GULF OF MANNAR MARINE BIOSPHERE RESERVE: STRATEGIES FOR CONSERVATION AND MANAGEMENT

A REPORT SUBMITTED TO

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THE NATIONAL BIODIVERSITY ALLIANCE: CONSERVATION ACTION - 1994

BY

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PREFACE

Under the Wild Life Protection Act (1972) and several state laws and statutes may Wildlife Areas have been declared by State Governments as National Parks and Sanctuaries. About 3.7% of the Reserved Forest area is thus under the protected areas system now. Of late there is a distressing and disturbing trend in the management of the protected areas due to factors such as conflicts with local communities commercial activities, poaching and inadequate understanding of the importance of protected areas for the ecological security of the country.

Some recent examples of threats to protected areas are : (a) Narayan Sarovar Sanctuary, (Gujarat), (b) Gulf of Kutch Marine National Park (Gujarat), (c) Bhitar Kanika Sanctuary (Orissa) (d) Konark - Balukhand Sanctuary (Orissa), (e) Manas (World Heritage Site, Assam) (f) Nagarhole (Kanataka). In the face of such threats, wildlife conservationists cannot remain complacent and rest content that these areas have already been notified as protected areas. There is need for arousing national awareness and concern towards this problem. Strategies for ensuring the safety of "protected" areas will have to be developed. Forests and wildlife managers who are entrusted with the task of managing these areas, community leaders and NGO groups who have actively championed the cause of wild life conservation and mass media representatives who act as watch dogs and have promptly drawn attention to issues in wild life protection, have to get together to prepare a common agenda for saving our priceless genetic estate. For development a NGO-Forester-Media coalition to prevent further damage to our protected areas to two day workshop was convened at MSSRF, on 18 and 19 December, 1993.

The Global Biodiversity Convention which came into force on 29 December 1993, recognises for the first time, in a legally binding article, the sovereign rights of national over their biological resources. The Biodiversity Convention also recognises *in situ* conservation, represented by Biosphere Reserves, National Parks, Wildlife Sanctuaries and other forms of protection, as the predominant conservation strategy. It is in this context that attention to the growing threats to the limited protected areas in the country, which are reservoirs of our genetic wealth, becomes urgent.

Realising the vital role of this rich reservoir of biodiversity for the future of India and her large population, be it water or soil conservation, agricultural productivity or the essential balance that makes life possible, the participants at the Madras Dialogue unanimously decided to form a *National Biodiversity Alliance* and to launch *Conservation Action* -94, an action programme designed to preserve India's selected area system for present and future generations.

The members of the National Biodiversity Alliance decided to look at some of the crisis points of India's protected areas on a site-specific basis. The aim of the Alliance is to force and reinforce government action on the basis of an understanding of the maladies affecting each protected area and propose potential remedial measures.

The following six areas were chosen on the basis of the seriousness and diversity of threats on the one hand, and richness of biological wealth on the other, for inclusion in

Conservation Action - 1994. The scientists and activists who were entrusted with the task of preparing the study reports are also mentioned.

a.	Manas World Heritage Site (Assam)	-	Shri. Deb Roy, IFS
b.	Bhitar Kanika area (Orissa)	-	Dr. Hemal S. Kanvinde and Shri. C.R. Das
c.	Dudhawa Tiger Sanctuary and National Park (Uttar Pradesh)	-	Shri. Valmik Thaper and W.W.F. India.
d.	Kutch Marine National Park (Gujarat)	-	Prof. G.M. Oza Shri. Lovkumar Khachher Smt. Prithi Nambiar
e.	Gulf of Mannar Marine National park (Tamil Nadu)	-	Dr. Sanjay V. Deshmukh Shri. G. Venkataramani
f.	Nilgiris Biosphere - (Tamil Nadu, Kerala, Karnataka)	-	Dr. R. Ranjit Daniels Dr.V.S. Vijayan

The above areas represent or typify serious problems arising from commercial and industrial exploitation of natural resources, poaching of plant and animal species, high intensity of grazing and pressure of human population, including ethnic conflicts.

The Convenors will form site-specific alliances and were authorised to co-opt appropriate individuals/ institutions in the preparation of integrated Status-cum-Action Reports by November, 1994.

We are grateful to the Rajiv Gandhi Foundation who kindly extended financial support for the preparation of the project reports,. The present report, on the Gulf of Mannar Biosphere Reserve prepared by Dr. Sanjay V. Deshmukh and G.Venkataramani contain the following information :

- Description of the Gulf of Mannar Biosphere Reserve with maps and pictures with particular reference to its unique features :
- Current status - anthropogenic and commercial pressures
- A plan of action for restoring and maintaining the BR in a pristine condition.

We hope that the this programme of saving threatened national parks and sanctuaries, coupled with the proper implementation of management guidelines mentioned in this document, would help to arrest genetic erosion and conserve biological diversity.

M.S. Swaminathan, FRS

CONTENTS

	Page No.
PREFACE i	
ACKNOWLEDGEMENTS	v
GENERAL INTRODUCTION	1-6
STATUS OF CURRENT CONSERVATION EFFORTS IN INDIA	9-15
GULF OF MANNAR : BACKGROUND INFORMATION	19-29
GULF OF MANNAR : STATE OF THE ART	31-88
GULF OF MANNAR : CURRENT CONSERVATION EFFORTS	91-99
GULF OF MANNAR : THREATS TO THE CONSERVATION	103-109
GULF OF MANNAR : STRATEGIES FOR CONSERVATION AND MANAGEMENT	113-126
LITERATURE CITED	129
GULF OF MANNAR : A GLIMPSE OF RESOURCES	133-170

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Finally, we are grateful to Prof.M.S.Swaminathan, FRS for his sustained interest and encouragement given to us.

Sanjay V. Deshmukh, Ph.D.
G. Venkataramani

GENERAL INTRODUCTION

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GENESIS

Conservation of nature and the ecosystems has been tried in many ways during the past. Preservation areas, National Parks, Nature Reserves were set apart to preserve nature and different ecosystems. Of them the concept of the Biosphere Reserve is the latest. Biosphere Reserves are created and managed under the guidelines laid down by the UNESCO (United Nations Educational Scientific and Cultural Organisation). They are on land as well as in the oceans. Ecosystems on the land as well in the waters of the oceans can thus be preserved as a whole including the human populations which form an integral part of them.

Marine environment accounts for 72% of the earth's surface and plays an important role in the substance of life. It also balances the heat of the deserts and the cold of the polar regions. Besides the intertidal ecosystems such as mangroves, seagrasses, coral reefs and salt marshes, there is a direct link of estuaries and mudflats with the marine realm. The area near coral islands receive the maximum penetrative light and the consequent benefits are myrid and diverse. The oceans are biologically very rich in terms of species and their population size and thus are considered to be the cradle of life. They have the potential meet the protein requirements of the exploding human population. Therefore, protection of coastal ecosystems which form natural barrier between the land and sea, is important.

DESCRIPTION OF COASTAL ECOSYSTEMS

Coastal ecosystems include both land and sea. The ecological systems of sea can achieve great complexity, as in coral reefs, and very high productivity as in "upwelling" areas where ocean waters rise to the surface. These systems differ from terrestrial systems in many ways. Three- dimensional phenomena, are of course, more marked and important in the ocean, where organisms are less tied to the solid bottom than are land organism to the earth. But more importantly, because of the fluid nature of the seas whole biological communities rest as floating plankton based entities distributed

horizontally and vertically through broad ocean spaces and are displaced over time as they drift with ocean currents. Currents are also great mixers, transporting organic nutrients produced at one site to distant locations and carrying planktonic eggs and larvae of organism to colonise distant habitats.

In addition, marine species migrate long distances, like tunas, turtles, whales, and yet other creatures such as sea birds, depends on these. Since marine organisms are in closer chemical contact with their surrounding medium than land organisms, they are jeopardised more by pollution.

The coastal zone of India is rich in estuaries, beaches, mangroves, coral reefs, seagrass and algal beds and many small island ecosystems. Each of these marine ecosystems, with its associated habitats, supports a wealth of marine resources. These resources, comprised of various life forms and nutrients, help maintain the ecosystems itself and others associated with it; provide physical protection to the coastal environment, and benefit people directly.

Many economically important marine fish, invertebrates and seaweeds are dependent on both site-specific and widespread ecosystems for habitats and nutrients. From the regions near shore, shallow water, soft bottom grounds, especially areas near estuaries or those concentrated with mangroves, the commercially important catches include shrimps, crackers, snappers, sea perch, cat fish, crabs and clams. The soft-bottom grounds further offshore, both shallow and deep, provide commercially important catches of seabream, pony fish, cat fish, lizard fish, fusilier, flat fish, congreels and lobster.

Some of these are also caught from the many coral reef or seagrass areas. Others are dependent on reefs for nutrients or as nursery areas. Reef fisheries are often dominated by such commercial species as snapper, grouper, big eyes, grunt, part of fish and lobster. Many shallow fishing grounds support commercially important.

Mangrove ecosystem

Mangrove forest provide food and shelter during part or all of the life cycle of many marine species. Economically valuable organisms of this serf includes penaeid

prawns, crabs, shrimps and various species of fish. Mangrove also are direct source of fire-wood and charcoal, some medicinal extracts, roof thatching and minor foods. In their natural state, mangroves help stabilize coastal areas by reducing wind damage and wave energy during storms and by checking soil erosion. They build land through slow and long-term trapping of land-derived sedimentation.

Coral ecosystem

Coral reefs are distinctive ecosystems rich in species and are highly productive. They serve humans in many ways in food production, coastline protection, as a source of medicines, sponges and jewelry items, for aesthetic and related economic benefits and for scientific and educational use.

Seagrass ecosystem

Seagrasses are the marine flowering plants inhabiting the shallow coastal water in tropical and temperate zones. There are about fifty species classified into 12 genera, 9 of which belong to the Potamogetonaceae and other 3 to Hydrocharitaceae family of monocotyledons. They are (a) adopted to grow in a saline medium, (b) adopted to grow when completely submerged, (c) adopted to an anchoring system to withstand wave action and tidal currents, (d) It has the hydrophilous pollination.

Seagrasses usually occur as beds and are the prominent plant communities of shores where the bottom is soft. As primary producers they play a major role in the local ecology by providing a substrate for epiphytic algae, some crustaceans and many molluscs.

For the preservation and conservation of the genetic diversity and the marine resources in a sustainable manner maintaining the ecological processes and life supporting systems, protecting areas with such diversity becomes imperative. Unfortunately, it has been observed that areas of ecological significance which are brought under the category of protected areas, are themselves becoming endangered.

PROTECTING THE PROTECTED AREAS

The Vast coastline of India is facing serious problems of stress from human pressures and interference similar to those on land. Rapid industrialisation, human settlement, constrains of man-made engineering works, more intense fishing pressures in coastal and estuarine areas, dumping of unwanted wastes, reclamation of coastal wetlands and deforestation of mangroves and unplanned tourism development are but a few serious threats facing the coastal zone.

The widely increasing pollution problems, extensive destruction and modification of marine habitats in the interest of techno-economic advances and the prodigious over-exploitation of renewable resources are definite indications of our heading towards a point of no return in many areas of our country, without concern for the future. Rapid mechanisation processes in the exploitation of marine living and non-living resources with increasing industrial involvement have added to the plethora of difficulties. Because of the conflict of uses in the coastal zone, coast-related island systems and surrounding habitats, many facets of the marine ecosystem and habitats are being increasingly tampered with on behalf of activities such as commercial fishing, navigation, energy exploitation, national defence, recreation and quarrying for industrial needs. Conservation of habitats will thus turn out to be the most biologically non-destructive means of reaching 'Zero habitat loss' (Kellert, 1979).

In recent years, the conservation of marine resources and habitats has assumed great significance in developing countries in the context of the role of conservation in Socio-economic development and the recognition of its functional role. The other values attached to this are aesthetic and cultural. The enormous range of marine environmental problems pose a serious challenge which has evoked both biocentric and anthropocentric arguments in favour of biospheres, natural preserves, parks, sanctuaries, core areas and buffer zones being established to rehabilitate, reconvert, rejuvenate and retain the pristine glory of the ecosystem and habitats.

The recent example of shelving the 'Silent valley project' in Kerala because of the adverse verdict of conservationists is a standing proof of the concern of the national

Government in the wild life preserves and the biogeographic pride of the nation. In this context establishment of National Marine Parks in India is not only a means of preserving the endangered marine species and some of the critical habitats, but also a flexible device for enabling the marine fisheries to be used on a sustainable basis. There are several regions in India with its extensive coastline which need our immediate attention in establishing a network of protected areas.

As a policy decision, it was proposed by the Government of India in the letter No.K11011/39/76 FRY (WL) dated 23 November 1976 that the area that should initially be considered for the establishment of India's first Marine National Park should be in the Gulf of Mannar region in Tamil Nadu where there are 21 islands, most of which are of coral origin and very significant from the Zoological point of view. This area is the last refuge of the most endangered mammal, the Dugong (*Dugong Dugon*). This region contains the rare and unique 'Balanoglossus', which is a link between invertebrates and vertebrates. It is richly endowed with unique coral formations, mangrove and seagrass ecosystems, marine shells, molluscs and tropical fish (associated with coral islands). The playful dolphins are also seen in this area. All these need protection from irretrievable destruction.

Government of Tamil Nadu in G.O Ms.No.226 Forest and Fisheries, Department dated 3 March 1980 Notified the intention of setting up of a Marine National Park in the Gulf of Mannar for the protection of Wildlife and its environment. Subsequently in G.O.Ms.No.962, Forests and Fisheries Department issued on 10 September 1986, a renotification on the intention to declare the Marine National Park in Gulf of Mannar area in Tamil Nadu for the purpose of protecting Wildlife there in and its environments, including 3.5 fathom depth of sea on the bay side and 4.5 fathom depth on the seaward side.

The 21 islands and the marine habitat around the islands have been now notified as a Marine Biosphere Reserve. The management of the islands and people living on the coastline have to be regulated in order to conserve the significant biological wealth of the area. The people living on the coastline have traditionally enjoyed unrestricted rights of fishing, collection of species of the marine environment, mining of corals from the islands

etc. The status and management of the coastline has a strong impact on the quality of the marine environment. Pollution from domestic wastes, sewage, industrial effluents, siltation down the river systems, shifting sands are all very important and have deleterious effects on the marine flora and fauna. In order to mitigate and control unplanned activities on the coastline by the people, government agencies and the private entrepreneurs, a coordinated management system involving all concerned has to be evolved. The biosphere reserve concept of management aims at this coordinated functioning and conservatory approach to prescribe sustainable limits for all activities undertaken on the area. Hence the people, various government departments and private entrepreneurs have to be motivated and explained about the deleterious effects of their past actions and prescription of restrictions for sustainable management of the resources needs to be emphasised.

STATUS OF CURRENT CONSERVATION EFFORTS IN INDIA

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INTRODUCTION

Nature is more bountiful in the tropics. There is something noble about the art of conservation. It signifies a concern for an empathy beyond the narrow and selfish end of mere human survival. It is now recognised that human survival. It is now recognised that human survival is dependent on man's natural environment. Recent events have borne out the froth that whenever and where the environment was indiscriminately destroyed, the human inhabitants have invariably suffered.

The above facts are looked into by the policy makers of various countries and international legislations and treaties are derived for better implementation of conservation programmes which are of global significance.

NATIONAL POLICIES AND PROGRAMMES

India, the country which supports the largest democracy in the world and where about 15% of the world's human population is struggling to survive on less than 2% of the world land. It is here that the natural resource base is perhaps under the severest stress - more specifically the fauna and flora, including forests.

Forest legislation in India dates back to 1865, when the Indian Forest act was defined for the first time. In 1927, a more comprehensive Indian Forest Act was adopted, which continues to date. However, after the National Forest Policy was announced in 1952 following independence, some States enacted their own forest legislation and some others, where the Indian forest act was already in force, amended this Act to suit their local needs. These enactments have also provided a kind of legal framework for the protection of wildlife in India. Particularly since not much of India's wildlife in found is the forest areas.

A significant achievement after independence was the incorporation in the constitution of India, adopted in 1951, of specific references to the need of protecting the natural environment and promoting ecological security. The Indian Constitution lays down in the sections of the Directive Principles of forest policy, the following duties and responsibilities for the State and the citizen.

Article 48 states that

"The state shall endeavour to protect and improve the environment and to safe guard the forests and will save life of the country".

Article 51 - A *inter alia* states that

"It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures".

In 1976, the subjects of "Forests" and "protection of wild animals and Birds" were transferred from List II (State list) to list III (concurrent list) of the Constitution of India.

A little earlier in 1972, the Wildlife (protection) Act had been enacted to provide central legislation for the first time - a legal framework for the protection of wildlife in the country. This enactments are applicable throughout the country, except in Jammu and Kashmir which has the similar law with the same name and modelled on the Central Act.

In 1980, the Forest (conservation) Act was enacted which lays down that no forest area can be dereserved or diverted to any non-forest purpose without the prior approval of the Central Government.

Despite such strong constitutional and legislative support, India bears scars of violence done to its natural environments and the overall situation is indeed a matter of great concern. This has given rise to demands for the review and revision of the National Forest Policy, the Indian Forest Act and Wildlife Protection Act. The exercise has been

taken in hand and it is hoped that a new forest policy will be announced which should provide the basic framework for revising the existing forest legislation.

If the aforesaid new policy comes, the fragile coastal ecosystems will automatically be protected, under the Forest Act.

Considering the importance of mangroves, seagrasses and coral reefs which together form an integral part of the coastal ecosystems, the Department of Environment, Government of India in 1979 constituted the National Mangrove Committee which recommended the following objectives for research and development as well as management of the coastal environment.

1. Nation-wide mapping of the coastal areas, preferably by remote sensing techniques coupled with land surveys. Times series should be obtained to make an assessment of the rate of degradation of the ecosystem.

2. Survey of mangrove forests quantitatively for area, climatic regime, rate of growth of forest trees, seasonal variations of environmental parameters.

3. Research and Development activities such as ecology, resources inventory, associated flora and fauna, hydrology, reproductive biology, energy flow, qualitative and quantitative studies for organic production, biochemistry of organic matter and sediments, afforestation of degraded mangrove areas and management of mangrove forests.

4. Assessment of suitable sites for declaration as "reserve forests" to undertake intensive conservation programmes.

The Committee is also responsible for the following:

1. Advice the Government in appropriate policies for conservation of mangrove and related ecosystems in the coastal areas.
2. Advise in research and training on mangrove and related ecosystems.

3. Suggest selective mangrove areas for conservation.
4. Help Government of India in the development of collaborative projects with UNDP/UNESCO and other inter-governmental bodies, in the field of coastal ecosystems.
5. Suggest suitable action programmes for conservation of mangroves and coral reefs within the country.

On the basis of the recommendations of this committee 15 mangrove areas were identified for conservation and preparation of action plans for management of these areas. Action plan have so far been prepared for 12 mangrove areas. Gulf of Mannar marine biosphere is one of the fifteen identified area and the efforts made by forest department of the Government of Tamil Nadu are highlighted below:

Programmes undertaken by the Tamil Nadu Forest Department

1. Declaration of the mangroves of Gulf of Mannar, "protected" under the section 26 of Tamil Nadu Forest Act 1882 and section 16 of Tamil Nadu Forest Act.
2. Survey and demarcation of land and forest area.
3. Collection of data on flora and fauna with the help of Botanical Survey of India, and Zoological Survey of India.
4. Protection of mangrove forests from illicit felling and cutting by coastal communities.
5. Eco-restoration of coastal vegetation.
6. Public awareness campaign in the coastal villages.

ORGANISED CONSERVATION EFFORTS WITH LEGAL PROTECTION

Eversince the establishment of the first marine reserve about seventy years ago, several nations have towed the line following the recommendations resulting from base line studies conducted. In recent years, IUCN has provided a set of principles, criteria and guidelines for the selection, establishment and management of marine and coastal areas (IUCN, 1980).

Biosphere Reserve

The concept of biosphere reserve mooted by the UNESCO was as early as 1971, in its Man and Biosphere (MAB) Programme. The UNESCO in larger global interests and with the idea of oneness of humanity transcending national frontiers, recognised the need for conservation of world's vanishing species and habitats. The heritage of Mankind is common and so the principles underlying the conservation programme have universal application. Hence, the formulation of the programme by UNESCO with expert panel studies, criteria and modalisatis for the entire world's adoption found ready acceptance. Thus National M.A.B. have been formed in many countries.

In India, the M.A.B. Committee has been functioning under the direct patronage of the Government of India-Department of Environment, Forests and Wildlife.

For us the conservation effort is not new, as it has been ingrained in our religious and cultural ethos since time immemorial. However, the spirit behind this is dampened during twentieth century.

Thus, in India, we have now 13 such potential biosphere reserves. Their number will increase depending upon the success of the programme. These 13 areas are chosen as representatives of varied and heterogenous ecosystems of the country. Gulf of Mannar is one such reserve declared recently.

The Gulf of Mannar is the first marine Biosphere Reserve not only in India, but also in the entire south and southeast Asia. The Gulf is part of the southward extension of the Bay of Bengal as is meets the Indian Ocean. This sea of the Gulf of Mannar may aptly termed as a marine province in a geographical sense. It straddles across two countries - India and Sri Lanka.

Marine National Park

The United Nations list of Protected Areas is compiled by the IUCN Commission on National Parks and Protected Ares (CNPPA), with the assistance of UNEP, UNESCO

and the WWF. The ten categories for conservation management identified in the year 1982, are divided into three groups as follows:

1. Group A - Areas of particular interest to CNPPA: These are categories for which the CNPPA has taken responsibility to monitor the status and provide technical advice as required. They are (a) Scientific Reserves/ Strict Nature Reserves, (b) National Parks/provincial parks, (c) National Monuments/Natural Landmarks, (d) Nature Conservation Reserves/ Managed Nature Reserves/Wildlife Sanctuaries, and (e) Protected landscapes.

2. Group B - Areas of interest to IUCN in general: These categories are of particular importance to IUCN as a whole and are generally found in most nations, but would not be considered exclusively within the scope of CNPPA. However, CNPPA may wish to monitor and provide expertise on those areas which are of particular importance of nature conservation. These include. (a) Resources Reserves, (b) Anthropological Reserves, and (c) Multiple use Management Areas/Managed Resources Areas.

3. Group C - Internationally recognised/affiliated designations : These categories form part of international programmes and have specific relevance to nature conservation. Many areas in such cases have already received protection under previous category. CNPPA may be called upon to monitor these categories and to provide special attention in co-operation with other institutions with which IUCN has consultative status. These include (a) biosphere reserves and (b) world heritage sites.

According to the above categories, the existing network of protected areas in the Gulf of Mannar in Groups A and B is as follows:

Group A: Category II (Marine National Park) - 1
Category IV (Bird Sanctuary) - 2
Category IX (Marine Biosphere Reserve) - 1

4. Ramsar sites

In addition to the mangrove forests in the Gulf of Mannar Marine Biosphere Reserve in Ramanathapuram District, there are two important wetland habitats inland. They are Chitrangudi and Kanjurankulam. These two wetland ecosystems have been recently declared as bird sanctuaries.

STRENGTHENING EFFORTS FOR CONSERVATION

In many of the developed and lessser developed countries the awareness for the creation of Marine Parks and reserves has never been greater than it is today. In India which has a tradition of established Wildlife Sanctuaries and Conservation Projects, the concept of Marine Parks and reserves is new. Nevertheless, we are seized of the urgency of the problem.

The recently established Marine Biosphere Reserve in the Gulf of Mannar is still in an incipient stage of development. Another major marine park has been proposed, along the Malvan-Vengurla Coast, Maharashtra. Some of the wildlife sanctuaries such as Bhitar Kanika in Orissa abut on the coastal zone and few of the contiguous beaches, which are well known nesting grounds for sea turtles, have been included now as protected areas. In the recent past, on the basis of beach surveys a number of potentially important areas of the sea turtle nesting beaches have been identified and possibilities of declaring some of these areas as reserves or for seasonal protection of the habitat needs serious consideration. Similarly, the mangrove habitat needs protection from human depredation in many areas. Sand mining and Coral quarrying has resulted in irreversible damages in some areas. Added to this, industrial pollution, human settlements in the coastal zone, increased fishing, tourism and other activities has brought about large-scale changes in many places including the inshore and estuarine areas. With all these perturbations there is an urgent need for developing a national policy for the setting up of marine parks and reserves. No policy can succeed unless it is an integrated effort taking into consideration interaction with wide ranging human activities such as fishing, land and beach and water use for tourism and agriculture and exploitation of diverse living and non-living resources.

GULF OF MANNAR :
BACKGROUND INFORMATION

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LOCATION

The Gulf of Mannar Marine Biosphere Reserve comprises 21 islands lying on the eastern coast of Rameswaram to Tuticorin, parallel to the coast with an area of about 5 km around themselves as a territorial boundary. These islands lie between latitude 8°47' N and 9°15' N and Longitude 78°12' E and 79°14' E. They lie off the coast of two Districts - Ramanathapuram and V.O.Chidambaranar as detailed below.

Name of the Island	Group	District	Area (Ha)	Circumference (m)
1. Van Tivu	Tuticorin	Chidambaranar	16.00	2,015
2. Kasuwar			19.50	2,160
3. Karaichalli			16.46	1,610
4. Villanguchalli			0.95	614
5. Upputhanni	Vembar	Ramanathapuram	29.94	2,292
6. Pulvinichanni			6.12	1,372
7. Nallathanni			110.00	4,700
8. Anaipar	Keelakarai	Ramanathapuram	11.00	1,605
9. Valimunai			6.72	1,170
10. Appa			28.63	4,840
11. Poovarasanpatti			0.25	161
12. Talairi			75.15	8,338
13. Valai			10.15	1,889
14. Mulli			10.20	1,712
15. Hare (Musal)	Mandapam	Ramanathapuram	129.04	11,520
16. Manoli			25.90	2,958
17. Manoputti			2.34	940
18. Poomarichan			16.58	2,500
19. Pullivasal			29.95	5,520
20. Krusadai			65.80	5,193
21. Shingle			12.69	1,736
Total			623.12	64,684

Source: Tamil Nadu Forest Department (1991)

LEGAL STATUS OF THE ISLANDS

All the islands except Nallathanni and Hare were Poramboke lands. The Hare island which till recently belonged to Mandapam Markayar, was purchased by the State Government at a cost of Rs.29,88,216/- and Nallathanni island from Kottampsa for Rs.9,03,138/-.

All the 21 islands have been notified as reserve lands under Sec.26 of the Tamil Nadu forest Act and are proposed to be notified as reserve forests. The intention to notify these islands and the sea around the islands upto 3.5-5 fathom depth, as a National Park under the provisions of the Wildlife Protection Act 1972 have also been published.

Draft notification of the islands under Section 4 of the Tamil Nadu Forest Act 1882 has been sent and is under scrutiny. The Forest settlement officer at Sivaganga is taking further action under sections 19 to 25 of the Wildlife Protection Act 1972 to constitute these island and the area around them as Marine Biosphere Reserve Actions are being pursued on these.

PREVIOUS PLANNING INITIATIVES

The Forest Department tookover the management of the Gulf of Manner area only from 1.11.89. The islands were taken charge from the revenue and fisheries department only recently is detailed below.

1. 8 islands off Ramanathapuram coast from revenue department on 12.10.1991.
2. 4 islands off Chidambaranar coast from revenue department in August 1991.
3. 8 islands off Ramanathapuram coast except Krusadai island from fisheries department in December 1992.

Till 1989, the research activities in the Gulf of Mannar area was undertaken by the Tamil Nadu Fisheries Department. From 1990-91, action plans were formulated by the Forest Department and the various activities were undertaken.

SOCIO-CULTURAL ASPECT

History

The entire Gulf of Mannar region has been noteworthy since prehistoric times. From time immemorial, the pearl banks of the Gulf have been highly productive of priceless pearls. The coastline was engaged in maritime trade including pearls, with the Greek and the Roman Empires from the days prior to Augustus Caesar (63 B.C. - 14 A.D.). Pliny, the historian (2 century A.D.), has eloquently described this trade. The pearls were also exchanged as royal gifts.

Culture

Gulf of Mannar occupies a prominent place, in the cultural heritage and history of India. The famous pilgrim centre of Rameswaram depicted in Ramayana is situated in the Gulf on the island of Pamban. It is said that after his victory over Raavana, Rama worshipped Shiva here, on his way to Ayodhya. The places mentioned and connection with Ramayana situated in the environs of Rameswaram, still cherish this memory, drawing thousands of pilgrims daily from all over India (some of the nearby places are Dhanushkodi, Kandamadhana Parvatham, Navabashnam and Villundal). In fact, the mainland and coastline of Ramanathapuram district (the district is also named after Rama) too is associated with places where the events mentioned in Ramayana are supposed to have taken place (e.g., Tirupulani, Devipatnam, Darbasayanam). Rameswaram is also known for its Sethu. The adage "from the Himalayas to Sethu" speaks of the oneness from of India prehistoric times.

The Raja of Ramanad from the mediaeval times (with the title "Sethupati") ruled over Rameswaram also and thus the islands in the region of the Gulf of Mannar came under his possession. It is said that he later parted away some of the islands either as gifts or for use in trade to the businessmen. Thus, some of the islands like Musal and Nalla Thanni were either fully or partly owned by individuals, and the ones like Krusadai were ceded to the British long ago.

ECOLOGY OF COASTLINE BORDERING THE GULF OF MANNAR

Rameshwaram coast

The southern coast of Rameshwaram island borders a part of the northern section of the Gulf of Mannar. The coast is 27 Km long from the lands end, that is starting from Adam's Bridge, to Kugual point. It is sandy all through but slopes down suddenly into the sea at various points. The sea is deeper, about 5 to 7m even near the shore. The shoreline from Kundugal point to Pamban boat jetty is a combination of marsh and sand. This area exposes itself well during low tide. The boat jetty area is sandy but the intertidal area has stony coral bottom which has been used to lay the foundation for a strong jetty. The sandy layer above this coral bed is useful as anchorage for the fishing trawlers.

Raman point to C.M.F.R.I. Jetty

Raman point is the tip of the land of Mandapam projecting into Pamban Bridge. It is a sandy shore pitted intermittently with leaching granite slabs both along the shore and at the intertidal region. The algal forms, particularly *Sargassum* spp., are found in plenty which damp the wave action on the shore. The sea bottom between Krusadai islands and Mandapam shore abounds in coral reefs towards the island end and is sandy clayey as one approaches towards Mandapam. Mechanised fishing trawlers in large numbers operate from Mandapam and land heavy catch of fish and prawns.

CMFRI Jetty to Pudhumadam

This area includes two major fish-landing centres, i.e., *Vedhalai and Pudhumadam* while Nochiurani is a minor fish-landing centre. Large number of mechanised boats and sail boats operate from the shore of Vedhalai. The coast is sandy, fringed with coconut plantation. A large quantity of *Gracillaria* sp. is landed on this coast by sail boats. This centre is noted for seaweed harvest and export. Boats load of seaweeds are landed on this coast everyday, dried and sold to dealers for export.

Two types of fishery exists in many parts of Gulf of Mannar area which is conspicuously observed at Vedhalai. Fish, small prawns and crabs are landed for local and inland consumption while cattle fish, large prawns, sea cucumbers, ornamental gastropods and seaweeds are landed exclusively for export purposes. *Holothuria scabura* solely fished in this area as a consumable item of South-east Asian countries known as *Bech-de-Mer*, where as . *Holothuria atra* is left behind untouched, hence is easily found everywhere.

Pudhumadam to Sethukarai

Muthupettai, Periapattanam and sethukarai are the three major fish-landing centres of this piece of coast. The sea is slightly more deeper in this area ranging from 4m along the coast to 8m towards the islands. Muthupettai and Periapattanam have both mechanised and sail boats. The main profession is fishery and sea diving. During seasons fishing is mostly undertaken for capturing migratory fish like seer fish. Diving for corals and large gastropod shells, large seafans and sea cucumber *(Beach-de-Mer)* is one of their main occupations as the products thus collected have value in the international market. Sethukarai coast and its intertidal region is very shallow from the coast to a distance of one kilometre towards the sea. This is due to the presence of stony corals, *Acropora* and various other species, that have grown to a distance of 2 to 3 km parellal to the coast to form a 'RIDGE'.

Sethukarai to Valinokkam

There are two major fish-landing centres such as Kilakkarai and Ervadi and one minor centre - Pallivasalur. Kilakkarai fishermen have more number of mechanised boats which cover the entire coast during trawl fishing. The depth of the fishing area varies from 4 to 7m. All along the coast from Sethukarai to North of Ervadi and from the seashore to about 200m into the sea, the sea bottom is covered with corals and lush growth of seaweeds. The fisherwomen of both Kilakkarai and Ervadi during the low tide, harvest *Gracillaria* spp. and related seaweeds and process them for export. The mechanised fishing trawlers extend their fishing area upto Valinokkam. The shore from Chinna Ervadi to Valinokkam holds a large Bay. Although the shore along the coast is

shallow, the core area is deep upto 6m and the sea bed is sandy. There is a ship dismantling unit at Valinokkam. The fishermen of Valinokkam have few trawlers but they use more number of mechanised boats for gillnet operation.

Valinokkam to Sippikulam

This is a long coast with three estuaries and five fishing villages, such as Kil Mundal, Mel Mundal, Oppilan, Terku Mukkayur and Vembar. But majority of the population excepting those at Kil Mundal, Terku Mukkayur and Sippilulam, is interested in fishing. Others are interested in jobs at the major salt factories situated all along the coast. The landings at Sippikulam are appreciable since the fish catch includes seer fish, tuna and carangids of very large size.

Sippilulam to Tuticorin

This covers the main fishing areas over the pearl fishing grounds (Parrs) where unbelievably large-sized coral fishes of various species are captured by trawlers, which come from Tuticorin fishing harbour. The use of certain type of gears over the Parrs actually shaves off the Parrs and innumerable kind of sedentary organisms like sponges, coelenterates, marine algae, cerenoides, crawling organisms belonging to different phyla and crevices - loving forms etc. are caught. This probably is one of the reasons that might have affected the settlement of pearl oyster spats over the past.

SOCIO-ECONOMIC ASPECTS

The Gulf of Mannar Marine Biosphere Reserve as an ecosystems has got a sound and firm resource base, but over the years the coastal waters have been misused or over-used so much that there are already pressures on the fragile ecosystem.

ECONOMIC ACTIVITIES IN THE AREA

Exploitation of fishery resources in the inshore waters had been the sole occupation of several thousand fisher families living along the coast for centuries. They have been in so close intimacy with the sea that their lifestyle, culture and social life

centres around the sea. Some of the major activities of the fishermen residing in the villages adjoining the park area are discussed below.

Fishing

There are about 47 fishing villages along the coast of which 38 are in Ramanathapuram district and 9 villages are in V.O. Chidambaranar district bordering the park area. The fishermen from these villages depend solely on fishing for their livelihood. There are altogether about 50,000 fisher-folk living in these villages of whom more than 12,000 are active fishermen. The population of fisher-folk village-wise is furnished in the tables. The fisher-women are engaged in allied activities such as marketing, dry fish and net mending.

POPULATION OF FISHING VILLAGES AROUND THE BIOSPHERE AREA

Sl. No.	Name of the fishing village	Taluk	Total population	Active fishermen
1.	Mandapam	Ramanathapuram	3206	784
2.	Marakkayarpattinam	Ramanathapuram	150	35
3.	Vedalai	Ramanathapuram	1011	231
4.	Valayarvadi	Ramanathapuram	979	262
5.	Seeniyappa Dharga	Ramanathapuram	165	42
6.	Pudumadam	Ramanathapuram	1061	301
7.	Muthupettai	Ramanathapuram	984	328
8.	Sudukattanpatti	Ramanathapuram	112	27
9.	Thalaithoppu	Ramanathapuram	372	67
10.	Indiranagar (Pudukkudiyiruppu)	Ramanathapuram	315	75
11.	Periappatinam	Ramanathapuram	2139	400
12.	Koolayarvalasai	Ramanathapuram	70	25
13.	Thoppuvalasai (Salaithoppu)	Ramanathapuram	230	63
14.	Periapattinam	Ramanathapuram	268	66
15.	Kalimangundu	Ramanathapuram	695	188
16.	Kuppuvalasai (Vellayarvalasai Mottiyanvalasad)	Ramanathapuram	89	26
17.	Kuppachivalasai	Ramanathapuram	90	31
18.	Kattayanvalassai	Ramanathapuram	124	29
19.	Kattayanvalaai	Ramanathapuram	176	47
20.	Shanmugavelpattinam	Ramanathapuram	408	108
21.	Thinaikulam	Ramanathapuram	102	22
22.	Agasthiyartheertham (pudukudi)	Ramanathapuram	75	22
23.	Setinukkarai	Ramanathapuram	241	63
24.	Pakkiriyappa Pallivasal (kunchirankudi)	Ramanathapuram	180	40
25.	Keelakkarai	Ramanathapuram	2858	753
26.	Mayakulam (Sri Mangaleswari Nagar)	Ramanathapuram	549	167
27.	Bharathinagar	Ramanathapuram	578	170

Sl. No.	Name of the fishing village	Taluk	Total Population	Active fishermen
28.	Chinna Erwadi	Mudukulam	2288	633
29.	Valinokkam	Mudukulam	2815	702
30.	Kenhamundal	Mudukulam	1370	318
31.	T.Mariyoor	Mudukulam	306	81
32.	Oppilan	Mudukulam	1190	293
33.	Mokkaiyur	Mudhukulathur	661	140
34.	Naripaiyur	Mudhukulathur	1481	374
35.	Rochmanagar	Mudhukulathur	1227	348
36.	Kundugal	Rameswaram	294	85
37.	Chinnappallam	Rameswaram	609	135
38.	Therkuvadi	Rameswaram	1002	245
	CHIDAMBARANAR DISTRICT			
39.	Vembur	Vilathikulam	882	232
40.	Patchayapuram	Vilathikulam	285	65
41.	Periasamypuram	Vilathikulam	108	28
42.	Keeshavaippar	Vilathikulam	1845	439
43.	Sippirulam	Vilathikulam	857	261
44.	Pattinamaruchur	Ottappidaram	474	120
45.	Thuruvaikulam	Ottappidaram	2259	448
46.	Tuticorin North	Tuticorin	10312	2576
47.	Tuticorin South	Tuticorin	1909	475
		Total	49401	12370

Source: Office of the Fisheries' Commissioner (Tamil Nadu), Madras, 1994.

The fishermen employ traditional crafts such as catamarans, vallams, musula boats and dug-out canoes for their fishing operations. The mechanised fishing boats of 30'-32' size, introduced by the Fisheries Department in the late fifties have proved extremely popular especially with the subsidy and soft loan facilities. Presently, 500 of these boats operate in this area mainly from Pamban, Mandapam and Valinokkam. About 165 traditional crafts in this area are mechanised under the modernisation programmes introduced by the Department during the last few years. Despite the mechanisation programmes initiated four decades ago, about 70% of the fish landings are still brought in by the traditional crafts. Since these islands are in close proximity to the main land, most of the fishing operations are conducted with their bases in the main land.

The various fishing gears used by the fishermen for fish capture are trawl, nets, gill nets, shore seines, drift nets, Olaivalai, Karavalai, Kalamkatti valai, long-lines, traps

and others. Of these, drift nets, long-lines, bottom-set gill nets, olavalai, Karavalai and Kalamkatti valai are mainly operated in and around these islands. Nylon and polypropylene had replaced the earlier cotton nets which were popularised by the Department by providing subsidy and loans.

Average annual fish landings from the Marine Park area during the last five years (from 1989) are about 46,000 tons of demersal fishes and 33,000 tons of pelagic fish. These are landed in 33 fish landing centres along the coast bordering the park area. Of the total landings of 1,05,273 tonnes during 1988-89, prawns constitute 2300 tons which has become an important fishery in the last 3 decades in view of the high unit price it commands both in National and International markets.

Holothurian fishing

Fishing for holothurians has gained importance during the last ten years although Holothurian industry is ancient and reported to have been established about a hundred years ago. The two commercial important species that are collected by fishermen are *Holothuria scabra* and *Holothuria spinifers* which are processed and exported to Singapore and Hongkong. The fishermen collect the holothurians by diving in shallow waters of 2 to 10 metre depth. Fishermen from Chinnapalam, Vadalai, Mandapam, Periapattinam, Kilakarai and Tuticorin are engaged in this fishing. Annually 60 tons of Holothurians valued at Rs.90 lakhs are collected from Ramanathapuram district of which 50% are from the Gulf of Mannar area. Presently Holothurians are over exploited and unless resource conservation and the restrictions imposed by the Government of India banning the export of Holothurians below the size of 7.5 cm are strictly implemented these are likely to become endangered.

Seaweed collection

The species that are commercially valuable are *Sargassum, Turbinaria, Gelidiella* and *Gracilaria* spp., which are in demand for the production of agar agar, cellulose and algin used for food processing and pharamaceutical industries. Annually 5000 - 7000 tonnes (dry weight) are harvested of which *Sargassum* spp. form the bulk. More than 1000

fishermen and 450 fisherwomen are engaged in seaweed collection which brings in a daily income of Rs.20/- to 30/- each. The fishermen and women collect seaweeds near the islands and at times stay in the islands and collect them. The islands where large quantities of seaweeds are harvested are Anaipar, Vallimunai, Nallathanni, Mulli, Appa, Manoli, Manoliputty and Hare islands.

Coral collection

Coral reefs play a complex by a significant role in the marine ecosystem. Coral reefs are said to be one of the most productive aras in the sea. Corals which were indiscriminately fished a few years ago has been banned since 1982. Although this may help halt further degradation and facilitates the recovery of the depleted areas, improved management would be necessary to assess and maintain sustainable utilisation of reef resources.

Diving

Diving for pearl oysters and chanks had been another important occupation of fishermen for more than 2000 years and collection of chanks by diving is still a major avocation for several hundred fishermen. Pearl fishery which is a Government monopoly had been conducted sporadically depending on the abundance of spat falls with great fan fare and had attracted pearl merchants from all over the world. The last pearl fishery was conducted in 1961 and since then due to various reasons, the population of pearl oysters had not been adequate enough to organise a fishery.

Chanks *(Turbinella pyrum)* which are also a Government monopoly, however, continues to be fished on an annual basis which is of considerable commercial importance. The Department of Fisheries registers divers for fishing from November to May, takes over the chanks collected and pay the divers predetermined rates depending on the size and quality of chanks fished. The Tuticorin jadi variety of chanks are in demand in West Bengal for making ornaments and for manufacturing artefacts. Chanks below the size of 60 mm. dia., considered juvenile when caught, are released to sea and no payment is made for such collections. Chanks diving supports nearly 770 divers who

take to this profession by hereditary. The average collection of chanks during the last five years is 4,80,000 which would fetch a revenue of Rs.48 lakhs.

Firewood collection

Drift wood and dry twigs are collected from the islands by fisherwomen as firewood and sold. Tough this is not a major occupation, this is taken up by fisherwomen for supplementring the family income.

Details on resources inventory of the Gulf of Mannar Marine Biosphere Reserve can be seen in the following chapter.

GULF OF MANNAR : STATE OF THE ART

GULF OF MANNAR : STATE OF THE ART

GENESIS

The Global Biodiversity Convention which came into force on 29 December 1993, recognises for the first time, in a legally binding article, the sovereign rights of national over their biological resources. The Biodiversity Convention also recognises *in situ* conservation, represented by Biosphere Reserves, National Parks, Wildlife Sanctuaries and other forms of protection, as the predominant conservation strategy. It is in this context that attention to the growing threats to the limited protected areas in the country, which are reservoirs of our genetic wealth, becomes urgent.

Realising the vital role of this rich reservoir of biodiversity for the future of India and her large population, be it water or soil conservation, agricultural productivity or the essential balance that makes life possible, the participants at the Madras Dialogue unanimously decided to form a *National Biodiversity Alliance* and to launch *Conservation Action* -94, an action programme designed to preserve India's selected area system for present and future generations.

The members of the National Biodiversity Alliance decided to look at some of the crisis points of India's protected areas on a site-specific basis. The aim of the Alliance is to force and reinforce government action on the basis of an understanding of the maladies affecting each protected area and propose potential remedial measures.

Gulf of Mannar Marine Biosphere Reserve was one of the six areas which were chosen on the basis of the seriousness and diversity of threats on the one hand, and richness of biological wealth on the other, for inclusion in Conservation Action - 1994. For this study, satellite images were obtained from the national remote sensing agency, Hyderabad and ground truth data collection was made by personal visits to all the islands. Interviews were conducted in several villages for understanding the socio-economic aspects and also to the schools to understand the level of awareness generation. Observations made during field visits to all the islands in the biosphere reserve are highlighted in this chapter. The information related to the resources inventory made by various teams of experts also forms a part of this document.

BIO-PHYSICAL ENVIRONMENT

Topography

There are no hills on any of the islands, which are plain. Low pounds are formed by shifting sand duties here and there.

Currents

The currents in are swift. The sea is rough between April and August and calm during Septemeber, while during June to August it is very stormy. October to December months have North. East monsoon with occasional rains.

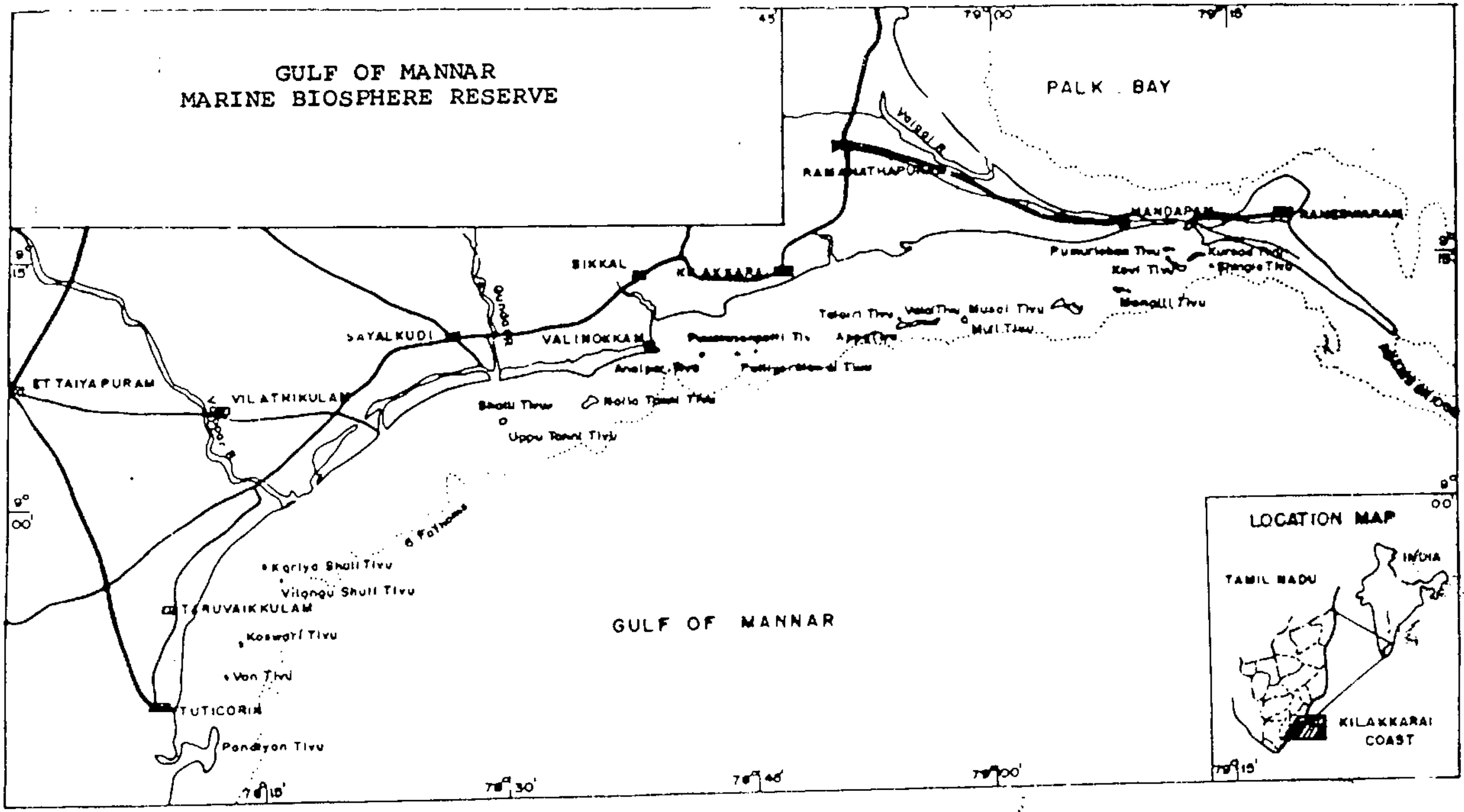
Soil

The soil is typical coastal sand, strewn with shingles in some places. There are swamp regions in Van Tivu, Kasuwari, Mulli, Poomarichan, Pullivasal, Krusadai and Shingle islands. Quick sand is also observed in places in Mulli and Krusadai Islands.

Geographical/Geomorphological Features

Some of the geographical and geomorphological features within the Gulf are biologically notewrothy for their rich variety and the support they provide to sustain uniqueness of the living resources.

Geographical/geomorphological features	Around noteworthy island/locations
A. Geomorphological feature	
1. Shingle	Manalli, Pulli, Margarita
2. Patches	Batt, Mansfield
3. Promontory	Kund/gal point, Ramanpoint
4. Pass	Pamban pass
5. Channel	Puma/channel
6. Shoal	Pulli
7. Reef	Manoli, Pullivasal
B. Bio-geographical feature	Nallathanni tivu and near Tuticorin.
1. Pearl banks	Between Mukkaiyur and south of
2. Sacred Chank beds	Tuticorin.


GULF OF MANNAR
MARINE BIOSPHERE RESERVE
PALK BAY
Vaigai R.
MANDAPAM
SIKKAL
SAYALKUDI
VALINOKKAM
ETTAIYAPURAM
VILATHIKULAM
TUTICORIN
Pandiyan Tivu
Von Tivu
Koswari Tivu
Vilangu Shuli Tivu
Kariya Shuli Tivu
6 Fathoms
Shalli Tivu
Uppu Tanni Tivu
Nalla Tanni Tivu
Mulli Tivu
Manoli Tivu
GULF OF MANNAR
LOCATION MAP
TAMIL NADU
INDIA
KILAKKARAI
COAST
78°30'
78°45'
79°00'
79°15'
9°15'
9°00'

Tides

There is a large diurnal tidal inequality which advances or delays the timings of high and low tides. This time difference extends upto about an hour or even more. Due to this, the tidal range increases or decreases by about half-a-meter. At neap tides, there is a rise of only 3 to 5 cm during the two full days. At Pamban, the tides are irregular, owing to the wind forces.

It is interesting to notice that during the northeast monsoons (October-December) there is less water throughout the whole "space" to the southward of the 'Pass' (Pamban Pass). During the southwest monsoon season the reverse phenomenon occurs and the water level is higher on lower reaches in direct proportion to the windforce.

The flood stream enters between Kundagal Point and the island of Krusadai. It sets westward along the (aligment) face of Pulli reef till it is joined by the stream setting in (entering) through the Puma Channel, which then takes a northerly direction to go with the force of wind. The current passing through the pass frequently records a velocity of even about 6 knots an hour, rendering the pass at times very difficult to take in, even for fully-powered streamers (vessels) for transit. The water currents through the pass during the northeast monsoon, as stated earlier, set southward and in South-West monsoon, north ward. The notable tidal stream occurs during March and April and October, "when it generally set six hours each way".

Climate and rainfall

The area comes under the spell of both South-West and North-East monsoon. The South-West monsoon contributes only very little towards the annual rainfall of the area. Rainfall is moderate to heavy during October to mid-December with occasional gales. The mean annual rainfal varies from 762 mm to 1270 mm. The monthly average annual atmospheric temperature varies from 25°C to 31°C with the maximum and minimum in May and January respectively.

Water resources

Fresh water is available only in Nallathanni island as the name of the island itself spcifies. Tolerably good water is available in rainy season and winter in Talairi Hare and Pullivasal islands though not in abundance.

ISLANDS AT A GLANCE

1. VAN TIVU

1.	(a)	Area	:	16.0 ha.
	(b)	Circumference	:	2015 m
2.	Distance from mainland		:	6 km from Tuticorin (Running time 50 mnts. by launch)
3.	General Nature of Island		:	Sandy with sparse vegetation of low bushes, mostly grasses and xerophytic plants.
4.	Habitation		:	Uninhabited.
5.	Sweet water		:	Nil
6.	Maximum height		:	1 mt. above high water spring tide.
7.	Erosion		:	Northern tip of the westward shore during S.W. monsoon period.
8.	Human interference		:	1. Visits by fishermen from Taruvaikulam & Tuticorin for collection of coral rubbles from the shallow water zone around the island for lime industry. 2. Camping fishermen who operate Tirukaivalai and Olaivalai in nearby areas. 3. Fishermen operating shore seines on the western side (shoreward).
9.	Birds		:	Very few
10.	Insects		:	Moths and butterflies, grasshopper and spider
11.	Reptiles		:	Only garden lizards.
12.	Turtle nesting		:	Possibilities exist.
13.	Dugong browsing ground		:	Nil.
14.	Live coral reef		:	Fringing reef on the eastern face of the island 0.5 km away.
15.	Snorkeling area		:	Near the western shore and in the shallow zone between the eastern shore of the fringing reef.

16.	Area for conservation	:	Entire island and surrounding area.
17.	Other features	:	A swamp of an area of 0.5 ha. on the southern half of the island.

2. KASUWAR ISLAND

1.	(a)	Area	:	19.50 ha
	(b)	Circumference	:	2160 m
2.	Distance from mainland		:	7 km from Tuticorin
3.	General Nature of Island		:	Mainly sandy, with small sand mounds here and there, highly strewn with shingles; a few bushes here and there but devoid of trees. Whole island is covered with xerophytic vegetation.
4.	Habitation		:	Uninhabited
5.	Sweet water		:	No
6.	Maximum height		:	2 m
7.	Erosion		:	Shoreward and southern corner of the island during S.W. monsoon.
8.	Human interference		:	1. Visited by fishermen from Thiruvaikulam and Tuticorin mainly for coral rubble exploitation. 2. Olaivalai operation by fishermen. 3. Shore seine operated by fishermen.
9.	Birds		:	A few species are present.
10.	Insects		:	Butterflies, grasshoppers, dragon-flies.
11.	Reptiles		:	Garden lizard.
12.	Turtle nesting		:	Possibilities exist.
13.	Dugong browsing ground		:	Nil.
14.	Live coral reef		:	In the south west corner of the islands live reef exists 500 m away from the shore.
15.	Snorkeling area		:	Northern side of the island and North west region.

16. Area for conservation : Entire island.

17. Other features : Swamp on south western side and a small saline water pond near the western shore.

3. KARAICHALLI ISLAND

1. (a) Area : 16.46 ha
   (b) Circumference : 1610 m

2. Distance from mainland : 15 km from Tuticorin

3. General Nature of Island : Sandy island, thickly set with tall bushes in the centre and western side. The whole island is covered with grasses and small plants.

4. Habitation : Uninhabited.

5. Sweet water : No.

6. Maximum height : 3 m

7. Erosion : Southwest corner and southern shore during S.W. monsoon.

8. Human interference :
   1. Men from Taruvaikulam and Tuticorin collect coral rubble from the eastern side (seaward side).
   2. Fishermen from nearby villages camp here for operation of bottom-set gill nets.
   3. Men from Ervadi collect seaweeds around the island.

9. Birds : A few birds.

10. Insects : Moths, butterflies, grasshopper etc.

11. Reptiles : Garden lizard.

12. Turtle nesting : Not reported. Possibilities exist.

13. Dugong browsing ground : Nil.

14. Live coral reef : Exist all around the island at a distance of 500 m to 1 km.

15.	Snorkeling area	:	Shallow area on the north, north east and western shore.
16.	Area for conservation	:	Entire island and surrounding within a radius of 2 km.
17.	Other features	:	Diversity in coral species; needs protection.

4. VILANGUCHALLI ISLAND

1.	(a)	Area	:	0.95 ha
	(b)	Circumference	:	614 m
2.	Distance from mainland		:	15 km from Tuticorin.
3.	General Nature of Island		:	Very small island, completely strewn with coral rubble with some bushes and grasses grouped towards middle of the island.
4.	Habitation		:	Uninhabited.
5.	Sweet water		:	Nil.
6.	Maximum height		:	4 m
7.	Erosion		:	At the eastern corner, due to wave action. South western end of the island submerged during high tides, visible only in extreme low tide.
8.	Human interference		:	Fishermen and coral quarrying men come and stay overnight. Evidence of recent collection of coral rubbles seen.
9.	Birds		:	A few sea birds.
10.	Insects		:	Grasshoppers, moths
11.	Reptiles		:	Garden lizard
12.	Turtle nesting		:	Not reported; but possibilities exist.
13.	Dugong browsing ground		:	Nil
14.	Live coral reef		:	Isolated patches of thin reef of corals along south eastern side of the island.
15.	Snorkeling area		:	Not suitable

16. Area for conservation : Entire Island

17. Other features : –

5. UPPUTANNI ISLAND

1. (a) Area : 29.94 ha
   (b) Circumference : 2292 m

2. Distance from mainland : 8 km from Vembar

3. General Nature of Island : A fairly big sandy island with plenty of coral rubbles all over the island; there are a few trees here and there with a number of tall bushes; entire island is covered with grasses.

4. Habitation : Uninhabited

5. Sweet water : Not available

6. Maximum height : 5 m

7. Erosion : Northeastern, eastern corner and southern shore.

8. Human interference :
   1. Several fishermen from Naripaiyoor camp here to quarry coral boulders lying buried in the centre of the island mass, thus disturbing the natural formation in the island.
   2. Groups of fisherfolk camp here regularly for the commercial exploitation of the weed *Gelidiella* and *Gracillaria* from the reefs around the island.
   3. Destruction of wooded trees by the fishermen for firewood.
   4. Collection of live cowries, cones and other marine curios on commercial lines from the reefs.
   5. Harvesting of naturally growing *Dolichos* sp. (Motchai-local language) by the visiting fishermen.
   6. Operation of seines over the shallow areas for catching fishes during certain seasons.

Immediate steps are to be taken to stop coral quarrying from the island.

9.	Birds	:	Both mainland and seabirds are noticed.
10.	Insects	:	Moths, butterflies, wasps.
11.	Reptiles	:	Garden lizard.
12.	Turtle nesting	:	Possibilities exist.
13.	Dugong browsing ground	:	Shallow area of the northern, eastern side upto a distance of 1 km from the shore.
14.	Live coral reef	:	Fringing reef girdling the island from the mid-eastern portion rounding south upto the western middle portion at a distance of 150 to 300 m. from the island.
15.	Snorkeling area	:	Eastern shore of the island.
16.	Area for conservation	:	Entire Island.
17.	Other features	:	--

6. PULUVINICHALLI ISLAND

1.	(a)	Area	:	6.12 ha (12.50 ha as per 1994 satellite image)
	(b)	Circumference	:	1372 m
2.	Distance from mainland		:	18 km from Vembar
3.	General Nature of Island		:	With a good sandy beach; fairly good portion of the island has thick vegetation. A few *Thespesia* trees on the eastern side of the island.
4.	Habitation		:	Uninhabited.
5.	Sweet water		:	Nil.
6.	Maximum height		:	2.5 m
7.	Erosion		:	South western corner of the island is eroded.

8.	Human interference	:	1. Fishermen from Kilakarai frequent this island and at times stay for weeks, conducting lobster-fishing. 2. Some people are engaged in algal and live shell collection.
9.	Birds	:	Sea birds only.
10.	Insects	:	Grasshoppers, moths.
11.	Reptiles	:	Garden lizards.
12.	Turtle nesting	:	Nesting occasionally
13.	Dugong browsing ground	:	Nil
14.	Live coral reef	:	Island surrounded by live coral reef all round except for a small stretch on the eastern side.
15.	Snorkeling area	:	All round the island.
16.	Area for conservation	:	Entire island and surrounding area.
17.	Other features	:	–

7. NALLATHANNI ISLAND

1.	(a)	Area	:	110 ha
	(b)	Circumference	:	4700 m
2.	Distance from mainland		:	2 km from mainland (Mundal, a place near Valinokkam).
3.	General Nature of Island		:	One of the big islands containing about 4000 coconut trees, palmyrah and other woody trees.
4.	Habitation		:	Inhabited by a few families of fishermen.
5.	Sweet water		:	Available.
6.	Maximum height		:	5 m
7.	Erosion		:	Northern shore and north eastern corner of the island.

8.	Human interference	:	1. Good number of fishermen frequently visit the island for carrying out fishing operations. 2. Fisherfolk engaged in algal and live shell collection.
9.	Birds	:	Many; including domestic birds raised by inhabitants.
10.	Insects	:	Grasshoppers, moths, bufferflies.
11.	Reptiles	:	Lizards and snakes.
12.	Turtle nesting	:	Turtle nesting in large scale.
13.	Dugong browsing ground	:	Ideally suited.
14.	Live coral reef	:	Coral reef and coral boulders allround the island at a distance of 0.5 km on the southern side and very near to northern shore.
15.	Snorkeling area	:	All round the island
16.	Area for conservation	:	All round the island
17.	Other features	:	1. A small temple dedicated to local deity attract nearby villagers. 2. Wild hare present.

8. ANAIPAR ISLAND

1.	(a)	Area	:	11.0 ha
	(b)	Circumference	:	1605 m
2.	Distance from mainland		:	9 km from Kilakarai
3.	General Nature of Island		:	An island fully covered with tall shrubs and *Acacia* trees.
4.	Habitation		:	Uninhabited.
5.	Sweet water		:	Nil
6.	Maximum height		:	3 m
7.	Erosion		:	Eastern point.

8.	Human interference	:	Fishermen engaged in lobster and trap fishing. Men & Women collecting shrubs.
9.	Birds	:	Small birds inhabiting shrubs.
10.	Insects	:	Moths and grasshoppers.
11.	Reptiles	:	Garden lizard.
12.	Turtle nesting	:	Takes place.
13.	Dugong browsing ground	:	Grounds exist.
14.	Live coral reef	:	Good amount of dead coral blocks partly exposed on the southern shore upto a distance of 200 m, with a good growth of seaweeds. Live coral reef is seen near western shore of the island upto a maximum distance of 200 m from the shore.
15.	Snorkeling area	:	Not suitable.
16.	Area for conservation	:	Entire island.
17.	Other features	:	–

9. VALLIAMUNAI ISLAND

1.	(a)	Area	:	6.72 ha (17.00 ha as per 1994 satellite image)
	(b)	Circumference	:	1170 m
2.	Distance from mainland		:	9 km from Kilakarai
3.	General Nature of Island		:	Sandy island with shore strewn with coral rubbles; island completely covered with *Acacia* trees and tall bushes of *Zizyphus jujuba*.
4.	Habitation		:	Uninhabited.
5.	Sweet water		:	Nil
6.	Maximum height		:	1.5 m
7.	Erosion		:	Southern corner, during N.E. monsoon.
8.	Human interference		:	1. Fishermen visit the island for lobster fishing and traps (coral fished).

2. Women and boys engaged in algal and live shell collection.

9.	Birds	:	Very few small birds are seen.
10.	Insects	:	Moths and grasshoppers.
11.	Reptiles	:	Garden lizard only.
12.	Turtle nesting	:	Takes place.
13.	Dugong browsing ground	:	Grounds are present.
14.	Live coral reef	:	South western corner at a distance of 200 m from the shore. Dead coral stones are met with all round the island.
15.	Snorkeling area	:	Good places exist for snorkeling.
16.	Area for conservation	:	Entire island.
17.	Other features	:	–

10. APPA ISLAND

1.	(a)	Area	:	28.63 ha (40.25 as per the 1994 satellite image)
	(b)	Circumference	:	4840 m
2.	Distance from mainland		:	8 km from Kilakarai
3.	General Nature of Island		:	Island is traversed on the southern side by an intervening coral-stone strudded sandy flat which is flooded during high tide preventing easy accessibility from one end to the other. The southern island portion is highly elevated (6 m) standing on fossilised coral stones of large dimensions. The northern portion like other islands has an elevation of only 2.5 m from the spring tide level.
4.	Habitation		:	Uninhabited, except for the shepherds tending in sheep grazing. Temporary sheds put up by weed-gatherers exist in the island.
5.	Sweet water		:	Nil
6.	Maximum height		:	6 m

7.	Erosion	:	Southern shore of the eastern half of the islands.
8.	Human interference	:	1. Fishermen stay for a continuous period of 10 days a month for fishing, seaweed collection and shell collection.
			2. Shepherds live permanently.
9.	Birds	:	Sea birds and a few mainland birds are noticed.
10.	Insects	:	Moths, grasshoppers & dragon flies.
11.	Reptiles	:	Garden lizard only.
12.	Turtle nesting	:	Turtles come a shore for nesting.
13.	Dugong browsing ground	:	Grounds exist.
14.	Live coral reef	:	Good reef exists in the entire southern side of the island. Good number of dead coral stones, boulders are found in the north west corner of the island which extends upto the distance of 1.5 km.
15.	Snorkeling area	:	Good for snorkeling.
16.	Area for conservation	:	Entire island
17.	Other features	:	An interesting island easily approachable from Kilakarai.

11. POOVARASANPATTI ISLAND (KILINJAN PAAR)

This is a narrow sandy flat of about 0.25 ha exposed during low tide and fully covered over by high tide water. It is misnomer to call this an island. It lies midway between Appa island and Valliamunai island.

Live reef surrounds the area upto a distance of 100 metres, except on the northern approach. Apart from a few boulder type corals occurring on the eastern side the rest are branching type of corals which lie at depths of 1-2 m.

Collection of seaweed (*Gelidiella*) by fishermen is the only activity of interest here.

12. TALAIRI ISLAND

1.	(a)	Area	:	75.15 ha (101.75 as per 1994 satellite image)
	(b)	Circumference	:	8338 m
2.	Distance from mainland		:	10 km from Kilakarai.
3.	General Nature of Island		:	An extensive elongated island with linear axis parallel to the shore; the broadest portion of the island is on the western tip. Thickly covered with trees and cattle grazing meadows. There is a narrow strip of foreshore on the northern side and a restricted foreshore on the southern side.
4.	Habitation		:	Except for 2 or 3 people living in huts put up by seaweed collecting fishermen on the western portion of the island, it is uninhabited.
5.	Sweet water		:	Tolerably good water is available in rainy season and winter.
6.	Maximum height		:	3 m
7.	Erosion		:	Southern shore and south western region of the island.
8.	Human interference		:	Fishermen stay for 7 or 8 days continuously for fishing, including lobster net operations, gathering seaweeds and live shells.
9.	Birds		:	Sea birds plenty.
10.	Insects		:	Moths and grasshopper.
11.	Reptiles		:	Garden lizards.
12.	Turtle nesting		:	Nil
13.	Dugong browsing ground		:	Grounds exist.
14.	Live coral reef		:	Live coral reef exists very close to the shore to the entire length of island on northern shore except for an area near north western edge. Continuous fringing reef exist at a distance of 0.75 km all along the southern side.
15.	Snorkeling area		:	Ideally suited.

16. Area for conservation : Entire island.

17. Other features : –

13. VALAI ISLAND

1. (a) Area : 10.15 ha (13.25 ha as per 1994 satellite image)
   (b) Circumference : 1889 m
2. Distance from mainland : 10 km from Kilakarai.
3. General Nature of Island : Small linear island lying parallel to mainland and connected to Talairi Island by a channel which is submerged during high tide.
4. Habitation : Uninhabited.
5. Sweet water : No
6. Maximum height : 3 m
7. Erosion : Northeastern corner during N.E. Monsoon.
8. Human interference : Fishermen from Periapatnam operate shore seine daily. Seaweed collectors, live shell collectors stay for a stretch of 6 or 7 days.
9. Birds : Sea birds and mainland birds are seen.
10. Insects : Moths, butterflies.
11. Reptiles : Garden lizard.
12. Turtle nesting : Turtles nesting.
13. Dugong browsing ground : Foraging grounds present.
14. Live coral reef : The western side of northern shore has a good portion covered by boulder reef as well as branching coral types. The southern reef is far out beyond the breather zone and lies at 3 m depth.
15. Snorkeling area : Ideally suited.
16. Area for conservation : Entire island.
17. Other features : –

14. MULLI ISLAND

1.	(a)	Area	:	10.20 ha (16.00 as per 1994 satellite image)
	(b)	Circumference	:	1712 m
2.	Distance from mainland		:	9 km from Kilakarai.
3.	General Nature of Island		:	A small, sandy island completely covered with tall shrub and bushes with a swamp top.
4.	Habitation		:	Uninhabited.
5.	Sweet water		:	Not available.
6.	Maximum height		:	3 m
7.	Erosion		:	East, south east and north corners eroded.
8.	Human interference		:	1. Fisherfolk from Kilakarai and Periapatnam come daily and operate shore seines. 2. Seaweed collectors visit the island daily.
9.	Birds		:	A few swamp birds and bush birds.
10.	Insects		:	Moths and grasshoppers only.
11.	Reptiles		:	Garden lizard.
12.	Turtle nesting		:	Turtles are nesting.
13.	Dugong browsing ground		:	Browsing grounds present.
14.	Live coral reef		:	Northside approach to the island studded with boulder reef. On the eastern side low fringing reef continues outward upto 3m depth. The south reef is far outside at a distance of 1.25 km from shore and extends west also.
15.	Snorkeling area		:	Suitable on the shoreward side.
16.	Area for conservation		:	Entire island.
17.	Other features		:	Quick sand or mud present around the swamp. Walking in that area to be avoided.

15. HARE ISLAND

1.	(a) Area	:	129.04 ha (179.00 ha as per 1994 satellite image)
	(b) Circumference	:	11.520 m
2.	Distance from mainland	:	7 km from Mandapam Camp.
3.	General Nature of Island	:	Extensive island completely covered by thick vegetation of *Acacia* trees, palmyrah, coconut plantations and other trees. It is a privately owned island.
4.	Habitation	:	Inhabited by watchman of the island.
5.	Sweet water	:	Tolerably good drinking water present, but this source is undependable for large-scale needs.
6.	Maximum height	:	4 m
7.	Erosion	:	Nil.
8.	Human interference	:	1. Dead coral stone quarrying from intertidal flats. 2. Fishermen operating shore seine. 3. Large scale wood cutting for mainland supply.
9.	Birds	:	Many varieties are noticed
10.	Insects	:	Grasshoppers, ants, moths.
11.	Reptiles	:	Garden lizard.
12.	Turtle nesting	:	Turtles nesting.
13.	Dugong browsing ground	:	Dugong foraging area extensive.
14.	Live coral reef	:	Very interesting assemblage of coral reefs around the island. Boulder reef on the southern lagoon in several places. Fringing reef at 1.5 km distance on south side all along. This continuous to the middle western portion also. On the eastern side fringing reef continuous but becomes discontinuous as it proceeds northwards. Coral boulders commonly noticed on northern side approach to the island.
15.	Snorkeling area	:	Shoreward side and lagoon area on the south.
16.	Area for conservation	:	Entire island.

17.	Other features	:	Monkeys, introduced earlier thrive well, numbering to some 25. Field rats also occur. A pair of donkeys introduced a few years ago.

16. MANOLI ISLAND

1.	(a) Area	:	25.90 ha (87.50 as per 1994 satellite image)
	(b) Circumference	:	2958 m
2.	Distance from mainland	:	6 km from Mandapam Camp
3.	General Nature of Island	:	A small island surrounded by sand flats and mud flats exposed during low tide and well covered by trees and shrubs.
4.	Habitation	:	Uninhabited.
5.	Sweet water	:	Nil.
6.	Maximum height	:	6 m
7.	Erosion	:	Nil.
8.	Human interference	:	Fishermen and seaweed collectors stay for a stretch of 6 or 7 days with families.
9.	Birds	:	A few mainland birds also seen.
10.	Insects	:	Moths and grasshoppers.
11.	Reptiles	:	Garden lizard.
12.	Turtle nesting	:	Nesting takes place.
13.	Dugong browsing ground	:	Grounds present.
14.	Live coral reef	:	Extensive reef on southern and northern sides at 250 m distance. Both branching and boulder reefs are met with.
15.	Snorkeling area	:	Exist around the island.
16.	Area for conservation	:	Entire island.
17.	Other features	:	Approach is somewhat difficult due to a 600 m stretch of broken corals and shingles. Field rats occur.

17. MANOLI-PUTTI ISLAND

1.	(a)	Area	:	2.34 ha
	(b)	Circumference	:	940 m
2.	Distance from mainland		:	6 km from Mandapam Camp.
3.	General Nature of Island		:	A very small island separated from the nearby Manoli by an extensive sand flat fully exposed during low tide.
4.	Habitation		:	Uninhabited.
5.	Sweet water		:	Not available
6.	Maximum height		:	2 m
7.	Erosion		:	Nil
8.	Human interference		:	Fisherfolk camp here for a week for seaweed and live shell collection only.
9.	Birds		:	Some sea birds and wading birds are noticed.
10.	Insects		:	Grasshoppers and moths.
11.	Reptiles		:	Garden lizards place.
12.	Turtle nesting		:	Nesting takes place.
13.	Dugong browsing ground		:	Grounds exist.
14.	Live coral reef		:	Patchy distribution of live coral reef and boulder reef all round the island at 500 m distance from shore.
15.	Snorkeling area		:	Good for snorkeling.
16.	Area for conservation		:	Entire island.
17.	Other features		:	–

18. POOMARICHAN ISLAND

1.	(a)	Area	:	16.58 ha (27.50 ha as per 1994 satellite image)
	(b)	Circumference	:	2500 m

2.	Distance from mainland	:	About 5 km from Mandapam Camp.
3.	General Nature of Island	:	Almost a horse-shoe shaped island, with a scanty foreshore, surrounded by marshy area and broken coral stones; thickly wooded like a jungle.
4.	Habitation	:	Uninhabited.
5.	Sweet water	:	Nil.
6.	Maximum height	:	1.5 m
7.	Erosion	:	Nil
8.	Human interference	:	1. Occasionally fishermen collecting live shells get into the island. 2. Fishing operations along the island shore.
9.	Birds	:	Many varieties of birds.
10.	Insects	:	Grasshoppers, sand flies and mosquitoes.
11.	Reptiles	:	Garden lizard.
12.	Turtle nesting	:	No
13.	Dugong browsing ground	:	Grounds exist
14.	Live coral reef	:	Extensive reef formed on the western and eastern side of the island at a distance of 150 m. from island shore. On the southern side continuous reef of dead and live coral reef exists close to the shore.
15.	Snorkeling area	:	Not an ideal place.
16.	Area for conservation	:	Entire island.
17.	Other features	:	Swampy spots are to be avoided. Dangerous during high tides.

19. PULLIVASAL ISLAND

1.	(a)	Area	:	29.95 ha
	(b)	Circumference	:	5520 m
2.	Distance from mainland		:	5 km from Mandapam Camp.

3.	General Nature of Island	:	To be approached from Poomarichan island side by crossing the channel separating the two islands. Thickly wooded like a jungle.
4.	Habitation	:	Uninhabited.
5.	Sweet water	:	Tolerable water available during monsoon.
6.	Maximum height	:	5 m
7.	Erosion	:	Nil
8.	Human interference	:	Seaweed collectors sometimes stay for a few days.
9.	Birds	:	Some birds are present.
10.	Insects	:	Moths and beatles.
11.	Reptiles	:	Garden lizard only.
12.	Turtle nesting	:	Nesting takes place in the season.
13.	Dugong browsing ground	:	Foraging grounds present but of doubtful utility.
14.	Live coral reef	:	Fringing coral reef on the southern side at a distance of 200 m. A similar patchy reef distribution beyond the muddy area on the northern side.
15.	Snorkeling area	:	Areas exist.
16.	Area for conservation	:	Entire island.
17.	Other features	:	Swamy island. Walking around the northern shore is not feasible.

20. KRUSADAI ISLAND

1.	(a)	Area	:	65.80 ha (82.00 ha as per 1994 satellite image)
	(b)	Circumference	:	5193 m
2.	Distance from mainland		:	3 km from Pamban : nearest land is Kundugal point, 500 m away.
3.	General Nature of Island		:	An island, owned by Govt. of Tamil Nadu; completely covered with trees and bushes and having many varieties of animal life.

4.	Habitation	:	Inhabited by staff members of Department of Fisheries. It is proposed to have a new museum and laboratory.
5.	Sweet water	:	No
6.	Maximum height	:	3 m
7.	Erosion	:	South east corner.
8.	Human interference	:	Poaching by local fishermen for biological specimens such as *Balanoglossus*; 'Kalamkatti' valai operating fishermen camp for few days.
9.	Birds	:	Many varieties of mainland birds.
10.	Insects	:	Sandflies, grasshoppers and butterflies abundant; mosquitoes.
11.	Reptiles	:	Lizards, snakes.
12.	Turtle nesting	:	Possibilities exist.
13.	Dugong browsing ground	:	Nil.
14.	Live coral reef	:	Continuous fringing reef on the southern side of the island at 500 m distance. The lagoon in this area also contains live coral patches. On the northern and eastern side also there are a few patches of branching coral varieties.
15.	Snorkeling area	:	Very good areas exist.
16.	Area for conservation	:	Entire island.
17.	Other features	:	1. Sandy-flies cause skin rashes. 2. Watch-man's bay area on the northern side is slushy with 'quick-sand' areas. 3. Field rats occur in the island.

21. SHINGLE ISLAND

1.	(a) Area	:	12.69 ha (24.75 ha as per 1994 satellite image)
	(b) Circumference	:	1736 m
2.	Distance from mainland	:	4 km from Pamban
3.	General Nature of Island	:	An island full of shingle and coral rubbles, heaped all along the shore to a height of 0.75 m fully covered by bushes and trees.
4.	Habitation	:	Uninhabited.
5.	Sweet water	:	Nil.
6.	Maximum height	:	5 m
7.	Erosion	:	North east corner, upto 5 m already eroded.
8.	Human interference	:	Nil.
9.	Birds	:	A few swamp birds present.
10.	Insects	:	Grasshoppers and a few moths.
11.	Reptiles	:	Garden lizard only.
12.	Turtle nesting	:	Possibilities exist.
13.	Dugong browsing ground	:	Grounds exist.
14.	Live coral reef	:	Fringing reef on the eastern, northern and western aspects of the island, mostly of *Acropora* spp. upto 300 m distance from island shore; patchy distribution of live coral boulders also.
15.	Snorkeling area	:	Good for snorkeling.
16.	Area for conservation	:	Entire island.
17.	Other features	:	Swamp in the eastern portion of the island. Walking near the swamp should be avoided.

GENERAL OBSERVATIONS

Most of the Islands are situated close to the mainland. With the exception of Shingle Island, standing on a small reef patch, they are sand structures with gravel forming a minor component and coral boulders major. Though some are large, such as Hare Island and Talairi Island, they occupy a small proportion of reef flats on which they stand. Except for the fact that they are located closer to the leeward (northern) than windward (southern) sides of the reefs they are not associated with gape or prominent angles of the reef. The islands have irregular outlines, with spits and partially enclosed bays and often higher sandy beach ridges enclose areas of mud flats and standing water within the bay. On many islands sand dunes formations were noticed raising the height of the island; otherwise they are all extremely low, all less than 3 metre above the level of high water springs. Many areas are low enough to form shallow pools. Xerophytic vegetation and tall wooded trees are in all groups except the Tuticorin group of Islands. *Acacia* growth attains prolific proportions from Nallathanni Island to Manoli Island. Mangrove woodland is characteristic of all Islands but extensively developed in Mandapam group than in others.

Except for Krusadai Island, Hare Island and Nallathanni Island other Islands do not have any freshwater surface springs worth mentioning. This has acted as one of the deterrents for fishermen not electing to settle down in many of the Islands although their activities in and around the Islands go on all the year round. In Nallatanni Island alone there are 50 or so huts bordering the north west portion of the shore where fishermen families permanently live since the Island has two or three freshwater springs meeting the drinking water requirements of these people.

Birds such as thrushes, swallows, eagles, honey suckers and the bee eaters were noticed in the islands off Kilakarai and Mandapam. Sheep, goats and cows and donkeys have been introduced in the Islands of Kilakarai group and Hare island. All islands are subjected to daily human interference and activities in one or many of the following aspects.

1. Coral rubble collections from the leeward shallow areas of the fringing reefs.

2. Quarrying coral stones from interior of island and along the island shore.
3. Operation of drift nets and long lines off the Islands by fishermen camping in the nearest Island.
4. Operation of bottom set gill nets for lobsters.
5. Olaivalai, Karaivalai and trap fishing operations in and around the Islands.
6. Kalamkatti valai operations.
7. Men, women and children engaged in marine algal collection (*Sargassum, Gracillaria* and *Gelidiella*).
8. Men gathering firewood from thickly wooded islands.

As a result of extensive mining of corals done during the past few years, one of the islands in the Manoli group is now completely submerged during high tide. The reef as well as the quarried flat of the island are now covered with sand and there is no possibility of live corals growing in that area.

The general overall picture obtained from the survey of the coral reefs around the islands is that in all places the branching coral types are extensive from 1m-5m depths when compared to the large boulder type of massive corals which generally occur beyond the breaker zone. Evidences of recent removal of boulder type corals of *porites, Goniopora, Favia* and *Goniastrea* from shallower waters were seen in many localities, thus creasing imbalances in the Islands' biotic set up and physiography. This may assume serious dimensions, if allowed to continue and deserves to be handled sternly and swiftly.

Protection of dugong

With regard to dugong browsing grounds it was noticed that the seagrass (*Cymadocea* etc.) on which they feed occur generally on the shoreward side of the islands; in the muddy/sandy zones between the islands and the mainland, as well as in between the islands also. This feature is more pronounced from Upputanni island to Krusadai island. It appears safe to treat the entire zone from Valinokam to Pamban as a 'Dugong sanctuary'. Already the enforcement of regulation prohibiting fishing for dugongs seem to be yielding results, especially as the local fishermen are aware of this regulation.

Conservation of natural ecosystem and vegetation on islands

Increasing human interference in various forms as outlined above pose a serious threat upsetting natural ecosystems on the island as well as the adjacent reef areas. Evidence of cutting down of trees, shrubs and bushes were seen on almost all islands. If unchecked the islands will be denuded of natural vegetation within a few years, thereby posing more serious problems of erosion and shifting of sand due to wind action.

NATURAL RESOURCES

About 3600 species of fauna and flora have been identified in this region by Various Institutions. Notably among them are Central Marine Fisheries Research Institute (CMFRI),BSI, ZSI, NIO and other organisations. The fauna is said to be one of the richest in the entire Indo-West paciffic region.

Flora

The Vegetation in the islands is not uniformly spread and it generally consists of thorny of strubs and can be said to correspond to Group 4 - Littoral and swamp forests according to the classification of Champion and Seth. It is characterised by species like *Thespesia populnea, Acacia planifrons, Tamarix, Vitex,* etc.

Mangroves and their associate apecies are seen in Shingle, Krusadai, Pullivasal, Poomarichan, Manoli and Manoliputti islands with *Avicennia, Rhizophora, Scaevola, Brugueira, Pemphis* and *Pandanus* skirting the periphery of the islands.

Trees species such as Palmyra, Casuarina, Coconut, Mango, Tamarind, etc., raised in the past can be seen in Shingle, Krusadai, Hare and Nallathanni islands. An indicative list of flora is given in subsequent tables.

TABLE : CHECK-LIST OF PLANTS OBSERVED ON THE ISLANDS OF GULF OF MANNAR

CAPPARIDACEAE

Cadaba indica Lam.
Capparis sepiria L.
Cleome viscosa L.
Cleome angustifolia Forsk
Gynandropsis pentaphylla DC.

PORTULACACEAE

Portulaca oleracea L.

STERCULIACEAE

Waltheria indica L.

ZYGOPHYLLACEAE

Tribulus terrestris L.

VITACEAE

Cissus quadrangularis L.

SAPINDACEAE

Cardiosperumum canescens Wallich

LEGUMINOSAE

Crotalaria retusa L.
Dalbergia coromendeliana Prain
Indigofera enneaphylla L.
Indigofera oblongifolia Forsk
Phaseolus trilobus Aiton
Cassia auriculata L.
Prosopis juliflora DC.

LYTHRACEAE

Pemphis acidula Forst

CUCURBITACEAE

Coccinia grandis (L.) Voigt

Cucumis pubescens Willd.

CACTACEAE

Opuntia dillenii Haw.

AIZOACEAE

Sesuvium portulacastrum L.

Gisekia pharnaceoides L.

Mollugo cerviana Ser.

Mollugo nudicaulis Lam.

RUBIACEAE

Spermacoce hispida (L.)

Oldenlandia umbellata L.

COMPOSITAE

Blumea obliqua (L.) Druce.

Launaea pinnatifida Cass

Tridax procumbens L.

Vernonia cinerea Less.

GOODENIACEAE

Scaevola plumeri (L.)

Scaevola sp.

SALVADORACEAE

Salvadora persica L.

ASCLEPIADACEAE

Caralluma bhupinderema Sarkaria

Pentatro is microphylla Wight and Ara

Oxystelma esculentum R.Br.

GENTIANACEAE

Enicostemma axillare Blume

BORAGINACEAE

Cordia sp.

CONVOLVULACEAE

Evolvulus alsinodes L.

Ipomoea pes-caprae sweet

SOLANACEAE

Physalis minima L.

PEDALIACEAE

Pedalium murex L.

ACANTHACEAE

Justicia simplex D. Don.

VERBENACEAE

Clerodendrum inerme Gaertner

Lippia nodiflora (L.) A Rich

AVICENNIACEAE

Avicennia marina Bl.

LAMIACEAE

Genisporum prostratum (L.)

Leucas aspera Sprc

Cyperus rotundus L.

Cyperus sp.

Scripus sp.

POACEAE

Aeluropus lagopoides Trin.

Chloris barbata Sw.

Cynodon dactylon Pers

Eragrostis sp.

Panicum repens L.

Spinifex littoreus Mers.

Themeda sp.

Algal resources

An estimate of algal reserves was carried out for the entire coastal stretch of Gulf of Mannar by a team of Scientists from various Institutions and a report was submitted to the Forest Department in 1978. The standing crop was estimated for the islands and the values were given in wet weight in tons. The following information is taken mainly from this Report and wherever needed, additional field information now collected is added. As earlier stated, about 160 species are known so far; 40 species are found growing in abundance on the islands.

TABLE : OCCURRENCE OF MARINE ALGAE IN GULF OF MANNAR

Sl. No.	Species	Gulf of Mannar Mainland Coastline	Gulf of Mannar Islands	Palk Bay
	CHLOROPHYTA			
	Ulvaceae			
1.	*Enteromorpha clathrata*	-	+	-
2.	*Entermorpha flexuosa*	-	+	-
3.	*Enteromorpha prolifera*	-	+	-
4.	*Enteromorpha* sp.	-	+	-
5.	*Ulva lactuca*	-	+	-
6.	*Ulva reticulate*	+	+	+

	Cladophoraceae			
7.	*Chaetomorpha antennina*	+	-	-
8.	*Chaetomorpha littorea*	+	-	-
9.	*Chatomorpha torta*	-	+	-
10	*Cladophora fascicularia*	-	+	-
11	*Cladophora* sp.	+	+	-
12.	*Rhizoclonium kerneri*	+	+	+
	Protosiphonaccae			
13.	*Bryopsis indica*	-	+	-
	Caulerpaceae			
14.	*Caulerpa crassifolia*	-	+	+
15.	*Caulerpa cupressoides*	-	+	+
16.	*Caulerpa cupressoides* var. *lycopodium*	-	+	+
17.	*f.elegance*	-	+	-
18.	*Caulerpa fastigiatc*	-	+	-
19.	*C. fergusonii*	-	+	+
20.	*C. freycinetii*	-	-	-
21.	*C. lentellifera*	+	-	+
22.	*C. peltata*	-	-	+
23.	*C. racemosa*	+	+	-
24.	*C. racemosa* var.*clevifora*	-	-	+
25.	*C. racemosa* var.*lateverense*	+	-	-
26.	*C. racemosa* var. *uvifera*	-	-	-
27.	*C. racemosa* var. *chemnitzia*	-	+	+
28.	*C. sertularioides*	+	+	-
29.	*C. taxifolia*	+	+	-
30.	*C. verticillata*	+	-	-
	Desycladeccae			
31.	*Neomeris annulata*	-	+	+
	Codiaceae			
32.	*Avrainvillea erecta*	-	+	+
33.	*Avrainyillea* sp.	-	+	-
34.	*Codium corenatum*	-	-	-
35.	*Codium dwartense*	-	+	-
36.	*Codium iyengarii*	-	+	+
37.	*Codium* sp.	-	-	-
38.	*Halimeda gracilis*	-	+	-
39.	*Halimeda macroloba*	+	+	+
40.	*Udentea flabellum*	+	-	-
41.	*Udotea indica*	+	-	+
42.	*Udotea iyengarii*	-	+	-
43.	*Udotea iavensis*	-	-	+

1	2	3	4	5
	Valoniaceae			
44.	*Anadyamene stellata*	-		
45.	*Dietyosphoeria favulosa*	-		
46.	*Microd. ctyen tenuis*	-		
47.	*Boergescnia forbesii*	+		
48.	*Valoniopsis pachynema*	-		
49.	*Valoniopsis* sp.	-		
	PHAEOPHYTA			
	Ectocarpaceae			
50.	*Bachelotia antillarum*	-		
51.	*Ectoocarpus* sp.	-		
	Dictyotaceae			
52.	*Dictyota bartayresiana*	-		
53.	*Dictyota dichotoma*	-		
54.	*Dictoyata* sp.	-		
55.	*Padina gymnospora*	-	+	-
56.	*Padina paronica*	+	+	-
57.	*Pocockiella variegata*	+	+	-
58.	*Spatoglossum asperum*	-	+	-
59.	*Steochospermum marginatum*	+	+	-
60.	*Zonaria crenato*	+	+	-
	Punctarianceae	-	+	-
61.	*Colpomenia sinuosa*		+	+
62.	*Hydroclathurs chlaithratus*	+		
	Chonosporaceae	-	-	+
63.	*Chonospora fastigiata*			
	Cystoseiraceae	-	-	+
64.	*Cystoseria trinodis*	+		
65.	*Hormophysa triguetra*		+	-
	Saragassceae	+		
66.	*Sargassum ilicifolium*	+		
67.	*Sargassum linifolium*	+		
68.	*Sargassum plagiophyllum*	+		
69.	*Sargassum tenerrimum*	-		
70.	*Sargassum weightii*	-		
71.	*Saragassum* sp.	-		
72.	*Tubinaria conoides*	+		
73.	*Tubinaria conoides*var. conoides			
74.	*T.concides* f. evesciulosa	-		
75.	*T. ornata f. erecta*	-		
76.	*T. ornata f. erecta*	+		
77.	*Acrochactium* sp.	+	-	-
	Chentransiaceae			
78.	*Galaxaura oblongata*	-	-	-
	Gelidiaceae			
79.	*Gelidium heteroplatos*	-	+	-
80.	*Gelidium micropterum*	+	-	-
81.	*Gelidium pusillum*	+	-	-

	Gelidielleceae			
82.	*Gelidiella acerosa*	+	+	
	Rhizophyllidaceae	+		+
83.	*Chondrococcus hornemani*		+	
	Squamariaceae	-		+
84.	*Peyssonelia obscura*		+	
	Corallinaceae	-		+
85.	*Amphiroa anceps*	-	-	
86.	*Amphiroa fragiliasima*	-	+	+
87.	*Amphira foliacca*	+	+	+
88.	*Cheilosportum spectabile*	+	-	-
89.	*Jania iyengarii*	-	+	-
90.	*Jania capillacea*	-	+	-
91.	*Lithothamanion prolifera*	-	+	+
92.	*Lithothamnion* sp.	-	+	-
93.	*Lithophyllum* sp.	-	-	-
94.	*Molobesia farinosa*	-	-	-
	Crataloupiaceae	+	+	-
95.	*Halymenia floricsia*		-	+
				+
	Gracilariaceae			
96.	*Gelidiopsis repens*	+	+	+
97.	*Gelidiopsis veriabilis*	+	+	-
98.	*Grecilaria corticata*	-	-	-
99.	*Graciaria crassa*	-	+	+
100.	*Gracilaria disticha*	-	+	-
101.	*Gracilaria dura*	-	+	-
102.	*Gracilaria edulis*	-	+	-
103.	*Gracilaria foliters*	+	+	+
104.	*Grailaria folifera* f.granatea	-	+	-
105.	*Gracilaria pagmaceae*	-	+	-
106.	*Gracilaria verrucosa*	+	-	-
107.	*Gracilaria* sp.	-	+	-
	Sclieriaceae			
108.	*Sareonema filiforma*	-	+	-
	Hypneaceae			
109.	*Hypnea esperi*	-	+	-
110.	*Hypnea musciformis*	-	+	-
111.	*Hypnea pannosa*	+	+	+
112.	*Hypnea servicornis*	+	+	-
113.	*Hypnea valentiae*	-	+	-
114.	*Hypnca* sp.	-	+	-
	Phyllophoraceae			
115.	*Phyllophora* sp.	+	-	-
	Rhodymeniaceae			
116.	*Rhodymenia*	-	+	-
117.	*Rhodymenia dissecta*	-	+	-

118.	*Rhodymenia* sp.	-	+	-
	Lorentariaceae			
119.	*Champia parvula*	-	+	-
	Ceramiaceae			
120.	*Hormothamnion entromorphoides*	-	-	-
121.	*Centroceras clavulatum*	-	+	-
122.	*Ceramium gracillimum*	-	+	-
123.	*Ceranium subdichotomum*	-	+	-
124.	*Ceramium* sp.	-	+	-
125.	*Spyridia filamentosa*	-	+	-
	Deleaseriaceae			
126.	*Vanvoorsitia spectabilis*	-	+	-
	Rhodomelaceae			
127.	*Acamtyophora delilei*	+	-	+
128.	*Acanthophora muscoides*	+	+	-
129.	*Acanthophora spicitera*	-	+	-
130.	*Acanthophora thierii*	-	+	-
131.	*Acanthophora tenalla*	-	+	-
132.	*Bostrvehia tenella*	-	+	-
133.	*Chondria armata*	-	-	+
134.	*Chondria armata var plumaris*	-	-	
135.	*Chondria dasyphylla*	+	+	-
136.	*Chondria dasyphylla*	-	-	-
137.	*Herposiphonia insidiosa*	+	+	-
138.	*Herposiphonia tenella*	-	-	-
139.	*Baurencia ceylonica*	+	+	-
140.	*Laurencia cruciata*			
141.	*Laurencia bostrychodes*	-	+	-
142.	*Laurencia paniculata*	+	-	-
143.	*Laurencia perforata*	+	+	+
144.	*Laurencia papillosa*	-	+	+
145.	*Laurencia* sp.	-	+	-
146.	*Leveillea jungermannioides*	-	+	-
147.	*Fostiella minutata*	+	+	-
148.	*Tolypeocladia glomerutata*	+	+	-
149.	*Neurymenia fraxinifolia*	-	+	+
150.	*Polysiphonia* sp.	+	-	-
	CYANOPHYTA			
	Oscillatoriaceae			
151.	*Lynghya majuscula*	-	+	-
152.	*Lyngbya* sp.	+	+	+
153.	*Phormidium tenuis*	-	+	-
154.	*Microcoleus chthnoplastes*	-	+	-
155.	*Oscillatoria* sp.	-	+	-

Source: Subbaramaiah *et al.*, 1978.

TABLE : ALGAL RESOURCES OF GULF OF MANNAR

Region		Productive area in hectares*	Standing crop fresh wt. (tonnes)
1.	Region 1-including Appa island to Shingle island and southward coastline Mandapam to Kilakarai (and Northward Athankari-Rameswaram)	8,416	17,322
2.	Region 2-Kilakarai to Mukkaiyur	1,826	512
3.	Region 3-Mukkaiyur to Tuticorin	4,552	623
4.	Region 4-Tuticorin to Kanyakumari	1,732	3,439
All area inclusive		16,526	21,896

* : Interdial zone limited extent only considered

Source: Subbaramaiah *et al.*, 1978.

TABLE : MEAN ALGAL DESNTIY (Kg/m^2) IN GULF OF MANNAR

Region	Fresh weight (kg/m^2)
I	0.206
II	0.028
III	0.014
IV	0.198

Average for all IV Regions 0.11 kg/m^2. It is maximal in I Region and arranged in ascending order of increase runs like this :

Region III → Region II → Region IV → Region I

Source: Scientific report to Forest Department (1978).

TABLE : TOTAL AVAILABLE MARINE ALGAL SOURCES (REGION I)

Region	Agarophytes (tonnes)	Percentage	Alginophytes (tonnes)	Percentage	Rest (tonnes)	Percentage	Total
I	1,180	69.07	8,990	87,65	7,143	70.94	17,322
II	184	10.75	168	1.63	160	1.60	512
III	176	10.28	10	0.10	437	4.34	623
V	145	8.46	24	9.94	2,673	22.57	3,139
		98.56		99.32		99.45	

(% values given in total estimated standing crop)

Source: Subbaramaiah *et al.*, 1978.

TABLE : MAINLAND AND ISLANDS BETWEEN KILAKARI AND MUKKAIYUR (REGION II) : TOTAL ALGAL RESOURCES

Name	Productive area (ha)	Agarophytes %	Alginophytes %	Others %	Total crop fresh	Standing (tones weight)
Mainland	167.45	7.0	47.0	46.0	56.18	142.31
Upputhanni	20.04	7.0	43.0	50.0	29.32	30.59
Shalli	7.69	12.0	46.0	42.0	28.9	40.46
Nallathanni	61.29	68.0	31.0	1.0	188.71	205.87
Anaipar	20.49	7.0	29.0	64.0	47.11	55.31
Pallivasal	44.25	2.0	0.5	97.5	46.95	55.88

* l = lower limit; u. limit = upper limit.

Source: Subbaramaiah *et al.*, 1978.

TABLE : REGION III - MAINLAND AND ISLANDS BETWEEN MUKKIYUR AND PUNA KAYAL (TUTICORIN).
ESTIMATED STANDING CROP IN FRESH WEIGHT (tonnes)

Mainland and Island	Productive area (ha)	Agarophytes %	Alginophytes %	Others %	Total upper limit	lower limit
Mainland	62.64	1.10	0.04	98.86	304.458	239.106
*Karaichalli	37.92	82.70	-	17.30	174.607	54.547
*Shalli	21.96	18.80	26.30	54.90	48.570	26.733
Van island	47.38	35.65	-	64.35	265.852	131.466
Total	169.90	28.20	1.60	70.20	793.488	451.852

Total No. of species 24; * : Now known as Karaichalli Tivu
Source: Scientific Report to Forest Department (1978).

On Krusadai and Shingle islands very rich algal beds of Litho thamnion (calcareous alga), *Padina, Caulerpa* (ten species), *Ulva reticulata, Sargassum, Martensia, Clandia, Anadyomeme,* etc., are found (Iyengar 1927).

The algal species composition on the coral reefs is different from that found in the lagoons. The following species are noticed in the reefs:

Coral Reef Algae

Ulva reticulata
Halimeda opuntia
H.tuna
Caulerpa racemosa var. *clavifera*
Pocockiell sp.
Chnospora implexa
Sargassum sp.
Turbinaria conoides
T. ornata

Gelidiella acerosa

Chondrococcus harnemanni

Padina is observed on the shores and lagoons. *Gracillaria lichendoides* is found more the shore and lagoon than on reefs. *Sargassum* and *Turbinaria* are found on the shoreward part of the reefs.

The predominant species on the coral reefs are *Halimeda opuntia. Caulerpa, Sargassum, Amphiroa fragilissima, Gracilaria lichenoides* are among other dominant species.

The Sea grass ecosystem

The Gulf of Mannar area is rich for its seagrasses. The following species belonging to Hydrocharitaceae and Potamogetonaceae have been recorded. The sea grass beds provide food sources for the sea mammals, particularly *Dugong dugon* which feeds upon these pastures on the gulf shoreline and surrounding islands like Krusadai. The Dugongs prefer pastures of *Halodule uninervis* for food. The species composition of seagrasses is as follows :

Hydrocharitaceae :

Enhalus acoraides (with ribbon-shaped blades)

Thalassia hemprichii

Halophila ovalis

H. ovata

H. beccari

H. stipulacea

Potamogetonaceae :

Cymadocea serrulata

C. rotundata

Halodule uninervis

Syringodium isoetifolium

The Mangrove vegetation

The Gulf of Mannar islands posses unique mangrove vegetation. It is interesting to note that such vegetation consists of species belonging to Rhizophora, Avicennia, Bruguiera, Ceriops, Lumnitzera, etc. Although mangroves are obtained on a good majority of the islands, this vegetation on Manalli is striking for its luxuriance and diversity. They are not very tall trees, perhaps the height as curtailed due to strong winds lashing here perannially and with greater velocity during monsoons, periodical cyclones, etc. The plants are healthy. The whole island is carpeted as it were with pneumatophores wherever the mangrove forests are formed.

Table: Mangrove and associates as observed in the Gulf of Mannar islands

Name of Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Avicennia marina					P			P				P		P	P	P	P	P	P	P	P
Salvadora persica			P	P	P	P	P	P		P		P	P	P		P	P	P			
Sessuvium portulacastrum			P	P	P	P	P	P	P	P			P	P	P	P	P	P	P	P	P
Scaevola plumieri			P	P	P	P	P	P	P			P	P	P						P	P
Scaevola sp.																					P
Pemphis acidula								P	P			P	P		P	P	P	P	P	P	P
Thespesia populnea						P	P	P	P			P	P	P	P	P	P	P	P	P	P
Suaeda maritima												P		P	P	P			P		
Suaeda monoeica														P	P						
Salicornia bracheata			P	P	P			P				P			P		P				
Lumnitzera racemosa												P			P	P		P			P
Clerodendrum inerme					P	P			P												
Bruguiera cylindrica																P		P	P		
Ceriops tagal																P		P	P		
Rhizophora mucronata																P		P	P	P	
Pandanus sp.																				P	P
Phoenix sp.																		P			

1. Van Tivu; 2. Kasuwar; 3. Karaichalli; 4. Villanguchalli; 5. Upputhanni; 6. Pulvinichalli; 7. Nallathanni; 8. Anaipar; 9. Vallimunai; 10. Appa; 11. Poovarasanpatli; 12. Talairi; 13. Valai; 14. Mullai; 15. Hare; 16. Manoli; 16. Manoliputti; 18. Poomarichan; 19. Pullivasal; 20. Krusadai; 21. Shingle.

Corals

In the Gulf of Mannar fringing and patch coral reefs occur. The reef framework is complex. Of the Gulf of Mannar islands, the eastern side of the islands have a greater expanse of living coral reefs since the human exploitation of the coralline stones is concentrated on the northern and the western sides. (Issac Rajendran ad Kanagarai David, 1972). The Government of Tamil Nadu have prohibited the Quarring of Corals.

There are about 120 species corals in the Gulf of Mannar along (Gopinatha Pillai, 1971). They belong to 33 genera. Of this, 110 species grouped in 36 genera are hermatypic. The conspicuous species belong to the families Acroperidae. Peritides and Fairidae. The corals here are fast deteriorating in the 4 islands off the Ghidambaranar coast due to human interference.

Some of the factors affecting coral reefs growth are regression of coral growth due to silt-laden water with greater load of suspended matter during monsoon flow, wind blown sandy deposition, cyclone, quarrying for limestones, effect of current, etc. A detailed account on the exploitation of coral using it (in trade of the exploited products) as raw materials in industrial ventures such as cement industries, brick manufacture masonry work, lime-kilns, etc., is given by Mahadevan and Nagappan Nair (1972). For the industries in the adjoining Tirunelveli district, the exploited materials are ferried from islands north of Nalla Thanni Tivu. The reefs on some islands have been totally exploited beyond recognition.

The coral reefs are fast deteriorating due to human interference, greater silt inflow draining from the maintained, etc. The wind force spoils racemose types of corals greater than the encrusting and massive coral types. The coral reefs act as breakers and their removal will after the current pattern along the coastline. They act as coastguard against powerful tidal waves. Hence caution should be exercised against indiscriminate exploration and extensive siltation due to loss of forest cover on the coastline.

Loss of vegetation on the coast-ling causes extensive siltation. The reefs on the four islands off the Chidamparanar coast have been exploited beyond recognition and portions of these islands and one island entirely have become submerged under water and visible only at low tides.

The occurrence of the various genera of Scleractinia in the Indian part of Gulf of Mannar. The number in parentheses against each genus indicates the number of species so far recorded. Genera are listed in alphabetical order (Gopinatha Pillai 1971).

Sl.No	Genus	Southeast India
1	2	3
1	*Acanthastrea*	-
2	*Acropora*	X (24)
3	*Astreopora*	X (1)
4	*Balanophyllia*	X (1)
5	*Coscinaraea*	X (1)
6	*Culicia*	X (1)
7	*Cycloseris*	-
8	*Cyphastrea*	X (3)
9	*Dendrophyllia*	X (1)
10	*Diploastrea*	-
11	*Echinopora*	X (2)
12	*Endopsammia*	X (1)
13	*Euphyllia*	-
14	*Favia*	X (5)
15	*Favites*	X (5)
16	*Fungia*	-
17	*Galaxed*	X (2)
18	*Goniastrea*	X (3)
19	*Goniopora*	X (5)
20	*Hydnophora*	X (3)
21	*Leptastrea*	X (2)

22	*Leptoria*	X (1)
23	*Lobophyllia*	-
24	*Merculina*	X (1)
25	*Montipora*	X (20)
26	*Mycedium*	X (1)
27	*Pachyseris*	X (1)
28	*Pavana*	X (4)
29	*Paracyathus*	X (1)
30	*Platgyra*	X (1)
31	*Plesiastrea*	X (1)
32	*Pocillopora*	X (2)
33	*Polycyathus*	X (1)
34	*Podabacia*	-
35	*Porites*	X (13)
36	*Psammocora*	X (1)
37	*Slderastrea*	X (2)
38	*Stylophora*	-
39	*Symphyllia*	X (2)
40	*Tubastrea*	X (1)
41	*Turbinaria*	X (4)

From the region (between 9°05 - 9°05'N and 78°25' - 78°40') long off Uppu Thanni Tivu, we have a shallow channel of uniform depth of about 11 metres favouring pearl bank formations. The region between Tuticorin and Kanyakumari have extensive pearl banks.

In fact, the area upto Nalla Thanni comprising of 8 islands (from New Tuticorin Port to Nalla Thanni) also possess extensive pearl banks. Off the coast of Terku Mukkaiyur of the mainland and in the environs of Uppu Thanni island, there are pearl banks between 11 and 15 metres.

In the region near Tuticorin their concentration is found even at depths of about 37 metre at 7825' E 8°47'N. the maximal concentration is along the depth contour of about 16 to 20 metres. Near about Van Tivu and Koswari Tivu, there are pearl banks at depths of 11 to 15 metres, and opposite Kariya Shuli and Vilangu Shuli islands also support pearl banks.

Avifauna

Aquatic birds not only play an important role as members of the secondary consumer trophic level in estuarine and intertidal habitat, but also help in recycling the nutrients such as phosphates and nitrogen into the coastal ecosystem. Sudden appearence and disappearence of birds due to migration in the coastal environment will have some impact on the ecosystem. Hence it is essential to determine where birds are, and when, where and how they move between places; all these aspects are vital in providing information to conserve their habitats.

The visit by Salim Ali during 1982 and that of another survey party in August 1985 to Mandapam, brought to light the importance of this area regarding migratory movements of uncommon waders and flamingos in India.

In addition to the marine fauna and flora, the physical, chemical and biological features of the coastal habitat in the Gulf of Mannar are well known. The area is of particular significance as the islands in the area are the resting place for the birds

migrating to and from Sri Lanka. The diversity in the ecosystem in the area has made it the wintering and moulting grounds for many thousands of waders.

Owing to its geographical situation of the islands in the Gulf of Mannar, (being much closer to Sri Lanka), occurrence of pelagic birds are also occasionally recorded. A check-list of the water birds of the Gulf of Mannar has been given in the following table.

TABLE : CHECK-LIST OF THE BIRDS OF GULF OF MANNAR

No.	Common Name	Species
	Order : Gaviformes Family : Podicepidae	
1.	Dabchick	*Podiceps ruficollis*
	Order : Procellariformes Family : Hydrobatidae	
2.	Wilson Storm Petrel	*Oceanites oceanicus*
	Order : Pelecaniformes Family : Phaethonidae	
3.	White Tropic-bird	*Phaethon lepturus*
	Family : Pelecanidae	
4.	Grey or Spottedibilled Pelican	*Pelecanus philippensis*
	Family : Phalocrocoracidae	
5.	Large Cormorant	*Phalacrocorax carbo*
6.	Little Cormorant	*Phalacrocorax niger*
	Order : Ciconiformes Family : Ardeidae	
7.	Grey Heron	*Area cinerea*
8.	Large Egret	*Ardea alba*
9.	Little Green Heron	*Ardeola striatus*
10.	Pond Heron	*Ardeola grayii*
11.	Cattle Egret	*Bubulcus ibis*
12.	Samller or Median Egret	*Egretta intermedia*
13.	Little Egret	*Egretta garzetta*
14.	Indian Reef Heron	*Egretta gularis*
15.	Night Heron	*Nycticorax nycticorax*
16.	Black Bitten	*Ixobrychus flavicollis*

No.	Common Name	Species
	Family : Ciconidae	
17.	Painted Stork	*Mycteria leucocephala*
18.	Openbill Stork	*Anastomus oscitans*
19.	White Stork	*Cinonia ciconia*
	Family : Threskiornithidae	
20.	White Ibis	*Threskiornis aethiopica*
21.	Black Ibis	*Pseudibis papillosa*
22.	Spoonbill	*Platalea leucorodia*
	Family : Phoenicopteridae	
23.	Flamingo	*Phoenicopterus roseus*
	Order : **Anseeriformes** Family : **Anatidae**	
24.	Barheaded Goose	*Anser indicus*
25.	Pintail	*Anas acuta*
26.	Common Teal	*Anas crecca*
27.	Spotbill Duck	*Anas poecilorhyncha*
28.	Wigeon	*Anas penelope*
29.	Garganey	*Anas querquedula*
30.	Shoveller	*Anas clypeata*
	Order : **Falconiformes** Family : **Accipitridae**	
31.	Blackwinged Kite	*Elanus caeruleus*
32.	Pariah Kite	*Mivus migrans*
33.	Brahiminy Kite	*Haliastur indus*
34.	Shikra	*Accipiter badius*
35.	Sparrow Hawk	*Accipiter nisus*
36.	White-eyed Buzzard Eagle	*Butastur teesa*
37.	Booted Hawk-Eagle	*Hieraaetus krinerii*
38.	Whlite bellied Sea Eagle	*Haliaeetus leucogaster*
39.	Scavenger Vulture	*Neophron percnopterus*
40.	Pale Harrier	*Circus macrourus*
41.	Pied Harrier	*Circus melanoleucos*
42.	Marsh Harrier	*Circus aeruginosus*
43.	Short-toed Eagle	*Circaetus gallicus*
44.	Crested Serpent Eagle	*Spilornis cheela*
45.	Osprey	*Pandion haliaetus*
	Family : Falconidae	
46.	Peregrine Falcon	*Falco peregrinus*
47.	Kestrel	*Falco tinnunculus*

No.	Common Name	Species
	Order : Galliformes **Family : Phasianidae**	
48.	Grey Partridge	*Francolinus pondicerianus*
49.	Common Peafowl	*Pavo cristatus*
	Order : Gruiformes **Family : Rallidae**	
50.	Ruddy Crake	*Porzona fusca*
51.	Whitebreasted Waterhen	*Amaurornis phoenicurus*
	Order : Charadriiformes **Family : Haematopodidae**	
52.	Osytercatcher	*Haemotopus ostralegus*
	Family : Recurvirostridae	
53.	Blackwinged Stilt	*Himantopus himantopus*
	Family : Dromadidae	
54.	Crab plover	*Dromas ardeola*
	Family : Burhinidae	
55.	Stone Curlew	*Burhinus oedicnemus*
56.	Great-Stone Plover	*Esacus magnirostris*
	Family : Charadriidae **Sub Family : Charadriinae**	
57.	Redwattled Lapwing	*Vanellus indicus*
58.	Yellow-Wattled Lapwing	*Vanellus malabaricus*
59.	Grey Plover	*Pluvialis squatarola*
60.	Eastern Golden Plover	*Pluvialis dominica*
61.	Large Sand Plover	*Charadrius leschenaultii*
62.	Ringed Sand Plover	*Charadrius hiaticula*
63.	Little Ringed Plover	*Charadrius dubius*
64.	Kentish Plover	*Charadrius alexandrinus*
65.	Lesser Sand Plover	*Charadrius mongolus*

No.	Common Name	Species
	Sub Family : Scalopacinae	
66.	Whimbrel	*Numenius phaeopus*
67.	Curlew	*Numenius arquata*
68.	Blacktailed Godwit	*Limosa limosa*
69.	Bartailed Godwit	*Limosa lapponica*
70.	Common Redshank	*Tringa totanus*
71.	Marsh Sandpiper	*Tringa stagnatilis*
72.	Greenshank	*Tringa nebularia*
73.	Green Sandpiper	*Tringa ochropus*
74.	Wood or Spotted Sandpiper	*Tringa glareola*
75.	Terek Sandpiper	*Tringa terek*
76.	Common Sandpiper	*Tringa hypoleucos*
77.	Turnstone	*Arenaria interpres*
78.	Pintail Snipe	*Gallinago stenura*
79.	Knot	*Calidris canuta*
80.	Eastern Knot	*Calidris tenuirostris*
81.	Eastern Little Stint	*Calidris ruficollis*
82.	Little Stint	*Calidris minuta*
83.	Dunlin	*Calidris alpina*
84.	Curlew-Sandpiper	*Calidris testacea*
85.	Broadbilled Sandpiper	*Limicola falcinellus*
	Sub Family : Phalaropinae	
86.	Rednecked phalarope	*Phalaropus lobatus*
	Family : Sterocoraridae	
87.	Skua	*Catharacta skua*
	Family : Laridae	
88.	Herring Gull	*Larus argentatus*
89.	Brownheaded Gull	*Larus brunnicephalus*
90.	Blackheaded Gull	*Larus ridibundus*
91.	Whiskered Tern	*Chlidonias hybrida*
92.	Gullbilled Tern	*Gelochelidon nilotica*
93.	Caspian Tern	*Hydroprogne caspia*
94.	Common Tern	*Sterna hirundo*
95.	Little Tern	*Sterna albiforns*
96.	Large Cresed Tern	*Sterna bergii*
97.	Indian Lesser Crested Tern	*Sterna bengalensis*
98.	Sandwish Tern	*Sterna sandvicensis*
99.	Noddy Tern	*Anous stolidus*

No.	Common Name	Species
	Order : Columbiformes **Family : Columbidae**	
100.	Greyfronted Green Pigeon	*Treron pompadora*
101.	Blue Rock Pigeon	*Columba livia*
102.	Indian Ring Dove	*Streptopelia decaocto*
103.	Indian Spotted Dove	*Streptopelia chinensis*
	Order : Psittaciformed **Family : Cuculidae**	
104.	Roseringed Parakeet	*Psittacula krameri*
	Order : Cuculiformes **Family : Cuculidae**	
105.	Redwinged Crested Cuckoo	*Clamator coromandus*
106.	Pied Crested Cuckoo	*Clamator jacobinus*
107.	Small Cuckoo	*Cuculus poliocephalus*
108.	Common HawkCuckoo or Brainfeverbird	*Cuculus varius*
109.	Indian Plaintive Cuckoo	*Cacomantis passerinus*
110.	Indian Banded Bay Cuckoo	*Cacomantis sonneratii*
111.	Indian Drongo Cuckoo	*Surniculus lugubris*
112.	Koel	*Eudynamys scolopacea*
113.	Small Greenbilled Malkoha	*Rhopodytes viridirostris*
114.	Crow-phesant	*Cetropus sinensis*
	Order : Strigiformes **Family : Strigidae** **Sub Family : Striginae**	
115.	Spotted Owlet	*Athene brama*
116.	Short-eared Owl	*Asio flammeus*
	Order : Caprimulgiformes **Family : Caprimulgidae**	
117.	Common Nightjar	*Caprimulgus asiaticus*
	Order : Apodiformes **Family : Apodidae** **Sub Family : Apodinae**	
118.	Alpine Swift	*Apus melba*
119.	Palm Swift	*Cypsiurus parvus*

No.	Common Name	Species
	Order : Coraciformes **Family : Alcedinidae**	
120.	Lesser Pied Kingfisher	*Ceryle rudis*
121.	Common Kingfisher	*Alcedo atthis*
122.	Whitebrested Kingfisher	*Halcyon smyrnensis*
123.	Blackcapped Kingfisher	*Halcyon pileata*
124.	Bluetailed Bee-eater	*Merops philippinus*
125.	Green Bee-eater	*Merops orientalis*
	Family : Coracidae	
126.	Indian Roller or Blue Jay	*Coracias benghalensis*
	Family : Upupidae	
127.	Hoopoe	*Upupa epops*
	Order : Piciformes **Family : Picidae**	
128.	Lesser Goldenbacked Woodpecker	*dinopium benghalense*
	Order : Passeriformes **Family : Pittidae**	
129.	Indian Pitta	*Pitta brachyura*
	Family : Alaudidae	
130.	Bush Lark	*Mirafra assamica*
131.	Redwinged Bush Lark	*Mirafra erythroptera*
132.	Ashycrown Finch-Lark	*Eremopterix grisea*
133.	Eastern Skylark	*Alauda gulgula*
	Family : Hirundidae	
134.	Swallow	*Hirundo rustica*
	Family : Lanidae	
135.	Baybacked Shrike	*Lanius vittatus*
136.	Brown Shrike	*Lanius cristatus*
	Family : Oriolidae	
137.	Golden Oriole	*Oriolus oriolus*
	Family : Dicruridae	
138.	Black Drongo	*Dicrurus adsimilis*
139.	Grey Drongo	*Dicrurus leucophaeus*

No.	Common Name	Species
	Family : Artamidae	
140.	Ashy Swallow-Shrike	*Artamus fuscus*
	Family : Sturnidae	
141.	Greyheaded Myna	*Sturnus malabaricus malabaricus*
142.	Whiteheaded Myna	*Sturnus malabaricus blythili*
143.	Brahminy Myna	*Sturnus pagadorum*
144.	Rosy Pastor	*Sturnus roseus*
145.	Common Myna	*Acridotheres tristis*
	Family : Corvidae	
146.	Indian Tree Pie	*Dendrocitta vagabunda*
147.	House Crow	*Corvus splendens*
148.	Jungle Crow	*Corvus macrorhynchos*
	Family : Campephagidae	
149.	Common Wood Shrike	*Tephrodornis pondicerianus*
150.	Blackheaded Cuckoo-Shrike	*Coracina melanoptera*
	Family : Irenidae	
151.	Common Iora	*Aegithina tiphia*
	Family : Pycnonotidae	
152.	Redvented Bulbul	*Pycnonotus cafer*
153.	Whitebrowed Bulbul	*Pycnonotus luteolus*
	Family : Muscicapidae **Sub Family : Timalinae**	
154.	Common Babbler	*Turdoides caudatus*
155.	Whiteheaded Babbler	*Turdoides affinis*
	Sub Family : Muscicapinae	
156.	Brown Flycatcher	*Muscicapa latirostris*
157.	Brownbreasted Flycatcher	*Muscicapa muttui*
158.	Bluethroated Flycatcher	*Mascicapa rubeculoides*
	Sub Family : Monarchinae	
159.	Paradise Flycatcher	*Terpsiphone paradisi*

No.	Common Name	Species
	Sub Family : Sylvinae	
160.	Tailor Bird	*Orthotomus sutorius*
161.	Blyth's Reed Warbler	*Acrocephalus dumetorum*
162.	Paddyfield Warbler	*Acrocephalus agricola*
163.	Lesser Whitethroat	*Sylvia curruca*
164.	Largebilled Leaf Warbler	*Phylloscopus magnirostris*
165.	Dull Green Leaf Warbler	*Phylloscopus trochiloides*
	Sub Family : Turdinae	
166.	Blue Chat	*Erithacus brunneus*
167.	Magpie-Robin	*Copsychus saularis*
168.	Indian Robin	*Saxicoloides fulicata*

Source: K. Krishnamurthy, Personal Communication.

Other Fauna

The Porifera, are represented by species belonging to genera *Tetraxonida* and *Keratosa* (Burton, 1937).

Among Coelenterates, sea anemones, *Cavernularia* etc., are noticed. The *Bryozoa* species (formely called Polyzoa) are recorded. The phorionids and Sipunculids have also been recorded. Among the many other groups recorded from here, mention must be made of polychaetes, pychogonids, capvellids and echinoderms. Ascidians were recorded besides the encrusting colonies of ascidiozoords by Gravely. *Esteinascidi thurstoni, E. multiclathrata, Diplosoma* and *Distoma* were also recorded.

Many coloured coral fishes, Eals, molluscs, (special mudifranches) and stomatopods are found here. Sea anemones of different kinds, planarians, hydroid colonies, memertine worms, polychaete worms, ear-shells, chitons, Octopus, holothurians and ascidians are very common. Siphomophores (*Physalia, Ultriculers, Perpita, Velella*) Pelagic gadroponds *(Ianthina, Cubo medusae, Lucernorporis)* Phyenogonides, polychaete crabs, colonies of aleyonariaas, barnacles, starfish, sea urchins and hermit crabs are also present. Mudskippers (*Periophthalmus* and *Boleophthalmus*) are found in plenty on the lower branches of the mangrove trees fringing the shore. Sea snakes *(Hydrophia* and *Enhydrina)* are also seen here.

Milk fish (*Chanos chanos*) spawn here in favourable season and the larvae are seen in millions here in the months of March, April and May.

Balanoglossus (*Ptychodera flava*), the unique link between the invertebrates and vertebrates which is said to be so rare that it is seen to occur only near Krusadai island - only the second place in the world, and Holothurians (sea cucumbers) are seen in a patch of about 4.5 ha. in extent close to Kurusadi island. Dolphins are more common here than any other region in the Bay of Bengal and young whales have been known get stranded and die on the coast here. The area is a favourite browsing ground of the highly endangered dugongs (*Dugong dugon*).

All the 5 species of Marine turtles (*Lepidochelye*) are known to nest on the islands here. The bird life abounds in partridges in Musal Tivu, ibises, stilts and cormorants in the mud flats and a host of other sea birds. A list of Bryozoan species is given elsewhere.

SUMMARY OF "SWOT" ANALYSIS

In order to understand the overall situation prevailing on these islands, a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) was carried out. The major points emerged out of this are highlighted below:

Strengths

1. Unique ecosystem endowed with over 3200 species of plants and animals.

2. Presence of endemic flora and fauna.

3. Natural breeding and feeding ground for a variety of organisms.

4. Easy accessibility due to closeness to the mainland

5. The presence of "Sethusamudram" (a natural underground link between India and SL) enriches the entire Gulf area minimising the effect of strong under currents

of the sea and provides protection against coastal storms by serving as natural barrier.

6. The Government policies and also the on-going efforts of the Forest Department of Tamil Nadu has facilitated the protection and conservation of this region.

Weaknesses

1. Lack of adequate staff (for protection and management) and support facilities such as speed-boats and communication facilities.

2. Lack of co-ordination among research institutions, Government Departments (Forest, Fisheries, Navy Coast Guard and NGO's).

3. Lack of active research by Maritime Institutions specific to individual groups of plants and animals.

4. Lack of awareness among the coastal communities about the uniqueness and importance of GOM MBR.

Opportunities

1. Improvement of basic infrastructure

2. Strengthening conservation and protection by increasing patrolling staff

3. Networking of all research institutions to undertake comprehensive research work.

4. Promotion of ecologically sustainable utilisation of natural resources by integrating the efforts of various

5. Promotion of eco-tourism and departments awareness generation

6. Providing alternate source of livelihoods to the coastal communities to relieve the pressure on the fragile ecosystem.

Threats

1. Rapid industrialisation in the coastal region around the GOMMBR

2. Exploitation of natural resources such as coral and sea-grass extraction, dynamite fishing and intensive trawling.

3. Threats from industrial pollution particularly due to thermal wastes and fly ash

4. Proposed "Sethusamudram canal project" which would endanger the entire ecosystem.

5. Poaching of threatened species.

6. Unauthorised human settlements on the islands during some part of the year.

7. Proposed coastal aquaculture.

Following chapters highlight current conservation efforts undertaken by various institutions and government departments in the Gulf of Mannar Marine Biosphere Reserve.

GULF OF MANNAR :
CURRENT CONSERVATION EFFORTS

GULF OF MANNAR : CURRENT CONSERVATION EFFORTS

PRESENT ADMINISTRATIVE SET UP

The Gulf of Mannar Marine National Park division was first formed on 1.11.1989 as per G.O.Ms.No.638 of the Department of Environment and Forests, dated 2.9.1989. At the time of formations, the Headquarters of the Wildlife Warden was fixed temporarily at Palayamkottai, and from 16.2.90, the headquarters was moved to Mandapam. Subsequently, the headquarters was shifted to Ramanathapuram as per G.O.Ms.No.153, of the Department of Environment and Forests on 4.3.1991, and started functioning from 26.6.1991.

The staff position of this Biosphere reserve is as follows :

Sl.No.	Category	Permanent	Temporary	Total
1.	Wildlife Warden	1	..	1
2.	Ranger	1	3	4
3.	Forester	1	7	8
4.	Forest Guard	10	..	10
5.	Selection Grade Assistant (Upgraded as Superintendent)	..	1	1
6.	Assistant	..	1	1
7.	Junior	..	1	1 (Utilised in Circle office)
8.	Steno Typist	..	1	1 Vacant
9.	Junior Assistant	..	1	1
10.	Junior Draughting Office	..	1	1
11.	Office Assistant	1	2	3
12.	Office Watchman	1	..	1
13.	Mali	..	1	1
14.	Driver	1	1	2
Total		16	20	36

The following ranges are functioning in the division.

Range and Jurisdiction	Headquarters	Staff Attached
1. Mandapam Islands of jurisdiction	Mandapam	
1. Shingle 2. Krusadai 3. Pullivasal 4. Poomarichan 5. Manoliputti 6. Manoli 7. Hare		1. Ranger - 1 2. Forester - 1 3. Forest Guard - 2 Total - 4
2. Keelakarai Islands of Jurisdiction	Keelakarai	
1. Mulli 2. Valai 3. Talairi 4. Poovarasanpatti 5. Appa 6. Vallimunai 7. Anaipar		1. Ranger - 1 2. Forester - 1 3. Forest Guard - 2 Total - 4
3. Ramanathapuram Areas of Jurisdiction	Ramanathapuram	
1. Vettangudi 2. Chitrangudi 3. Kanchirankulam 4. Ramanad Big Tank 5. Sakkrakottai Tank these are bird sanctuaries		1. Ranger - 1 2. Forester - 2 (1 post is vacant) 3. Forest Guard 2 4. Mali - 1 5. Tractor Driver - 1 - - Total - 7
4. Tuticorin Islands of Jurisdiction	Tuticorin	
1. Nallathanni 2. Puluvinichalli 3. Upputhanni 4. Vilanguchalli 5. Karachalli 6. Kasuwar 7. Van tivu		1. Ranger - 1 2. Forester - 3 3. Forest Guard - 4 4. Jeep Driver - 1 5. Office Assistant - 1 Total - 10

MANAGEMENT ACTIONS

After taking over charge of the work related to the Gulf of Mannar Marine Biosphere Reserve, the Forest Department has taken charge of (a) 8 islands off Ramanathapuram coast from Revenue department on 12.10.1991, (b) 4 islands off the Chidambaranar Coast from Revenue department August 1991, and (c) Remaining 8 islands in Ramanathapuram coast from Fisheries Department except Krusadai island in December 1992. All the islands have been notified under section 26 of the Tamil Nadu Forest Act 1882. Under the section 4 of the notification of the Tamil Nadu Forest Act, these islands are notified as 'National Park'.

Thirty two feet wooden boats (2 nos.) have been acquired in the month of October 1991, for patrolling in this area. In addition to this, two fibre glass boats with four out-board motors have been acquired from the customs department. Erection of descriptive boards in all the islands has been done.

Pamphlets about conserving the endangered species, Dugong and sea turtles have been printed and distributed among the public, students and fishermen community. Video Cassettes depicting importance of wildlife have been purchased, and are used as an educational material to create awareness among various sections of the society such as students and coastal communities. Three nature camps are also conducted on some of the islands involving school and college students and local public.

Afforestation with native species has been undertaken on these islands and also along their periphery, to stabilise and conserve the soil. This has helped in stabilisation of shifting sand and also coastal erosion.

Buildings have been acquired from Port Trust at Keelakarai and they have been maintained and allotted to the field staff as residence, to ease the pressure of continuous patrolling and for easy accessibility. An education and interpretation centre is being set up at Keelakarai in the campus acquired from Port Trust. Installation of a VHF wireless network has been completed.

Training of field personnel in the management of the marine protected area and purchase of special equipments for monitoring the various aspects of the ecosystem has been planned and is under execution.

Acquisition of 2 hectares of land in the Ramanathapuram Collectorate Master Plan Campus has been done and construction of office and guest house for the Wildlife Warden, Education Center etc. have been planned and are under construction. A watch tower was erected in the Vettangudi Bird Sanctuary area and planting of miscellaneous species such as Barringtonia, *Acacia, Pongamia* was done to improve the bird habitats. Similar activities are planned for the Gulf of Mannar islands.

CONSERVATION EFFORTS

Coral reef conservation

Coral reefs which are among the most productive areas in the marine ecosystems, are seen deteriorating in the Gulf of Mannar area, particularly in the four islands of the Chidambaranar District due to human interference. This was due to illicit removal of corals. These activities have been brought down by the Forest Department after taking over the charge of these islands. Legal measures were also taken to check this activity and prevent further loss of live corals.

Legal measures

Period	Cases Booked		People Accused		"C" Fees Collected	
	Tuticorin Range	Mandapam Range	Tuticorin Range	Mandapam Range	Tuticorin Range	Mandapam Range
December '91 to March '92	44	2	111	2	8	500
April '92 to March '93	49	7	106	8	No record available	

Control over illicit removal

Authorities of the SPIC and TAC industries have been informed to avoid procuring their calcium carbonate requirements from the island region and they have also agreed to look into these suggestions, and help in stopping coral extraction. Chief Conservator of Forests (Wildlife) and Chief Wildlife Warden have sent proposals to the Government of India to bring all the existing species under schedule IV of the Wildlife Protection Act and this is being followed up.

Strict protection to control illicit mining of coral materials itself has shown tremendous results.

Reclamation of submerged portions of islands

The islands such as Kasuwar, off Chidambaranar coast which were eroded due to removal of coral reef barriers were tried for pilot scale effort for reclamation. The seized coral materials were dumped on the borders of eroded island portions which acted as a base or core, over which the land got built up. Thus, with strict control over illicit coral removal and deposition of dead coral material and sand, eroded portions of the islands have been reclaimed. A study undertaken by scuba divers recently confirmed fresh coral regeneration and building up of colonies in the newly formed island portions.

Vilanguchalli island which got submerged due to heavy removal of coral reefs, can be visited only during low tides, when a small portion of this island gets exposed. Dumping of rubble stones on this exposed portion to act as a barrier is proposed and an action plan to undertake reclamation work has been prepared. This activity can be continued every year in the identified island portions which need reclamation.

Coral cultivation activity

There is no need to undertake artificial coral cultivation for rehabilitation of this important area. If the required protection and natural phenomena are available, they develop naturally, though the natural regeneration and coral formation takes a very long time. Shingle, one of the largely affected islands due to heavy biotic pressure, has been

chosen for pilot studies. To arrest the sand and debris from being washed over the live coral formations due to wave action, a rubble barrier was created at low tide during the year 1993. This helped in trapping of dead coral debris and sand and thus protected the excellent proliferation of live corals.

Sea turtle conservation programme

There are five species of sea turtles in the Indian seas and all are considered endangered and placed in Schedule I of the Indian Wildlife (Protection) Act of 1972. These species are also listed in Appendix I of the convention of International Trade in Endangered species of Wild Fauna and Flora (CITES) which prohibits turtle products by party countries. None of the five species are endemic and migrate over long distances in search of suitable feeding and breeding grounds, often across international boundaries.

A sea turtle conservation programme is being developed involving national experts wherein following points will be given highest priority.

1. Protection of nesting grounds and aquatic habitats, including minimization of environmental disruption at these sites.
2. Use of hatcheries and short-range transplantation of nest to protect eggs at the nesting beaches.
3. Conservation through education.
4. Cottage Industry Turtle ranching.
5. Employing non-commercial captive breeding techniques to maintain gene pools.

Seagrass conservation programme

The string of islands in the Gulf of Mannar forms a unique ecosystem on the eastern coast. The rich seagrass vegetation includes some of the rare forms, endemic to this region. Some of these species belonging to Hydrocharitaceae and Potamogetonaceae are listed below:

Hydrocharitaceae :

Enhalus acoraides	*Halophila ovata*
Thalassia hemprichii	*H. baccari*
Halophila ovalis	*H. stipulacea*

Potamogetonaceae :

Cymadocea serrulata
C. rotundata
Halodule uninervis
Syringodium isoetifolium

The seagrass beds provide a habitat for many different organisms. Such as worms, crustaceans, molluscs, fishes and mammals. Basically, Dugong prefers pastures of *Halodule uninervis* for food. To avoid further deterioration of algal beds in the region in general and Tuticorin group of islands in particular, immediate task to be undertaken would be planting of seagrasses in shallow areas. Seagrasses have an extensive root system that reaches upto 1.5 m in depth and there ability to spread laterally helps them to eventually dominate the area where they grow.

It is proposed undertake studies related to understanding distributional pattern of seagrasses so that restoration can be undertaken. The primary aim of this programme is to conserve the natural habitat of Dugong, which is an endangered aquatic mammal and protected under the Indian Wildlife Protection Act (1972).

Conservation of sea cucumber (*Holothuria atra* and *H.scabra*)

There are over 650 species of holothurians known from various parts of the world, out of which nearly 200 species of holothurians are known, to occur along the Indian coast and thirteen species among them are of commercial value. Holothurians which are large in size and with thick body wall are used for processing. In India, *Holothuria scabra* and *Holothuria spinifera* were among the species being fished in the Gulf of Mannar and Palk Bay region till recently. It has been taken over by *Holothuria atra* by which is now recognised as commercially profitable species. They are collected by hand during low tide in the intertidal regions and lagoons where depth of water is less than a metre. Scuba

diving in waters upto a depth of 2 to 10 metres, is also one of the methods of collection. Live holothurians fetch a better price. Fishing is done throughout the year.

In the Palk Bay the holothurian fishing is done from March to October, the peak season being April and May and in the Gulf of Mannar from October to March, with peak in December and January. Along the Gulf of Mannar, Chinnapalam, Vedalai, Mandapam, Periapattinam, Kilakarai and Tuticorin whereas in the Palk Bay, Rameswaram, Devipatinam, Tirupalakudi, Karangadu, Mollimonai, Tondi, Pasipatnam, Pudipatnam, Kattaipatnam, Ammapatnam and Kattumavadi are important centres of holothurian collection. Among these, Tirupalakudi is the most important centre.

Over exploitation can easily take place as the animals are defenseless and passive. So, to conserve the resources, regulation regarding the size at collection should be imposed. This can be strictly implemented by the Gulf of Mannar Marine Biosphere Reserve in authorities, Tamil Nadu Forest Department, as the collection is being done in the Gulf of Mannar Marine Biosphere Reserve Agree. Catching material below the size of 35cm depth length may be banned.

Between July to October should be declared as closed seasons, as it is the peak spawning period for the Becheder-mer.

Attempts should be made to augment production and boost up export-locate the beds where juveniles are in large numbers and develop hatchery system through the CMFRT.

Mannar and Balk day. This has resulted in over fishing in certain pockets. The sizes of the species caught have reduced and the returns to unit of effort have also fallen significantly. In earlier period *Holothura scabra* and *Holothuria spinifera* were only collected. Due to uncontrolled over fishing, the above said species have become rare to get. So, now *Holothuria atra* is being collected and one day this will also become endangered.

Conservation

The Fisheries act of 1897 does not provide protection of any immature beche-de-mer left unfished another year, the product would increase three fold in weight and will get increased value.

It is pointed out here, that *Holothuria scabra, Holothuria spinifera* and *Holothuria atra* are likely to be endangered unless conservation measures are taken.

Legal measures

- Government of India took up a decision on the export of beche-de-mer below the size of 7.5 cm, it can be enhanced to 10 to 18 cm as in East Africa, Indonesia and Singapore.

- *Holoithuria scabra* breeds round the year, it has two spawning peaks, one in July and the other in October. So it is suggested to collect and process the material during January to May for two reasons. The first reason is that it can be quietly dried in the sun during January to May Sun dried material is preferred to smoke dried ones in export market. Smoke dried product is also incurs additional expenditure by way of fuel. The second reason is that in summer there is no breeding peak. *June to December may declared as closed season* as it is essential to allow the animals to spawn atleast once in their life time to replenish the stock.

- If the following species are included in the Schedule IV of the Wildlife (Protection) Act 1972, it will be very easy to control. They are *Holothuria scabra, Holothuria spinifers* and *Holothuria atra.*

Inspite of above mentioned efforts by Forest Department, there are various biotic and abiotic components posing various threats on the Gulf of Mannar Marine Biosphere reserve. They are discussed in the following chapters.

GULF OF MANNAR :
THREATS TO THE CONSERVATION

GULF OF MANNAR : THREATS TO THE CONSERVATION

The Gulf of Mannar Marine Biosphere Reserve on the East coast of India is a unique ecosystem. With over 90 species of live corals, which form an integral part of this system, it harbours a rich variety of coral flora and fauna. Based on the survey of all the islands, the degree of human interference present in the Biosphere area was determined. Following are some of the threats to the conservation of this unique ecosystem.

DEVELOPMENTAL PROGRAMMES

1. INDUSTRY

Industrial development thereby setting up of industries have great relevance to the economic growth of the country. It has significant impact on the environmental features in the developing countries which results in the exploitation of biological resources. In the Gulf of Mannar region, Tuticorin is under severe pressure due to the heavy concentration of industries on the coast. It poses serious threat to the adjacent ecosystems. The major industries located in and around Tuticorin are Tuticorin Power Plant, Southern Petrochemical Industries Corporation Limited (SPIC), Tamil Nadu Alkali Chemicals (TAC), Dharanghadhara Chemicals, Gulf Polefins and Tuticorin Salt Marine Chemicals.

The Thermal discharge from the power plant adversely affects the sea grass ecosystems in the vicinity as the sea grasses undergo thermal stress above 40°C. It has been noted that the seagrasses have disappeared from areas within the distance of 5 km near the thermal power station.

Another industry related activity such as quarrying of corals is a regular activity in the Gulf of Mannar area, although it is prohibited by the Mines and Mineral Regulation Act. The fringing coral reefs in the Gulf of Mannar face partial to total destruction due to unauthorised coral quarrying by the industries. The coral which is used as a source of calcium carbonate, is then converted to calcium carbide and used in the acetylene, and other industries such as SPIC and Tamil Nadu Alkali Chemicals.

For production of marine chemicals such as agar and alginate, industries located around the Gulf of Mannar Marine Biosphere Reserve (on the mainland) harvest the seaweeds near the coral reef areas. The association of seaweed with coral forms an important component of the reef community complex and it has been observed that in some cases, they are biologically more productive than coral reef alone and form a source of food for a variety of fish when the latter occupy the quaet coral complex for spawning.

The mangrove areas in Tuticorin are dominated by *Avicennia marina,* a shrubby mangrove species. The mangrove habitat is well known for its socio-economic value in terms of fuel wood and food resources for the marine fisheries and nesting site for the migratory birds. Large areas of this habitat in Tuticorin and Valinokkam have been reclaimed for salt pond construction which requires a complete eradication of trees and shrubs, levelling and dicing of the reclaimed land and intensive mechanical compaction of the soil surface. The repeated inundation and drying of the soil surface increases the salt content of the soil and also alters the soil structure. The restoration of the mangrove habitat cannot be achieved in such an area as the reclaimed area for salt pond construction becomes unsuited for plant growth due to high salinity. The mangroves are sediment binders and in the natural habitat they prevent the siltation towards the seaward communities. Their destruction is leading to soil erosion causing a threat to the tropical nearshore environment.

UNSUSTAINABLE EXPLOITATION

The Gulf of Mannar islands are the best examples of over-exploitation of natural resources taking place. Some of the methods of exploitation are described below:

1. EXPLOITATION OF SPECIES

Important species like *Cypreae talpa, C. tigrinus C. serpentis, Conus amadis, C. textile, Strombus cananium, Murex adustus, Murex haustellum, Veluta lapponica,* are exploited commercially. In this process the breeding habitats are destroyed on account of exploitation throughout the year.

Over-fishing of holothurians in the Gulf of Mannar has resulted in reduction of density of two species namely *Holothuria scabra* and *H. spinifera* only to make them rare. Now the third species of *Holothuria* - *H. atra* is also collected in unsustainable manner. Thus all the three species are likely to become endangered.

2. CORALS

The corals, live branching varieties of *Acropora* and *Montipora* spp., are hacked and taken out for decorative purposes thus decapitating the growing surfaces resulting in decay and subsequent gradual destruction of the fringing reef barrier.

The spit and wash of the coral reef brought about by the wave action and natural forces which constitute a strong base for marine algal growth are being scoured and collected for manufacturing lime. The luxuriant growth of commercially important seaweeds such as *Sargassum, Turbinaria, Gracilaria, Gelidium* and *Gelidiella* spp. are being removed daily by nearly 500 fishermen and women. The rate of extraction has been estimated to be of the order of 5000-7000 tonnes (dry weight) a year. This has created imbalance in the ecosystem.

3. SEAGRASSES

Extensive areas abundant with seagreass such as *Cymadocea* spp. *Thalassia* spp. and *Enhalus* spp. found in and around these islands are being disturbed by stake-net and wall-net fishing resorted to by fishermen throughout the year.

4. SEAWEEDS

Destruction of seaweeds deprive the base of attachment for the rare species of *Medusa leucernaria* (*Halicristis*), a form serving as an indicator species for current systems. This unique species is also getting endangered.

5. MANGROVES

Destruction of the mangrove vegetation lining the water front and swampy inlets, creek and pools of almost all islands has degraded the areas, biologically upsetting the rhythm of mangrove associated fauna, denying ideal shady hideouts for spawning fish and marine reptile species and depriving the natural nursery grounds for hundreds of thousands of fry of milkfish, mullets and prawns. Removal of mangrove has also led to erosion in some areas.

The mangrove forests are also present on the mainland near Tuticorin. Due to the high density of fisherman population along the coast, the mangrove trees are cut for fuelwood. The disturbance to the mangrove ecosystem is also caused by the activities such as extension of salt pond construction.

6. COLLECTION OF ENDEMIC SPECIES

Large-scale collection of Balanoglossus (*Ptychodea flava*) by specimen dealers has virtually annihilated the population density. This is another unique species occurring in the sandy flats of the northern islands at the head region of the Gulf of Mannar.

Depletion of the rich holothurian population, particularly of *H. scabra*, by seasonal collection for Bech-de-mer Industry. The coarse and sandy stretches adjacent to the coral reef are good feeding and breeding grounds for them.

Indiscriminate tampering with the dead coral reef endangering the rich variety of prosobranch and opisthobranch molluscs is also noticeable.

Indiscriminate fishing for Dugongs, the most endangered among the mammals, has reduced the population size to the point of endangering their existence in this area. The dugongs find the seagrass beds an ideal feeding ground.

BIOTIC INTERFERENCE

1. HUMAN INTERFERENCE

Human settlements though not permanent, are found on Poomarichan, Pullivasal, Manoliputti islands. They live in the temporarily constructed huts and bring water from the shores for drinking purposes. They use the vegetation available in the islands for cooking. However, the fishermen from mainland camp in the islands for a few days carrying their drinking water. These camps are also fortunately limited further due to the natural elements such as the cyclonic weather during northeast monsoons and also regular patrolling by Forest officials.

a. Denudation of the vegetation in the islands

On almost all the islands evidence of cutting down of trees, shrubs and bushes are seen. For example, in Shingle island 90% of the land area is without any vegetation, whereas 40% of the area on the western side of Kurusadai island is devoid of vegetation. Van, Kasuwar, Karichalli and Villanguchalli islands are without any vegetation except with some grasses and runners.

b. Aquaculture

There was no aquaculture of any type existing in the mangrove forests of Tamil Nadu till recently. Because of illegal acquisition of privately owned coastal lands, this activity is threatening the existence of natural resources. Entire coastal belt between Rameswaram and Tuticorin may face a serious problem within a few years from now. An estimated 27,500 ha. of land is available on the mainland for the culture of fishes and prawns as well as *Artemia* species, along the coastal belt.

c. Collection of Zoological specimens

A trip to Kurusadai island for collection of Zoological specimens has become a must for all colleges with undergraduate and graduate courses in Zoology. The number

has increased much over the past few decades, depleting the resource base and making various species of plants and animals rare.

d. Poaching of Dugongs and Dolphins

Killing of Dugongs and dolphins (both these are locally called as "Avolia" and "Kadalpandri" respectively) for sale for meat has become much less now, owing to the implementation of the Wildlife (protection) Act 1972 and the publicity given about the protection accorded to these mammals in the Act. However, stray incidents of poaching of these and of accidental catches of these by the fishermen are known.

e. Fishing

Island based stake-net operations have entailed heavy destruction by fisherfolk of the marine turtle eggs which are laid seasonally by the olive ridely on the seaward sandy beaches of almost all islands. This region has been identified as an important feeding ground for the green turtle and the hawksbill. Drift-netting in the turtle nesting sites traps the breeders coming for nesting, and thus affects the behaviour of turtles.

Other activities like (i) operation of drift nets, along lines off the islands by fisherman camping in the nearest island (ii) operation of bottom set gill nets for lobsters. (iii) 'Clavivalai', 'Karaivalai' and trap fishing operation in and around the islands, and (iv) Kalamkatti valai operations are all contributing to the destruction of both flora and fauna on the islands.

f. Mining of Corals

Coral reefs were and are formed by unicellular algae called "*Zooxanthellae*" which turnout enormous quantities of oxygen into the water and provide an ideal and safe breeding ground for fish and other marine life forms. They are used as a source of calcium carbonate and also for building blocks and rubble for formation of roads. Their large scale use is as raw-material by the calcium carbide industry because of their low phosphorus content.

IMPACT OF SETHUSAMUDRAM PROJECT

This issue has been recently brought up. What may be hailed as a great engineering feat might prove to be a serious environmental disaster. (THE HINDU, September 13, 1994). Its impact on the marine biosphere reserve should be critically analysed, since the passage will entail constant dredging, throwing up mud deposits on the reefs and thereby smothering the rare biofauna and flora in addition to destroying the seaweed and seagrass beds and dugong breeding and browsing habitats. The frequent passage of ships will also disturb the habitat by oil spills and other wastes. The classic instance of progressive disappearance of live coral reef inside Tuticorin harbour and surrounding areas due to increased sea traffic and oil discharge should forewarn of such an eventuality. The introduction of harmful exotic biofouling communities in the area by the passage of ships from one geographical area to another through the medium of the hull harbouring them is another serious matter.

Considering the above-mentioned threats, there is a vital question to be assured. A long term national level research and development activity will have to be developed keeping in view conservation based development for the benefit of coastal communities within the purview of biosphere reserve. Following chapter highlights the strategy planned for the conservation and management of this important ecosystem.

GULF OF MANNAR : STRATEGIES FOR CONSERVATION AND MANAGEMENT

GULF OF MANNAR MARINE BIOSPHERE RESERVE: STRATEGIES FOR CONSERVATION AND MANAGEMENT

INTRODUCTION

While planning the establishment of National Park for conservation and development of the habitat, the socio-economic aspects have to be taken into consideration in deciding the management strategies. As stated earlier, the Gulf of Mannar Marine Biosphere Reserve Zone is located along a coastline in an under developed and economically backward region of the country. The coastal water is a main source of livelihood for the sizeable fishing communities living there. Natural Resource conservation, as it is understood to-day, is not mere protection and preservation for posterity but also involves optimal use of the natural resource in such a way that the utilisation of the resources for production of goods and services does not unduly disturb the potential of the resource to meet the needs and aspirations of future generation. Conservation management should ensure sustained productivity for meeting the present and future needs of the community depending upon the resource.

MANAGEMENT STRATEGY AND APPROACH

The objectives of management of the Gulf of Mannar Marine Biosphere Reserve could be as follows:

1. To accord complete protection to the breeding and feeding grounds of the endangered and vulnerable fauna and flora and to gradually eliminate the disruptive and destructive factors adversely affecting the system.
2. To develop the Biosphere habitat as Gene pool Reserve for Marine acquatic species.
3. To restore and protect natural vegetation and to stablize the island by promoting natural regeneration and by resorting to artificial regeneration.
4. To create awareness on the need for conservation and management of the Marine eco-system on scientific lines for proper socio-economic development of the region.

5. To promote a judicious and optimal utilisation of the landscape in the islands and the sea waters within the National Park Zone, for Research, Educational and Recreation purposes, consistent with the ecological principles of habitat management.

Considering the above-mentioned aspects a broad strategy will have to be followed for the Management of the Gulf of Mannar Marine Biosphere Reserve, the major components of which could be:

1. Maintenance of essential ecological processes and life support systems.
2. Conservation of biological diversity.
3. Ensuring sustainable utilisation of species which support local people.

Each of these aspects are highlighted separately as follows.

Defining zones of the biosphere

From a biosphere reserve management point of view, all the 21 islands and the sea portions surrounding the islands upto 3.5 0 fathom depth should form the core zone and the rest of the area of the sea and the coastal areas, the buffer zone. The protection given to the core zone will result in spill-over and migration of the faunal wealth to the buffer zone and would be available sustainably to the people depending on these resources for their livelihood. It will also help in the economic development and a source of revenue to the State Government.

Management of environment

The surface currents in the waters of Gulf of Mannar Region play a very important role in the occurrence and distribution of a variety of fish and other fauna. There trophic requirements are largely dependant on the changes in the currents which show a reversal from the south-eastward drift during the south-west monsoon to a northerly drift commencing from the east coast of Sri Lanka towards the Tuticorin coast and from the Cape towards northwest along Kerala coast during the north-east monsoon. The transport of pollutants from the industrial belt around Tuticorin to the coral reef

areas of the island is an example of the changes in surface currents. It is alone would have an adverse impact on the survival of existing flora and fauna. It is therefore proposed to develop a continuous monitoring system for air, land and water for planning simultaneously an effective action.

Management of habitats

The compelling reasons for the management of the Gulf of Mannar Marine Biosphere Reserves should be to overcome the stresses causing irreparable damage done to a variety of habitats, such as coral reefs, seagrass beds, mangroves and local vegetation. The changes in habitat structure is posing serious threats to various endangered species such as dugongs in this region. It is therefore important to plan strategies for restoring these habitats.

Management of species

Special attention is needed for the management of the species, especially the endangered and vulnerable. Some of the endangered species in this region are dugong *(Dugon dugong)*, Sea turtles *(Chelonia mydas, Erethmochelya imbricata, Lepidochylus olivacea)*, Sea snakes, chanks, various species of corals and coral associated fauna.

Management of adjacent areas

Proper control of the surrounding areas is absolutely essential to avoid conflicts in utilization of resources open entry systems, escalation of unauthorized activities and creation of ecological imbalances which may result in siltation, pollution and other man-made changes. There should be a close monitoring of the activities of the surrounding areas to advise on developments which may impair conditions in the Biosphere Reserve where necessary legislative action should be taken. It is imperative to have the good will of the people of the surrounding areas and the plans for the surrounding areas should have this as an underlying principle to prevent avoidable conflicts in interests.

Socio-economic problems

It is inevitable that some activities will have to be phased out or regulated in the Park Area. In such cases, advance action is necessary to identify alternate avocations or the enhancement of similar activities in the surrounding areas. An example would be the phasing out of the collection of seaweeds, which results in considerable damage to the reef as well. An alternative would be mariculture of seaweeds combined with the establishment of village-level processing units.

Manpower development

Management of Marine biosphere reserve certainly has many components, which are different from that of Wildlife Sanctuaries and National Parks. An appreciation of underwater situations is essential. So also the nature of reconnaissance, surveillance and monitoring differ. It is very important that a separate cadre of people be trained for this at different levels.

Tools for surveillance, reconnaissance and enforcement

Use of Remote sensing, satellite systems and geographic information systems for resources data handling, analysis, and management should be considered. Census of dugong populations in Australia is done by aerial survey and such techniques may be adopted. So also Radio-telemetry for understanding the migratory movements of some species such as the Dugong, dolphin and sea turtles.

Multiple uses and coordination

The Gulf of Mannar Biosphere Reserve will have many user agencies and unless the activities and programmes are well coordinated, nothing much will be achieved. This will not imply cutting out such involvement by different agencies. What is needed is a well-coordinated action to meet the goals.

Marine biosphere enhancement programme

It may be necessary to enhance some of the ecological situations by establishing aggregating devices or artificial reefs. This may have to resorted to in selected areas.

RESEARCH

This forms a vital component of the park activities. Besides ecological and biological research that may be facilitated, it may be necessary to demarcate some areas for intensive research as "Island for Science". One or two of the Islands in the Gulf of Mannar may be designated as such, so that they will have minimal human interference. In addition to this, following research activities are proposed:

(i) Establishment of Field stations on atleast three islands for long term monitoring of the changes in the ecosystem structure.
(ii) Studies on resources inventory.
(iii) Eco-redevelopment studies such as restoration, sand-dune stabilisation
(iv) Establishment of specialised centres for conservation and consolidation of genetic resources of both, plants and animals.
(v) Monitoring changes in the hydrology of the region.
(vi) Suggest measures for sustainable harvesting of natural resources.

Establishment of research stations

No additional research institutive will be necessary and all the local institutions should be involved in the identified activities. But fellowships to trained scholars to undertake constant monitoring of the various endangered species and to collect all relevant studies and literature for constant managerial input should be offered.

Development of conservation plans

Suitable projects for conservation of endangered species should be taken up. The immediate task to be undertaken under this will be the rearing and release programme for all the turtle species and the planting of mangrove vegetation in the intertidal region.

This should be extended for other endangered species also in the years to come. Reclamation of island portions affected due to coral by suitably technology should also be tried.

Conservation of endangered species

The first step should be to make more naturalists organisations and government agencies aware about the fact that certain species do have definable habitats and may in fact require two or more quite discrete environmental systems at different times of the year. "Breeding habitats" may be defined by distance from the shore, depth of water, shelter from predators, prevailing winds or strong currents, sub-surface topography and substrate (mud, sand or platform reef), water temperatures, salinity. "Feeding habitats" may be defined by distance from shore, water temperature and salinity, oceanographic boundaries of greater or lesser scale, substrate, turbidity levels, current velocities and most importantly, concentrations of prey (which often are strictly seasonal) sufficient to meet the energy requirement of the location-specific species.

Thus sound and well-planned research studies have to be taken up to derive definitions of habitats and range in each season of the year in terms of time and spatial requirements which help scientists appreciate the specific significance.

Major habitats for endangered species should be identified and they could be regarded as ecologically "sensitive".

Considering the 200 mile national limits as the international ocean boundaries, it would be easy to protect a significant area of the Indian ocean and close the area for directed hunting. However, species like dolphins and dugongs which are subject to intensive threat from fishing gear, it would be much harder to justify closure of huge areas. It is therefore suggested to encourage modifications to fishing techniques to minimise the damage to these animals.

Financial and other support will be required for undertaking this huge task and hence bilateral and multilateral donar agencies will have to come forward for the conservation and "non-consumptive" development of these animals. For monitoring the

behaviour of the endangered species a separate research programme may be initiated for recording the sighting of these species (both small and large) from fishing and research vessels and ships of opportunity in the coastal waters as well as in the Exclusive Economic Zone may be organised.

Existing legislations, especially with reference to EEZ will have to be updated in accordance with modern ideas concerning the needs for conserving endangered animals and their habitats.

There is little public knowledge of the rapid disappearance of these animals, therefore vigorous national campaigns by regional/international co-operation will have to be done.

A data information exchange and reference centre already established at the M.S.Swaminathan Research Foundation, Madras can be strengthened for research on marine endangered animals.

Development of data base

A functional Geographical Information System will have to be developed, as it would help in better understanding of the dynamics of the ecosystem. Consultants and computer technicians with necessary infrastructure will be necessitated for this activity.

SOCIAL WELFARE ACTIVITIES

Special emphasis should be given to activities relating to social welfare of local people. Socio-economic survey at regular intervals to monitor the effects of the various activities should be taken up. Involving people in income generating activities like apiculture, local crafts, etc. should be ensured. Providing certain community services like recreation centres, community halls, health care and educative centres, drinking water supply and other welfare measured should be undertaken. All these will have to be done after ascertaining the views and needs of the local people and this will be an activity which will earn the goodwill and voluntary co-operation of the locals in the protection of the ecosystem.

Compensation

For eliminating certain rights and privileges and for damages caused to local people due to unforeseen circumstances a provision is made.

PROPOSED MANAGEMENT PROGRAMMES

MANAGEMENT ACTIVITIES

Delineation of boundaries

The boundaries of the Biosphere Reserve and of the different zones will have to be suitably demarcated with different colour buoys or markers so as to be easily visible to the users of the coastal waters. The erection of piles and provision of stretch cables between the piles would be necessary. Periodical mapping of the locations and distribution of various resources will be done.

Conserving the environment

Suitable machinery and equipment for patrolling the waters to control the illicit activities should be undertaken. Any management activity will be effective only if there is an effective means of communication between the various levels of enforcement staff. Residential Quarters and office accommodation have to be provided to the various staff so that they are available always to meet any emergency. Engaging protection watchers to monitor the poaching activities and engaging boat driver, helpers and others are absolutely necessary to ensure protection of the eco-system components.

Eco-redevelopment activities

Schemes for additional income generation and habitat improvements like afforestation works in degraded portions of the islands; planting of homesteads; planting of fuel and fodder species in the poromboke lands; popularisation of energy alternatives like solar powered devices etc. should be undertaken.

Rangeland management

Soil and water conservation works coupled with suitable planting activities in the coastal zone, which will help in minimising the deleterious effects on the ecosystem should be undertaken.

Disaster management activities

The coastal region is prone for heavy wind action and violent storms. A shelter belt along the coast and various activities to stabilise shifting sanddunes which will help in the management of the rangeland should be developed.

DEMONSTRATIONS ACTIVITIES

Activities Emphasising ecologically appropriate and compatible technologies should be supported. These are to supplement the management activities and to help in demonstrating the various benefits. The various detailed actions under this programme are as follows:

Integrated aquaculture

Integrated aquaculture for recycling of precious resources coupled with economical gains like Piggery-cum-aquaculture; poultry-cum-aquaculture, Dairying-cum-acquaculture; sheep-rearing-cum-aquaculture; Duck- and rabbit-rearing-cum-aquaculture should be demonstrated at a few centres along the coast. The coastal people will have to be motivated to undertake such activities by approaching the various financial and lending institutions.

Aquaculture of marine ornamental fishes

Aquaculture of marine ornamental fishes which have a very high demand in urban centres will be demonstrated. Dynamic youth from the coastal villages should be imparted training in this activity in the fisheries college at Tuticorin and they can motivate others into taking up this avocation.

Demonstration for developing value-added products

At present certain organisms which are caught during fishing, but which do not have a ready market locally are being dumped and are wasted. Certain demonstration centres to explain the various way by which local fisherfolk can undertake preparation of value-added products from these wasted resources should be set up. For example (i) poultry and animal feed can be prepared by sundrying the wasted small fish catches (ii) proper methodology for handling, cleaning, defatting, boiling, burying, drying, smoking and quality improvement in processing holothurians which have a good foreign market should be done.

All these demonstration centres should be located in certain key locations all along the coast so as to serve the residents of the coastal villages. The experts on these fields from the local research institutions like CMFRI, fisheries college should be involved and the local youth be trained to man the centres.

INTERPRETATION, TRAINING AND AWARENESS

This should form part of Biosphere management activities. The creation of an awareness is crucial regarding the importance of this region would prove very crucial. Public awareness programmes could be strengthened by the establishment of an Oceanarium within the Biosphere region. Kundukal point at Rameswaram Road could be and ideal site for this.

Training

Personnel involved in the management and development of the National Park should be adequately trained to ensure effective handling of the conservation and development programme. Forest personnel involved in the Park Management should acquire adequate scientific knowledge about the fauna and flora and should be trained in institutions like C.M.F.R.I., National Institute of Oceanography and the Fisheries College at Tuticorin. They also may be encouraged to take up research studies under the guidance of the University Faculties who should be involved in research projects of the Biosphere Reserve.

Awareness

Creating public awareness would encourage participation of the people in the management of the biosphere reserves. It will facilitate harmonious relationship between indigenous populations and the environment. For effective management, the human resource development of the park staff of various levels and of the local public should be done.

Extension and Interpretation

The concepts of conservation, need for protection and development on ecologically sound lines and the long-term benefits of conservation efforts have to be infused among the general public. There is likely to be conflicts with the Managers of the Biosphere Reserve and the local people when restriction on the use are imposed. Therefore, it is essential that the local community and the District administration are involved in planning the management of the Biosphere Reserve. The communication gap between the policy makers, administrators and Park Managers on the One hand and the local communities on the other hand have to be bridged through suitable extension activities. The assistance of suitable non-governmental organisations or/and voluntary agencies to form linkages or liaison with the local communities will have to be developed. Local committees in selected fishing villages along the coast may have to be formed and the Managers have to meet the committees, explain to them about the Biosphere project and the benefits and seek their co-operation in implementing the programme. Besides the representative of the local bodies, the influential local religious leaders and personnel from educational, revenue administration and police departments may be also coopted as members of the committees.

The various media through which interpretation and awareness will be created are as follows:

Attended Services

(i) Information Contact:

1. Entrance stations and road side booth
2. Visitor centre and information desk
3. Roving contact by publicity van

(ii) Guided activities:

1. Conducted boat rides, walks and hikes
2. Snorkeling and SCUBA diving
3. Demonstration, Video/filmshows, talks in the off-site locations, etc.

Unattended Services

(i) Printed Materials:

1. Signs and Lables
2. Publicity in Newspapers and Magazines
3. park brochure

(ii) Exhibits:

1. Indoor activities like Museum, Aquarium, Dolphinarium, under water galleries, illustrated panels, bulletin boards, etc.
2. Out door activities like way-side exhibits and models.

This has to be taken up by trained experts to be more effective.

TOURISM AND RECREATIONAL ACTIVITIES

This forms a component of the Marine Biosphere Reserve. The problem is to what extent this activity should be developed and the areas where tourism and recreational activities are to be permitted without impairing the natural ecosystem. The types of a activities will have to be identified, planned and regulated.

Eco-tourism

Recreational tours for hand-lining and rod- and line-fishing may be permitted in selected areas. For tourist to derive the benefits of appreciating the beauties of nature, tours should be organised with bases for stay on the mainland and facilities provided in areas such as Krusadai, Hare and Nallatanni islands for snorkeling and diving. Provision of glass-bottomed boats, inflatable boats, out-board engine-fitted boats may be permitted in regulated numbers to facilitate observations. The expansion of tourism development activities should be planned in a way compatible with ecological principles and guidelines and this should be chalked out by the National Committee.

Krusadai appears to be the best suited for education and recreational purpose. In this respect this island can be developed with a possible second choice of Nallathanni island, where specific zones can be set aside for under-water viewing and swimming, boating, sport fishing, SCUBA diving and chartered boat tours with specified anchor sites. On no account the tourist should be allowed to have staying facilities in any island but only to visit and return. Establishment of an oceanarium cum 'Sea World' at Kundukal Point, Pamban, Rameswaram island should be taken up as a Centre for tourist attraction.

Visiting Scientists should get all laboratory and field facilities for detailed studies in Krusadai island and Nallatanni tivu and one of the southern islands should be reserved for studies on restoration of the reefs.

LOCAL COORDINATION COMMITTEES

There is no local co-ordination committee at present and they have to be formed with the local field staff, members of N.G.O. and the locally influential persons to have dialogues with the fishermen and enforce control in the exploitation of the resources and help in Conservation of ecosystem. The co-ordination committee will not only deal with subjects related to recreational, interpretive and educational aspects but also develop a conservation based developmental plan based on following flowchart.

Conceptual design of the plan

↓

Resources inventory

↓

Identification and survey of critical areas

↓

Identification of interventions

↓

Management goal and master planning

↓

Implementation of policies

↓

Development of recreational facilities

↓

Environmental monitoring and research

↓

Reassessment and revision

CONCLUSION

Proper demarcation of boundaries of the protected areas in general and that for island ecosystems in particular is becoming increasingly important as man cannot be separated out from the ecosystem concept. The sustainable utilization of the natural resources in the protected areas will have to be done keeping in view the pressures mounting on these areas day by day. This is as important as looking at future calamities like global warming and/or sea level rise. For saving island ecosystems efforts will have to be made in defining appropriate conservation strategies. This document is one such example of what conservation means to man and will pave way for preservation of various marine endangered protected areas throughout the world.

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LITERATURE CITED

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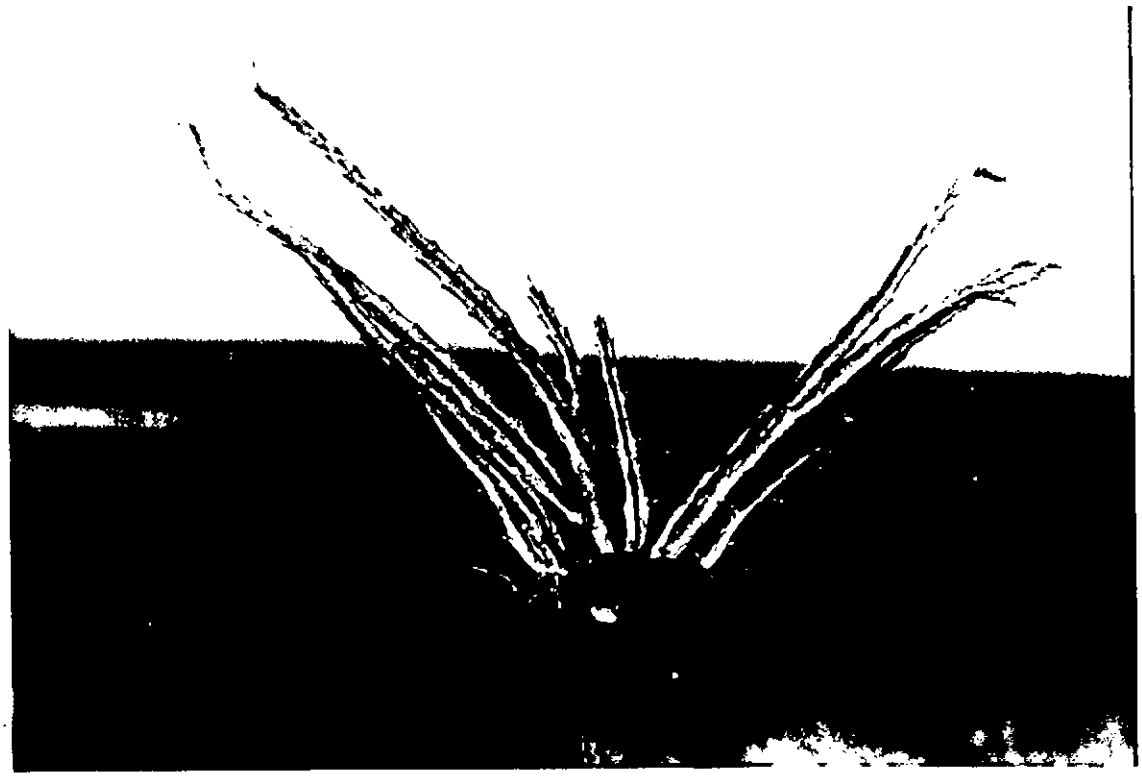
GULF OF MANNAR:
A GLIMPSE OF RESOURCES

Dolphin - an endangered species, fallen victim to intensive fishing activities off Tuticorin

Seagulls hovering over Van Tivu, the Southernmost island

Shri. Neelakantan, Conservator of Forests Inspecting the coral deposits at Van Tivu

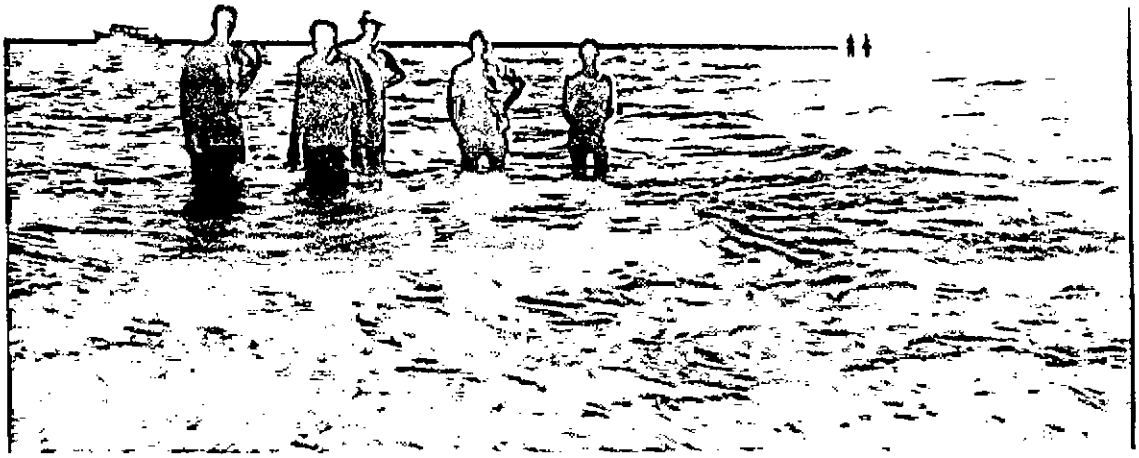
Dwarf *Scaevola*, an associate of mangroves on Karaichalli Island



***Karalluma bhupinderema*, an endemic xerophyte at Karaichalli Island**

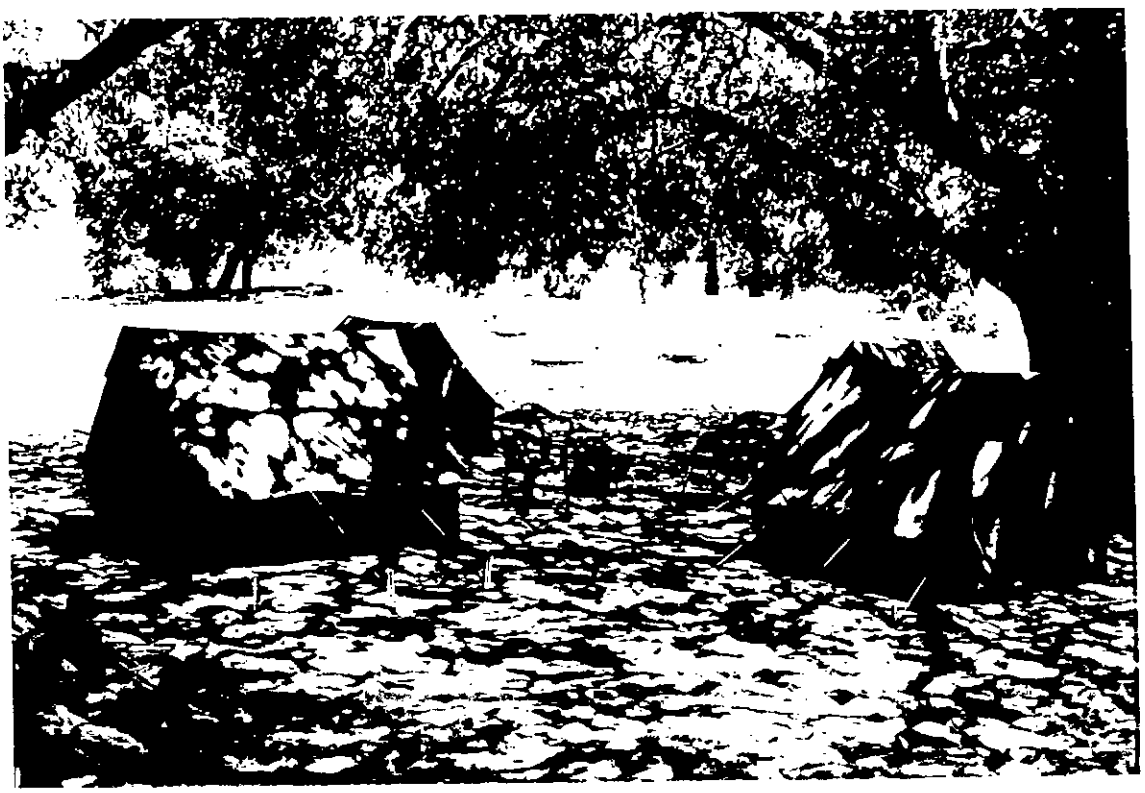
Sand dune formations on Karaichalli Island

Villanguchalli island at low tide

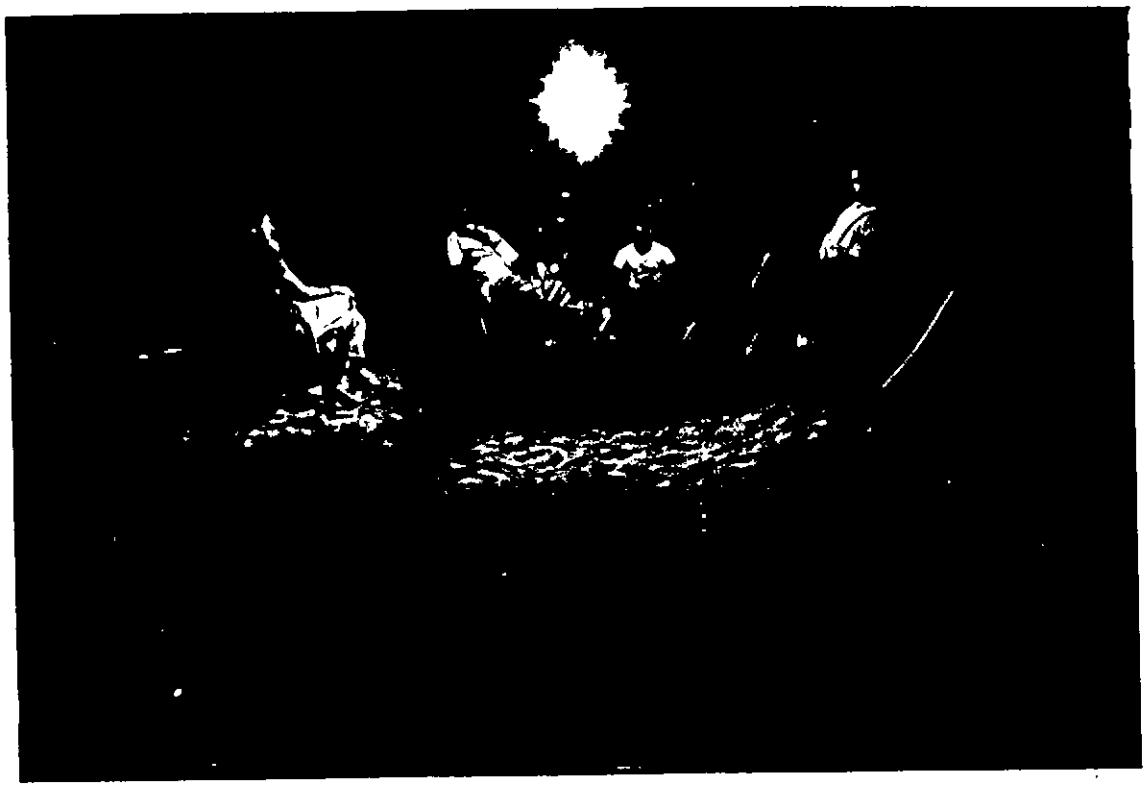


Revival of submerged portion of Villanguchalli island, being inspected by forest officials

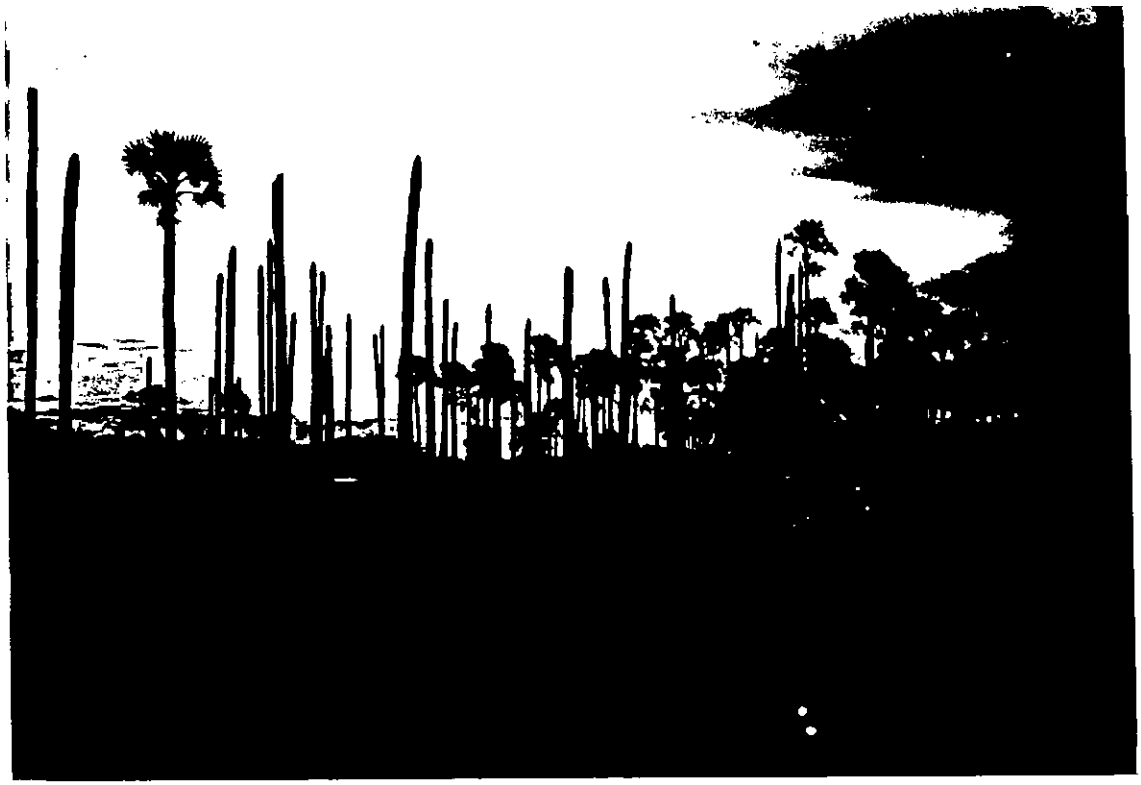
A natural pond on the southeastern portion of Nallathanni island



Camping site at Nallathanni island, solar distillation units in the background

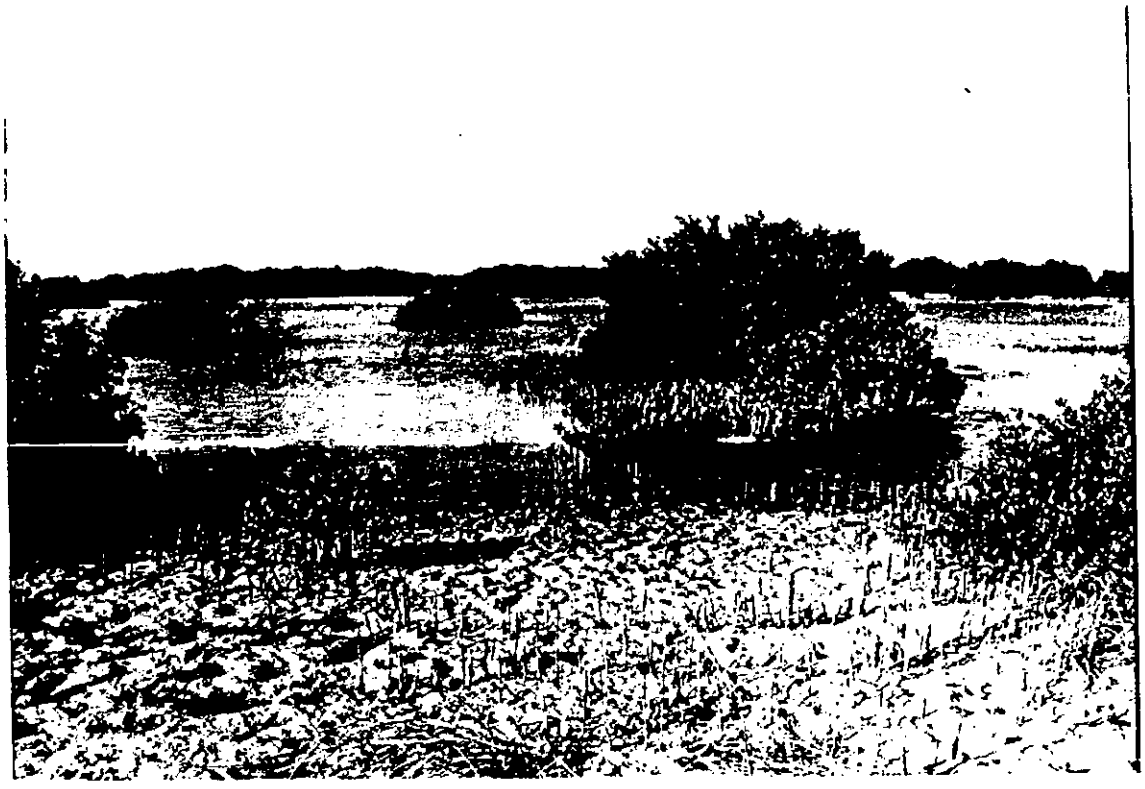


Camp site, Nallathanni Island

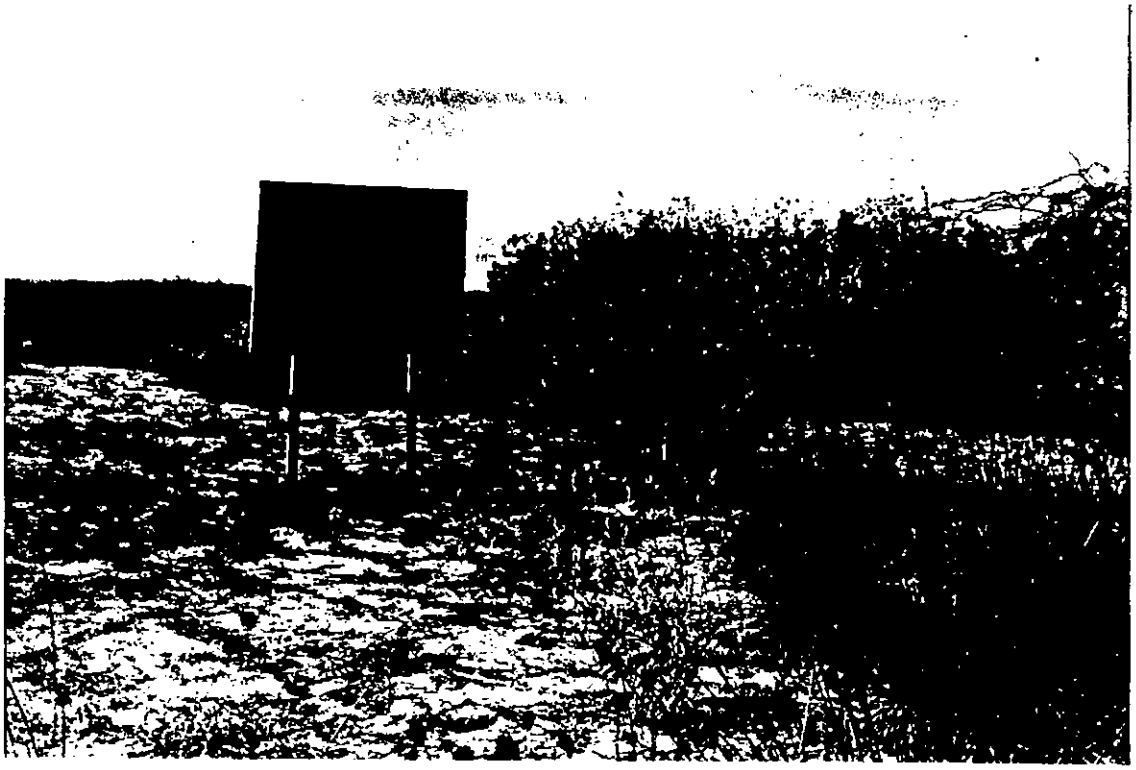


Twilight at Nallathanni Island

Swamp showing mangroves in Upputhanni Island



Stunted *Avicennia marina* in Upputhanni Island



Signboard at Pulvinichalli Island

Thespesia and *Salvadora* species at Anaipar Island

Signboard at Mulli Island

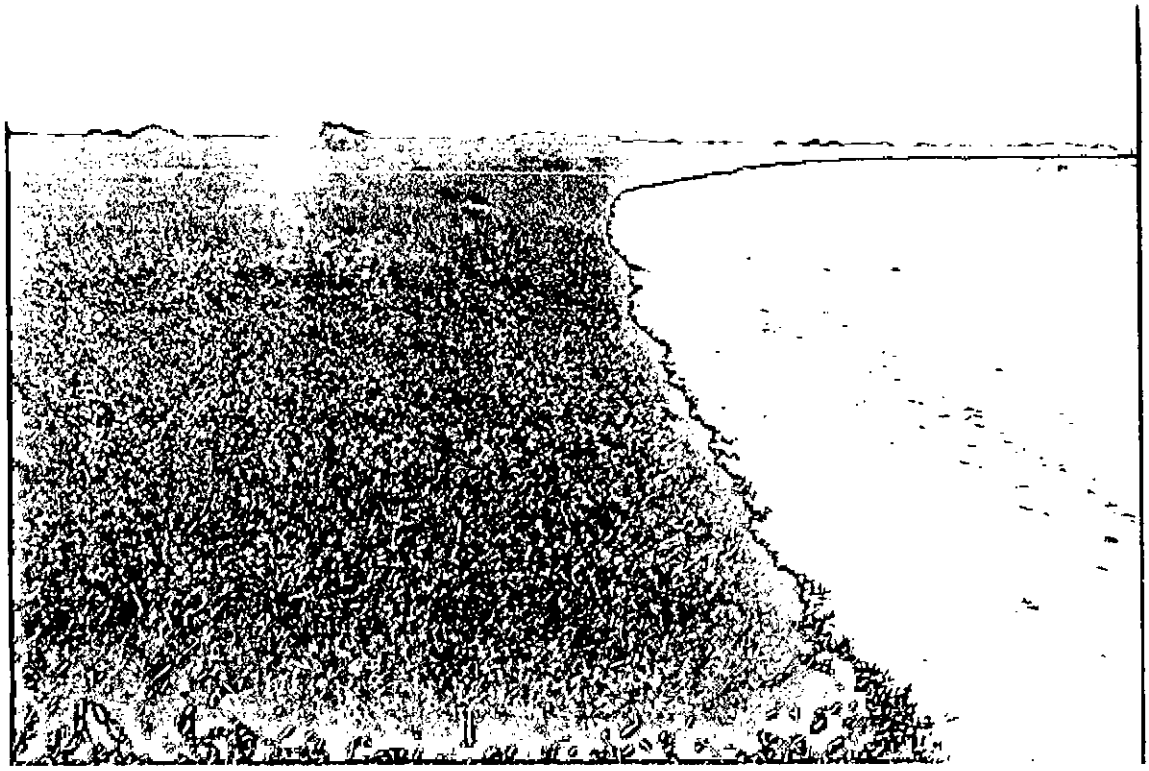
A nantural pond surrounded by *Scaevola* sp. In Valai Island

A close up of *Sesuvium* and *Pemphis* bordering the pond at Valai island

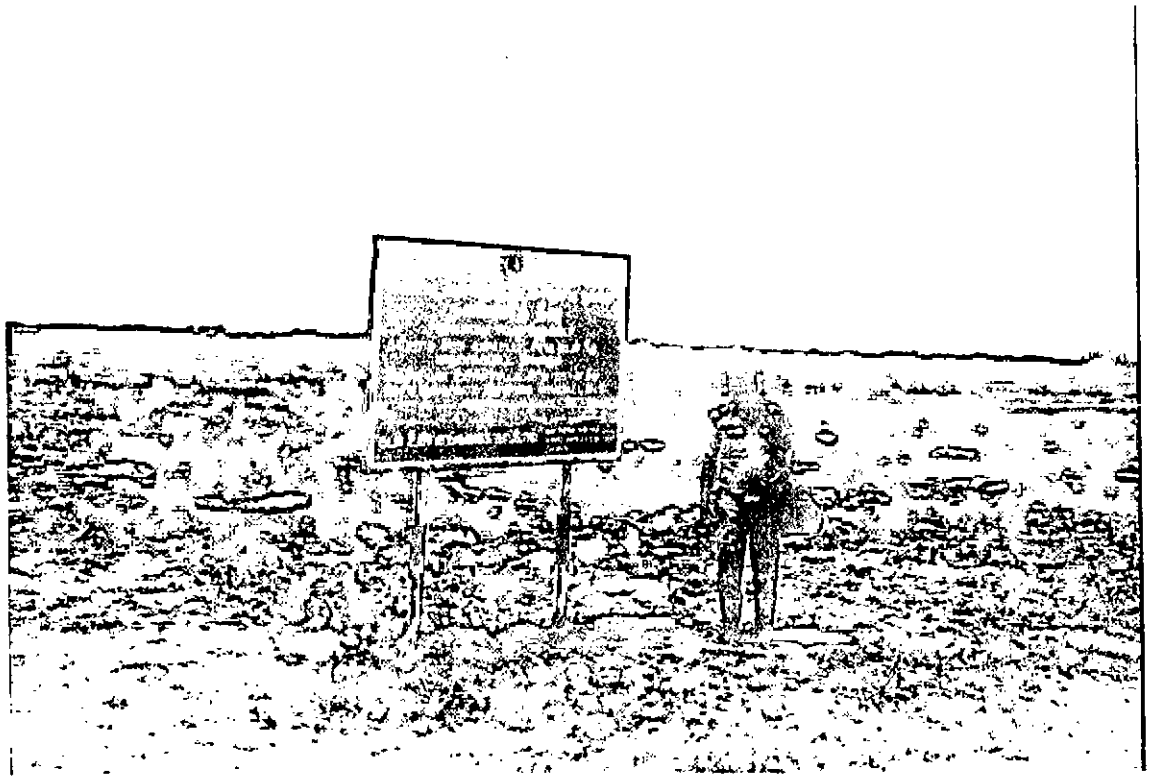
A mat of *Suaeda maritima* around the saltwater pond, Valai Island

Wind-swept *Avicennia* at Valai Island

Lumnitzera and *Pemphis* in salt-stressed area facing exploitation on Talairi Island

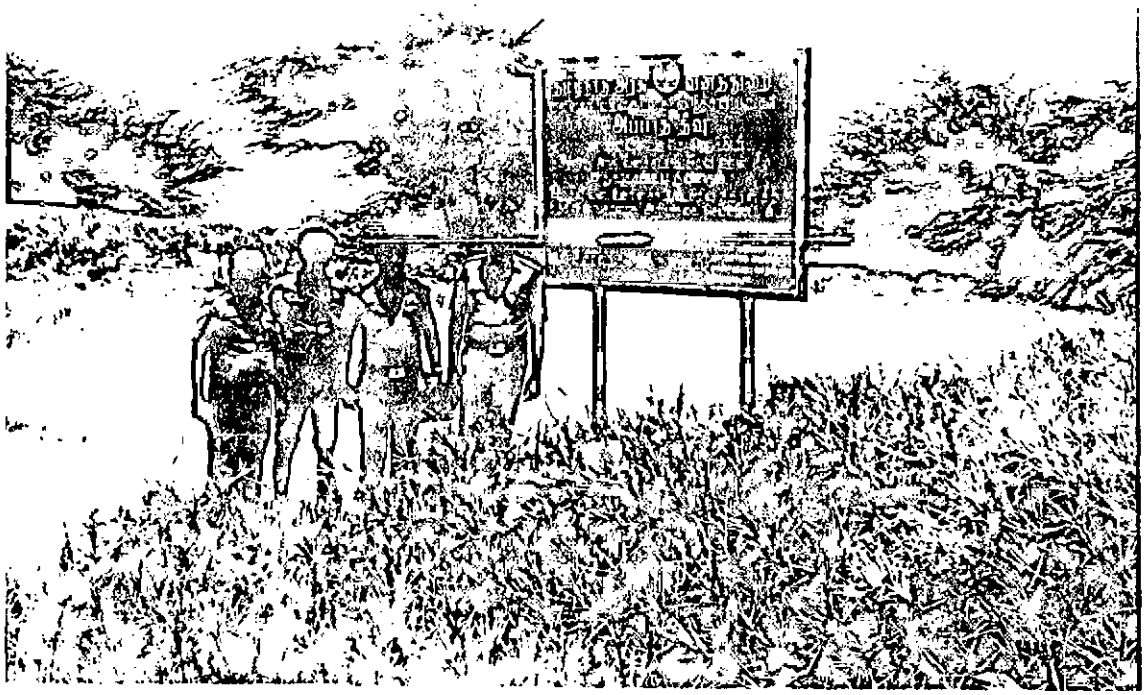


A mat of *Sesuvium portulacastrum* on Talairi Island



Signboard at Talairi Island

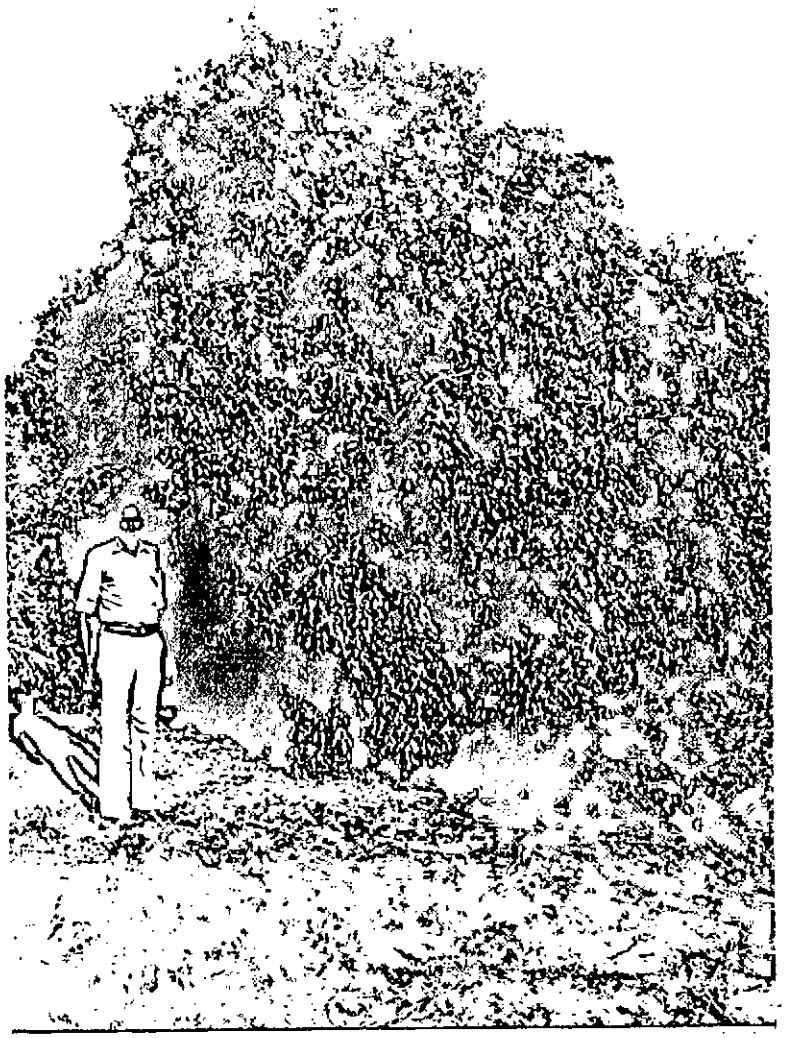
Multi-hued sand on the shore
of Appa island



Signboard at Appa island

Coconut grove at Hare Island

Sign board at Hare Island



Salvadora persica tree at Hare Island

Seaweeds washed ashore on Hare Island

A salt water pond in the northeastern region on Vallimunal island

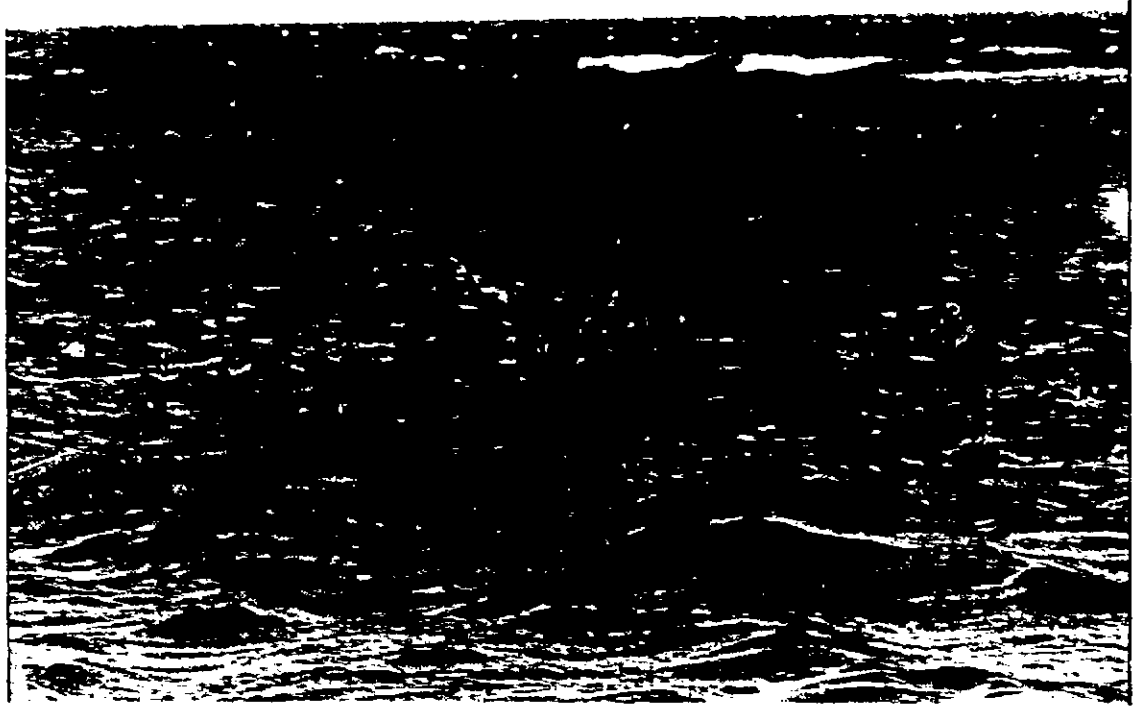
Mangrove associates around a natural pond at Vallimunal island

Countryboats berthed at Vallimunal Island

Sesuvium - *Scaevola* association on the northern banks of Vallimunai Island

Signboard at Vallimunai island

A school involved in environmental awareness compaign of the Forest Department at Keelakkarai



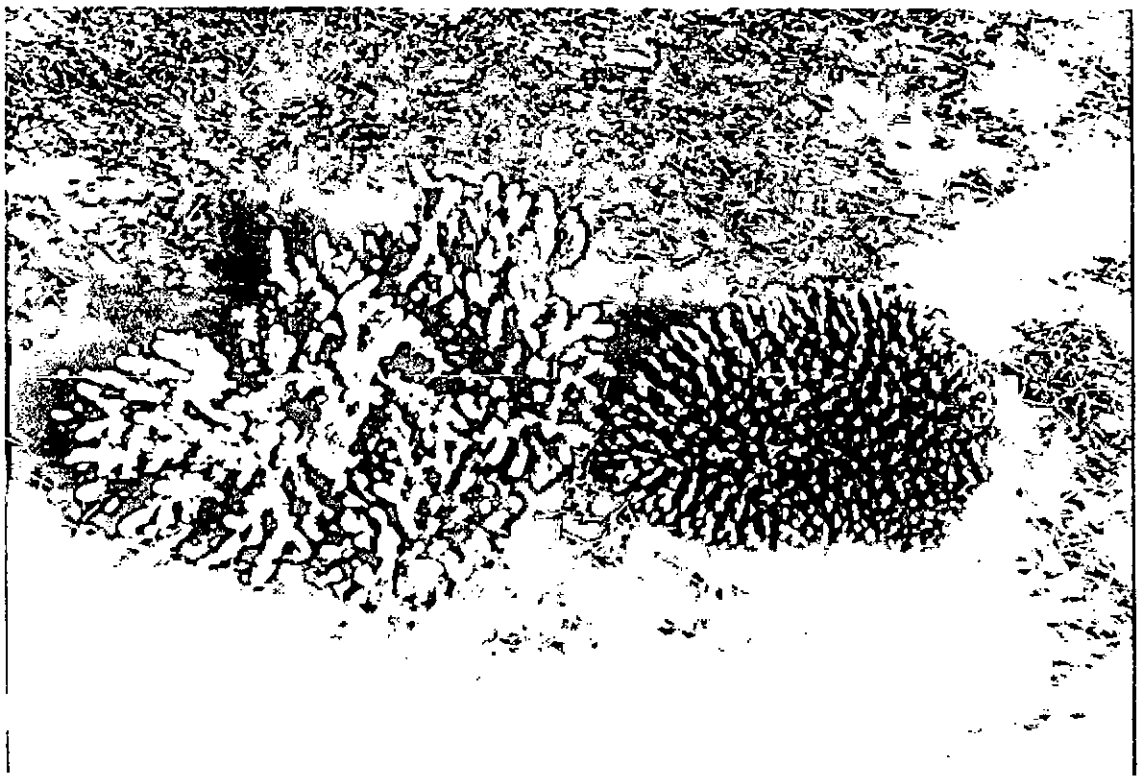
Culturing seaweeds on the coir rope, Keelakkarai

Seaweed culture project : an encouragement to coastal communities, Keelakkarai

Solar distillation units at Manoli Islands

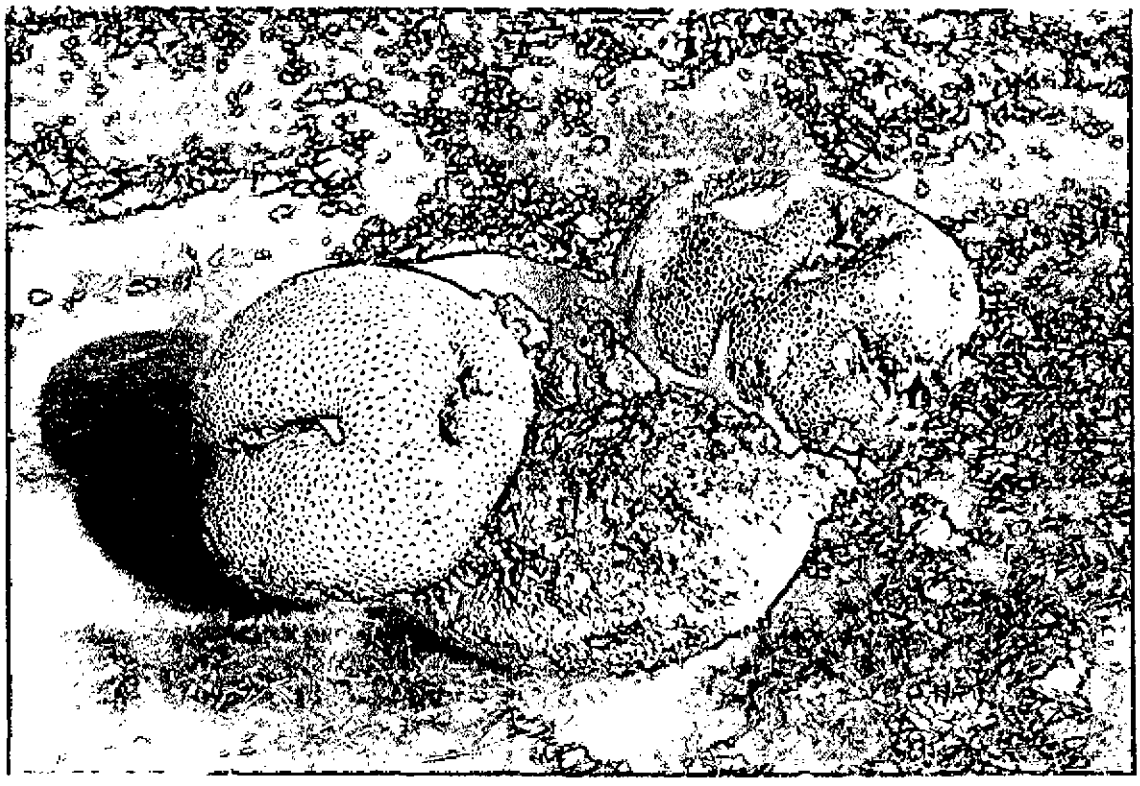
Monoculture of *Lumnitzera racemosa* on Manoli island

Forest "watcher" holding aloft corals at Manoli Island



Corals in close-up

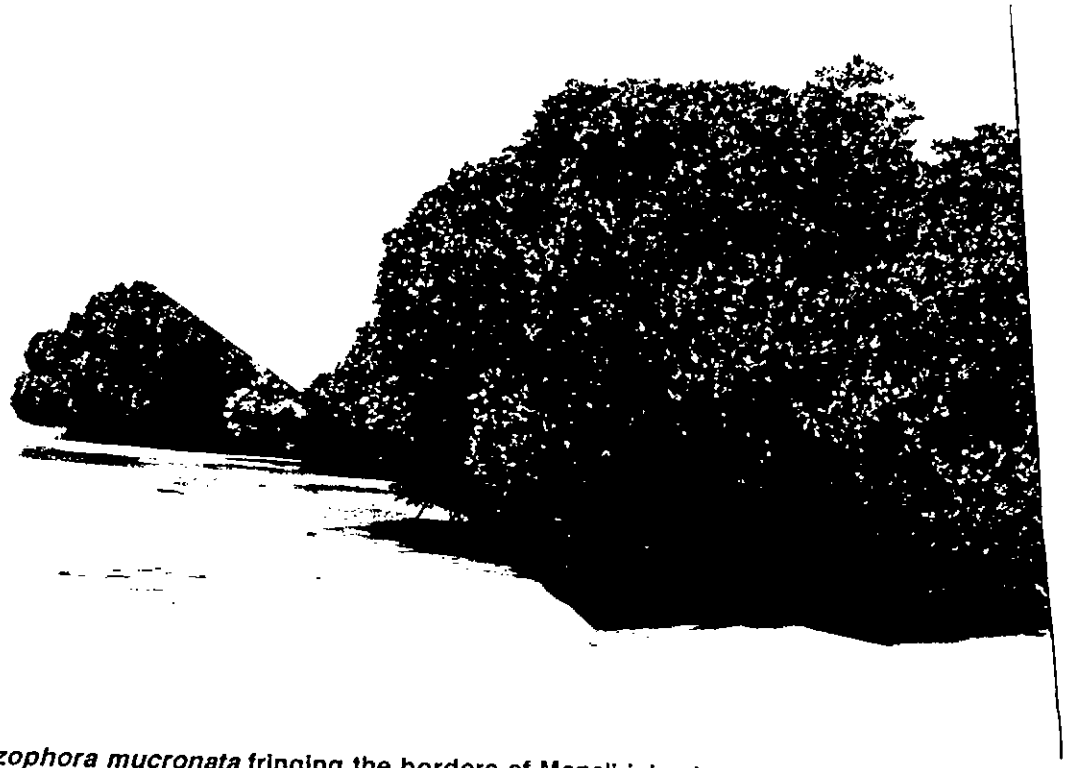
Scylla serrata, a commonly occurring crab at Manoli Island



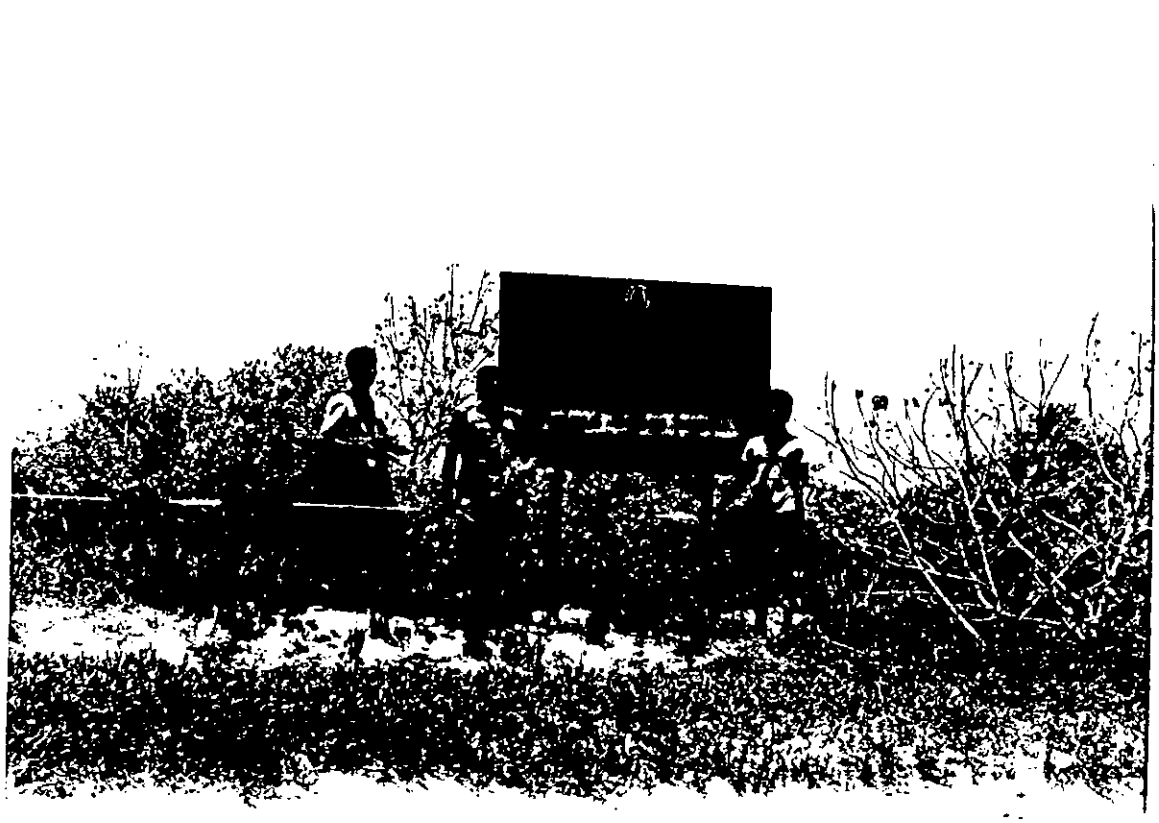
Brain corals

Human interference at Manoli island

Approaching Manoliputti trough a narrow sand-bar connecting it with Manoli island

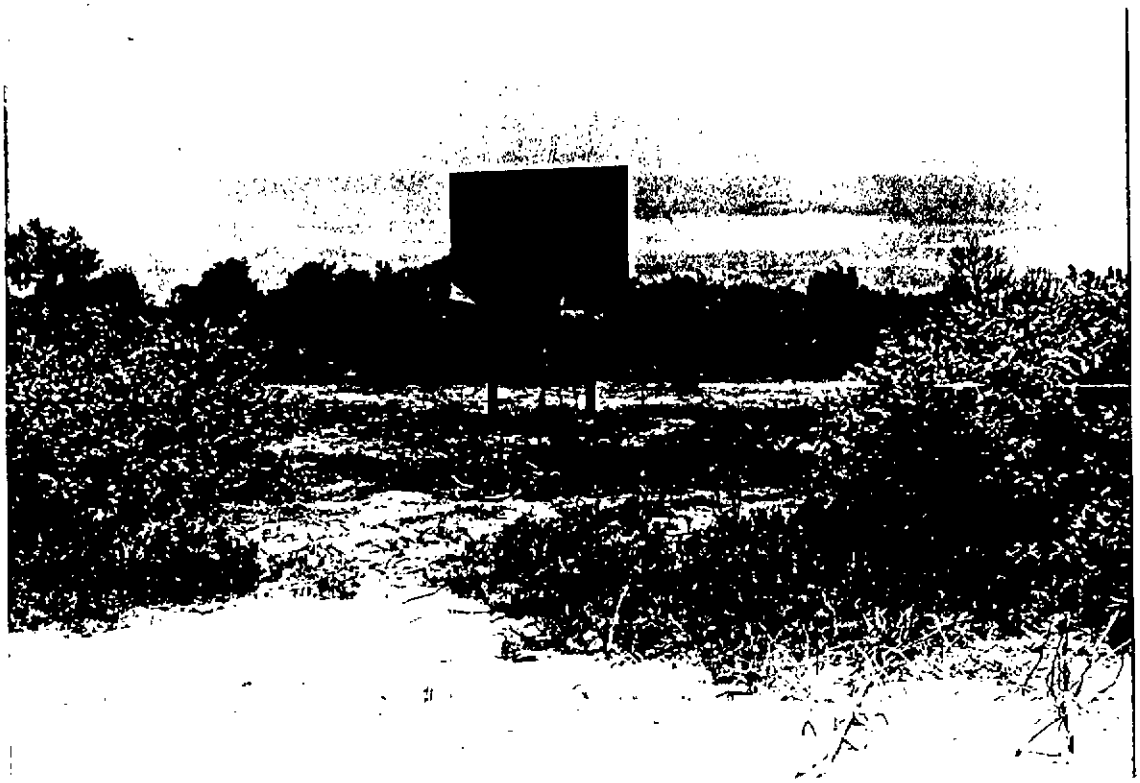


Rhizophora mucronata fringing the borders of Manoli Island



Signboard at Manoli Island

Cable roots of *Avicennia marina* exposed due to wave action



Signboard at Manolliputti Island

Salt-stressed area and high temperature leading to death of *Suaeda* saplings at Manoliputti Island

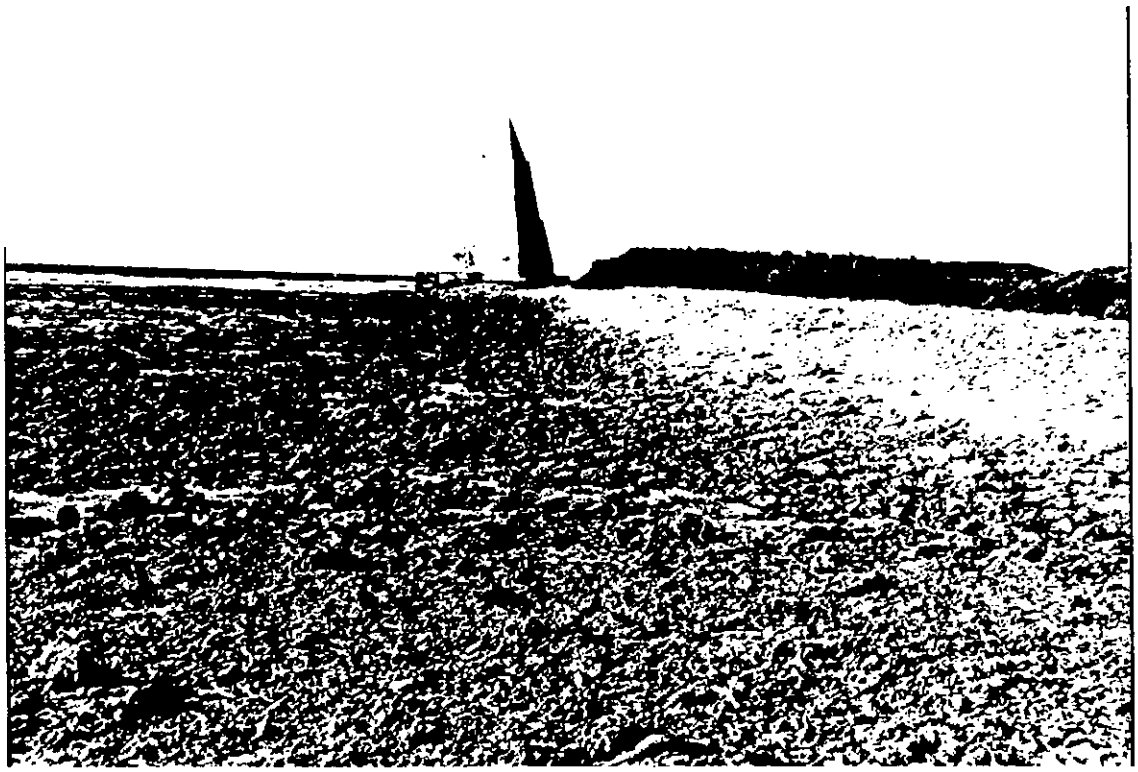
Solitory trees of *Avicennia* and *Salvadora* on Manoliputti Island

Krusadai Island,paradise of crustaceans

***Balanoglossus*, one of the highly endangered species on Krusadai Island**

Jelly fish washed ashore at Krusadai Island

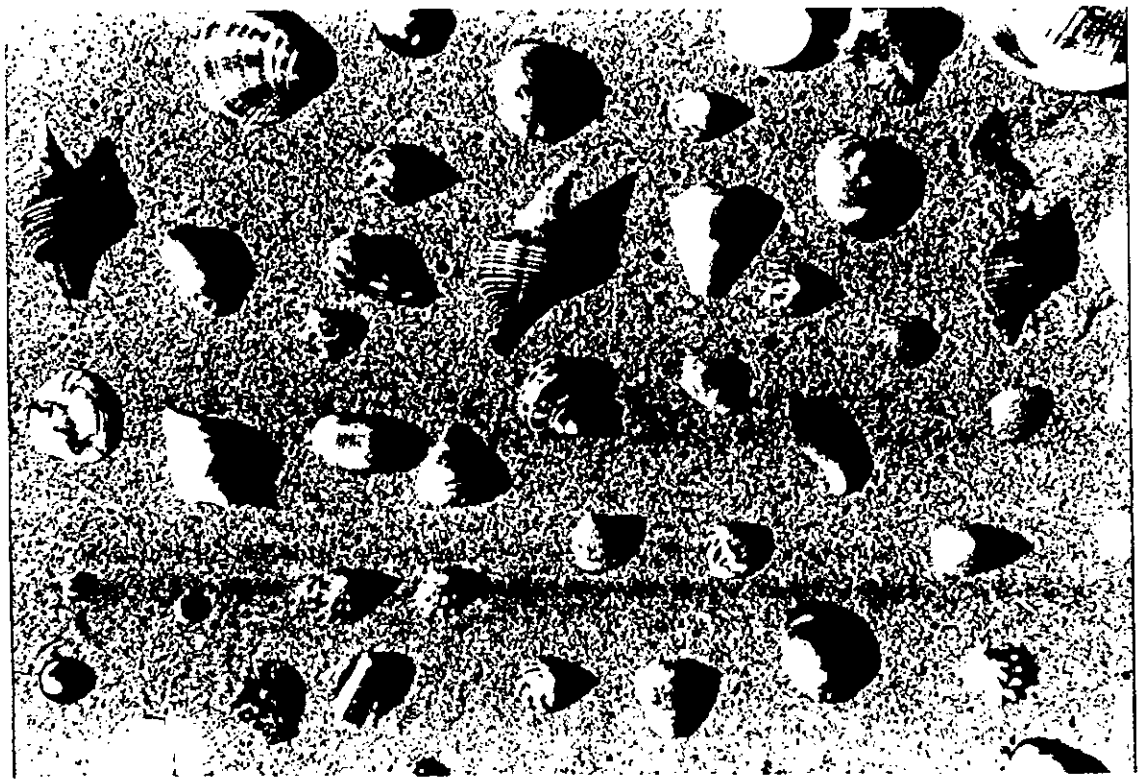
Pearl oyster culture setup at the Krusadai Island



Dead corals washed ashore on shingle island

Pandanus stands on Shingle island

Reclaiming lost portions of Shingle island



A variety of shells observed at Shingle Island

Poorvarsanpatti, an island, vanishing from the map of Gulf of Mannar due to over-exploitation leading to complete erosion

Signboard at Poomarichan island

Sea cucumbers ready for sale, Poomarichan Island

Fisherwomen inhabiting Poomarichan Island for collection of seaweeds and sea cucumbers

Lagoon formation at Poomarichan Island

Rhizophora mucronata at its best

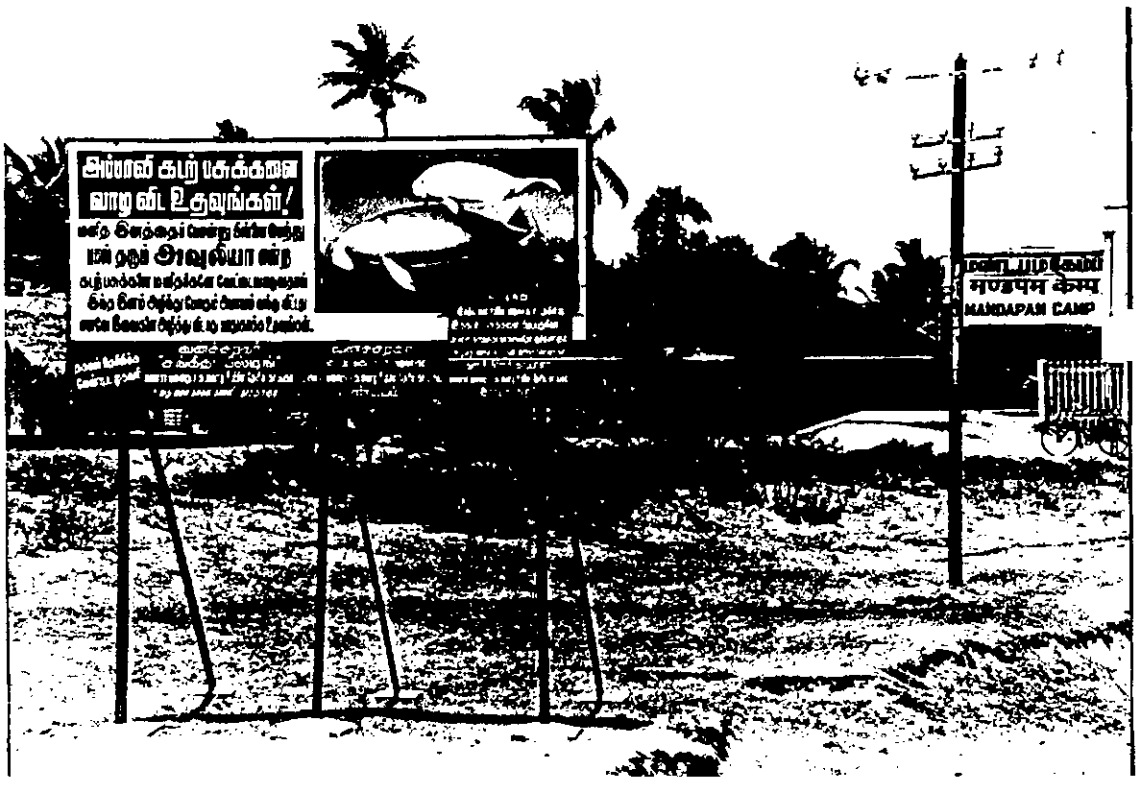
A channel of sea cutting through Poomarichan and Pullivasal islands

Avicennia marina stands at Pullivasal Island

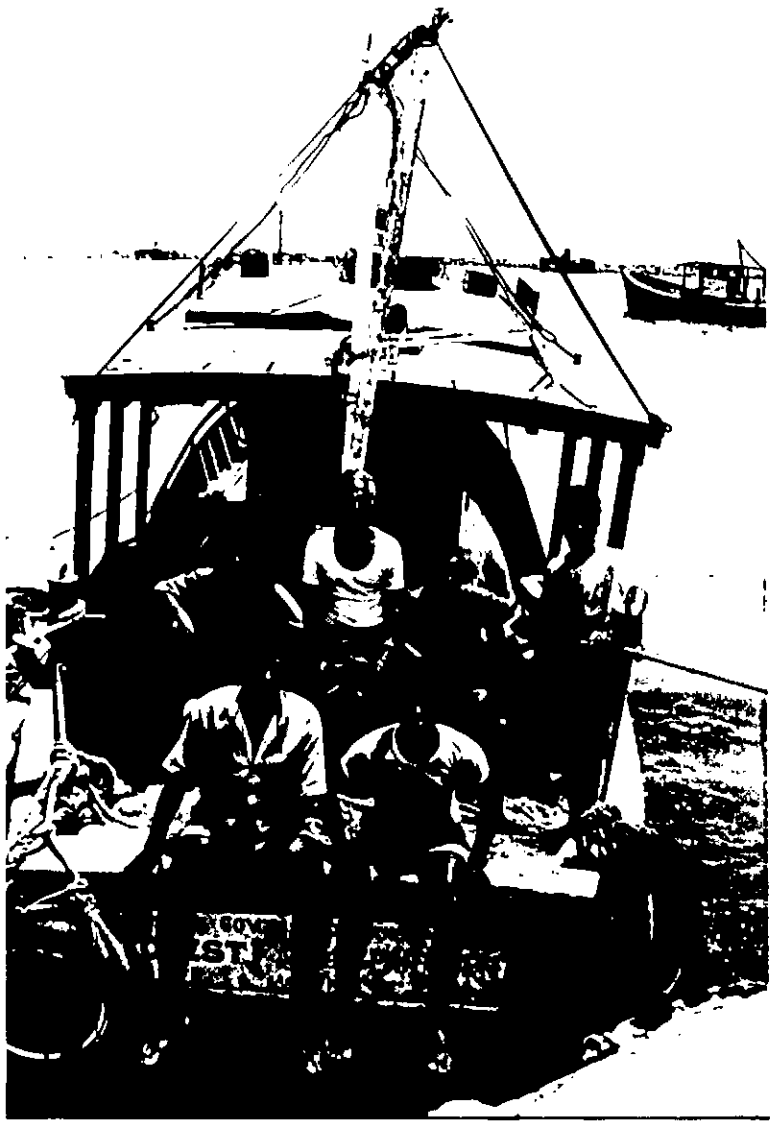
Natural regeneration of *Rhizophora mucronata*, Pullivasal Island

Understanding peoples' needs by group interaction in the village at Rameswaram

Dugongs, endangered species of the Gulf of Mannar Biosphere reserve



A board for the publicity of Dugongs in the Gulf of Mannar Biosphere reserve



The boat crew of the Forest Department who made our endeavour, a success