Amba, Ulhas, etc. (Maharashtra State Gazetteer, 1984).

Biodiversity of the Coast

Different types of coastal areas are occupied by different types of organisms, both plants and animals. Rocky shores that are washed by tides are inhabited by marine algae - red, brown and green low plants. A large number of molluscs, copepods and bivalves also inhabit the wet rocks. Sandy beaches harbour some algal species and an exceptionally wide diversity of animals - annelid worms, shanks and bivalves, star fish and urchins, sea anemones and sea cucumbers, etc. Sea grasses and corals are present on the lower side of intertidal zones while green algae and crabs inhabit upper side of it. By far, the highest productive shoreline is the third type, i.e., the mud-flats with their highly specialized vascular plants carrying out equally specialized functions of ecological significance. These plants are called mangroves.

Mangrove Forests

Mangroves are salt tolerant forest ecosystems of the tropical and sub-tropical intertidal regions of the world. These ecosystems are reservoirs of species of plants and animals, associated together over a long evolutionary time, and are still imperfectly known and not fully understood. Mangrove trees and shrubs dominate the habitat and provide an economic resource widely used by coastal people of the tropics for thousands of years.

During the course of evolution, mangroves are adapted to the characteristic features of the habitat - seasonal fluctuations in salinity in estuaries and creeks and diurnal fluctuations in water levels caused by tidal movements, at the lower parts of the plants. Uniformly dense foliage of plants, root systems specialized for anchorage in loose mud and breathing in spite of flooding, capturing litter in the network of roots, contributing to formation of excellent habitat for a variety of fauna that are looking for shelter and food, are important functions of mangroves. A large variety of fishes, prawns, molluscs, crabs, reptiles, birds, etc., use mangrove habitats for deriving food and shelter. Deep Sea fishes are known to use the habitat for breeding and bringing up the juveniles in the food-rich and safe shelters of mangroves.

Zonation in Mangroves

Since water situation and tidal forces operate at different intensities in different parts of an intertidal zone, the species of mangroves prospering in these areas also are different (Chaphekar and Deshmukh, 1996). Starting from seaside, one notices the following sequence of mangrove species while progressing towards land:

Rhizophora - Avicennia, Sonneratia, Aegiceras - Acanthus - Aeluropus

It is common to come across situations where the zonation pattern is disturbed due to different operative factors such as tidal forces, land features, human activities and differential sensitivities/ tolerances of different species to pollutants (Chaphekar, 1994).

Mangroves of Maharashtra

In general, number of plant species adapted to the demanding environmental conditions of intertidal zones, is limited. Mangrove flora of India comprises of about 97 species of both, exclusive and non-exclusive (salinity tolerant plants that are found growing along with mangroves towards landward region of high tide level or above) mangroves. About 60 odd species of mangrove and

associates belonging to 41 genera representing 29 families are observed along the coast of Maharashtra. List of plant species exclusively observed in the intertidal regions of coastal habitats of Maharashtra is given in Table 1.

Table 1 : Mangrove species growing in coastal habitats of Maharashtra and their economic importance and appropriate position in the intertidal region.

No.	Name of plant and family	Economic importance	Estuary location	Intertidal position
1.	*Acanthus ilicifolius* (Acanthaceae)	-	L,U	M,H
2.	*Acrostichum aureum* (Pteridaceae)	-	D,I	H
3.	*Aegiceras corniculatum* (Myrsinaceae)	Fuel	I,U	M
4.	*Aeluropus lagopoides* (Poaceae)	Fodder	U	H
5.	*Avicennia alba* (Verbenaceae)	Fuel	D	L,M
6.	*Avicennia marina* (Verbenaceae)	Fuel, fodder	D,I	L,M,H
7.	*Avicennia officinalis* (Avicenniaceae)	Fuel, fodder	I	L
8.	*Bruguiera cylindrica* (Rhizophoraceae)	Fuel	D,I	M
9.	*Bruguiera gymnorrhiza* (Rhizophoraceae)	Fuel	D,I	M,L
10.	*Bruguiera parviflora* (Rhizophoraceae)	Fuel	D,I	M,L
11.	*Ceriops tagal* (Rhizophoraceae)	Fuel	D,I	M,L
12.	*Clerodendron inerme* (Verbenaceae)	Hedges	I,U	M,H
13.	*Derris heterophylla* (Fabaceae)	-	I,U	M,H
14.	*Excoecaria agallocha* (Euphorbiaceae)	-	D,I	L,M
15.	*Kandelia candel* (Rhizophoraceae)	Fuel	D	L
No.	Name of plant and family	Economic importance	Estuary location	Intertidal position
16.	*Lumnitzera racemosa* (Combretaceae)	Fuel	D	M,H
17.	*Pandanus tectorius* (Pandanaceae)	Religious	U,I	H
18.	*Porteresia coarctata* (Poaceae)	Wild rice	D	L
19.	*Rhizophora apiculata* (Rhzophoraceae)	Fuel, tannin	I	M
20.	*Rhizophora mucronata* (Rhizophoraceae)	Fuel, tannin	I,D	M,L
21.	*Salvadora persica* (Salvadoraceae)	Fodder,oil	U	H

No.	Name of plant and family importance	Economic location	Estuary position	Intertidal
22.	*Salicornia bracheata* (Chenopodiaceae)	Food	U	H
23.	*Sesuvium protulacastrum* (Chenopodiaceae)	Food	U	H
24.	*Suaeda maritima* (Chenopodiaceae)	Food	U	H
25.	*Sonneratia alba* (Sonneratiaceae)	Fuel	D	L
26.	*Sonneratia apetala* (Sonneratiaceae)	Fuel	D	L,M
27.	*Sonneratia caseolaris* (Sonneratiaceae)	Fuel	D	M

(Locality in the estuary is shown as D : Downstream; I : Intermediate; U : Upstream. Position in the intertidal region is shown as L : Low; M : Middle and H : High).

Mangrove plants prosper along protected coastal areas. As such, though some mangroves are noticeable on open sea-fronts, abundant growth of these plants forming continuous cover with their round canopies is seen along the banks of estuaries and creeks. Total area of mangroves is estimated to be 330 sq. km in Maharashtra, roughly 13 per cent of the total mangrove area in the country.

Table 2 highlights frequency (occurrence) of mangrove species (numbering 29) along shorelines of estuaries and creeks (totaling 59) in five districts of Maharashtra.

Table 2 : Occurrence (frequency) of mangroves in five districts of Maharashtra.

Name of species	Thane	Mumbai	Raigad	Ratnagiri	Sindhudurg	Frequency (%)
Acanthus ilicifolius	p	p	p	p	p	100
Acrostichum aureum	a	a	p	p	p	60
Aegiceras corniculatum	p	p	p	p	p	100
Aeluropus logopoides	p	p	p	p	p	100
Avicennia alba	p	a	a	p	p	60
Avicennia marina	p	p	p	p	p	100
Avicennia officinalis	p	p	p	p	p	100
Bruguiera cylindrica	p	p	p	a	a	60
Bruguiera parviflora	a	a	a	a	p	20
Ceriops tagal	p	p	p	p	p	100
Clerodendron inerme	p	p	p	p	p	100
Derris heterophylla	p	p	p	p	p	100
Excoecaria agallocha	p	p	p	p	p	100
Kandelia candel	p	p	p	p	p	100
Lumnitzera racemosa	p	a	p	p	p	80
Pandanus tectorius	p	a	p	p	p	80
Porteresia coarctata	p	a	a	p	p	60
Rhizophora apiculata	p	a	p	p	p	80
Rhizophora mucronata	p	p	p	p	p	100

Name of species	Thane	Mumbai	Raigad	Ratnagiri	Sindhudurg	Frequency (%)
Salvadora persica	p	p	p	p	p	100
Salicornia bracheata	p	p	p	p	p	100
Sesuvium protulacastrum	p	p	p	p	a	80
Suaeda maritima	p	p	p	a	a	60
Sonneratia alba	p	p	p	p	p	100
Sonneratia apetala	p	p	p	p	p	100
Sonneratia caseolaris	a	a	a	p	a	20

Plants in the "Strand" Region

In addition to the mangroves and their associate plant species growing in the intertidal region, a large number of plant species grow on land that is adjacent to that region. Though these plants from the neighbourhood terrestrial habitat belong to a variety of taxa, but have one common feature - they are tolerant to some amount of salinity of soil and salt sprays. Some of the mangrove and their associate species are also likely to be present in these habitats, where in general, trees are small in size, saturated, scrub growth is ample and ground may be covered completely with grasses, sedges, etc. This vegetation is sometimes referred to as **"strand vegetation"** (Chaphekar and Deshmukh, 1996).

A list of plants recorded as components of strand vegetation in coastal areas of Maharashtra in general and that of Mumbai in particular, are listed in Table 3.

Table 3: Plants of "strand" vegetation in coastal habitats of Maharashtra.

No.	Name of plant	Family	Life form
1.	*Abutilon indicum*	Malvaceae	Herb
2.	*Cleome viscosa*	Capparidaceae	Herb
3.	*Malachra capitata*	Malvaceae	Herb
4.	*Sida acuta*	Malvaceae	Herb
5.	*Typha angustifolia*	Typhaceae	Herb, Perennial
6.	*Thespesia populnea*	Malvaceae	Tree
7.	*Salmalia malabarica*	Bombacaceae	Tree
8.	*Melia azadarach*	Meliaceae	Tree
9.	*Zizyphus mauritiana*	Rhamnaceae	Tree / shrub
10.	*Aeschynomene indica*	Fabaceae	Herb
11.	*Derris heterophylla*	Fabaceae	Perennial climber
12.	*Derris pinnata*	Fabaceae	Tree
13.	*Gliricidia sepium*	Fabaceae	Tree
14.	*Tephrosia purpurea*	Fabaceae	Herb
15.	*Cassia siamea*	Caesalpiniaceae	Tree
16.	*Delonix regia*	Caesalpiniaceae	Tree
17.	*Parkinsonia aculeata*	Caesalpiniaceae	Tree
18.	*Peltophorum pterocarpus*	Momosaceae	Tree
19.	*Acacia auriculiformis*	Momocaceae	Tree
20.	*Pithecolobium dulce*	Momosaceae	Tree
21.	*Bruguiera cylindrica***	Rhozophoraceae	Tree
22.	*Sesuvium portulacastrum***	Aizoaceae	Herb, Perennial
23.	*Salvadora persica***	Salvadoraceae	Tree / shrub
24.	*Ipomoea carnea*	Convolvulaceae	Shrub
25.	*Hygrophilla auriculata*	Acanthaceae	Herb, Perennial
26.	*Clerodendrum inerme***	Verbenaceae	Shrub
27.	*Avicennia officinalis***	Avicenniaceae	Tree
28.	*Lantana camara*	Verbenaceae	Shrub

No.	Name of plant	Family	Life form
29.	*Hyptis suaveloens*	Labiatae	Herb
30.	*Boerhaavia difusa*	Nyctagenaceae	Herb, Perennial
31.	*Alternanthera sesselis*	Amaranthaceae	Herb, Perennial
32.	*Jaatropa curcas*	Euphorbiaceae	Shrub
33.	*Ricinus communis*	Euphorbiaceae	Shrub
34.	*Trema orientalis*	Urticaeae	Tree
35.	*Ficus hispida*	Moraceae	Shrub
36.	*Casuarina equisitifolia*	Casuarinaceae	Tree

Note : In addition, a large number of grasses, cyperaceae plants and monsoon annuals are also reported, but not listed here. ** : Mangroves and / or their associates.

Observations on Mangroves of Maharashtra

The mangroves of Maharashtra have received inadequate and insufficient attention so far, the studies being few and scattered. No sustained effort has been made to study them in a comprehensive manner. Considering the fact that some of the best mangrove patches still exist along the coastal regions. They have not received the attention they deserved. The present surveys of the mangrove areas are also not claimed to be adequate, especially since the estimates of areas under mangroves need to be constantly revised, correctly appraised and periodically reviewed, in view of continuous destructive activity in progress in the regions.

Materials and Methods

Aerial photographs (Scale 1:250,000; 1:50,000) of the coast of Maharashtra taken in 1973 and 1984 by the National Institute of oceanography and those taken by the Centre for Studies in Resource Engineering (IIT, Mumbai) in 1990 (scale 1:50,000), were used to delineate the areas under mangroves of different estuaries, creeks and backwaters. This information was used as the basis for collecting ground truth data.

Visits were made several times to all the creeks and observations were made to determine the occurrence of mangrove species along the entire coastal regions.

Observations

Thane District

Thane, the northernmost district of the Konkan, lies adjacent to the Arabian Sea in the North-west of Maharashtra state. Its Northern limits adjoin the Union Territory of Dadra Nagar Haveli and the state of Gujarat, while the district of Raigad is to the South and Greater Mumbai to the South-West (Bombay Gazetteer, 1882; Maharashtra State Gazetteer, 1984).

The rivers of the district mainly belong to two river streams, namely the Vaitarna the largest of Konkan rivers and the Ulhas. The Ulhas meets the sea at Vasai, while the Vaitarna enters the sea through a wide estuary off Amala. All along the coast, there are many small creeks (9 in number) in which the tidal waters flood upstream and inundate much of the low ground, which is under mangrove cover. Human interference in many cases has helped in converting such grounds into mud-flats, the type seen at Bhivandi, Chinchani and Dahanu.

The most common species of Thane district are *Avicennia marina* and *Acanthus ilicifolius*. The former, alongwith *Rhizophora mucronata* forms the outermost bell at lowest tidal portions. *Sonneratia apetala* also is found near the banks at places like Mumbra and Diva near Thane.

The zonation of mangrove species can be observed in the undisturbed mangroves com-

munity along the Vaitarna and in some areas of the Ulhas river estuary. The middle zone is characterised by mixed vegetation of species like *Ceriops tagal, Aegiceras corniculatum* and *Excoecaria agallocha*. The landward zone is occupied by *Acanthus ilicifolius, Sesuvium portulacastrum, Salicornia brancheata* alongwith bushy growth of *Salvadora persica* and *Clerodendrum inerme*. A climber, *Derris heterophylla* is common along most of the creeks. *Bruguiera gymnorrhiza* and *Lumnitzera racemosa* have almost vanished from the estuaries of Ulhas (Vasai creek), while species like *Sonneratia alba, Rhizophora apiculata, Acrostichum aureum* are absent from this region.

Table 4 shows the occurrence of mangrove species along the different creeks in Thane district.

Name of species	Names of creeks								
	1	2	3	4	5	6	7	8	9
Acanthus ilicifolius	+	+	+	+	+	+	+	+	+
Aegiceras corniculatum	+	+		+			+	+	
*Aeluropus lagopodies**	+	+		+			+	+	+
Avicennia alba									+
Avicennia marina	+	+	+	+	+	+	+	+	+
Avicennia officinalis			+			+	+	+	+
Bruguiera cylindrica								+	+
Bruguiera gymnorhiza								+	
Ceriops tagal						+		+	+
*Clerodendrum inerme**	+	+	+	+		+		+	+
*Cyperus rotundas**		+				+	+	+	+
Derris heterophylla		+		+	+			+	+
Excoeraria agallocha		+				+		+	+
Kandelia candel								+	
Lumnitzera racemosa								+	
Porteresia coarctata		+					+		
Rhizophora mucronata								+	
Salicornia brachiata	+			+			+	+	
Salvadora persica	+	+	+	+			+	+	+
Sesuvium portulacastrum		+		+	+	+	+	+	+
Sonneratia apetala						+	+	+	+
Suaeda fruticosa		+			+			+	+

* : mangrove associates + : present

1 = Zai; 2 = Samata; 3 = Tarapur; 4 = Nawapur; 5 = Satpati; 6 = Kelwa Mahim; 7 = Arnala; 8 = Vasai; 9 = Thane

Names of creeks	Rivers
Samta	Dahanu
Arnala	Vaitarna
Vasai	Ulhas

Urban area of Greater Mumbai District

The district of Greater Mumbai is situated south of Thane district. The Manori Creek separates the Greater Bombay regions from the Thane district in the North while Thane creeks separates the City from Raigad on mainland in the South. The coastal margin along the West coast is inundated by small creeks namely Manori, Malad and Mahim, while the harbour waters surround Bombay in the East (Maharashtra State Gazetteer, 1977).

Table 5 shows the occurrence of mangroves along the three creeks. There is hardly any place like Mumbai, where the mangroves are being denuded on the scale seen here. An extensive survey of the mangroves of Greater Mumbai has been carried out and the distribution of mangroves along the coasts of Mumbai has also been studied. Being an urban ecosystem, the mangroves in Mumbai face several problems simultaneously, due to reclamation, disposal of sewage, excessive dredging of sand, industrial pollution, etc., leading to loss of habitats and disappearance of certain species. Due to the uniqueness and severity of the problem, the data generated deserve special attention.

Table 5 : Presence of mangrove and associate species along different creeks in the Urban Area of Greater Mumbai.

Name of species	Names of creeks		
	1	2	3
Acanthus ilicifolius	+	+	+
Aegiceras corniculatum		+	+
Aeluropus lagopodies		+	+
Avicennia alba		+	
Avicennia marina	+	+	+
Bruguiera cylindrica			+
Ceriops tagal		+	+
*Clerodendrum inerme**		+	+
*Cyperus rotunus**			+
*Derris heterophylla**		+	+
Excoeraria agallocha	+	+	+
Kandelia candel			+
Rhizophora mucronata			+
*Salvadora prsica**		+	
*Sesuvium portulacastrum**		+	+
Sonneratia alba	+		

* : mangrove + : present 1 = Manori; 2 = Malad; 3 = Mahim.

Raigad District

Raigad district has a coastal stretch of about 160 km. from North to South. The rivers of this region have a common characteristic that their courses are divided into two well-marked sections above and below the limits of the tide. Their upper courses are steep and rugged with torrential waters flowing during the monsoon season (Maharashtra State Gazetteer, 1964). They are the Gadi (Panvel creek), the Amba (Dharamtar creek), the Kundalika (Revdanda creek), the Rajpuri (Mhasala creek) and the Savitri (Bankot creek).

The mangrove vegetation of Raigad, as seen in Table 6, mainly constitutes *Sonneratia apetala* and *Acanthus ilicifolius* as the most common species, next to *Avicennia marina. Rhizophora apiculata* (Revdanda, Mhasala, Valvati and Bankot Creeks) and *Sonneratia alba* (Valvati, Srivardhan and Mhasala creeks) make their appearance in this district alongwith *Lumnitzera racemosa*, frequently seen along the banks of Nandgaon, Murud, Valvati and Bankot creeks. Species like *Bruguiera cylindrica* and *Salicornia bracheata* are hardly seen while *Clerodendrum inerme* is observed in some places.

Table 6 : Occurrence of mangrove plants in Raigad district.

Name of species	Names of creeks												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Acanthus ilicifolius			+	+	+	+	+	+	+	+	+		+
*Acrostichum aureum**													+
Aegiceras corniculatum				+			+			+			+
*Aeluropus lagopodies**	+	+		+	+	+	+	+			+		+
Avicennia alba	+						+			+			+
Avicennia marina	+	+	+	+	+	+	+	+	+	+	+	+	+
Avicennia officinalis				+	+	+							+
Bruguiera cylindrica							+			+			
Bruguiera gymnorhiza							+			+			+
Ceriops tagal							+	+	+	+		+	+
*Clerodendrum inerme**	+	+			+		+	+	+		+		+
*Derris heterophylla**							+			+			+
Excoeraria agallocha									+	+	+		+
Kandelia candel										+			+
Lumnitzera racemosa								+	+		+		+
Rhizophora apiculata							+			+	+		+
Rhizophora mucronata							+			+	+	+	+
*Salicornia brachiata**			+		+								
*Salvadora prsica**	+	+		+	+								+
*Sesuvium portulacastrum**				+	+								
Sonneratia alba										+	+	+	
Sonneratia apetala			+				+			+	+	+	+
Suaeda fruticosa *			+	+	+								

*:mangrove associates + : present

1 = Panvel; 2 = Mora; 3 = Karanja; 4 = Dharamtar; 5 = Alibag; 6 = Paolo; 7 = Revdanda; 8 = Nandgaon; 9 = Murud; 10 = Mhasala; 11 = Valvati; 12 = Srivardhan; 13 = Bankot.

Name of creeks	Rivers
Panvel	Gadi
Dharamtar	Amba and Bhogeshwari
Revdanda	Kundalika
Mhasala	Rajpuri
Bankot	Savitri

Ratnagiri District

The boundaries of this district are marked by the Savitri river in the north and the Vaghotan river (Vijaydurg creek) in the south (Maharashtra State Gazetteer, 1962). The coastline of the district extended to about 240 km. It is uniformly rocky and shallow, though locally there are variations due to projecting bluffs and promontories that enclose small sandy bays. These are interspersed by the estuaries of more important rivers like the Bhaja (Anjarle creek), the Jog (Adhe creek), the Vasishthi (Dabhol creek), the Guhagar (Govalkot creek), the Shastri (Jaigad creek) the Kajvi (Bhatye creek), the Muchkundi (Purnagad creek) and the Jaitapur (Rajapur Creek). There are 21 such creeks along the banks of which growth of mangroves are recorded (Table 7).

Table 7 : Occurrence of mangrove plants in Ratnagiri district.

Name of species	Names of creeks																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Acanthus ilicifolius	+	+	+	+	+	+	+	+		+	+	+	+	+		+	+	+	+		+
*Acrostichum aureum**					+														+	+	+
Aegiceras corniculatum	+				+			+		+	+	+	+								
*Aeluropus lagopodies**	+	+											+	+					+		
Avicennia alba														+		+		+			
Avicennia marina	+	+	+	+	+	+	+	+	+	+		+		+		+					
Avicennia officinalis					+		+	+		+	+	+			+		+	+	+		+
Bruguiera gymnorhiza					+					+		+									+
Ceriops tagal					+					+	+	+		+		+	+	+	+	+	+
*Clerodendrum inerme**	+				+				+			+				+	+		+	+	
*Cyperus rotundus**																			+		
*Derris heterophylla**														+							
Excoeraria agallocha				+		+		+		+	+	+	+	+		+	+		+		+
Kandelia candel						+						+						+	+		
Lumnitzera racemosa							+					+		+		+	+	+	+		+
*Porteresia coarctata**					+							+	+						+		+
Rhizophora apiculata					+					+					+	+			+		+
Rhizophora mucronata	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
*Salvadora prsica**			+			+		+									+	+	+		
Sesuvium portulacastrum					+						+	+		+	+						
Sonneratia alba		+	+		+	+	+		+	+		+	+	+	+	+	+		+	+	+
Sonneratia apetala		+	+		+					+								+			
Sonneratia caseolaris					+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

* : mangrove associates + : present

1 = Kelshi; 2 = Anjarle; 3 = Adhe; 4 = Kolthare; 5 = Dabhol; 6 = Govalkot; 7 = Palshet; 8 = Hedvi; 9 = Naravane; 10 = Jaigad; 11 = Nandivade; 12 = Malgund; 13 = Nevare; 14 = Arye; 15 = Kalbadevi; 16 = Bhatye; 17 = Pawas; 18 = Ganeshgule; 19 = Purnagad; 20= Wada Vetye; 21 = Rajapur.

Names of creeks	Rivers	Names of creeks	Rivers
Anjarle	Bhaja	Jaigad	Shastri
Adhe	Jog	Bhatye	Kajvi
Dabhol	Vasishthi	Purnagad	Muchkundi
Govalkot	Guhagar	Rajapur	Jaitapur

Rhizophora mucronata and *Sonneratia alba* are amongst the frequently observed species along the creeks, while *Avicennia marina, A. officialis, Ceriops tagal* and *Excoecaria agallocha* are also seen. *Bruguiera cylindrica, B. parviflora, Salicornia bracheata* and *Suaeda maritima* are not seen in any of the creeks in Ratnagiri.

Sindhudurg

Table 8 : Occurrence of mangrove and associate species in Sindhudurg.

Name of species	Names of creeks											
	1	2	3	4	5	6	7	8	9	10	11	12
Acanthus ilicifolius					+	+	+	+		+		+
*Acrostichum aureum**	+						+	+	+	+	+	+
Aegiceras corniculatum	+	+			+	+	+	+		+		+
*Aeluropus lagopodies**	+				+	+						
Avicennia alba					+	+	+	+				+
Avicennia marina	+		+		+		+					
Avicennia officinalis	+			+		+	+	+	+	+	+	+
Bruguiera gymnorhiza	+	+	+		+							
Bruguiera parviflora	+											
Ceriops tagal	+	+		+	+	+	+	+	+	+		+
*Clerodendrum inerme**				+					+		+	+
*Derris heterophylla**		+	+		+							+
Excoeraria agallocha	+	+	+		+	+	+	+				+
Kandelia candel		+		+	+	+	+	+				
Lumnitzera racemosa					+	+	+	+				
*Porteresia coarctata**					+							+
Rhizophora apiculata	+	+		+	+	+	+	+				
Rhizophora mucronata	+	+		+	+	+	+	+				+
*Salvadora persica**												+
Sonneratia alba	+		+		+	+	+	+		+	+	+
Sonneratia caseolaris					+							

*:mangrove associates + : present

1 = Vijaydurg; 2 = Deogad; 3 = Mithamumbri; 4 = Mithbav; 5 = Archari; 6 = Kalawali; 7 = Kolamb; 8 = Karli; 9 = Kelus; 10 = Vengurla; 11 = Talawade; 12 = Terekhol.

Names of creeks	Rivers
Vijaydurg	Waghotan
Aachra	Aachra
Kalawali	Sarjekot
Karli	Tarkarli

The major portion of this district is furrowed by numerous streams which have mostly a parallel drainage pattern. Rising from the Sahyadri scrap, these streams drain the waters to the Arabian Sea through a region that is hilly and mostly bare, However, the estuarine portion have comparatively good soils which support mangrove vegetation. The coastline between the Vaghotan river (Vijaydurg creek) at its North and the Banda river (Terekhol creek) at its lower reaches is about 160 km (Maharashtra State Gazetteer, 1962).

The majority of the mangrove vegetation of Sindhudurg district is occupied by *Rhizophora mucronata, Sonneratia apetala* and *Ceriops tagal. Bruguiera gymnorrhiza, Derris heterophylla, Avicennia alba* and *Kandelia candel* are among the less frequent species.

Status of Mangroves along Coastal Maharashtra

The mangrove flora of India comprises about 59 species belonging to 41 genera and 29 families. Out of 34 species from the west coast, 28 species of mangroves and their associates have so far been reported along the 720 km length of the coast of the Maharashtra. Mangrove forests in the state reveal three strata such as ground cover, shrub stratum and tree stratum.

Ground Cover

The ground cover comprises species like *Sesuvium, Suaeda, Aeluropus, Salicornia* and *Porteresia coarctata* alongwith *Acanthus ilicifolius*. These species, expect Porteresia, form a continuous ground cover in the areas that are less frequently inundated. While *Porteresia* can be observed along the seaward zone of mangroves, it seems that in the course of this century, there has been a rupture in the equilibrium - indirectly by the biotic action, i.e., denudation of slopes and directly by the human interference, i.e., exploitation of mangroves (Deshmukh, 1990).

The appearance of the species like *Sesuviam* and *Suaeda* was quite common along almost all the creek in Thane district; they were seen less frequently along the coast of Raigad (e.g., along Dharamtar and Alibag creeks) and occupied the zones above the mean high tidal level.

The grass *Porteresia coarctata* appeared to be in the regions near mean sea level. In the areas where the exposed ground was drying up after the rains, *Aeluropus lagopoides* was found to be forming a continuous ground cover, almost as a pure culture. It covered the regions of upper shores, near mean high water level of spring tides. This species was frequently seen in Thane and Raigad districts alongwith the Urban area of the Greater Mumbai region.

The zones of middle shores where *Avicennia* was located, as observed in Ratnagiri and Sindhudurg districts, appeared to have given way to *Acanthus ilicifolius* in the more urbanised northern districts such as Thane and Mumbai, probably due to excessive cutting and removal of mangroves for fuel.

Some aquatic species like *Halophylla* were also observed in some of the places like Nevare creek of Ratnagiri district. Table 11 gives the status of the above-mentioned species along the coast of Maharashtra.

Table 11 : Mangrove species in "ground cover" along the Maharashtra coast

Status : Ground cover ; Height < 1 meter

Name of species	Creek/s	District
Acanthus ilicifolius	Dahanu, Nawapur, Satpati, Arnala, Vasai, Thane	Thane
	Manori	Greater Bombay
	Dharamtar, Alibag	Raigad
Aeluropus lagopoides	Zai, Dahanu, Arnala, Thane	Thane
	Panvel, Mora , Alibag	Raigad
	Kelshi, Anjarle, Purnagad	Ratnagiri
Porteresia coarctata	Aachra	Sindhudurg
	Arnala	Thane
	Malgund	Ratnagiri
	Terekhol	Sindhudurg

Shrub Stratum

It comprises short growth of *Avicennia* and shrubby growth of *Ceriops, Aegiceras, Bruguiera, Lumnitzera, Kandelia* and *Excoecaria*. Many creeks, estuaries and backwater areas studied, showed extensive degradation leading to low canopy vegetation mostly dominated by *Avicennia marina, Ceriops tagal, Rhizophora mucronata* and *Sonneratia alba* (Table 12).

Table 12 : Mangrove species in "shrub stratum" along the Maharashtra coast

Status : Shrub Stratum; Height 1 - 3 meters

Name of Species	Creek/s	District
Avicennia marina	Zai, Dahanu, Tarapur, Navapur, Kelwa Mahim, Arnala, Vasai, Thane	Thane
	Manori, Malad, Mahim	Greater Bombay
	Panvel, Mora, Karanja, Dharamtar, Alibag	Raigad
	Anjarle, Adhe, Malgund, Kalbadevi Bhatye, Pawas	Ratnagiri
	Aachra, Kolamb	Sindhudurg
Ceriops tagal	Malad, Mahim	Greater Bombay
	Mhasala, Srivardhan	Raigad
	Kolthare, Pawas, Ganeshgule, Purnagad, Rajapur	Ratnagiri
	Deogad, Mithbav, Kalawali	Sindhudurg
Rhizophora mucronata	Vasai	Thane
	Malad, Mahim	Greater Bombay
	Valvati, Srivardhan	Raigad
	Adhe, Govalkot, Palshet, Malgund, Kalbadevi, Kalbadevi	Ratnagiri
	Aachra, Kalawali, Karli	Sindhudurg
Sonnertia alba	Manori, Elephanta Island	Greater Bombay
	Mhasala, Valvati, Srivardhan	Raigad
	Anjarle, Adhe, Dabhol, Kolthare, Naravane, Malgund, Neware, Arye, Pawas	Ratnagiri
	Kalawali, Kolamb	Sindhudurg

Tree Stratum

As one goes Southwards along the coast of Maharashtra, there are a number of undisturbed mangrove areas which display a distinct zonational pattern of mangrove vegetation. These are the regions (as seen in Table 13) where the third stratum - the tree stratum is found intact. The height of the mangroves in these areas is more than 3-4 meters and some of the trees reach a height even upto 10 meters.

Table 13 : Mangrove species in "tree stratum" along the coastal Maharashtra.

Status : Tree stratum; Height > 3 - 5 meters

Name of species	Creek/s	Districts
Avicennia alba	Kelwa Mahim, Arnala, Vasai, Thane	Thane
	Manori, Mahim	Greater Bombay
	Dharamtar, Murud, Nandgaon	Raigad
Avicennia officinalis	Vasai, Thane	Thane
	Dharamtar	Raigad
Bruguiera gymnorrhiza	Mhasala, Bankot	Raigad
	Vijaydurg	Sindhudurg
Excoecaria agallocha	Vasai	Thane
	Bankot	Raigad
	Jaigad, Purnagad	Ratnagiri
	Kalawali	Sindhudurg
Rhizophora apiculata	Mhasala, Bankot	Raigad
	Dabhol, Jaigad, Bhatye, Pawas, Purnagad, Rajapur	Ratnagiri
	Vijaydurg, Mithbav, Terekhol	Sindhudurg
Sonneratia alba	Govalkot, Jaigad, Kalbadevi, Purnagad, Rajapur	Ratnagiri
	Vijaydurg, Mithmumbri, Aachra, Karli, Terekhol	Sindhudurg
Sonneratia apetala	Arnala, Vasai, Thane	Thane
	Dharamtar, Revdanda, Srivardhan	Raigad
	Kelshi, Anjarle, Dabhol	Ratnagiri

Discussion

The exploitation of mangrove forests has been going on for many years along the coasts of Maharashtra. The poor appearance of mangroves is due to excessive cutting. *Avicennia* for example, forms excellent fuel, hence this species has been extensively destroyed for this purpose, in many rural areas in Thane and Raigad districts. This practice has changed the nature of vegetation in many of the estuarine regions in these districts. Natural regeneration is generally low. As a result the land which once supported a luxuriant mangroves vegetation is now becoming devoid of this vegetation and is slowly being occupied by bushy species like *Suaeda, Acanthus* and grasses like *Aeluropus*.

Another factor which is responsible for the destruction of mangroves is the population pressure. Population explosion continuously exerts a mounting pressure on the mangroves ecosystem as on all the other ecosystems. Some of the activities like construction of residential complexes, are a direct threat to mangroves. Similarly due to industrialisation in urban as well as in rural areas, minor creeks and backwaters are being converted into dumping grounds for industrial waste, ill effects of which are obvious. Due to construction of dams for harnessing fresh water resources for productive purpose, upstream waters are diverted, leading to an increase in salinity of the estuary. Sometimes, due to the frequent release of fresh water from the reservoirs salinity of estuarine water is altered. These activities have considerable effect on the structure, composition and minerals status of mangroves ecosystems in the regions.

Selection of sites for conservation of genetic diversity of mangroves

With a view to conduct continued research on coastal mangrove ecosystems as well as for long-term preservation of genetic diversity of mangroves of Maharashtra, criteria developed by Dr. M.S. Swaminathan and his colleagues (Swaminathan *et al.*, 1994) were applied. The primary objective of this work is to identify specific mangrove areas along the coastal Maharashtra based on the suggested criteria, as given below, and study mangroves at ecosystem, species as well as at intra-specific level.

1. Genetic factors : Migration and gene flow, introgression, natural outcrossing, competition, selection and polymorphism.
2. Ecological factors : Local flora and fauna, species richness and evenness and indicators of bio-diversity and pollution level.
3. Environmental features : Topography and environmental variables, level of environmental degradation, heterogeneity of micro-environment, frequency and intensity of cyclones, typhoons and other natural hazards.
4. Physiological factors : Overall forest health, individual species health, nutritional cycle, and estuarine characteristics.
5. Conservation value : Potential for both in situ and ex situ conservation of bio-diversity, seasonal fluctuations in environmental conditions, environmental extremes, and plant population density.
6. Socio-political factors : Political commitment for conservation and social development.
7. Economic factors : Long-term funding and degree of priority.
8. Human Resources : Training and motivation of staff and commitment of the national government.
9. Reconnaissance and monitoring facilities : Equipment, proximity, and preparedness of staff.
10. Anthropogenic factors : Population density in neighbouring areas, proximity to population centres and industries and conservation awareness.
11. Land size : A minimum of 100 ha.
12. Land tenure : Ownership of land.
13. Accessibility to the mangrove area.

Based on the above identified criteria, following sites have been identified for conservation along the coastal Maharashtra.

Thane district :

Arnala; Vasai; Thane.

Names of creeks	Rivers
Arnala	Vaitarna
Vasai	Ulhas

Greater Mumbai :

Manori; Malad.

Raigad district :

Mhasala; Srivardhan; Bankot.

Name of creeks	Rivers
Mhasala	Rajpuri
Bankot	Savitri

Ratnagiri district :

Dabhol; Govalkot; Jaigad; Purnagad; Rajapur.

Names of creeks	Rivers	Names of creeks	Rivers
Dabhol	Vasishthi	Purnagad	Muchkundi
Govalkot	Guhagar	Rajapur	Jaitapur
Jaigad	Shastri		

Sindhudurg district :

Vijaydurg; Aachra; Deogad; Kalawali; Karli; Terekhol.

Names of creeks	Rivers
Vijaydurg	Waghotan
Aachra	Aachra
Kalawali	Sarjekot
Karli	Tarkarli

While inviting financial assistance for conducting detailed studies on the sites, as mentioned above, initial information on each of the sites will be gathered. Ten broadly classified criteria are proposed (adopted from Swaminathan, *et al.*, 1994). They are :

1. Genetic aspects : Introgression, potential for ex situ preservation, visual polymorphism.
2. Ecological aspects : Species richness, nutritional level, environmental degradation.
3. Utilisation level : Human use and exploitation.
4. Neighbouring flora and fauna : Associated ecosystem.
5. State of the forest : Levels of degradation.
6. Accessibility : Distance from main population centres, transportation facilities.
7. Personnel : Training, turn-over, etc.
8. Anthropogenic factors : Threats, level of dependence, etc.
9. Socio-political factors : National commitment, land tenure and public awareness.
10. Land size : Area available at the proposed site.

The sites were evaluated largely according to these ten criteria and respective areas of expertise were given due consideration during final allocation of scores. For each criterion, an ordinal score between one and nine was assigned to each site, where 1 = best or most desirable and 9 = worst or least desirable. Scores for each of the criteria was averaged to determine the final score of a site for each criterion.

From the Ecologist's point of view all the sites that scored less than 5 have therefore been proposed for conservation. It is recommended that an inter-disciplinary team comprising a Botanist (Taxonomy), Ecologist, Marine Zoologist, Economist, Geneticist as well as Information Scientist may conduct this evaluation. Final list could be drawn for establishment of genetic estates of mangroves along the Maharashtra coast.

Conclusion

Mangrove ecosystems form an important component of coastal biome in tropics. This ecosystem occupies about 330 sq. km area in Maharashtra and forms about 13 per cent of the total mangrove area in the country. Due to its high productivity, the ecosystem supports a large diversity of faunal elements in addition to flora, which receive food and shelter from mangroves. The system also forms a protective cover on ground that is prone to erosion due to wave action and winds. Strand vegetation growing in areas adjacent to mangroves above the high tide level supports a

wide variety of salt tolerant plants and provides habitat for a wide variety of fauna.

Unfortunately, though a number of studies have been carried out on mangroves to understand their form, structure as well as functional aspects, there are numerous gaps in the data, especially in relation to the distribution of floral and faunal elements in different places, along different creeks and estuaries in the State. Information on fauna is still scanty. Intensive studies are needed for filling these gaps in out knowledge in this important subject.

For effective eco-rehabilitation and management of mangrove areas in the State, there is a need to obtain more and better information on the structure and the dynamics of the above-mentioned areas. As each area represents a distinct mangrove ecosystem and has its own structure and composition, detailed individual area studies are desirable, so as to draw guidelines for the management of respective mangrove ecosystems. In addition to generating and making available alternative fuel, fodder and timber, simultaneous measures to protect the remaining mangroves, as also increasing the same, are necessary. Intensive studies, not only of plant cover but also of other components of the ecosystem should be undertaken.

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CHAPTER FOUR

ANIMAL LIFE OF THE INTERTIDAL ZONE

"The edge of the sea is a strange and beautiful place. All through the long history of earth it has been an area of unrest where waves have broken heavily against the land, where the tides have pressed forward over the continents, receded and then returned. For no two successive days is the shoreline precisely the same." (Rachel Carson in The Edge of the Sea).

In these three sentences this great writer has so appropriately described the forces that shape the environment of the intertidal zone. It is indeed a fascinating place. The daily cycle of inundation and dryness it experiences may have its parallel in the different climatic zones that one experiences in climbing a great mountain. The time-scale however, here is so narrow that a number of parameters have to be telescoped into a narrow band. In this quick-changing world the web of life displays adaptations and survival skills that are truly amazing.

From the splash zone above the high tide line where waves throw their might but rarely, and where only the primitive blue-green algae and small periwinkles adapted to long periods of drought survive, to the almost permanently inundated zone populated by whelks, starfish and worms, the creatures of the intertidal zone display an astonishing capacity to take advantage of minute differences in temperature and salinity. In a study of five beaches around Mumbai Bhatt and Bal have described the animals found in different zones, viz. Upper littoral, Mid-littoral and Lower littoral zones. The major animals in these zones were found to be littorinids, Balanus-oysters and Trochids. According to them greater wave action favours Balanus sp. but discourages oysters. Trochids also are found less in numbers where wave action is intense. Sheltered beaches display greater diversity of animals than exposed ones. (Bhatt and Bal 1959). In general our findings compare well with theirs.

Ghost crabs (Ocypode) normally live in sand on high shores away from the high tide line. As the tide comes in they have to run to its edge to gather their food. Likewise the rock pools high on wave-cut platforms are only favoured by the strongest of waves. As the surrounding rock blazes in the sun, temperature shoots up and salinity increases through evaporation. Only a few tough algae and an occasional limpet survive here. Millions of little barnacles and oysters inhabit the zone that is normally reached by waves during the high tide. On sandy beaches where the surface dries out as water drains quickly, worms, clams and crabs burrow deep into the sand and come out only with the next bout of inundation.

In the middle section where the period of dryness is shorter than the one experienced by high shores, limpets, rock skippers, a few fish and crabs live in rock pools. On the sandy shores in this zone are spread minute signs left by worms who inhabit the shallow burrows and paths and tracks made by Pea (Pinnotheres), Porcelaine (Philyra) and Swimming (Matuta) crabs and button shells (Umbonium). Often egg cases of worms and moon snails (Natica) together with a variety of empty shells are found littered in this zone. As one moves to wetter zones than this, the sandy rock

pools and wet mud between boulders display a still greater variety. Often a whole boulder-field is found coated by tiny tubular structures made by Sabellaria worms. Plankton strainers are now gradually replaced by grazers and active predators. Algal variety increases and so is the diversity of grazers in them. A number of snails and worms, sea squirts and anemones, brittle stars and onchidium inhabit this zone. In the pools left by the receding tide on a sandy beach are found a number of shells occupied by Hermit crabs (Dardanus), a few stranded Jelly fish and Starfish or Sea Star half buried in the sand.

The last bands of the intertidal zone which get exposed for short periods only or during the lowest low tide offer a glimpse of that fascinating world which remains concealed below the surface of the sea most of the time. Shoals of Mole crabs (Emerita), Ctenophors, an occasional small Octopus and Cuttle fish (Sepia) brought up by waves, perhaps a large anemone half buried are seen on sandy beaches while the rocky ones display large fronds of Sargassum, great fields of anemones, rock pools and crevices littered with sea cucumbers and urchins, feather stars or sea lilys (Crinoids) and even coral patches adapted to turbid waters (Turbinaria). Sea hares (Aplysia) also inhabit this zone. Here also are found extensive fields of edible blue-green mussels (Mytilus). Acorn barnacles inhabit rocks where waves break with force and abandon incessantly.

Several factors must be contributing to this diversity of life witnessed in the intertidal zone. The Arabian sea as a part of the Indian Ocean is essentially oceanic in character and its surface waters are subject to nutrient replenishment drawn from a very wide area. Though strong up-wellings are rare on the west coast, the nutrients from those occurring on the Somali coast are driven northwards by waters moving along the coast of Arabia and Pakistan and then brought south to the west coast (Panikkar 1984). The strong southwest monsoon also brings a nutrient supply during summer. Nair and Peter report that seasonal changes in the overall oceanic conditions in the sea off the west coast appear to be similar from year to year. According to them the process of upwelling starts in March and continues during the south west monsoon and its maximum effect is seen in August-September. In March 1977 they found pockets of high zoo-plankton biomass south of Ratnagiri and great abundance of fish eggs in shelf waters between Trivendrum and Tuticorin (on the east coast). They concluded that shelf waters of the west coast were highly productive and sustain a rich and abundant planktonic life. (Nair V R and Peter G. 1980).

This abundant nutrient supply should make for very favorable breeding environment along the coast line. Existence of a broad continental shelf offering a variety of niches should also prove ideal for the life and reproduction of diverse life forms. "The film of water around every sand grain holds minuscule fauna of single-celled animals and plants, water mites, shrimp-like crustacea, insects and larvae of certain worms which are food to higher animals" (Carson 1983). The eggs and larvae produced in profusion in this region should be carried and distributed over an extensive area along the coast by offshore currents that flow throughout the year along our west coast.

How are the life forms of the inter-tidal zone distributed along the west coast between Mumbai and Goa? Can we highlight certain aspects in their distribution according to seasons or according to the character of places we visited and examined?

We began our investigations in October 1996. Most of the inter-tidal zone on this 500 km long coastline was covered by the end of May 1997. Over 80 beaches, both sandy and rocky, were examined on foot at low tide to observe the life of the inter-tidal zone. Only a few plant specimens were collected for identification in the laboratory. Only a few places could be visited two times. Obviously the data we present are of limited value. It covers the distribution and status (abundance of scarcity) of life forms during a particular season in the year 1996-97, i.e. during one year. They may differ from year to year or may not. A long-term study may only reveal some patterns in distribution according to seasons, climatic conditions or other ecological factors. Dr. Parulekar of National Institute of Oceanography, Goa, studied the marine fauna of Malvan inter-tidal zone over a number of years (1966-1981). He found 40 life forms divided into 208 species. In our quick survey of the coastal zone we could observe 28 of them though species identification was not possible in every case. Dr. Parulekar divides the inter-tidal zone (rocky, sandy and muddy) in 8

sub-zones which include mangroves also. He notes that eco-systems characterized by hard bottom deposits were faunistically richer than those with soft sub-stratum (Parulekar 1981).

We, however, made it a point to visit those place at least twice in different seasons, which we found to be strikingly rich in biodiversity. Additional confirmatory data about these spots were obtained from the local people. Our identification of places as 'biodiversity hot spots' is based not only on conditions found there in at least two seasons but also on sound local traditions. Indeed that all these places are rich in plant and animal life has been known to local people over generations. A few like Malvan, Ratnagiri and the vicinity of certain creeks have also been scientifically explored. (Parulekar ibid, Joshi, Bhosale, etc.).

The status of the beaches on the basis of plant diversity has already been described. The long table at the end of this chapter presents their status on the basis of animal diversity. The highlights of distribution noted during our one-year work are presented below.

In 1996 when we began the field work, monsoon had ended though it was still cloudy due to depressions that developed over the Bay of Bengal. High velocity winds swept westwards from the Bay making the Arabian sea choppy and turbulent with occasional heavy showers. We began by examining beaches in the region between the southern bank of the Dabhol estuary and Ratnagiri. By November the influence of depressions from the Bay of Bengal had waned, skies had cleared and sunny weather prevailed. At that time we examined beaches from south of Ratnagiri to Ambolgad (see map 1).

How was the distribution of life forms in this region during the post-monsoon period? Overall the most abundant life form was found to be rock crab (Grapsus, Neptunus), followed by oysters and barnacles. On some rocky beaches the numbers of sea anemones were spectacular, the white anemones coming next in abundance to red ones. While the red anemones averaged 3 cms in diameter, the former were small averaging only 1.5 cms. On some sandy beaches several Pea and Porcelain crabs swayed with the waves and dense rafts of mole crabs floated on the thin water film. Mysis stage larvae and young ones of lobsters were also numerous on certain beaches. Next in abundance came the numbers of limpets, gastropods, hermit crabs and zoanthus colonies in rock pools. While only a few sea urchins could be found, some beaches were seen to be littered with sea cucumbers. Live shells of Littorina, Thais, Trochus, Turritella and Cyprea were found also. The other highlights were a small octopus washed up by waves, bunches of small jelly fish, eels trapped in rocks, two species of star fish, a star fish with six tips, onchidiums, feather and brittle stars and extensive Sabellaria colonies. Dr. Badve who had studied these colonies notes that these can be found at many places along the west coast, especially in areas of high turbulence, strong currents and minimum sedimentation. According to him these reef-building animals offer a protective cover to the rocky surface, stabilize sand bottoms, retard wave and current erosion and help in shore-building (Badve 1996).

In winter we went further south first to examine beaches from Vijaydurg to Malvan and later went north to the beaches between Dabhol and Shreevardhan (see map 1). The weather was bracing and cool and skies clear. It was during these visits we could collect some evidence of marine turtle nesting on these beaches. Now great armies of sand crabs outnumbered the crabs of rocky beaches. Next in abundance came the porcelain and pea crabs. Gastropod shells including colourful button shells were found in abundance on certain beaches. The species of live shells recorded, were those of Nerita, Conus, Tibia and Oliva. Amazing numbers of starfish were also counted on some beaches. Though not found in large rafts, considerable numbers of mole and eight-oared swimming crabs were seen. Next in abundance were noted Sabellaria colonies, sea cucumbers and red and white sea anemones. A new form of white, and bluish-violet colour anemones were found also. Sea squirts, Chitons, Sea hare and Ball urchins were noted for the first time. Extensive mussel beds were found while egg cases of Natica littered many beaches. Live coral-like formations believed to be Turbinaria were also noted in abundance.

From March onwards we examined the beaches between Malvan and Goa and in the north

between Shreevardhan and Mumbai. In abundance and variety of life forms both these regions, especially the latter one, were found to be poorer than others. Crabs, starfish, urchins and sea cucumbers were mostly absent. Bivalves were found to be abundant including extensive mussel beds. Next came different species of gastropods including button shells. Ghost crabs dominated the sands of the southern beaches followed by other sand crabs like Soldier crab (Dotilla) and swimming crab. Sea stars, sea anemones, zoanthus and limpets were conspicuous in their absence. A rare species of butterfly was noted on the protected beach adjoining Raj Bhavan in Mumbai (Chaturvedi, pers. communication).

It is difficult to arrive at any conclusion on the basis of these observations. Our main task was to identify the so-called "Hot spots" of bio-diversity. Though our investigations did 'uncover' certain locations strikingly rich in bio-diversity, we considered this to be only one, though very important, parameter in our analysis. This overview of the coastline broadened our vision and convinced us of the importance of the conservation of vital ecological processes on which alone depends the richness of flora and fauna. This led us to examine certain supporting parameters. The final selection of "Bio-diversity Hot Spots" was made on the basis of all parameters. This forms the subject matter of the next chapter.

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Table No. 4.1

FAUNAL BIODIVERSITY OF THE KONKAN COAST ON SANDY BEACHES

Name of beach	Inter-tidal zone(m)	Faunal variety (Type and occurrence)				
		Bivalves	Gastropods	Jelly fish	Star fish	Worms
Rewas	150	2/few	2/moderate	-	-	1/few
Mandwa	150	-	1/abundant	-	-	1/few
Sasawane	100	-	4/few	-	-	-
Alibag	150	1/few	4/moderate	-	-	-
Nagaon	100	3/abundant	3/moderate	-	-	-
Chaul	75	1/few	2/few	-	-	-
Revdanda	75	1/few	2/few	-	-	-
Borlai	50	2/few	4/moderate	-	-	1/few
Kashid	75	1/few	2/moderate	-	-	-
Nandgaon	100	1/few	4/moderate	-	few	1/few
Dighi	50	1/few	2/moderate	-	-	-
Adgaon	50	1/moderate	2/few	-	-	-
Diveagar	100	1/moderate	3/moderate	few	-	1/moderate
Arwi	100	1/few	2/few	-	-	1/few
Murud Jan.	500	2/abundant	2/few	-	-	1/few
Shreewardhan	300	3/moderate	2/few	-	-	1/few
Velas	200	3/few	2/few	-	-	-
Kelshi	500	7/abundant	3/scarce	-	-	1/few
Adhé	150	3/abundant	3/abundant	-	-	1/few
Padlé	200	3/abundant	3/abundant	-	-	1/few
Anjarlé	150	3/moderate	2/moderate	-	-	-
Harnai	100	2/few	2/few	-	-	-
Murud	500	5/moderate	3/moderate	-	-	1/few

Name of beach	Inter-tidal zone(m)	Faunal variety (Type and occurrence)				
		Bivalves	Gastropods	Jelly fish	Star fish	Worms
Kadde/ Burundi	300	3/abundant	3/moderate	-	-	1/few
Koltharé	150	3/few	2/few	-	-	-
Guhagar	300	1/abundant	5/moderate	-	-	-
Sandkhol	200	-	-	abundant	-	1/few
Ratnagiri	300	5/abundant	5/abundant	few	2/moderate	1/few
Ganeshgulé	300	1/few	2/moderate	few	-	1/few
Ranpar	150	8/few	7/few	-	-	-
Gaonkhadi	200	1/abundant		-	-	-
Vetyé	150	-	-	-	-	1/few
Ambolgadh	150	4/few	2/few	few	moderate	-
Madban	50	1/few	3/few	-	-	-
Vijaydurg	50	-	1/few	-	-	-
" (S)	100	1/few	1/few	few	moderate	1/moderate
Kolewadi	150	-	1/moderate	-	-	-
Padawanewdi	300	-	-	-	-	-
Phanasewadi	200	1/few	-	-	abundant	-
Mithmumbri	300	1/moderate	1/abundant 1/moderate	-	abundant	few
Hindalé	100	-	-	-	-	-
Achra	300	1/abundant	1/abundant 1/moderate	-	abundant	few
Malvan (Rajkot)	150	1/moderate	4/moderate	-	-	-
Malvan (Bunder)	300	1/moderate	4/few	-	-	-
Tarkarli	300	1/moderate	4/moderate 1/abundant	-	-	-

Name of beach	Inter-tidal zone(m)	Faunal variety (Type and occurrence)				
		Bivalves	Gastropods	Jelly fish	Star fish	Worms
Bhogwewadi	50	1/abundant	1/abundant 2/few	-	few	-
Vayangani	50	-	1/few	-	-	few
Kelus	50	-	-	-	-	-
Ubhadanda	350	1/few	1/few	-	-	-
Mochemad	100	2/moderate	2/moderate	-	few	-
Aravali-Tak	200	2/moderate	2/moderate	-	few	-
Velagar	150	3/moderate	2/moderate	-	few	-

Name of the Beach	Faunal Variety (Types and Abundance)				
	Crabs	Cteno-phores	Egg-cases	Crusta-cean Larvae	others
Rewas	2/moderate	-	few	few	-
Sasawane	-	-	-	-	-
Alibag	2/moderate	-	few	few	-
Chaul	1/few	-	few	-	-
Revdanda	1/few	-	-	-	-
Borlai	2/moderate	-	-	-	-
Kashid	1/moderate	-	-	-	-
Nandgaon	3/moderate	-	few	-	-
Dighi	1/few	-	-	-	-
Adgaon	2/few	-	few	-	-
Diveagar	2/moderate	-	moderate	-	-
Arwi	1/few	-	few	-	-
Akshi-Nagaon	1/abundant	-	-	-	-
Mandwa	1/moderate	-	-	-	-

Name of the Beach	Faunal Variety (Types and Abundance)				
	Crabs	Cteno-phores	Egg-cases	Crusta-cean Larvae	others
Murud-Janjira	1/few	-	-	-	-
Srivardhan	1/moderate 1/few	-	1/few	-	-
Velas	1/abundant	-	1/few	-	-
Kelshi	2/abundant	-	1/few	-	-
Utambare	1/abundant	-	1/few	-	-
Adhé	1/moderate	-	moderate	few	-
Padlé	1/moderate 1/abundant 2/few	-	abundant	few	sea snake
Anjarlé	1/moderate	-	1/few	-	-
Harnai	1/few	-	-	-	-
Murud	1/abundant 2/moderate 1/few	-	1/few	-	-
Kaddhé	1/abundant 2/few	-	1/moderate	-	-
Ladghar-Burundi	2/abundant 1/moderate 1/few	-	1/moderate	-	-
Koltharé	1/abundant	-	1/few	-	-
Guhagar	-	-	-	-	-
Sandkhol	2/abundant	abundant	-	abundant	-
Jakimirya	2/moderate	few	-	abundant	-
Ganeshgulé	2/abundant	-	-	-	sandshrimp few
Ranpar	2/abundant 1/few	-	-	-	-
Gaonkhadi	1/abundant 1/moderate	-	-	-	-

Name of the Beach	Faunal Variety (Types and Abundance)				
	Crabs	Cteno-phores	Egg-cases	Crusta-cean Larvae	others
Vetyé	2/abundant 2/moderate 1/few	-	-	-	-
Ambolgad	1/abundant 2/moderate 1/few	few	-	-	-
Madban	3/moderate	-	-	-	-
Vijaydurg	3/abundant 1/few	-	-	-	-
" (II)	-	-	-	-	Whelks few
Padawnewadi	4/abundant	-	-	-	-
Phanasewadi	-	-	-	-	-
Deogad	3/moderate 1/few	-	-	-	-
Mithmumbri	3/abundant	-	-	-	-
Hindalé	3/abundant 1/moderate	-	-	-	-
Achra	1/abundant 2/moderte	-	-	-	-
Malvan (Rajkot)	1/moderte 1/few	moderate	-	-	sea-anemone few
Malvan (Bunder)	1/abundant	-	-	-	dead coral abundant Aplysia-few
Tarkarli	1/moderate 1/few	-	-	-	-
Bhogwewadi	1/moderate 1/few	-	-	-	-
Vayangani	1/abundant	-	-	-	-
Kelus	1/abundant	-	-	-	-

Name of the Beach	Faunal Variety (Types and Abundance)				
	Crabs	Cteno-phores	Egg-cases	Crusta-cean Larvae	others
Ubhadanda	1/abundant 2/few	-	-	-	-
Medhawadi	1/few	-	-	-	-
Mochemad Aravli	1/abundant 2/few	-	-	-	-
Velagar	1/moderate	-	-	-	dead corals few

Table 4.2

FAUNAL BIODIVERSITY OF KONKAN COAST ON ROCKY BEACHES

Name of the Beach	Inter-tidal zone	Faunal Diversity Barnacle	Oyster	Bivalve (Other)	Gastropod	Limpets
Sasawane	15	few	-	-	few	-
Borlai	25	moderate	few	-	few	-
Nandgaon	30	moderate	moderate	few	few	-
Dighi	30	few	few	few	-	-
Mandwa	30	abundant	abundant	-	abundant	few
Murud-Janjira	25	moderate	moderate	-	abundant	few
Srivardhan	25	moderate	moderate	-	moderate	-
Velas	20	abundant	abundant	-	moderate	-
Kelshi-Utambare	50	moderate	abundant	moderate	moderate	few
Padlé	30	moderate	moderate	moderate	moderate	-
Murud-Kaddhé	75	moderate	moderate	abundant	abundant	-
Ladghar-Burundi	75	abundant	abundant	abundant	abundant	-
Guhagar	30	abundant	-	abundant	moderate	-
Budhal	30	abundant	abundant	-	moderate	abundant
Sandkhol	35	abundant	abundant	moderate	abundant	abundant
Jakimirya	20	few	moderate	moderate	moderate	moderate
Ratnagiri	25	abundant	abundant	moderate	moderate	-
Ganeshgulé(N)	20	abundant	abundant	-	moderate	moderate
" (S)	20	moderate	moderate	-	moderate	moderate
Purnagad	20	abundant	abundant	-	moderate	abundant
Vettyé	15	few	moderate	abundant	few	moderate

Name of the Beach	Inter-tidal zone	Faunal Diversity				
		Barnacle	Oyster	Bivalve (Other)	Gastropod	Limpets
Ambolgad	15	moderate	moderate	-	moderate	few
Vijaydurg	20	-	few	moderate	abundant	-
" (mixed)	15	moderate	-	-	-	-
Kolewadi	25	-	-	abundant	abundant	few
" (mixed)	20	moderate	-	-	moderate	moderate
Padawnewadi	30	moderate	moderate	few	-	few
Deogad	15	few	abundant	-	few	-
Mithmumbri	20	moderate	few	-	few	moderate
Kunkeshwar	25	moderate	moderate	-	-	moderate
Malvan	30	few	few	-	-	-
Bhogwewadi	30	few	few	-	few	-
Kelus	15	abundant	abundant	-	-	few
Medhawadi	15	few	few	-	-	few
Mochemad	20	few	few	few	-	moderate

Name of the Beach	Inter-tidal Zone (m)	Faunal Diversity (Type and Occurrence)				
		Sabell-aria	Zooan-thus	Sponge	Sea Anemones	Corals
Sasawane	15	-	-	-	-	-
Borlai	25	few	-	-	few	-
Nandgaon	30	few	-	-	-	-
Dighi	30	-	-	-	-	-
Mandwa	150	-	-	1/few	1/moderate	-
Murud-Janjira	500	moderate	-	3/abundant	1/few	-
Srivardhan	300	-	-	-	-	-
Velas	200	moderate	-	-	-	-
Kelshi	500	-	-	-	-	-
Utambare-Padlé	200	-	-	-	1/few	-
Murud-Kaddé	500	abundant	-	-	1/moderate	few
Ladghar-Burundi	300	abundant	-	3/abundant	4/moderate	abundant?
Guhagar	50	abundant	-	-	1/abundant 1/moderate	-
Budhal	50	few	abundant	2/moderate	2/abundant	-
Sandkhol	75	moderate	abundant	3/moderate	2/abundant	-
Jakimirya	75	few	few	3/moderate	2/moderate	-
Ratnagiri	50	-	moderate	2/few	2/moderate	-
Ganeshgulé	30	-	moderate	1/few	2/moderate	-
" (S)	30	-	few	-	2/moderate	-
Purnagad	30	-	moderate	1/few	2/abundant	-
Vetyé	20	few	-	1/few	-	-
Ambolgad	30	-	moderate	4/few	2/moderate	-
Vijaydurg	30	-	abundant	1/few	-	-

Name of the Beach	Inter-tidal Zone (m)	Faunal Diversity (Type and Occurrence)				
		Sabell-aria	Zooan-thus	Sponge	Sea Anemones	Corals
V.Durg (mixed)	30	few	moderate	1/few	1/moderate	-
Koléwadi (mixed)	100	few	-	-	1/few	-
Koléwadi(R)	50	-	-	-	-	-
Padwanewadi	30	-	-	-	1/moderate	-
Deogad	20	-	-	-	-	-
Mithmumbri	50	-	moderate	3/few	3/moderate	-
Kunkeshwar	30	few	moderate	1/few	1/abundant 1/few	-
Malvan (Rajkot)	30	-	-	-	1/few	-
Malvan (Fort)	20	-	few	-	-	-
Bhogwewadi	50	few	moderate	-	-	-
Kelus	20	moderate	-	-	1/moderate	-
Medhawadi	30	-	-	-	1/few	-
Mochemad	30	-	-	-	1/few	-

Name of the Beach	Inter-tidal Zone (m)	Faunal Diversity (Type and Occurrence)					
		Crabs	SeaCucu--mbers	Sea-hare	Sea Urchin	Sea Squirt	Fishes
Sasawane	15	-	-	-	-	-	-
Borlai	25	1/few	-	-	-	-	-
Nandgaon	30	1/few	-	-	-	-	-
Dighi	30	1/few	-	-	-	-	-
Mandwa	30	1/few	-	-	-	-	-
Murud-Janjira	25	2/moderate	-	few	2/few	-	-
Srivardhan	25	1/moderate	-	-	-	-	-
Velas	20	-	-	-	-	-	few
Kelshi-Utambare	50	few	-	-	-	-	few
Utambare-Padlé	30	few	-	-	-	-	-
Murud-Kaddhé	75	1/moderate	-	few	2/moderate	-	-
Ladghar-Burundi	75	2/moderate	-	few	1/abundant	-	-
Guhagar	30	1/abundant 1/moderate	-	-	-	-	2/few
Budhal	30	1/abundant 1/few	-	-	1/few	-	1/few 1/abundant
Sandkhol	35	1/abundant 1/few	abundant	-	2/few	-	4/few
Jakimirya	20	1/abundant	abundant	-	-	-	2/few
Ratnagiri	25	-	-	-	-	-	-
Ganeshgulé (North)	20	1/abundant 1/few	few	-	dead abundant	-	1/moderate 1/few
"(South)	20	-	-	-	1/few	-	-
Purnagad	20	1/abundant	-	-	2/few	moderate	2/moderate
Vettyé	15	1/moderate	-	-	-	moderate	-

Name of the Beach	Inter-tidal Zone (m)	Faunal Diversity (Type and Occurrence)					
		Crabs	SeaCucu--mbers	Sea-hare	Sea Urchin	Sea Squirt	Fishes
Ambolgad	15	1/abundant	-	-	-	few	-
Vijaydurg	20	1/moderate	abundant	-	-	moderate	-
"(mixed)	15	1/few	-	-	-	-	-
Koléwadi	25	1/moderate	-	-	-	-	-
Padwanewadi	30	-	-	-	-	-	-
Mithmumbri	20	1/moderate	abundant	-	-	-	-
Kunkeshwar	25	1/abundant	-	-	-	few	-
Malvan (Rajkot)	30	1/moderate	few	-	-	-	-
Malvan (Fort)	15	1/moderate	-	-	-	-	-
Bhogwewadi	30	1/moderate	abundant	-	-	-	few
Kelus	15	1/moderate	-	-	-	-	-
Medhawadi	15	1/few	-	-	-	-	-
Mochemad-Aravali	20	-	-	-	-	-	-

CHAPTER FIVE

IDENTIFICATION OF BIODIVERSITY "HOT SPOTS"

To identify biodiversity "Hot Spots" it was found necessary to grade the beaches on the basis of certain parameters. These parameters are :

1. the extent and variety of dune vegetation;
2. the extent and variety of protective vegetation;
3. the extent and variety of algal cover;
4. the presence of nesting of White-bellied sea eagle;
5. the evidence of nesting by marine turtles; and
6. the variety and abundance of the animals of the intertidal zone.

Vegetation on beaches include the dune vegetation as also the plants naturally growing or planted, that protect the beach. The former has value not only as sand-binders but also as deterrents of climatic, wave-induced and stream-induced erosion. The latter includes vegetation such as Casurina groves planted by the Forest Department and Pandanus stands growing naturally. All this vegetation not only protects the beach but harbours biodiversity also. The casurina tree is almost exclusively used by the White-bellied sea eagle to build its nest overlooking the sea. Other birds such as species of woodpeckers, Ashy swallow shrike, kingfishers and kites also use these groves. Dense stands of Pandanus give shelter to herons as well as reptiles such as Monitor lizards. Pandanus also has cultural value as it is used in religious ceremonies.

The beaches were ranked on the basis of number of species of dune plants found on them and the area of the beach covered by dune plants. If the number of plant species was less than 8 and if they provided scant cover, the beach was ranked as poor; if the number of species was between 8 and 12 and upto 30% of the dunes were covered, it was ranked as good; if species number was between 12 and 15 with 40% cover, it was ranked very good and if the number of species is more than 15 providing more than 50% cover, it was termed as excellent.

For protective cover, number of species was not taken into account as these were only 2 or 3 but the extent of cover from upto 30% (Poor) to above 50% (Excellent) was considered.

The value of algal cover as food and shelter for the marine animals has already been noted. The estimated area covered by different algae and their number (genera) and status (abundance or scarcity) were considered while assigning grades to different beaches. For example, if the number of genera found on the shore was less than 5 and it provided scant cover, the

shore was ranked as poor (in algal cover); if the number of genera was between 5 and 9 with irregular, patchy cover, it was termed as good; if the number of genera was between 9 and 12 with 40% of the area covered, it was termed as very good and if the number of genera was above 13 with more than 50% cover, it was termed as excellent.

Our beaches exhibit a variety of birds though probably not as great as the coast of Saurashtra. Yet hordes of gulls and pelagic terns grace the beaches in winter together with such waders as sandplovers, sandpipers, red and green shanks, curlews, turnstones and oystercatchers. Resident birds include pond and reef herons, little green heron, white-throated, small blue and black-capped kingfishers, pariah and brahminy kites, and lastly the White-bellied sea eagle. It is this powerful raptor, whose nesting on our beaches was considered as a parameter indicating biodiversity. A full list of birds occurring on the beaches and nearshore areas is given in the appendix.

Again nesting of sea turtles was found to be the feature of a number of our beaches, though not in as large a number as on the east coast. Shaikh (1983) first collected information about nesting of sea turtles on beaches especially between Mumbai and Anjarle. Species that come to nest on our beaches have been identified as Green, Olive Ridley, Hawksbill and Leatherback. Our enquiries revealed evidence of turtle nesting on beaches south of Anjarle right upto the Goa border. Though we did not come across an actual nest, a dead Green turtle was discovered on one of the beaches whose inside was full of eggs. Remnants of another turtle were found which had earlier been consumed by local people. We came across areas where turtles and their eggs were relished by local people and also areas where turtles are held sacred and not touched. We prepared and distributed illustrated handouts which described in Marathi different turtle species found on our beaches and exhorted people to save them. Turtle nesting therefore, is an important parameter to grade the beaches.

Lastly marine animal variety such as oysters, barnacles and limpets, bivalves and gastropods, jellyfish and ctenophores, sea anemones and sea squirts, sea cucumbers and sea urchins, starfish, brittle stars, and sea lilys and their abundance put individual beaches on a higher pedestal than others. Shores were ranked on the basis of occurrence of life forms on them. For example, a poor rank means occurrence of only upto 10 life forms; occurrence of upto 15 life forms gives good, upto 20 life forms gives very good and more than 20 life forms gives excellent rank to individual shores.

Scores were allotted to individual beaches on the basis of the status of these parameters thereon. Table No. 5.1 given at the end of this chapter presents the status of these parameters on different beaches and scores assigned to them on that basis.

What does this scheme of ranking indicate? If these parameters are considered, among sandy beaches Murud south of Harnai in Ratnagiri district has the highest score. The second place is shared by beaches at Guhagar, Ratnagiri and Mochemad from Sindhudurg district. The third place is shared by Sandkhol and Ambolgarh from Ratnagiri district and Padavanewadi, Phanasewadi, Mithmumbri and Arawali from Sindhudurg district.

Among rocky beaches those to get the highest score are Ladghar-Burundi, Sandkhol and Bhudal from Ratnagiri district. The second place is shared by Murud-Janjira from Raigad district and Kolewadi from Sindhudurg district. The third place is shared by Jaki-Mirya and Purnagad from Ratnagiri district and Malvan from Sindhudurg district.

But the appearance and sustenance of this biodiversity appear to depend on several factors: marine, estuarine and terrestrial. Therefore, from the conservation standpoint we decided to include certain parameters which are important as supporting ecological processes which form the basis of this biodiversity. Nearness of an estuary or a stream as a source of freshwater, silt and nutrients and nearness of mangroves and forests go to support important ecological processes as

well as provide varied habitats. Though many of the beaches are exposed to direct wave action, some are protected by projecting headlands on both sides or by a bay or inlet. Biodiversity was found to be higher on sheltered beaches than on the exposed ones. Lastly the extent and severity of human activity do often have a detrimental effect on the biodiversity situation. All these factors have therefore, been considered in ranking beaches from the standpoint of support to vital ecological processes. Table 5.2 given at the end of this chapter gives this information.

Existence of these supportive factors in excellent condition was evident on the beaches of Achra and Deogad (Sindhudurg dist.). Next came beaches of Bhatye, Vettye and Kelus followed by those at Kelshi, Kelshi-Utambare, Anjarle, Ranpar, Purnagad, Mochemad and the rocky beach at Kelus.

But if rankings presented in Table Nos. 5.1 and 5.2 are taken together, i.e. not only biodiversity but sustenance of ecological processes is also considered, the following locations stand out: Among sandy beaches Achara and Deogad score the highest, followed by Murud (Harnai), with the third place shared by Kelshi, Sandkhol and Arawali. Among rocky beaches Bhudal, Sandkhol and Purnagad score the highest, followed by Kolewadi and Ladghar-Burundi, and the third place shared by Murud-Janjira and Vijayadurg. Truly these places are fit enough to be titled as "Biodiversity Hot Spots". (See accompanying maps).

If parameters in Table 5.2 are alone considered, Vayangani, Kelus, Vettye, Ranpar and Anjarle show the highest score.

All these places are shown on the accompanying maps by means of different signs. The maps show clusters of different signs in specific areas. Each cluster covers a particular Hot Spot and its hinterland. Thus it becomes apparent that conservation of biodiversity involves more than mere protection to specific locations. Their hinterlands having a supportive role are also important from the conservation standpoint. Beaches having a supportive role together with estuaries having extensive mangroves such as Kundalika, Rajpuri and Dabhol and Devgad and Achara and some streams also become equally important.

One such cluster is located between Murud-Janjira and Shreevardhan-Savitri estuary in Raigad district. There are two in Ratnagiri district: one from Murud (Harnai) to Sandkhol near Jaigad (this includes Dabhol estuary) and the other from Ratnagiri to Purnagad. Sindhudurg also has two: from Vijaydurg to Mithmumbri and from Achara to Malvan. The remaining locations though standing isolated can also be considered to be connected to and inseparable from others e.g. Kundalika, Kelshi, Anjarle, Ambolgad, Vayangani-Kelus and Mochemad-Arawali.

Conservation of biodiversity turns out to be a diverse and multi-faceted subject. To deal with its complexities and multiplicities, cooperation and coordination between a number of agencies, both official and non-official and the resident people are called for.

Let us now see what measures can be suggested to protect and conserve the biodiversity of the west coast between Mumbai and Goa. This forms the subject matter of the last chapter.

Peoples' Participation in Nature Conservation

We were quite impressed by the concern which people from different strata of the Society showed for the protection of nature. Most of them were worried about the effects the introduction of industries, railways and immigration of people will have on their farms and orchards and on their life-style. Though most of them were wary of organized resistance led by outsiders(e.g. to Enron project), suspicion about government's intentions was widely expressed. Government policies of free entry to outsiders in the fishing industry affected the traditional fishermen most and they were the ones who were in the forefront of organised resistance.

A few people we met had already taken steps towards nature conservation on their own.

For example, Shri Vaishampayan from Panchnadi and Shri Mahajan from Kolthare'had already decided to keep some of their land as forest as they were convinced of its necessity. Thus they were quite receptive to our suggestion of keeping 5 to 10 p.c. of their land-holding for the growth of natural forest. We were successful in persuading some of the groups from Pune who have purchased land in the Konkan to do the same. This we felt will help forest regeneration as most of the forest area in the Konkan is privately owned and will also promote peoples' participation in safeguarding their forest wealth.

The case of mangroves is still more complicated. Mangroves are not forest lands but revenue lands. Some of them are private holdings while some may be common village property. Some of them are being threatened by Kharland Development Programme which tries to stop the saline ingress over land by separating it from the influence of the sea. Though mangroves are to be retained as a buffer against the direct attack of the sea, we have seen that many a mangrove have been destroyed by the bunds trying to prevent sea intrusion. It is learnt that Government wishes to transfer mangroves from Revenue to Forest Department. This will lead to their maintenance as forests. But to save mangroves and the sea coast, it is also necessary that an extensive public awareness campaign and networking are initiated.

Public awareness and Networking

Campaign to save sea turtles is still going on. It is directed mainly at fishing communities some of whom pilfer turtle nests and/or eat their flesh. Black and white illustrated handouts are being distributed among these communities.

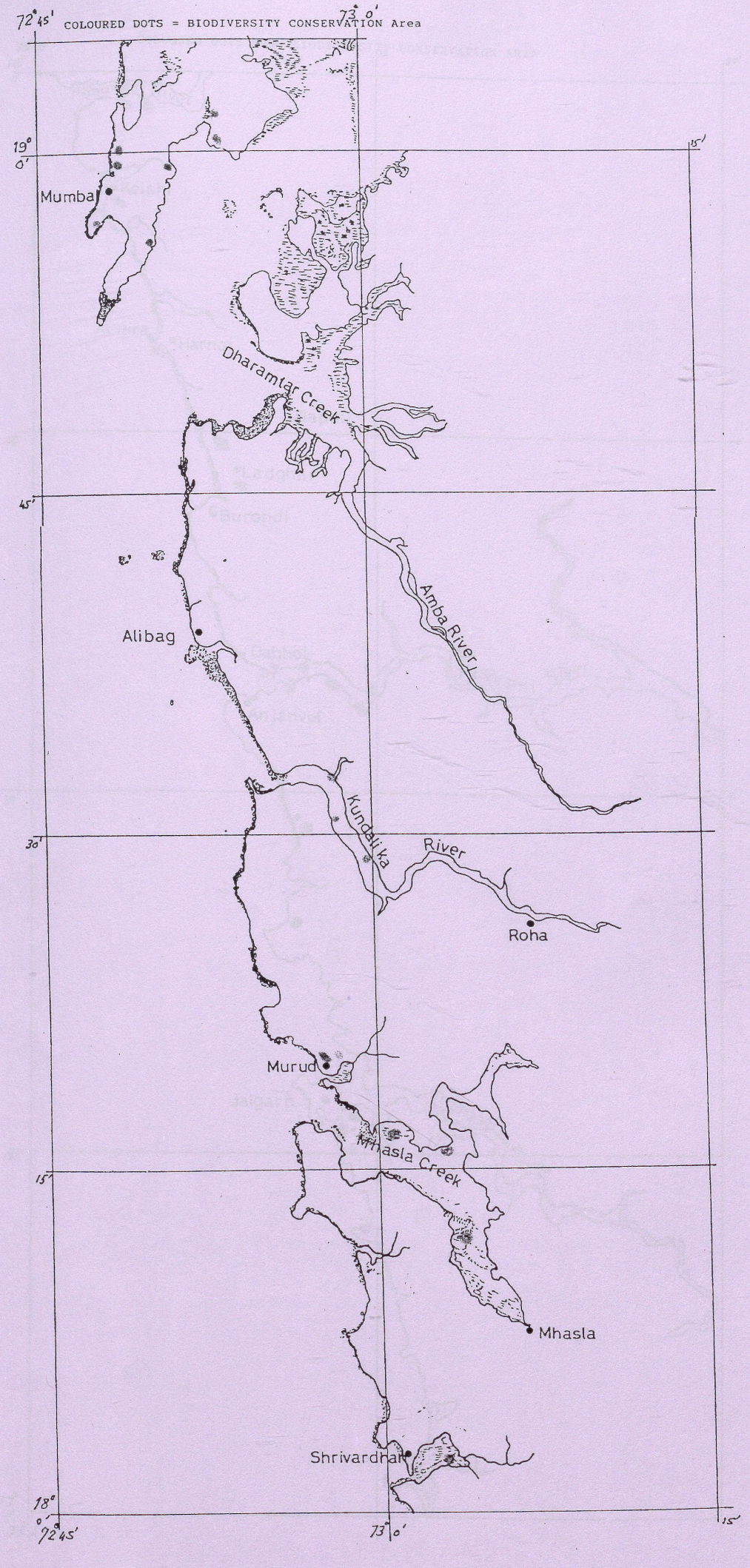
To make people aware of the coastal biodiversity conservation three meetings have been held so far. They were held at Ratnagiri, Deogad and Mangavali(as part of the Save the Western Ghat movement).

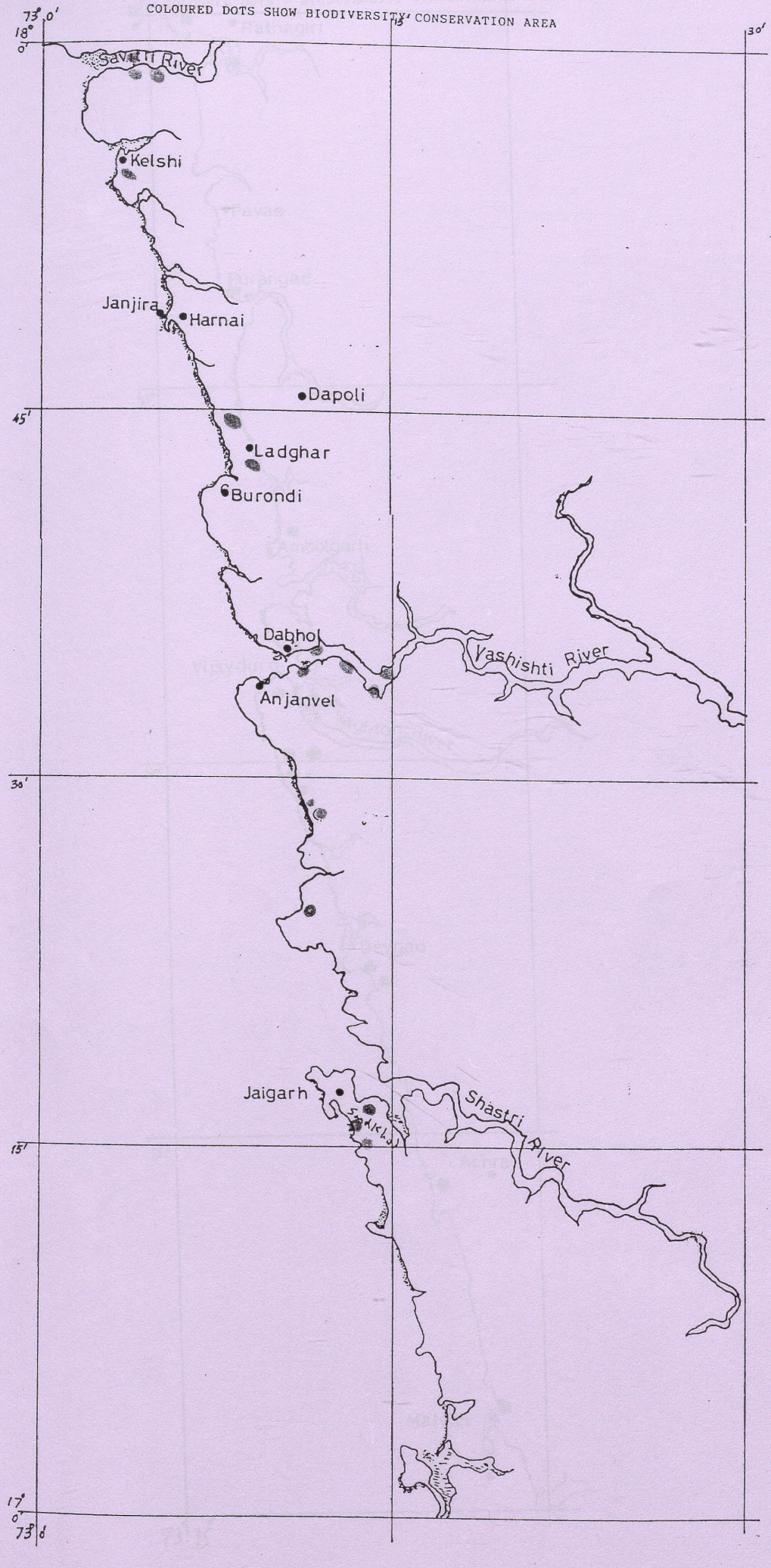
In addition, District Collectors of Ratnagiri and Sindhudurg districts have been alerted about the status of biodiversity rich areas in their respective districts(copies of letters attached). The Chief Engineer, Konkan Region, Irrigation Department, Govt. of Maharashtra and Vice-chancellor, Konkan Agricultural University have also been kept informed of the findings of our investigations. The latter has been requested to take lead to convene a meeting of government agencies, NGOs, academic people, nature-lovers, farmers and horticulturists, landowners and fishing community representatives to discuss especially the balance to be maintained between agriculture, horticulture, plantation forestry, natural forestry and mangroves to involve all sections of the society in the conservation of biodiversity. Vice-chancellor's reaction to this proposal has been positive.

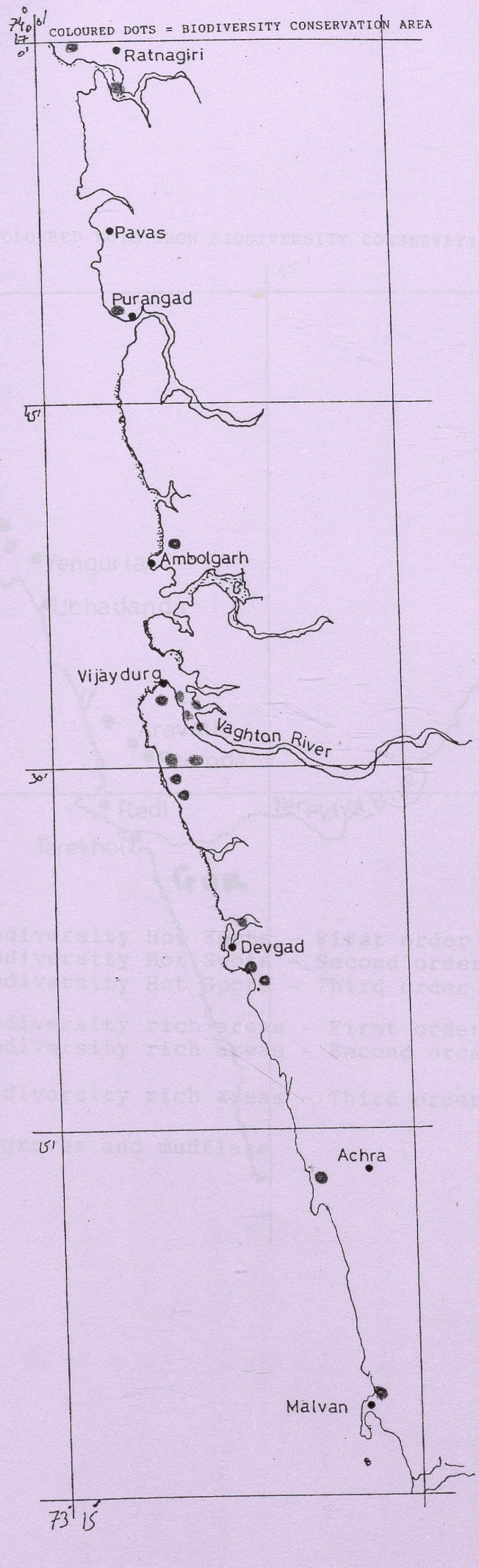
Several individuals from Khed, Dapoli, Murud, Chiplun, Guhagar, Ratnagiri, Deogad and Malvan have shown interest in our work and readiness to cooperate. Likewise several NGOs are in touch with us especially for the conduct of the socio-economic survey of fishing communities. A list of individuals and NGOs appears as appendix 1.

Reference

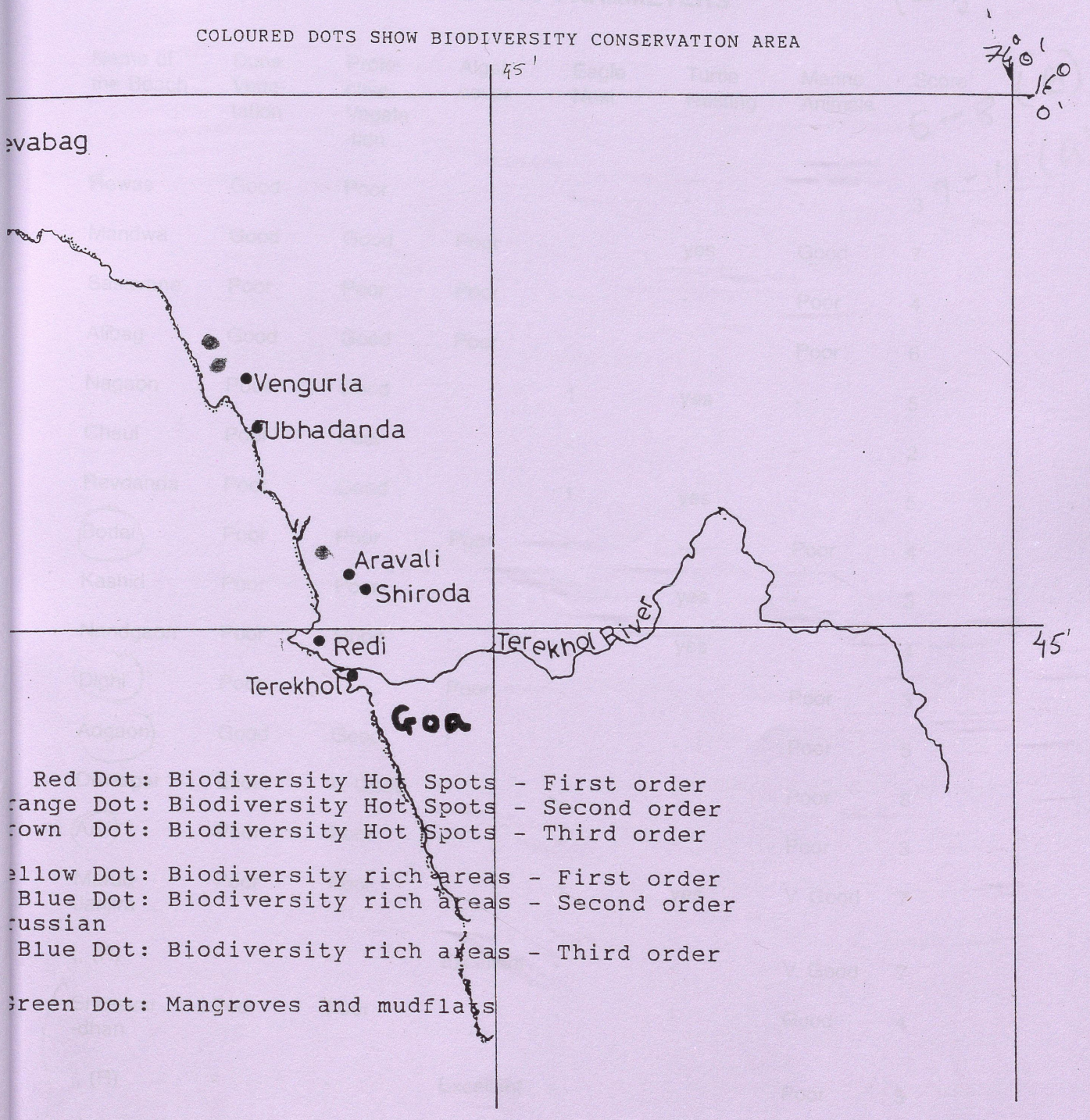
Shaikh K. A. 1984 — Distribution of nesting sites of sea turtles in Maharashtra, Journal of Bombay Natural History Society


COLOURED DOTS = BIODIVERSITY CONSERVATION Area
72°45'
73° 0'
19° 0'
15'
45'
30'
15'
18° 0'
Mumbai
Dharamtar Creek
Amba River
Alibag
Kundalika River
Roha
Murud
Mhasla Creek
Mhasla
Shrivardhan


COLOURED DOTS SHOW BIODIVERSITY CONSERVATION AREA
73° 0'
18° 0'
15'
30'
45'
30'
15'
17° 0'
73° 0'
Savitri River
Kelshi
Janjira
Harnai
Dapoli
Ladghar
Burondi
Dabhol
Anjanvel
Vashishti River
Jaigarh
Shastri River


COLOURED DOTS = BIODIVERSITY CONSERVATION AREA
Ratnagiri
Pavas
Purangad
Ambolgarh
Vijaydurg
Vaghton River
Devgad
Achra
Malvan
16'
45'
30'
15'
73° 15'

COLOURED DOTS SHOW BIODIVERSITY CONSERVATION AREA



Red Dot: Biodiversity Hot Spots - First order
range Dot: Biodiversity Hot Spots - Second order
rown Dot: Biodiversity Hot Spots - Third order

ellow Dot: Biodiversity rich areas - First order
Blue Dot: Biodiversity rich areas - Second order
russian
Blue Dot: Biodiversity rich areas - Third order

Green Dot: Mangroves and mudflats

Table 5.1

THE STATUS OF BEACHES ALONG THE WEST COAST BETWEEN MUMBAI and GOA BIODIVERSITY PARAMETERS

Name of the Beach	Dune Vege-tation	Prote-ctive Vegeta -tion	Algal cover	Eagle Nest	Turtle Nesting	Marine Animals	Score
Rewas	Good	Poor	-	-	-	-	3
Mandwa	Good	Good	Poor	-	yes	Good	7
Sasavane	Poor	Poor	Poor	-	-	Poor	4
Alibag	Good	Good	Poor	-	-	Poor	6
Nagaon	Poor	Good	-	1	yes	-	5
Chaul	Poor	Poor	-	-	-	-	2
Revdanda	Poor	Good	-	1	yes	-	5
Borlai	Poor	Poor	Poor	-	-	Poor	4
Kashid	Poor	Poor	-	-	yes	-	3
Nandgaon	Poor	Good	-	-	yes	-	4
Dighi	Poor	-	Poor	-	-	Poor	3
Adgaon	Good	Good	-	-	-	Poor	5
Diveagar	Excel	V. Good	-	-	-	Poor	8
Arvi	Poor	Poor	-	-	-	Poor	3
Murud Janjira	Poor	Poor	-	1	yes	V. Good	7
,, (R)	-	-	Excellent	-	-	V. Good	7
Shreevar -dhan	Poor	Poor	-	-	-	Good	4
,, (R)	-	-	Excellent	-	-	Poor	5
Velas	V. Good	Good	-	-	yes	Good	8
Kelshi	Good	V. Good	-	-	yes	Good	8
Kelshi-Utambare(R)	-	-	Good	-	-	Good	4

Name of the Beach	Dune Vege-tation	Prote-ctive Vegeta-tion	Algal cover	Eagle Nest	Turtle Nesting	Marine Animals	Score
Adhé	Good	V. Good	-	1	-	Good	8
Padlé	Good	V. Good	-	-	-	Good	7
Anjarlé	Good	Good	-	-	-	Poor	5
Harnai	Poor	Poor	-	-	-	Good	4
Palandé	Poor	Poor	-	-	-	Poor	3
Murud	V. Good	Good	-	2	yes	V. Good	11
Kaddhé(R)	-	-	Good	-	-	Excellent	6
Ladghar -Burundi(R)	-	-	Excellent	-	-	Excellent	8
Koltharé	Poor	V. Good	-	1	-	Poor	5
Guhagar	Good	V. Good	-	2	yes	Good	10
Guhagar(R)	-	-	Good	-	-	V. Good	5
Budhal(R)	-	-	Excellent	-	-	Excellent	8
Hedvi	Good	V. Good	-	1	-	Good	8
Hedvi(R)	-	-	Good	-	-	Good	4
Velneshwar	Good	Good	-	-	-	Poor	5
Sandkhol	Good	Good	-	1	-	Excellent	9
Sandkhol(R)	-	-	Excellent	-	-	Excellent	8
Ganpatipulé	Good	Good	-	1	yes	Good	8
Jakimirya(R)	-	-	Good	-	-	Excellent	6
Ratnagiri	Good	V. Good	-	1	yes	V. Good	10
Ratnagiri	Good	Good	-	1	-	V. Good	8
Ganeshgulé	Good	Good	-	1	yes	Good	8
" (R)	-	-	Good	-	-	V. Good	5
" (R)	-	-	Good	-	-	V. Good	5
Ranpar	Good	Good	-	-	-	Poor	5

Name of the Beach	Dune Vege-tation	Prote-ctive Vegeta-tion	Algal cover	Eagle Nest	Turtle Nesting	Marine Animals	Score
Purnagad(R)	-	-	V.Good	-	-	V. Good	6
Gaonkhedi	V. Good	Good	-	1	-	V. Good	8
Vetye	Good	Good	-	-	-	Poor	5
Ambolgadh	Good	Good	-	1	yes	V. Good	9
Ambol -gadh(R)	-	-	Good	-	-	V. Good	5
Madban	Poor	Good	-	-	-	Poor	4
Vijaydurg	Poor	Poor	-	1	-	V. Good	6
Vijaydurg(R)	-	-	Good	-	-	V. Good	5
Vijaydurg(s)	Poor	Poor	-	-	yes	V. Good	6
Kolewadi	Poor	Poor	-	-	yes	V. Good	6
Kolewadi(R)	-	-	Excellent	-	-	V. Good	7
Padavane-wadi	Good	V. Good	-	-	yes	V. Good	9
Phansewadi	V. Good	Good	-	-	yes	V. Good	9
Deogad	Poor	Good	-	2	-	V. Good	8
Deogad(R)	-	-	Poor	-	-	V. Good	4
Taramumbri	Good	Good	-	-	-	Good	6
Mithmumbri	Good	Good	-	-	yes	Excellent	9
,,(R)	-	-	V. Good	-	-	Good	5
Kunkeshwar	Good	Good	-	1	yes	Good	8
,,(R)	-	-	Good	-	-	V. Good	5
Hindalé	Good	Poor	-	-	yes	Good	6
Tambaldek	Good	Good	-	-	-	Poor	5
Achara	Poor	Good	-	1	yes	Excellent	9
Malvan	Poor	Poor	-	-	-	Excellent	6
Dandi	Poor	Good	-	1	-	Excellent	8

Name of the Beach	Dune Vege-tation	Prote-ctive Vegeta -tion	Algal cover	Eagle Nest	Turtle Nesting	Marine Animals	Score
Malvan(R)	-	-	Good	-	-	Excellent	6
Tarkarli	V. Good	Good	-	1	-	Good	8
Devbag	Good	Good	-	-	-	Good	6
Bhogvewadi	Poor	Good	-	-	yes	Poor	5
,,(R)	-	-	Good	-	-	V. Good	5
Vayangani	Good	Good	-	-	yes	Good	7
Kelus	Poor	Poor	-	1	yes	Good	6
,,(R)	-	-	Good	-	-	V. Good	5
Ubhadanda	Poor	Good	-	2	-	V. Good	8
Medhawadi	Poor	Good	-	-	-	Poor	4
Mochemad	Excellent	Good	-	-	yes	V. Good	10
Aravali / Tak	Good	Good	-	1	yes	V. Good	9
,,(R)	-	-	Poor	-	-	Good	3
Velaghar	Good	Good	-	-	-	Good	6

Ranking :

Dune Vegetation :
Poor : < 8 species and scant cover of Ipomoea pes caprae and Pandanus sp.
Good : <12 species and upto 30% area covered by I. pes caprae and Pandanus sp.
Very Good : <15 species and upto 40% area covered by I. pes caprae and Pandanus sp.
Excellent : >15 species and >50% area covered by I. pes caprae and Pandanus sp.

Protective Vegetation :
Poor : upto 30% of the shore covered
Good : upto 40% of the shore covered
Very Good : upto 50% of the shore covered
Excellent : > 50% of the shore covered.

Algal cover :
Poor : < 5 genera and scant shore area covered
Good : < 9 genera and irregular, patchy cover
Very Good : < 12 genera and upto 40% area covered
Excellent : > 13 genera and > 50% area covered

Marine Animals :
Poor : Occurrence of upto 10 life forms
Good : Occurrence of upto 15 life forms
Very Good : Occurrence of upto 20 life forms
Excellent : Occurrence of > 20 life forms

Score :

Dune Vegetation :
Poor = 1, Good = 2, Very Good = 3, Excellent = 4.

Protective Vegetation :
Poor = 1, Good = 2, Very Good = 3, Excellent = 4.

Algal Cover :
Good = 1, Very Good = 2, Excellent = 3.

Eagle Nest :
1 = 1, 2 = 2. Turtle Nesting : 1

Marine Animals :
Poor = 1, Good = 2, Very Good = 3, Excellent = 4.

Name of the Beach	Dune Vege-tation	Prote-ctive Vegeta-tion	Algal cover	Eagle Nest	Turtle Nesting	Marine Animals	Score
Malvan(R)	-	-	Good	-	-	Excellent	6
Tarkarli	V. Good	Good	-	1	-	Good	8
Devbag	Good	Good	-	-	-	Good	6
Bhogvewadi	Poor	Good	-	-	yes	Poor	5
,,(R)	-	-	Good	-	-	V. Good	5
Vayangani	Good	Good	-	-	yes	Good	7
Kelus	Poor	Poor	-	1	yes	Good	6
,,(R)	-	-	Good	-	-	V. Good	5
Ubhadanda	Poor	Good	-	2	-	V. Good	8
Medhawadi	Poor	Good	-	-	-	Poor	4
Mochemad	Excellent	Good	-	-	yes	V. Good	10
Aravali / Tak	Good	Good	-	1	yes	V. Good	9
,,(R)	-	-	Poor	-	-	Good	3
Velaghar	Good	Good	-	-	-	Good	6

Ranking :

Dune Vegetation :
Poor : < 8 species and scant cover of Ipomoea pes caprae and Pandanus sp.
Good : <12 species and upto 30% area covered by I. pes caprae and Pandanus sp.
Very Good : <15 species and upto 40% area covered by I. pes caprae and Pandanus sp.
Excellent : >15 species and >50% area covered by I. pes caprae and Pandanus sp.

Protective Vegetation :
Poor : upto 30% of the shore covered
Good : upto 40% of the shore covered
Very Good : upto 50% of the shore covered
Excellent : > 50% of the shore covered.

Algal cover :
Poor : < 5 genera and scant shore area covered
Good : < 9 genera and irregular, patchy cover
Very Good : < 12 genera and upto 40% area covered
Excellent : > 13 genera and > 50% area covered

Marine Animals :
Poor : Occurrence of upto 10 life forms
Good : Occurrence of upto 15 life forms
Very Good : Occurrence of upto 20 life forms
Excellent : Occurrence of > 20 life forms

Score :

Dune Vegetation :
Poor = 1, Good = 2, Very Good = 3, Excellent = 4.

Protective Vegetation :
Poor = 1, Good = 2, Very Good = 3, Excellent = 4.

Algal Cover :
Good = 1, Very Good = 2, Excellent = 3.

Eagle Nest :
1 = 1, 2 = 2. Turtle Nesting : 1

Marine Animals :
Poor = 1, Good = 2, Very Good = 3, Excellent = 4.

Table 5.2

Status of Beaches (contd.)
Supportive Parameters

Name of the Beach	Exposed/ sheltered	Inter tidal zone m.	Presence of				Score
			Stream/ estuary	Mangrove	Forest	Human activity	
Rewas	Exp	150	-	Mflat	-	Heavy	3
Mandwa	Shlt	150	-	-	-	Heavy	2
Sasawane	Exp	100	Str	-	Fair	Moderate	4
Alibag	Exp	150	Str	Mflat	-	Heavy	3
Nagaon	Exp	100	Str	Mflat	Fair	Heavy	4
Chaul	Exp	75	Str	Mflat	-	Heavy	3
Revdanda	Exp	75	-	Sparse	Fair	Heavy	4
Borlai	Exp	50	Str	-	Fair	Moderate	4
Kashid	Exp	75	Str	-	Fair	Moderate	4
Nandgaon	Shlt	100	Str	-	-	Moderate	3
Dighi	Shlt	50	-	Mflat	Fair	Moderate	4
Adgaon	Shlt	100	Str	-	-	Moderate	4
Diveagar	Exp	100	Str	Degraded	-	Moderate	3
Arwi	Shlt	100	-	-	-	Moderate	3
Murud Janjira	Exp	500	Str	-		V. Heavy	1
,,	Exp	150	Str	-	-	Moderate	3
Shree-vardhan	Shlt	300	Est	-	-	V. Heavy	3
,,(R)	Exp	30	-	-	-	Moderate	2
Velas	Exp	200	Str	Degraded	-	Mild	5
Kelshi	Shlt	500	Est	Degraded	-	Moderate	6
Kelshi-Utambare	Exp	300	Est	Degraded	Fair	Moderate	6

Name of the Beach	Exposed/ sheltered	Inter tidal zone m.	Presence of				Score
			Stream/ estuary	Mangrove	Forest	Human activity	
Adhé	Exp	150	Est	Degraded	-	Moderate	5
Padlé	Shlt	200	-	-	-	Moderate	3
Anjarlé	Exp	150	Est	Sparse	Fair	Heavy	6
Harnai	Shlt	100	-	-	-	Heavy	2
Palandé	Exp	200	Str	-	-	Moderate	3
Murud	Exp	500	Str	-	Fair	Moderate	4
Kaddhé	Exp	300	Str	-	Fair	Moderate	4
Ladghar-Burundi	Exp	300	-	-	Fair	Moderate	3
Koltharé	Shlt	150	Str	-	Fair	Moderate	5
Guhagar	Exp	300	-	-	-	Heavy	1
Guhagar(R)	Shlt	100	Str	Sparse	-	Mild	7
Budhal(R)	Shlt	100	-	-	-	Mild	4
Velneshwar	Shlt	200	Str	-	Fair	Moderate	5
Hedvi	Shlt	100	Str	-	-	Mild	5
Hedvi(R)	Shlt	25	-	-	-	Mild	4
Sandkhol	Shlt	200	Str	-	-	Mild	5
Sandkhol(R)	Shlt	100	-	-	-	Mild	4
Ganapatipulé	Exp	300	Str	-	-	V. Heavy	1
Jakimirya(R)	Shlt	50	-	-	-	Heavy	2
Ratnagiri	Shlt	300	-	-	-	V. Heavy	1
Ratnagiri	Shlt	300	-	-	-	Heavy	2
Bhatyé	Shlt	500	Est	Sparse	-	Moderate	7
Ganeshgulé	Shlt	300	Str	-	-	Mild	5
,,(R)	Shlt	50	Str	-	-	Mild	5
,,(R)	Shlt	50	Str	Degraded	Fair	Mild	7

Name of the Beach	Exposed/ sheltered	Inter tidal zone m.	Presence of				Score
			Stream/ estuary	Mangrove	Forest	Human activity	
Ranpar	Shlt	150	Str	Degraded	-	Mild	6
Purnagad	Exp	30	Est	Degraded	-	Mild	6
Gaonkhedi	Shlt	200	Est	Degraded	-	Heavy	5
Vetye	Shlt	150	Str	Degraded	Fair	Mild	7
Ambolgadh	Exp	150	Str	-	-	Moderate	3
Ambolgadh(R)	Shlt	30	-	-	-	Mild	4
Madban	Shlt	50	Str	-	-	Moderate	4
Vijaydurg	Shlt	50	Est	-	-	Moderate	5
Vijaydurg(R)	Shlt	25	Est	-	-	Mild	5
V.Durg (South)	Shlt	100	Str	-	-	Mild	5
Kolewadi	Exp	150	-	-	-	Mild	3
,, (R)	Shlt	30	-	-	-	Mild	4
Padwane-wadi	Exp	300	-	-	Fair	Mild	4
Phanse-wadi	Exp	200	Str	Threat	-	Moderate	3
Deogad	Shlt	50	Est	Good	-	Moderate	8
,,(R)	Shlt	50	Est	-	-	Moderate	5
Taramumbri	Exp	30	-	-	Fair	Moderate	3
Mithmumbri	Exp	300	-	-	Fair	Moderate	3
Kunkeshwar	Exp	300	Str	-	-	Heavy	2
Hindalé	Exp	100	Str	-	Fair	Mild	5
Tambadlek	Exp	50	-	Threat	-	Moderate	2
Achra	Exp	300	Est	Good	Fair	Mild	9
Malvan	Shlt	150	Str	Threat	Fair	Heavy	4
Dandi	Shlt	300	-	-	-	V. Heavy	1

Name of the Beach	Exposed/ sheltered	Inter tidal zone m.	Presence of				Score
			Stream/ estuary	Mangrove	Forest	Human activity	
Malvan(R)	Exp	50	-	-	-	,,	-
Tarkarli	Exp	300	Str	-	-	,,	1
Devbag	Exp	150	Est	-	Fair	V. Heavy	3
Bhogwe-wadi(R)	Exp	50	Est	-	Fair	Moderate	5
Vayangani	Exp	50	Str	-	Good	Mild	6
Kelus	Exp	50	Str	Sparse	Fair	Mild	7
Kelus(R)	Exp	20	Str	Sparse	-	Mild	6
Ubhadanda	Exp	350	Str	-	-	Moderate	3
Medhawadi	Exp	100	Str	-	-	Mild	4
Mochemad	Exp	100	Str	Degraded	Fair	Mild	6
Aravli / Tak	Exp	200	Str	Degraded	Fair	Moderate	5
Velaghar	Exp	150	Str	-	-	Heavy	2

Score :
Sheltered : 1, Stream : 1, Estuary : 2

Mangroves :
Threatened : 0, Degraded : 1, Sparse : 2, Good : 3, V. Good : 4.

Forest :
Fair :1 , Good : 2.

Human Activity :
V. Heavy : 0 , Heavy : 1, Moderate : 2 , Mild : 3.

CHAPTER SIX

MAN AND COASTAL BIODIVERSITY

On our palm-fringed coastline those who live closest to the sea, live off the sea. They are our traditional fishermen. This occupation is not restricted to a particular community. There are Bhois, Gabits, Kharvis and Kolis who are all fishermen. Their general distribution along the coastline has already been alluded to. These communities reside and occupy either sides of a village. In the Konkan a traditional village displays more or less a distinct zonation of community occupations. In the centre are the traders with their shops which often occupy the frontage of their houses. On either sides of the village centre, live owners of orchards (coconut, beetlenut, mango, spices etc.). Orchards occupy backyards of their houses, extending upto the seashore. Next in line are the cultivators whose rice fields occupy either the floodplain terraces of a stream or adjoining lower hill slopes. Both the ends of a settlement are usually taken up by fishermen. Also there are villages where fishermen and cultivators reside side by side. Some fishermen also own small orchards.

In a typical coastal village a single street runs parallel to the sea, the different communities taking up their respective positions along the street. Muslims who are mainly traders-exporters or boat-owners generally have their own settlement a little away from the village, often near the port.

Fishermen often have their huts and houses built on sand-dunes. There they haul their boats, sort out their catch, sundry fish, spread their nets and carry out odd maintenance work. Women help the men in every way except going out to the sea. Their homes are surrounded by coconut, mango, cashew and other fruit trees with a few flowering shrubs. The settlement usually has a temple or a mosque which serves as a meeting place for religious, cultural, social and even administrative work.

Obviously it is the fisherman who bears a close relationship with the intertidal zone and its biodiversity. The character of biodiversity along the coast will depend mainly on how these people make use of it. We therefore, wanted to know the degree to which fishing communities exploit the nature surrounding them, what methods they employ to harvest the resources, how do they satisfy their basic wants, how do they use a free access resource such as the sea and how government policies and forces of economic development affect them? Indeed without considering all these factors, it was difficult to arrive at a meaningful plan of coastal biodiversity conservation.

In order to elicit the information we first met community leaders and office-bearers of their representative organizations. We organized meetings to explain the nature and purpose of our work and asked for volunteers to help us in it. We then finalized a questionnaire in consultation with the leaders and office-bearers. An orientation camp was organized to train volunteers. Families were interviewed and questionnaires filled in by volunteers belonging to the fishing communities themselves. The volunteers moved along the coast between Bankot in the north to Malvan in the south. This area can be divided into north, central and south Konkan. Over 300 families were

interviewed from these three sectors. The family data and information gathered from them are presented according to the three segments mentioned above.

Fishermen's average family size was 6.08 in the north, 6.69 in the central and 6.08 in the south Konkan. Their educational level is given in table 6.1 below.

Table 6.1

Educational Level of Fishermen Families in Different Parts of the Konkan

Level of Education	North			Central			South		
	M	W	Ch	M	W	Ch	M	W	Ch
	(Percentages)								
Non-educated	12.9	20	-	10.4	18.4	2.9	26.9	17.3	-
Primary	38.7	60	51	38.4	43.4	48	12.3	23.9	77.9
Secondary	-	20	49	51	38	48	63	42.3	22
Upto XIIth	-	-	-	-	-	-	7	14.1	-
Undergradu.	-	-	-	-	-	-	7	2.1	-
Post-grad.	-	-	-	-	-	-	0.5	-	-

M = Men W = Women Ch = Children

The table shows that the number of uneducated men is higher in the south than in central and north Konkan. The number of uneducated women does not differ according to regions. Families however, seemed to have realized the importance of educating their children. Almost 50% of the children have reached primary level and the remaining 50% have reached secondary level in north and central Konkan while these proportions are 78 and 22 in the south. However, only in the south men and women have reached graduate and a few even post-graduate levels.

The educational level of the current working population however, appears to be low.

The main occupation for men was of course fishing in estuaries and the high seas. Both women and men in their spare time seem to take up alternative occupations such as net-weaving, weaving of coconut fronds, buying and selling of fish, buying and selling of coconut, poultry-keeping, cattle-herding, unskilled labour, orchard maintenance etc. More women than men were engaged in this work which practice was prevalent more in the south, less so in the north, while none of the families has reported any supplementary work in central Konkan.

Moreover these occupations did not seem to contribute to family income in any substantial way. Fishing seems to be the main and only source of income for most of the families (36% in the south, 60% in the north and 100% in central Konkan). It should however, be noted that in Central Konkan very few of the reporting families had their own fishing boats. Most of the men here were employed on trawlers owned in Mumbai. The proportion of boat-owning families was very high in the south (>80%) and substantial in the north (>60%).

How does the fisherman satisfy his basic needs of drinking water, fuel and timber? Table 6.2 presents this information regionwise.

Table 6.2

How Fishermen's Families Satisfy their Basic Needs?

Region	Water		Timber	Fuel	
	Well	Tap	Forest	Forest	Kerosene
			(Percentages)		
North	94.5	5.4	97.3	99.0	1.0
Central	51.0	48.9	100.0	100.0	-
South	98.7	1.2	58.5	58.6	41.4

In the north and south Konkan wells seem to supply drinking water to almost all the families. In central Konkan only, reservoir water is used by about 50% of the families for drinking while the remaining depended on wells. For fuel almost all the families in north and central Konkan use firewood from surrounding forests while in the south 60% depended on the forest the rest use kerosene as fuel. Again timber needs are satisfied from wood made available by the Forest Department in their depots or through saw mills.

For the satisfaction of their basic needs the families seemed to depend heavily on the biomass provided by the surrounding nature.

Families were asked what according to them was the main fishing season and when maximum quantity of fish was available? Regionwise information on these points is presented in Table 6.3.

Table 6.3

The Main Fishing Season and the Season when Maximum Catch can be Obtained as Reported by Fishermen Families

Season	North		Central		South	
	S. F.	Max. Cat.	S. F.	Max. Cat.	S. F.	Max. Cat.
July-Aug.	8.6	-	-	-	3.8	-
August	-	4.3	-	-	-	-
Aug-Sept.	13.0	-	-	44.4	-	-
Aug-Oct.	2.1	60.8	-	-	-	-
Aug-Nov.	6.5	17.4	-	-	-	-
Aug-Jan.	-	-	-	-	-	4.8
Aug-May	60.8	8.6	-	-	3.8	-
Sep-Dec.	-	4.3	-	-	24.0	-
Oct-Nov.	4.3	-	-	3.2	-	2.8
Oct-Jan	-	-	-	-	10.5	-
Oct-May	-	-	3.2	-	23.0	20.1
Nov-Dec.	-	-	-	-	1.9	38.4
Jan-Dec.	-	-	78.4	-	-	-

S. F. : (Main) Season of Fishing; Max. Cat.: Maximum Catch

In the north the fishing season began in August and ended in May as reported by 60% of the families. For the rest Aug-Sept, July-Aug., Aug-Nov. and Oct-Nov. seems to be the main fishing season. In central Konkan where most of the reporting families worked on trawlers or fished in estuaries the whole year constituted the "season" i.e. January to December or September to May.

The number of families who did not fish in the rainy season was quite small in this sector. In the south for 50% of the families the fishing season began in September-October and ended in May. The others reported the best season as October to January or August to May. In the south most of the families abstained from fishing during the monsoon.

In the north the maximum catch of fish was reported in August to December; in central Konkan in August-September or for many (34%) even August to May. In the south the maximum catch was reported in the months of September to December while for some (20%) it was October to May.

Families were asked what fish were still available in good quantity on the coast? The families from different regions reported the names of 21 fish species as generally available in good quantity. Their regionwise distribution in descending order of magnitude is given in table 6.4.

Table 6.4

The Fish Species that are Still Available in Good Quantity Along the Coastline

North	Central	South
Bangda	Palu	Bangda
Rastrelliger kanagorta	Hilsa ilisha	Rastrelliger kanagorta
Kolambi	Kachuk	Pedwa
Netapenaeus affinis	Ambassis commersonii	Sardinella imbriata
Balada	Komta	Mhakul
Rhizoprionodon acutus	Lates calcarifer	Sepia pharaonis
	Kolambi	Saranga
	Netapenaeus affinis	Pampus argenteus
	Situk	Tarli
	Gerrus filamentous	Sardinella longiceps
	Kolim	Kurli
	Acetus indicus	Chirocentrus dorab
	Veda	Toki
	Megalops cyprinoids	
	Sheng	Chingul
	Heterogneustis fossilis	
	Tambos	
	Lutianus argentimaculatus	
	Bangda	
	Rastrelliger kanagorta	
	Karli	
	Chirocentrus dorab	
	Lasa	
	Lutynus fulviflammus	
	Shingala	
	Batrachoceehalus mino	
	Konkani	

In the table above the local name appears first and below it is given the scientific name of each fish species.

The families also reported that 49 species were no longer available in good quantity. Their regionwise distribution is given in Table 6.5.

Considering Tables 6.4 and 6.5 together, it appears that some fish which were available in good quantity in a region were unavailable in others and vice versa. Thus Kachuk, Komta, Sheng, Tambos, Kurli, Toki, Tarli, Saranga, Kurli, Mhakul appear in both the tables. If we exclude these 39 species of fish appear to have become scarce on the Konkan coast.

Table 6.5

The Fish Species that are No Longer Available in Good Quantity Along the Coastline

North	Central	South
Shingala	Kachuk	Shingala
Tachysirus sona/jella	Ambassis commersonii	T. sona/jella
Ghol	Sheng	Tarli
Protonibea diacanthus	Heterogneustis fossilis	Sardinella longiceps
Rawas	Tambos	Paplet
Eleuthpronema tetradactylum	Lutianus argentimaculatus	Pampus argenteus
Shewand	Kurli	Rawas
Panulirus polyphagus	Chirocentrus dorab	E. tetradactylum
Paplet	Shiya	Chala
P. argenteus		
Surmai	Lev	Tiger
Scomberomorus sp.	Psuedorhombus arsius	Penaeus monodon
Sakla	Surli	Saranga
Rachycentron canadus		P. argenteus
Dhomi	Kolat	Shevand
Johnieops sina		P. polyphagus
Halwa	Khatu	Ien
Apolectus niger		
Tadmasa	Nali	Shark
Istiophorus gladius	Anoxypristis cuspidata	Carcharhinus melanopterus
Shark	Shivad	Handala
C. melanopterus		
Karandi	Toki	Karli
		C. dorab
Lanj	Mori	Mhakul
Rhynchobatus djiddensis	C. melanopterus	Sepia aculiata
		Gibhola
		Shivad

Boat-building, both traditional and mechanised, is an important profession on the coast. Families were asked what wood they used in boat-building and where did it come from? They reported the use of wood from 16 species of trees, most of them indigenous forest trees. Table 6.6 gives in descending order the 8 most important tree species that are reported by families to be used in boat-building.

Table 6.6

Main Tree Species used in Boat-building as Reported by Families from Different Regions

Local Name	Scientific Name	North	Central	South
		(Percentage of families reporting)		
Saag	Tectona grandis	50	82	20
Hirda	Terminalia chebula	8	27	95
Ain	Terminalia alata	34	65	20
Shivan	Gmelina arborea	27	45	1
Amba	Mangifera indica	7	29	25
Bivla	Pterocarpus marsupium	-	49	-
Undi	Calophyllum inophyllum	6	1	25
Bhendi	Thespesia populnea	21	1	2

The other species mentioned are Erythrina indica (Pangara), Acacia nilotica (Babhul), Magnolia champaka (Chapha), Terminalia belerica (Behda), Terminalia panniculata (Kinjal), Sterculia foetida (Deodar), Artocarpus integra/incisa (Phanas) and Adina cordifolia (Hed).

Families from different regions were unanimous in reporting that the timber from these trees was no longer available from local forests. The timber came from Karwar in Karnatak. Even large trees of wild mango in forests have become scarce.

It is therefore, necessary that plantations of these indigenous trees are raised. Since these trees grow slowly and returns can be had only over a long time, they have to be raised by the Forest Department, either on their land or common village land. In existing forest patches the remaining members of these tree species will have to be protected.

Do the traditional fishing communities protect and sustainably harvest the resources that they exploit for their livelihood? We tried to gather this information from the families of fishermen. The result was the reporting of 18 social and cultural practices that one way or the other contribute to conservation of natural resources. These conservation practices are listed below :

1. Fishing to begin after coconut festival (August-September).
2. Fishing to begin in September only
3. Fishing to begin after the festival to celebrate the birth of Lord Krishna
4. Fishing only by traditional methods
5. Fishing to cease between May and coconut festival
6. Fishing to begin only after certain religious ceremonies at the end of monsoon
7. Fishing to be closed during the annual festival

8. Fishing to be closed during the Holi festival for 20 days

9. No fishing allowed in the stretch dedicated to deities

10. No consumption of fish on traditional days of fasting

11. No consumption of fish during monsoon (July-Sept.)

12. Exploitation of resources to begin only after the propitiation of the goddess of the land and the sea

13. Turtles not to be harmed

14. No fish consumption once a week

15. Propitiate the deity in boats and fishing gear before going out to the sea

16. Those who break traditions and social norms are to be ostracized

17. No exploitation of resources in Sacred Groves

18. Those who break rules have to offer confessions and repentance before deities.

Most of the families from north and south Konkan have also shown awareness to protect the spawning grounds of fish which according to them are located in shallow waters among submerged rocks, in the root zone of mangroves and in seagrass beds. Some families have complained that the campaign for eradication of superstitious beliefs is eroding the traditional conservation practices. Some have suggested putting tetrapods or artificial reefs into the sea to increase the spawning area, while some have suggested prawn cultivation in estuary basins.

The picture of a traditional fisherman (and woman) that emerges from this investigation is of a poorly educated person who is fully immersed in his profession and is sensitive to the protection of marine resources; one totally dependent on nature for satisfaction of his basic wants. He is careful to educate his children but dissatisfied with available opportunities to better his lot and bitter about government policies which encourage foreign enterprises and large companies to fish in his domain.

CHAPTER SEVEN

CONSERVATION OF COASTAL BIODIVERSITY

Marine and related eco-systems are the richest in the world in terms of productivity. The mixing of salt water with the inflows of silt and sediment brought by the rivers with their freshwater generate unparalleled levels of biological productivity. In tropical seas the combination of coral reefs, estuarine areas, wetlands including mangroves and algal and seagrass beds provide varied habitats for a tremendous variety of life forms. Located there are spawning, feeding and nursery areas for a number of species; they provide staging locations and corridors for migrants including many waterfowl and seabirds. They are a refuge for many a threatened and endangered species. Coastal vegetation provides an important link with terrestrial eco-systems acting as a filter and moderator of terrestrial impacts on the marine biome. It provides a buffer to absorb the pounding of waves, storms and erosion by the sea. The processes of erosion and shore-building are therefore, held in a delicate balance.

The marine biome and the nearshore are an integral part of the life of millions of people in the world. Indeed more than one-half of the world's population lives within 60 km of the shoreline (IUCN 1995). It provides livelihood and sustenance to a number of traditional rural folk in developing countries. Shipping, export-import trade and related activities are the backbone of modern civilization. Mariculture, tourism and recreational pursuits involve a turnover of billions of dollars in the developed countries.

Inspite of all its importance to traditional communities and modern man, the capabilities and resources of the marine biome have not received the care and attention that they deserve. Marine resources have been overexploited resulting in the exhaustion of many a fishery. Its absorptive capacity has been threatened by irrational and unchecked flows of sewage, industrial effluents, toxic materials, agricultural run-offs, hot water flows etc. resulting in algal blooms, fish kills, crash in populations of marine organisms, the failure of their reproductive capacities, strandings, eutrophication and anoxia. Connections between terrestrial and marine eco-systems have been consistently ignored. Incompatible and even dangerous landuse patterns further threaten the marine capabilities.

The Crisis on the Konkan Coast

The 500 km coastline between Mumbai and Goa exhibits everything that is good and bad in this highly charged scenario. It still harbours locations and pockets of breath-taking beauty and nature in an almost pristine form. The area between Mumbai and Alibag on the other hand, reels under the impact of millions who populate the mega-city of Mumbai with its sewage and garbage, industrial and commercial outflows, construction activities and even oil spills that result from the heavy movement of ships and their cargo. At Chiplun and Roha industries have been located in complete disregard of their ecological and social impacts. Land has been acquired for industrial estates and vegetation over it cleared without considering the effects it will have on the surrounding

biology and stream flows. Dams have been built and land submerged under reservoirs though there are few buyers for irrigation water. Plans have been drawn up and land acquired for heavy industries and luxury tourism in total disregard of the interests of the residents and traditional fishing communities. Piers, walls, jetties and other structures are erected in the sea without full consideration of their effects on marine life. Protective walls to stop the ingress of sea water and provide more land for agriculture have in some cases threatened the survival of mangroves. Even proposals of nature conservation have been handled in a way that has only produced opposition, ire and bitterness among residents. The development of the region is being handled in a way that confers little, real, long-term benefits to the residents in terms of income and employment while it deprives them of their lands, other means of livelihood and traditional vocations and life style. The biological base of their life has been threatened. The essential life-sustaining goods that they used to get from surrounding nature free of charge, have ceased to flow. Modern industry and commerce have only brought non-essentials and those too at a greatly enhanced price. The residents of the whole region are therefore, seething in anger and resentment over the intrusion of outsiders in their life and surroundings.

In this crisis mode what can be done to stop further degradation of terrestrial and marine resources, protect and restore habitats and life-sustaining ecological linkages and promote sustainable development to confer lasting benefits to residents and traditional communities?

We have already identified locations on this stretch of the coast which still harbour spectacular variety of life forms. We have also identified eco-systems that sustain this variety and vital ecological processes. The basic assumption underlying these is that the management of the sea cannot be separated from that of the land. Now considering that marine eco-systems have a capacity for restocking and regeneration exceeding that of terrestrial communities, what measures are necessary and what administrative and organizational set up should support them to achieve reconciliation between conservation of biodiversity and economic development of the region?

The Administrative Requirements

The UN Convention on the Law of the Sea exhorts nation states to promote inter alia :

1. integrated management and sustainable development of coastal areas and islands including exclusive economic zones;

2. sustainable use and conservation of marine living resources on high seas and in areas under national jurisdiction;

3. and strengthening regional and international cooperation and coordination in these.

This is to be achieved through an integrated policy and decision-making process that will promote compatibility and balance of uses; identify existing and future uses of coastal areas and their interactions; carry out prior assessment and systematic observations of the impacts of major projects; and provide access to concerned individuals, groups and organizations to relevant information and opportunities for consultation and participation in planning and decision-making.

It is therefore, necessary to set up and strengthen co-ordinated mechanisms at state and local level to provide for consultation in land and water use and siting policies; implementation of integrated plans and programmes in improvement of coastal settlements, disposal of sewage etc. and in their periodic assessment of the impact of external factors and in conservation and restoration of critical habitats.

To develop marine living resources falling under national jurisdiction, it is necessary to :

1. take into account traditional knowledge and interests;

2. maintain and restore populations of marine species;

3. promote the development and use of selective fishing gear and practices that minimize waste;

4. protect and restore endangered species and

5. preserve rare or fragile eco-systems, habitats and ecologically sensitive areas. (IUCN 1991).

The Organizational Requirements

Keeping these imperatives in view it is best to suggest an integrated network of special purpose areas, multiple use areas having different levels of protection and peoples' participation.

The usual set up of creating sanctuaries and national parks needs to be replaced and cast into a new mould using new instruments of administration and implementation.

IUCN (1991) defines a marine protected area as: "Any area of intertidal or sub-tidal terrain, together with its overlying water and associate flora, fauna, historical and cultural features which has been preserved by law or other effective means to protect part or all of the enclosed environment". The MPA should provide : a) a geographic framework, b) articulation of an institutional structure for forward thinking and judicious development decisions, c) a tangible asset to local people and d) establish a set of reference points to assess environment and monitor success. The MPA should be sufficiently large to accommodate different zones and levels of sustainable use; and adequately protect threatened species, critical habitats and native taxa.

It is therefore, thought appropriate to propose a network of Biosphere Reserves and Sites of Special Scientific Interests for coastal biodiversity conservation and reconciling conservation needs of residents and local communities.

In UNESCO's Man and Biosphere Programme Biosphere Reserves have been recognized as especially suited for the marine environment. They are defined as: "protected areas of representative terrestrial and coastal environments which have been internationally recognized under the UNESCO MAB Programme for their value in conservation and in providing scientific knowledge, skills and human values to support sustainable use." (IUCN 1991)

Sites of Special Scientific Interest are areas or locations that harbour unique features and/or provide refuge to rare or endemic flora and fauna.

Management Requirements

These two categories have to be so managed as to reinforce conservation of genetic resources, eco-systems and biodiversity. Research and monitoring components here are especially important in assessing impact of pollution and effects of traditional and modern land use practices. They are expected to provide education, spread awareness and information exchange. Wherever possible local knowledge and traditional practices of sustainable use have to be encouraged as local users have a solid understanding of the location and seasonality of critical processes.

Moreover they are to be so managed as to give local people a sense of stewardship, control and sense of belonging. Involvement of local people in management and decision-making is therefore, imperative. As it needs to be based on correct scientific information, spread of information through brochures, mailings, public debates, seminars, talks and slide shows becomes very important. As conflict is likely to arise in fulfillment of short-term interests in preference to long-term ones, the more the dissemination of correct, scientific information the better is the likelihood of achieving sustainable use of resources. Demonstration activities displaying sustainable use are therefore, especially important.

For evolving a management plan based on correct scientific information and data the system of 5 biosphere reserves and 12 areas of special scientific interest may be considered as one whole; though for administrative and organizational needs the division into separate entities may be necessary. The management plan may be based on :

1. Lists of different life forms;
2. Their occurrence and status throughout the year;
3. Identification of habitats used by them for feeding and reproduction (and other activities such as roosting, loafing etc.)
4. Identification of dominant plant communities and their distribution according to habitats;
5. Identification of different plant communities used by different life forms for feeding and reproduction;
6. Identification of plant stages used by different life forms for feeding and reproduction;
7. Assigning a Versatility Rating to each life form on the basis of the above information;
8. Finding out how different management moves to protect specific species/habitats affect other versatile and less versatile species;
9. Studying how human activities affect different habitats and plant communities;
10. Studying how specific management moves to protect habitats/species will affect human interests;
11. Evolving and implementing measures required to restore degraded habitats; and
12. dividing the area into appropriate zones to achieve reconciliation between human and nature requirements and sustainable use of natural resources.

BIOSPHERE RESERVES AND SITES OF SPECIAL SCIENTIFIC INTEREST THEREFORE, BRING IN NEW DIMENSIONS AND TOOLS IN RESERVE MANAGEMENT.

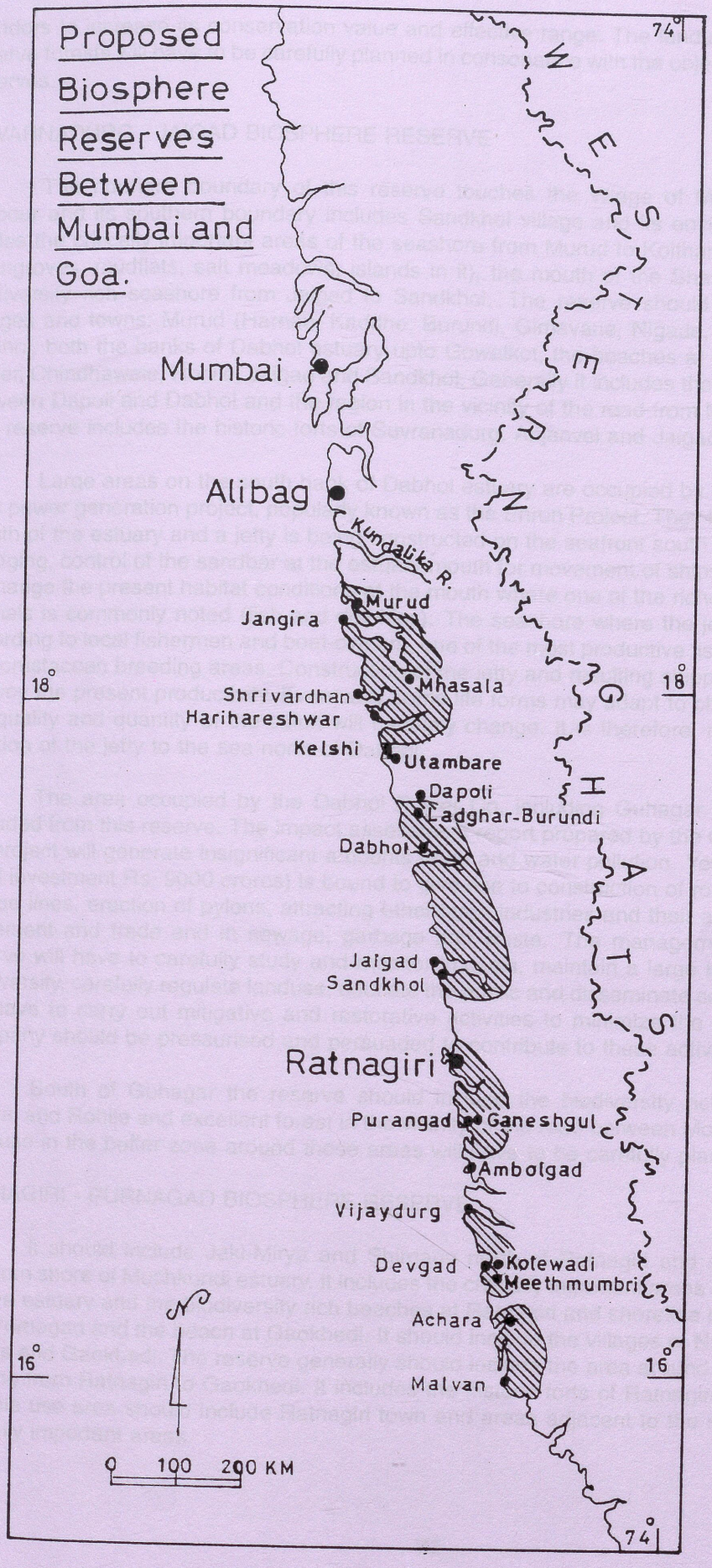
The Proposed Biosphere Reserves

The following Biosphere Reserves are proposed in the coastal region between Mumbai and Goa :

MURUD-JANJIRA, SHREEVARDHAN, SAVITRI BIOSPHERE RESERVE

It covers the area from the southern boundary of Murud town to the southern shore of the Savitri estuary. This area is bounded by the villages and towns of Tala, Mhasala, Harihareshwar, Terewadi and Bankot. The reserve is designed to protect the critically important areas of the mudflats and mangroves of the Mhasala or Rajpuri creek, the mudflats south of Shreevardhan and the mangroves of Savitri estuary. The reserve includes the biodiversity rich beaches at Murud-Janjira, Dighi and Harihareshwar. The historic fort at Murud-Janjira, the heritage sites at Shreevardhan and Harihareshwar are also included in the reserve. The rest of the area in the reserve is to be treated as multiple use area with varying levels of protection, landuse and peoples' participation.

The accompanying map shows the critically important areas and the multiple use area of this reserve. It is suggested that the area under reserve forests can be connected by certain


Proposed Biosphere Reserves Between Mumbai and Goa.
74°
WESTERN GHATS
Mumbai
Alibag
Kundalika R.
Murud
Jangira
18°
Shrivardhan
Harihareshwar
Mhasala
Kelshi
Utambare
Dapoli
Ladghar-Burundi
Dabhol
Jaigad
Sandkhol
Ratnagiri
Purangad
Ganeshgul
Ambolgad
Vijaydurg
Devgad
Kotewadi
Meethmumbri
Achara
16°
Malvan
0 100 200 KM
74°

corridors to increase its conservation value and effective range. The landuse in the area outside reserve forests will have to be carefully planned in consonance with the objectives of the biosphere reserves.

SUVARNADURG - JAIGAD BIOSPHERE RESERVE

The northern boundary of this reserve touches the village of Murud south of Harnai harbour and its southern boundary includes Sandkhol village and its environs. The reserve includes the critically important areas of the seashore from Murud to Kolthare, the Dabhol estuary (Mangroves, mudflats, salt meadows, islands in it), the mouth of the Shastri river including the biodiversity rich seashore from Jaigad to Sandkhol. The reserve should include the following villages and towns: Murud (Harnai), Kaddhe, Burundi, Gimavane, Nigade, Chikhalgaon, Tiware, Dabhol, both the banks of Dabhol estuary upto Gowalkot, the beaches at Guhagar,and Palshet, Sheer, Chindhawale, Rohile, Jaigad and Sandkhol. Generally it includes the area west of the road between Dapoli and Dabhol and the region in the vicinity of the road from Modka Agar to Rohile. The reserve includes the historic forts of Suvranadurg, Anjanvel and Jaigad.

Large areas on the south bank of Dabhol estuary are occupied by Dabhol Power Co. for their power generation project, popularly known as the Enron Project. They have built a pier at the mouth of the estuary and a jetty is being constructed on the seafront south of the estuary mouth. Dredging, control of the sandbar at the estuary mouth for movement of ships to and fro, are going to change the present habitat conditions at the mouth where one of the richest diversity of marine animals is commonly noted (fish and dolphins). The seashore where the jetty will be located is, according to local fishermen and boat-owners, one of the most productive fishing grounds and fish and crustacean breeding areas. Construction of the jetty and resulting shipping traffic are likely to destroy the present productivity. Eventually some life forms may adapt to changed conditions but the quality and quantity of the catch will certainly change. It is therefore, necessary to shift the location of the jetty to the sea north of Dabhol.

The area occupied by the Dabhol Power Co. including Guhagar town will have to be excluded from this reserve. The impact assessment report prepared by the Company implies that the project will generate insignificant amounts of air and water pollution. Yet such a large project (total investment Rs. 9000 crores) is bound to give rise to construction of roads and lanes, laying of pipe lines, erection of pylons, attracting other large industries and their ancillaries, increase in settlement and trade and in sewage, garbage and waste. The management of the biosphere reserve will have to carefully study and monitor impacts, maintain a large buffer zone to protect biodiversity, carefully regulate landuse, educate the public and disseminate scientific information. It will have to carry out mitigative and restorative activities to minimize the adverse effects. The Company should be pressurised and persuaded to contribute to these activities.

South of Guhagar the reserve should include the biodiversity rich seashore between Bhudal and Rohile and excellent forest in the vicinity of the road between Modka Agar and Rohile. Landuse in the buffer zone around these areas will have to be carefully planned.

RATNAGIRI - PURNAGAD BIOSPHERE RESERVE

It should include Jaki-Mirya and Shirgaon north of Ratnagiri and should stretch to the southern shore of Muchkundi estuary. It includes the critically important areas of Shirgaon mudflats, Bhatye estuary and the biodiversity rich beaches at Ratnagiri and shoreline between Ganeshgule and Purnagad and the beach at Gaokhedi. It should include the villages of Nachne, Kolhe, Golap, Pawas and Gaokhedi. The reserve generally should include the area around and west of the road running from Ratnagiri to Gaokhedi. It includes the historic forts of Ratnagiri and Purnagad. The multiple use area should include Ratnagiri town and areas adjacent to the shoreline beyond the critically important areas.

Landuse around Bhatye estuary with its mangroves, mudflats and salt meadows will have to be carefully regulated.

VIJAYDURG - DEVGAD BIOSPHERE RESERVE

The reserve should stretch from the mouth of the Vaghotan river to Mithbao south of Deogad. It includes the critically important areas of Vaghotan estuary with its mangroves, the biodiversity rich shoreline between Vijaydurg and Padawanewadi, the Deogad estuary and again the biodiversity rich shoreline south of Deogad upto Mithbao. It should include the port of Vijaydurg, and villages Tirlot, Padel, Wada, Devgad town, Kunkeshwar and Mithbao. Generally the reserve should cover the area west of and in the vicinity of the road between Vijaydurg and Mithbao. Historic forts of Vijaydurg and Devgad will be covered by this reserve.

The multiple use area beyond the important locations mentioned above contains scattered forests. Demonstration activities such as plantations of useful indigenous trees including bamboo around them involving local people as well as sustainable management of grasslands can be taken up in this reserve.

ACHRA - MALVAN BIOSPHERE RESERVE

It should stretch from north of Achra town to Malvan. The critically important areas in this reserve are: the Achra creek with its mangroves, the biodiversity rich shoreline between Achra bunder and Sarjekot and the sea surrounding Sindhudurg fort. Generally it should include the area west of the road between Achra and Malvan. This reserve will be noted for the marine turtle nesting areas, coral formations around Malvan and other rich biodiversity on beaches. It will also include the historic Sindhudurg fort.

The present proposal for a marine national park at Malvan will have to be reformulated to become an integral part of this biosphere reserve. In its present form the proposal has generated intense opposition among local people. The main complaint of the locals is they were neither adequately informed nor consulted in formulating the proposal and severe restrictions will be put on their fishing if the proposal becomes a reality. If the protected zone contained in the proposal is a part of the biosphere reserve, traditional fishing for local needs can be allowed in the critically important areas. Export-oriented intensive fishing will have to be regulated. In any case management plan for the biosphere reserve will have to be prepared in consultation with local people. If they are adequately informed about the nature of biodiversity that needs to be protected, if provisions are made to meet their basic needs of life and profession, a compromise can be reached. It is necessary that local people should get a say in the management of the reserve by evolving proper instruments of consultation and decision-making.

Biodiversity Protection and Biosphere Management

This string of biosphere reserves extending along the shoreline will protect and conserve important spawning, breeding and nursery areas for fish, marine animals and threatened and endangered species such as Smooth Indian Otter (Lutra perspicillata), freshwater crocodiles (Common in Vasishthi river) and marine turtles. They will protect and regulate mangroves and their use. They can be managed to enhance the area and quality of mangroves, and dune and protective vegetation. They will ensure protection of forests adjoining estuaries, and streams and uplands safeguarding further the maintenance and operation of critical ecological processes. They will also ensure conservation of geomorphological features such as lateritic mesas and plateaus harbouring such animals as Neelgai which are rare in coastal regions. They will give protection to flyways and corridors of migrant seabirds and waterfowl and to most of the breeding sites of the White-bellied sea eagle.

The boundaries of the reserves are only broadly indicated here. They will have to be delineated after careful surveys. The areas of critical importance and buffer zones (multiple use

areas) will have to be demarcated. In the former, natural resource exploitation should be allowed by traditional methods, by traditional communities and residents for local needs only. Its impact on biota needs to be carefully monitored. While different levels of exploitation will be permitted in the buffer zone, in certain areas such as stream banks, banks of the estuaries, inshore wetlands, hill-slopes adjoining mangroves, exploitation will have to be regulated and monitored. Demonstration activities such as plantations of useful indigenous trees, mangrove species, sustainable maintenance of wetlands, of upland meadows, woodlands and grasslands should be encouraged in the buffer zone.

Detailed management planning for these reserves will have to be carried out in consultation with representatives of local people, NGOs, the academic community, fishermen's organizations etc. These plans should be open for public review and debate before finalization. Monitoring of impacts, campaigns for public awareness, education through short courses, seminars and lectures should form a continuous activity.

Sites of Special Scientific Interest

This network of biosphere reserves should be supplemented by Sites of Special Scientific Interest further strengthening the conservation of coastal biodiversity. The following locations should be treated as S. S. S. I. :

1. The beach adjoining Rajbhavan at Mumbai (marine biodiversity)
2. Foreshore of Mumbai Port Trust area at Shivdi (Gr. flamingo roost)
3. Manori, Malad and Vikhroli mangroves and Diva mangroves along Thane creek
4. The Elephanta Island (cultural heritage and birds of prey)
5. Mudflats and mangroves at the mouth of Panvel creek
6. Mangroves of Kundalika estuary
7. Mudflats and shoreline of Kelshi-Utambare
8. Shoreline of Ade', Padle' and Anjarle'
9. The mangrove and rocky and sandy shore at Guhagar
10. The shoreline around Ambolgad and Musa Kazi
11. The shoreline between Kelus and Vengurla
12. The shoreline between Mochemad and Tak-Arawali

The precincts and the shoreline of the Raj Bhavan at Mumbai has been studies by Bombay Natural History Society. They report that it is an island of Biodiversity amidst the sea of urbanity that is Mumbai. It deserves to be set aside as an area of Special Scientific Interest. So is the Port Trust foreshore at Shivdi accepted by flamingos as their resting and roosting area. Manori, Malad, Vikhroli and Diva mangroves are the only extensive patches of mangroves near Mumbai which deserve to be protected from urban encroachments. While the former two are included by the Govt. of Maharashtra in their no development zone, the third one is protected by a private industrial group. The last one seems to be lacking effective protection. It needs all the protection that we can muster. The Elephanta island is a national heritage site which also has special biodiversity value. Mudflats and mangroves near the mouth of Panvel creek are also designated by Govt. of Maharashtra for protection. The Kundalika estuary still retains some fine mangrove patches that need to be

protected and managed. The status of other areas on the seashore has already been described. All of them are either under CRZ I or CRZ III according to the coastal zone regulation plan prepared by Govt. of Maharashtra. Their designation as areas of special scientific interest will highlight their scientific value that needs to be protected.

The SSSIs should be treated on par with critically important areas of Biosphere reserves. Resource use by residents for local needs should only be allowed. Collection of scientific specimens should not be permitted.

THE SCHEME OF MARINE PROTECTED AREAS SUGGESTED HERE SHOULD NOT BE BROUGHT INTO BEING BY AN ADMINISTRATIVE FIAT. IT SHOULD BE MADE PUBLIC FOR COMMENTS, CRITICISM AND DEBATE. SCIENTIFIC INFORMATION JUSTIFYING PROTECTED AREAS SHOULD BE MADE AVAILABLE TO EVERYONE. POSSIBLE IMPACTS ON LANDUSE, DIFFERENT PROFESSIONS AND TRADE SHOULD BE CONTEMPLATED AND DEBATED. MODES OF PEOPLES' PARTICIPATION IN PLANNING AND DECISION-MAKING SHOULD BE SET UP BEFORE THE ACTUAL ESTABLISHMENT OF PROTECTED AREAS.

Existing and Officially Proposed Protected Areas

At present in the Konkan the sanctuary at Phansad and the proposed marine national park at Malvan are meant to conserve biodiversity. Besides these, Rodgers and Panwar had suggested three small sanctuaries at Dasgaon, Vikhroli and Achra. The present proposals cover and supplement these.

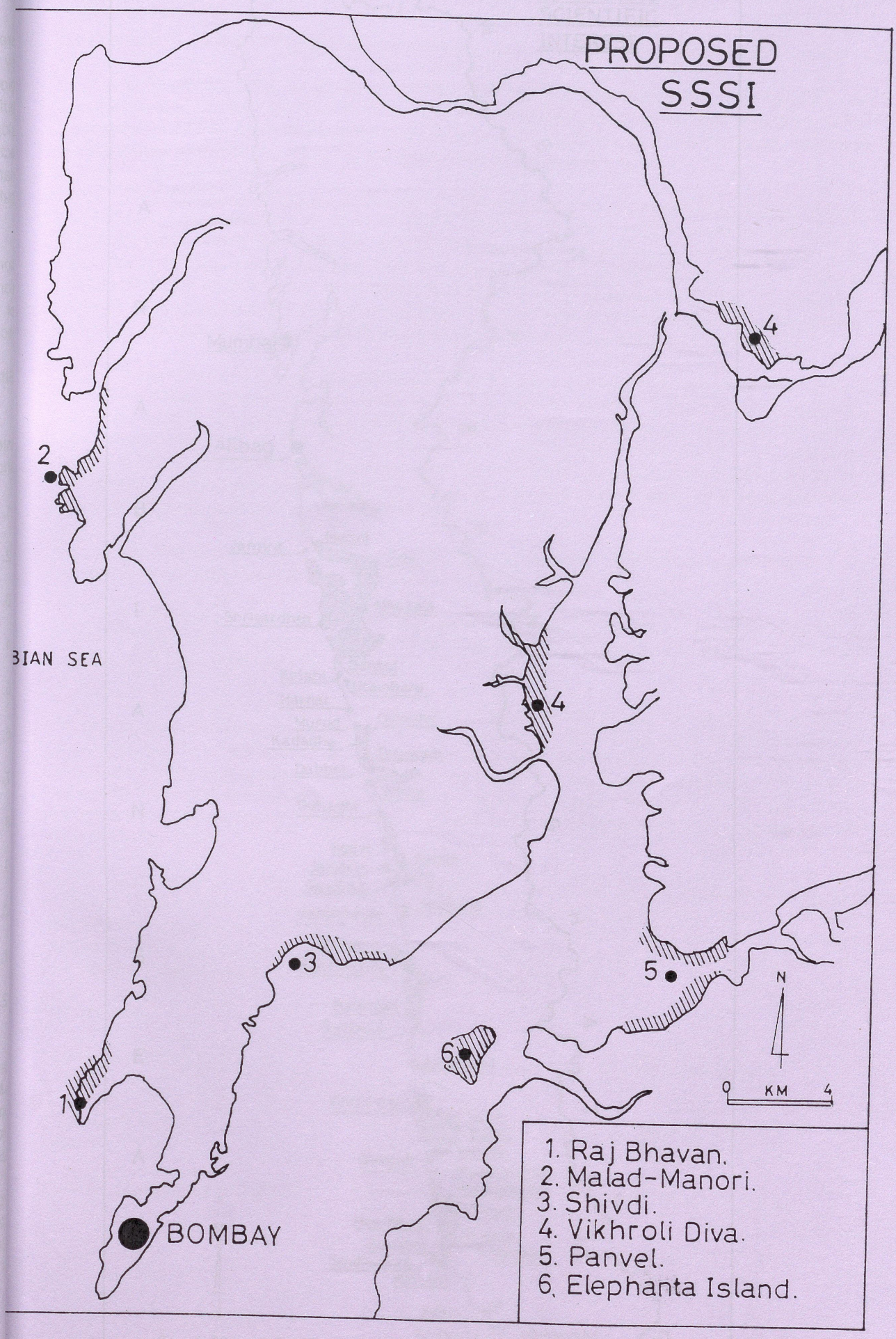
The Ministry of Environment and Forests, Government of India, published in the Government of India's Gazette dated 7.9.1988 a notice prohibiting establishment of industries from Murud-Janjira to Deogad along the coastline. Again MOEF by a notification dated January 1989 prohibited industries between 1 km from Korlai village to Harihareshwar and 1 km on both sides of Rajpuri creek in Raigad district. These notifications buttress the stand taken here for protecting different areas in the Konkan region.

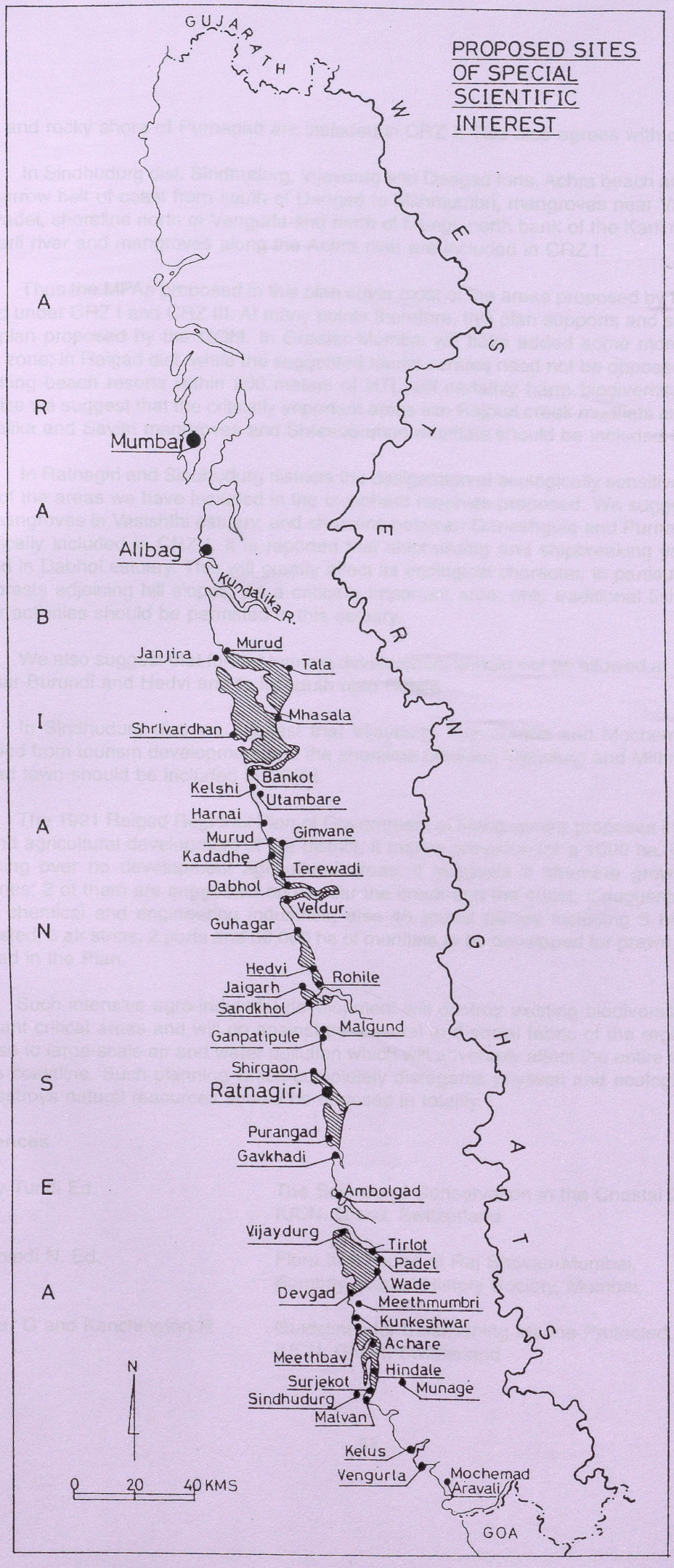
The Government of Maharashtra (GOM) has also designated areas that need to be accorded different levels of protection on the basis of coastal zone regulations promulgated by the Central Government. For Greater Mumbai the GOM designates no development zones along Manori, Malad and Thane creeks. In Raigad dist. Alibag, Kashid, Nandgaon, Nanivali, Adgaon and Harihareshwar are designated as tourist centres where beach resorts are permitted within 200 meters of the high tide line. Rest of the course between Murud-janjira and Shreevardhan is included in CRZ III. In Ratnagiri dist. only Jaigad fort and Ratnagiri fort are included in CRZ I i.e. fully protected zone, the rest of the coastline being under CRZ III. Tourism development has been suggested at Anjarle, Harnai, Murud, Ladghar, Guhagar, Velneshwar, Hedvi and Ganapatipule. Likewise in Sindhudurg dist. Vijaydurg and Sindhudurg forts are included in CRZ I, the rest of the coastal area excluding Malvan, Vengurla, Deogad and Redi towns having been included in CRZ III. Tourism development is proposed at Vijaydurg, Mithmumbri, Kunkeshwar, Mithbao, Malvan, Tarkarli, Deobag, Vengurla, Ubhadanda, Mochemad and Shiroda.

In addition the GOM designates certain areas as ecologically sensitive, especially in Ratnagiri and Sindhudurg districts. Thus in Ratnagiri dist. Jaigad fort and the creek south of it, part of the Shastri river towards south; Suvarnadurg fort, Sandkhol and Nandiwale, Hedvi, Borya Bunder, beaches south of Guhagar, Dabhol Bunder and inlets in the Vasishthi river, shoreline south of Kolthare, shoreline from north of Murud (Harnai) to Burundi, shoreline in front of Harnai town, shoreline from Anjarle to Kelshi and from Velas to Bankot are included in CRZ I.

This more or less agrees with the protected areas suggested in this report.

In the south Ratnagiri dist. Rajapur creek east of Jaitapur, an area of the coast north of Rajapur creek short of its mouth, the central part of Vijaydurg creek, Ambolgad, mouth of Purnagad


PROPOSED
SSSI
BIAN SEA
BOMBAY
N
0 KM 4
1. Raj Bhavan.
2. Malad-Manori.
3. Shivdi.
4. Vikhroli Diva.
5. Panvel.
6. Elephanta Island.


PROPOSED SITES OF SPECIAL SCIENTIFIC INTEREST
GUJARATH
MAHARASHTRA
WESTERN GHATS
Mumbai
Alibag
Kundalika R.
Janjira
Murud
Tala
Mhasala
Shrivardhan
Bankot
Kelshi
Utambare
Harnai
Murud
Gimvane
Kadadhe
Terewadi
Dabhol
Veldur
Guhagar
Hedvi
Rohile
Jaigarh
Sandkhol
Malgund
Ganpatipule
Shirgaon
Ratnagiri
Purangad
Gavkhadi
Ambolgad
Vijaydurg
Tirlot
Padel
Wade
Devgad
Meethmumbri
Kunkeshwar
Achare
Meethbav
Hindale
Surjekot
Munage
Sindhudurg
Malvan
Kelus
Vengurla
Mochemad
Aravali
GOA
N
0 20 40 KMS

creek and rocky shore of Purnagad are included in CRZ I. This also agrees with our scheme.

In Sindhudurg dist. Sindhudurg, Vijaydurg and Deogad forts, Achra beach and area behind it, a narrow belt of coast from south of Deogad to Mithmumbri, mangroves near Vijaydurg, Girye and Padel, shoreline north of Vengurla and north of Mungi, north bank of the Karli river, islands in the Karli river and mangroves along the Achra river are included in CRZ I.

Thus the MPAs proposed in this plan cover most of the areas proposed by the GOM to be placed under CRZ I and CRZ III. At many points therefore, this plan supports and strengthens the CRZ plan proposed by the GOM. In Greater Mumbai we have added some more areas to the green zone; in Raigad dist. while the suggested tourist centres need not be opposed, the policy of permitting beach resorts within 200 meters of HTL will certainly harm biodiversity of the coast. Likewise we suggest that the critically important areas like Rajpuri creek mudflats and mangroves, Kundalika and Savitri mangroves and Shreevardhan mudflats should be included in CRZ I.

In Ratnagiri and Sindhudurg districts the designation of ecologically sensitive areas covers most of the areas we have included in the biosphere reserves proposed. We suggest in addition, that mangroves in Vasishthi estuary, and shoreline between Ganeshgule and Purnagad should be specifically included in CRZ I. It is reported that shipbuilding and shipbreaking yards are to be located in Dabhol estuary. This will greatly affect its ecological character, in particular mangroves and forests adjoining hill slopes. As a critically important area, only traditional fishing and other similar activities should be permitted in this estuary.

We also suggest that further tourism development should not be allowed at Harnai-Murud, Ladghar-Burundi and Hedvi and to its south upto Rohile.

In Sindhudurg dist. we suggest that Vijaydurg, Mithmumbri and Mochemad should be excluded from tourism development and the shoreline between Vijaydurg and Mithmumbri except Deogad town should be included in CRZ I.

The 1991 Raigad Regional Plan of Government of Maharashtra proposes intensive industrial and agricultural development of the district. It makes provision for a 1000 ha. industrial zone by taking over no development agricultural areas; it suggests 9 alternate growth centres for industries; 2 of them are suggested on or near the creek and the coast; it suggests setting up of heavy chemical and engineering industries; also 45 tourist places including 5 hill stations are suggested; 3 air strips, 2 ports and 50,000 ha of mudflats to be developed for prawn cultivation are included in the Plan.

Such intensive agro-industrial development will destroy existing biodiversity, ecologically important critical areas and will go against the cultural and social fabric of the region. It will also give rise to large-scale air and water pollution which will adversely affect the entire Konkan region and its coastline. Such planning which completely disregards physical and ecological conditions and destroys natural resources should be opposed in totality.

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Appendix One

Networking of official and non-official agencies and individuals :

Officials :

Collector, Ratnagiri District
Collector, Sindhudurg District
Vice-Chancellor, Konkan Agriculture University
Chief Engineer, Konkan Region, Irrigation Department
Dean, Fisheries College, Ratnagiri

Organizations :

Shramik Sahayog, Chiplun
Sahyadri Nisarg Mitra, Chiplun
Vasundhara Nisarg Seva Sangh, Khed
Sahyadri Mitra, Mahad
Nature Clubs, Ratnagiri
Indian Society of Environmental Science and Technology, Ratnagiri Chapter
Save Western Ghats Movement, Mangavali
Swargandh, Deogad
Shramik Machchimar Sangh, Malvan.

Individuals :

Dr. Raja Dandekar, Dapoli; Shri B. R. Athavalé, Murud; Suhas Vaishampayan, Panchnadi; B. M. Mahajan, Koltharé; Vishwas Katdaré, Chiplun; Shashikant Kalé, Chiplun; Subhash Puranik, Chiplun; Vaishali Patil, Adoor; Rajan Indulkar, Chiplun; Dr. S. V. Joshi, Ratnagiri; Dr. Anil Ranade, Ratnagiri; Dr. S. B. Kadrekar, Ratnagiri; Prof. S. V. Shendye, Ratnagiri; Shri Charudatta Soman, Deogad; Ramesh Dhuri, Malvan; Sharad Dhuri, Malvan; Shri Deulkar, Malvan.

Appendix Two

SAND DUNE VEGETATION OF KONKAN COAST

1. Ipomoea pes caprae
2. Spinifex squarossus
3. Pandanus tectorius
4. Crotolaria burhia
5. Ergostris sp.
6. Euphorbia sp.
7. Erythrina indica
8. Sida sp.
9. Zizyphus sp.
19. Heydiotis nitida
21. Vitis trifoliata
23. Callophyllum inophyllum
25. Pandanus furcatus
27. Carallia integerrima
29. Nothopegia colebrookiana
31. Flacourtia sp.
33. Grewia microcos
35. Callophyllum tomentosum
37. Tridax procumbens
39. Vitex nigundo
41. Vernonia sp.
10. Setaria sp.
11. Lantana camara
12. Calotropis sp.
13. Opuntia sp.
14. Cyperus sp.
15. Leucas sp.
16. Argyreia speciosa
17. Pongamia glabra
18. Sesuvium porculacastrum
20. Clerodendron inderme
22. Thespesia populnea
24. Callophyllum tomentosum
26. Sterculia phoetida
28. Wendlandia notoniana
30. Pogostemon parviflorus
32. Gymnosporia sp.
34. Ficus sp.
36. Euphorbia sp.
38. Senecio sp.
40. Desmodium sp.
42. Celosia sp.

ALGAL SPECIES RECORDED ON THE COAST BETWEEN MUMBAI AND GOA

Green Algae **Chlorophyta**

Enteromorpha flexuosa, Ulva fasciata, Ulva sp., Chaetomorpha media, Rhizoclonium sp., Cladophora prolifera, Cladophora fascicularis, Caulerpa scalpelifornis, C. racemosa, C. peltata, Caulerpa sp. (4), Bryopsis plumosa, Bryopsis sp., Microdictyon tennuis, Spongomorpha indica, Halimeda sp.

Brown Algae **Phaeophyta**

Dictyota dichotoma, D. barteysiana, Padina tetrasomatica, P. pavonica, Colpomenia sinuosa, Sargassum swartzii, Spatoglossum asperum, Stoechospermum marginatum, Boergessenia sp.

Red Algae **Rhodophyta**

Grateloupia filicina, Gracilaria sp., Gracilaria corticata, G. verrucosa, Hypnea cervicornis, Polysiphonia macrocarpa, Chondria sp., Acanthophora spicifera, Laurencia papillosa, L. obtusa, Amphiroa sp.(2), Ceranium sp., Gelidium pusillum, Gelidiopsis sp., G. bariabilis, Champia sp., Scinaia sp., Cheilosporun spetabila, Halymenia porphyroides, Soleiria sp., Lithophylium sp., Melobasia sp., Jania rubens, Ahnfeltia plicata

Doubtful Cases

Caulocanthus sp., Ernodesnis verticillata

MARINE ANIMALS OF THE SANDY SHORE OF KONKAN COAST

1. Neries sp.
2. Aurelia sp.
3. Matuta sp.
4. Pinnotheres sp.
5. Philyra sp.
6. Eupargurus sp.
7. Emerita sp.
8. Dotilla sp.
9. Ctenophore sp.
10. Arca sp.
11. Meretrix sp.
12. Donax sp.
13. Sunetta sp.
14. Natica sp.
15. Nerita sp.
16. Murex sp.
17. Cypraea sp.
18. Conus sp.
19. Trochus sp.
20. Oliva sp.
21. Placuna sp.
22. Pecten sp.
23. Solen sp.
24. Mitra sp.
25. Epitonium sp.
26. Terebra sp.
27. Tibia sp.
28. Detalia sp.
29. Asteropecten sp.
30. Asterina sp.
31. Turitella sp.
32. Ocypode sp.
33. Umbonium sp.
34. Dardanus sp.
35. Scyphozoa sp.

MARINE ANIMALS OF THE KONKAN ESTUARIES

1. Uca sp.
2. Telescopium sp.
3. Tubinella sp.
4. Balanus sp.
5. Ostrea sp.
6. Meretrix sp.
7. Boleophthalamus sp.

MARINE ANIMALS OF ROCKY SHORES OF THE KONKAN COAST

1. Metridium sp.
2. Hydrallmania sp.
3. Sycon sp.
4. Tetilla sp.
5. Zoanthus sp.
6. Cucumaria sp.
7. Neptunus sp.
8. Alpheus sp.
9. Patella sp.
10. Turbo sp.
11. Thias sp.
12. Trochus sp.
13. Mytilus sp.
14. Littorina sp.
15. Ostrea sp.
16. Balanus sp.
17. Cypraea sp.
18. Chiton sp.
19. Aplysia sp.
20. Echinus sp.
21. Antedon sp.
22. Ophiotrix sp.
23. Isteblemius sp.
24. Therapon sp.
25. Gymnothorax sp.
26. Sabellaria sp.
27. Onchidium sp.
28. Babylonia sp.
29. Grapsus sp.
30. Turritella sp.
31. Isopods
32. Rock skipper

SOME FISH VARIETIES THAT HAVE INCREASINGLY BECOME UNAVAILABLE ON THE WEST COAST UNDER REFERENCE

Common English Name	Scientific Name
Blackfinned / Blacktipped Shark	Carcharhinus melanopterus
Grey Dog Shark	Rhizoprionodon acutus
Zebra Shark	Stegostoma fasciatum
Round / Hammerheaded Shark	Sphyrna zygaena
Pointed Saw Fish	Anoxypristis cuspidata
Spotted Eagle Ray	Aetobatus narinari
Frogheaded Cat Fish	Batrachocephalus mino
Silverbar Wolf Herring	Chirocentrus dorab
Indian Oil Sardine	Sardinella congiceps
Red Snapper	Lutiamis argentimaculatus
Indian Salmon	Eleutheronema tetradactylum
Seventhread Tassel Fish	Polynemus heptadactylus
Spotted Croaker / Jew Fish	Protonileca diacanthus
Grey Ribbon Fish	Trichiurus lepturus
Port Hole Fish / Leatherskin	Scomberrides lysan
Silver Pomfret	Pampus argentens
Barred Seer Fish	Scomboromorus commerson
Sword Fish	Xiphias gladius
Tiger Prawn	Penaeus monodon
Rock Lobster	Panulirus polyphagus

BIRDS OF THE KONKAN COAST AND NEARSHORE AREAS

Little Grebe (Podiceps ruficollis)
Cormorant (Phalacrocorax carbo)
Little cormorant (Phalacrocorax niger)
Grey heron (Ardea cinerea)
Little green heron (Ardeola striatus)
Pond heron (Ardeola grayii)
Cattle egret (Bubulcus ibis)
Large egret (Ardea alba)
Smaller egret (Egretta intermedia)
Reef heron (Egretta gularis)
Little egret (Egretta garzetta)
Night heron (Nycticorax nycticorax)
Black bittern (Ixobrychus flavicollis)
Spoonbill (Platalea leucorodia)
White ibis (Threskiornis aethiopica)
Glossy ibis (Plegadis falcinellus)
Cotton Teal (Nettapus coromandelianus)
Gr. Flamingo (Phoenicopterus roseus)
Blackwinged kite (Elanus caeruleus)
Pariah kite (Milvus migrans govinda)
Blackeared kite (Milvus migrans lineatus)
Brahminy kite (Haliastur indus)
Shikra (Accipiter badius)
Crested Goshawk (Accipiter trivirgatus)
Sparrowhawk (Accipiter nisus)
White-bellied sea eagle (Haliaeetus leucogaster)
Longbilled vulture (Gyps indicus)
Whitebacked vulture (Gyps bengalensis)
Pale harrier (Circus macrourus)
Marsh harrier (Circus aeruginosus)
Crested serpent eagle (Spilornis cheela)
Peregrine falcon (Falco peregrinus)
Shaheen falcon (Falco peregrinus peregrinator)
Hobby (Falco subbuteo)
Kestrel (Falco tinnunculus)
Red spurfowl (Galloperdix spadicea)
Grey junglefowl (Gallus sonneratii)
Common peafowl (Pavo cristatus)
Whitebreasted waterhen (Amaurornis phoenicurus)
Water cock (Gallicrex cinerea)
Purple moorhen (Porphyrio porphyrio)
Coot (Fulica atra)
Pheasant-tailed jacana (Hydrophasianus chirurgus)
Bronzewinged jacana (Metopidius indicus)
Oystercatcher (Haematopus ostralegus)
Painted snipe (Rostratula benghalensis)
Blackwinged stilt (Himantopus himantopus)
Redwattled lapwing (Vanellus indicus)
Eastern golden plover (Pluvialis dominica)
Large sand plover (Charadrius leschenaulti)
Kentish plover (Charadrius alexandrinus)
Lesser sand plover (Charadrius mongolus)
Whimbrel (Numenius phaeopus)
Curlew (Numenius arquata)
Redshank (Tringa totanus)
Marsh sandpiper (Tringa stagnatilis)
Green shank (Tringa nebularia)
Green sandpiper (Tringa ochropus)
Wood sandpiper (Tringa glareola)
Terek sandpiper (Tringa terek)
Common sandpiper (Tringa hypoleucos)
Turnstone (Arenaria interpres)
Pintail snipe (Gallinago stenura)
Fantail snipe (G. gallinago)
Eastern knot (Calidris tenuirostris)
Herring gull (Larus argentatus)
Lesser blackbacked gull (Larus fuscus)
Great blackheaded gull (Larus ichthyaetus)
Brownheaded gull (Larus brunnicephalus)
Blackheaded gull (Larus ridibundus)
Slenderbilled gull (Larus genei)
Gullbilled tern (Gelochelidon nilotica)
Caspian tern (Hydroprogne caspia)
Common tern (Sterna hirundo)
Brownwinged tern (Sterna anaethetus)
Little tern (Sterna albifrons)
Large crested tern (Sterna bergii)
Lesser crested tern (Sterna bengalensis)
Sandwich tern (Sterna sandvicensis)
Greyfronted green pigeon (Treron pompadora)
Blue rock pigeon (Columba livia)
Yellowlegged green pigeon (Treron phoenicoptera)
Spotted dove (Streptopelia chinensis)
Little brown dove (Streptopelia senegalensis)
Roseringed parakeet (Psittacula krameri)
Blossomheaded parakeet (Psittacula cyanocephala)
Indian lorikeet (Loriculus vernalis)
Common hawk cuckoo (Cuculus varius)
Indian cuckoo (Cuculus micropterus)
The cuckoo (Cuculus canorus)
Koel (Eudynamys scolopacea)
Small greenbilled malkoha (Rhopodytes viridirostris)
Crow pheasant (Centropus sinensis)
Barn owl (Tyto alba)
Spotted owlet (Athene brama)
Alpine swift (Apus melba)
House swift (Apus affinis)
Crested tree swift (Hemiprocne longipennis)
Common kingfisher (Alcedo atthis)
Threetoed kingfisher (Ceyx erithacus)
Storkbilled kingfisher (Pelargopsis capensis)

Whitebreasted kingfisher (Halcyon smyrnensis)
Blackcapped kingfisher (Halcyon pileata)
Green bee-eater (Merops orientalis)
Indian roller (Coracias benghalensis)
Hoopoe (Upupa epops)
Malabar grey hornbill (Tockus griseus)
Malabar pied hornbill (Anthracoceros coronatus)
Great pied hornbill (Buceros bicornis)
Large green barbet (Megalaima zeylanica)
Coppersmith (Megalaima haemacephala)
Rufous woodpecker (Micropternus brachyurus)
Lesser goldenbacked woodpecker (Dinopium benghalense)
Goldenbacked threetoed woodpecker (Dinopium javanense)
Yellowfronted pied woodpecker (Picoides mahrattensis)
Indian pitta (Pitta brachyura)
Crested lark (Galerida cristata)
Dusky crag martin (Hirundo concolor)
Swallow (Hirundo rustica)
Wiretailed swallow (Hirundo smithii)
Redrumped swallow (Hirundo daurica)
Baybacked shrike (Lanius vittatus)
Rufousbacked shrike (Lanius schach)
Golden oriole (Oriolus oriolus)
Blackheaded oriole (Oriolus xanthornus)
Black drongo (Dicrurus adsimilis)
Grey drongo (Dicrurus leucophaeus)
Ashy swallow shrike (Artamus fuscus)
Brahminy myna (Sturnus pagodarum)
Common myna (Acridotheres tristis)
Jungle myna (Acridotheres fuscus)
Tree pie (Dendrocitta javanica)
House crow (Corvus splendens)
Jungle crow (Corvus macrorhynchos)
Scarlet minivet (Pericrocotus flammeus)
Common iora (Aegithina tiphia)
Goldfronted chloropsis (Chloropsis aurifrons)
Goldmantled chloropsis (Chloropsis chochinchinensis)
Redwhiskered bulbul (Pycnonotus jocosus)
Redvented bulbul (Pycnonotus cafer)
Jungle babbler (Turdoides striatus)
Paradise flycatcher (Terpsiphone paradisi)
Ashy wren warbler (Prinia socialis)
Tailor bird (Orthotomus sutorius)
Great reed warbler (Acrocephalus stentoreus)
Blyth's reed warbler (Acrocephalus dumetorum)
Chiffchaff (Phylloscopus collybita)
Magpie robin (Copsychus saularis)
Pied bush chat (Saxicola caprata)
Blue rock thrush (Monticola solitarius)
Blackbird (Turdus merula)
Yellowcheeked tit (Parus xanthogenys)
Tree pipit (Anthus hodgsoni)
Paddyfield pipit (Anthus novaeseelandiae)
Grey wagtail (Motacilla cinerea)
Yellowheaded wagtail (Motacilla citreola)
Yellow wagtail (Motacilla flava)
Large pied wagtail (Motacilla maderaspatensis)
Thickbilled flowerpecker (Dicaeum agile)
Tickell's flowerpecker (D. erythrorhynchos)
Purplerumped sunbird (Nectarinia zeylonica)
Small sunbird (Nectarinia minima)
Loten's sunbird (Nectarinia lotenia)
Yellowbacked sunbird (Aethopyga siparaja)
White-eye (Zosterops palpebrosa)
House sparrow (Passer domesticus)
Yellowthroated sparrow (Petronia xanthocollis)
Baya (Ploceus philippinus)
Whitethroated munia (Lonchura malabarica)
Blackheaded munia (Lonchura malacca)
Common rosefinch (Carpodacus erythrinus)

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CAPTIONS TO ILLUSTRATIONS

Major Eco-systems of the Sea-shore

1 & 2 Exposed sandy shore with protective vegetation

3 Exposed rocky shore with gentle slope

4 Broad, wave-cut platforms

5 Mudflat in an estuary, people collecting clams etc.

6 A salt marsh

7 & 8 Typical mangrove formation in estuaries

9 A close-up of mangrove vegetation

10 Mangrove occupying an arm of an estuary

11 Sandbars and mudflats at the mouth of an estuary

12 A degraded mangrove at the mouth of an estuary

13 Protective vegetation and extensive Ipomoea biloba on dunes

14 Cashew plants covering sand dunes

15 Wetland on a sand dune

16 Extensive sand dune vegetation

17 Mangroves backed by excellent forest in Dabhol estuary

18 Dense forest on spurs radiating from Western Ghats

19 Sandbar formation at the mouth of the Karli river

20 Location of another sandbar at the mouth of Dabhol estuary

21 Mouth of the Dabhol estuary

22 Tail- end of Dabhol estuary

Faunal Diversity of the Intertidal Zone

23 & 24 Sponges of the intertidal zone

25 Sea cucumbers in a sandy pool

26 A Nereid worm exposed during low tide

27 & 28 Sea urchins in the intertidal zone

29 A live cowrie

30 Some typical live shells

31 Sea stars - one with six arms

32 A Sea hare (Aplysia)

33 A banded sea snake

34 A yellow-bellied sea snake

35 A dead Green Turtle carrying eggs

36 Hermit crabs occupying different shells

37 & 38 Typical Bivalves and Gastropods of the west coast

39 Cross-and-angels crab

40 Green mussel beds

41 A Chank

42 Thais shells and anemones

43 Sabellaria covering a rock

44 Sabellaria-covered rocky shore

Man and the Sea shore

45 A typical village of the fishing community

46 Inside the village

47 Women collecting mussels

48 Women assisting in hauling a boat ashore

49 Calling villagers to a meeting

50 Meeting in progress to discuss nature conservation

51 & 52 Explaining nature conservation to a town meeting

53 A typical foreshore scene

54 Ferrying across a channel - the traditional way!

55 Cleared for horticulture : mangroves and hill slope in the background

56 A bund built for prevention of sea-water ingress resulting in destruction of a mangrove

57 Jetty under construction for Dabhol Power Co. : the site harbours one of the richest fishing ground

58 The pier where at present goods are disembarked for the Co.

59 Shri Vaishampayan who has taken the initiative to keep some of his land for naturally growing forest

60 Inside his forest area









