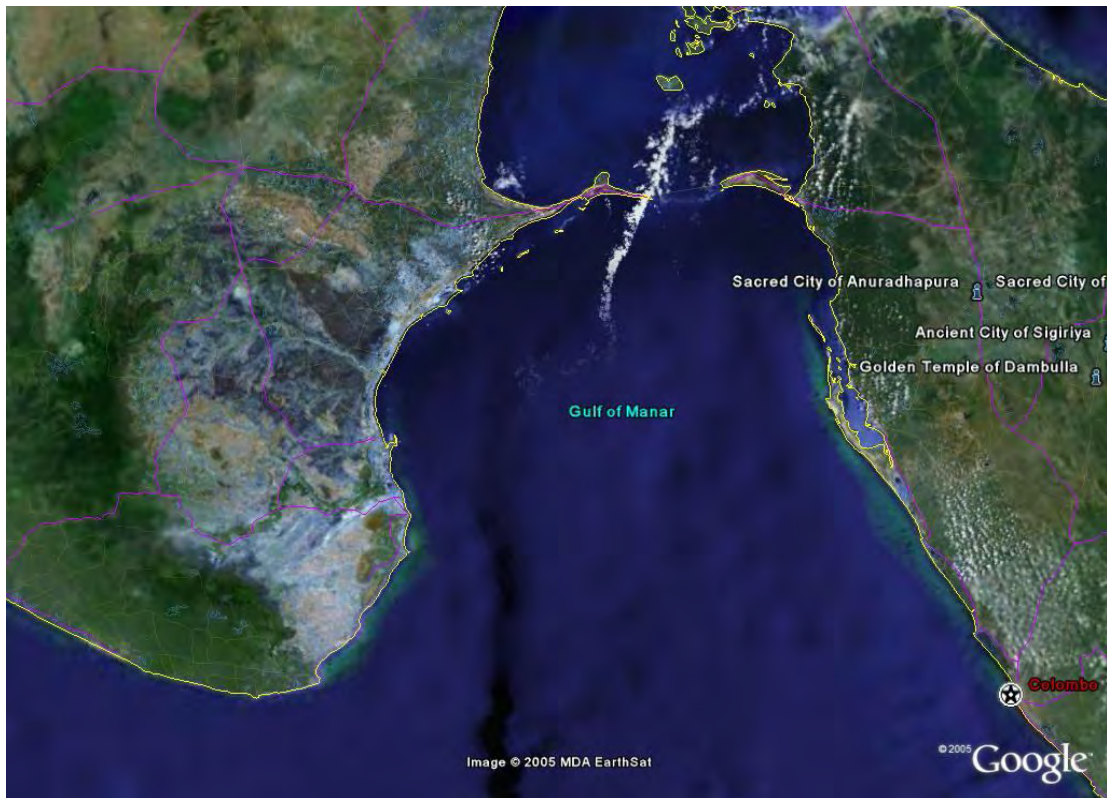


Integrated Management Plan for the Gulf of Mannar Marine National Park and Biosphere Reserve (2007-2016)



2007

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The Wildlife Institute of India have been associated with the Gulf of Mannar National Park and Biosphere Reserve since January 1990 when the Madurai Kamaraj University conducted the Indo-US Seminar on Marine Parks. Mr. K. S. Neelakantan who developed the first Management Plan for the Gulf of Mannar Marine National Park had significant interaction with the Institute and the officer trainees of various courses have regularly visited the Gulf of Mannar Marine National Park interacted and gained insights of managing the Marine Protected Area. With this background when the Gulf of Mannar Biosphere Reserve Trust approached the Institute in August 2004 to prepare a Management Plan for the Gulf of Mannar Marine National Park and Biosphere Reserve, we were more than happy to be associated in a programme of this nature. It was not only an opportunity but a challenge to compile a magnitude of information on the biological, ecological, socio-economic, cultural and socio-political situation before even embarking on a mission of this nature. It was only in July 2005 the WII signed an MoU with the GOMBRT and in January 2006 initiated the intensive field work and information gathering exercises by engaging a team of researchers.

By January 2007 the Institute's field researchers had completed gathering an one year all season field data and prepared the first draft of the plan to be shared with a core group in February 2007. After revising the first draft based on their inputs, the pre-final draft was shared with the State level advisory and steering committee in April 2007. The WII was encouraged by the response and constructive suggestions made by the State Level Advisory and Steering Committees and they have been used and reflected in the final integrated Management Plan for the Gulf of Mannar Marine National Park and Biosphere Reserve submitted to the GOMBRT in September 2007. This exercise and final the plan would not have been possible without the active support, suggestions, cooperation and guidance of a large number of Individuals and Organizations.

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The development of the Management plan necessitated interaction with a large number of professionals in various institutions foremost among which are Chief Naval Hydrographer, Forest Survey of India, Survey of India, Census of India, Indian Meteorological Department, WWF-India, MoEF-GOI, BNHS, CIFE, CMFRI-Cochin, NIO, SAC-Ahamadabad, GEER Foundation, Gulf of Kutch Marine National Park, CIFT, Anna University – ICMAM project, DOD, Zoological Survey of India, National Biodiversity Authority, WWF-Tamil Nadu, MSSRF, DHAN Foundation, CASMB, Madurai Kamaraj University, Tuticorin Fisheries College, Regional Deputy Director, Chennai, SDMRI, TRRM, PAD, ICSF, SHADOW, TMSS, Coast Guard, CMFRI-Mandapam, CSMCRI etc.

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B. C. Choudhury
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Chapter 1

Introduction and Background

1.1. Introduction

The Gulf of Mannar, the first Marine Biosphere Reserve in the South and South East Asia, running down south from Rameswaram to Kanyakumari in Tamil Nadu, India is situated between Longitudes 78⁰08'E to 79⁰30'E and along Latitudes from 8⁰35'N to 9⁰25'N with a total area of 10,500 Km². This marine Biosphere Reserve encompasses a chain of 19 islands and adjoining coral reefs off the coasts of the Ramanathapuram and the Tuticorin districts forming the core zone; the Marine National Park. The surrounding seascape of the Marine National Park and a 10 km strip of the coastal landscape covering a total area 10,500 sq. km., in the Ramanathapuram, Tuticorin, Tirunelveli and Kanyakumari Districts forms the Gulf of Mannar Biosphere Reserve.

The South and South-east Asia region in the southern hemisphere is one of the richest coastal and marine biodiversity area in the World with the maximum diversity of coral reef systems. In India, in addition to the Gulf of Mannar region in Tamil Nadu, the Gulf of Kutch in Gujarat, Lakhsadweep and Andaman and Nicobar islands are the other important coral reef systems supporting regions. The importance of the Gulf of Mannar region dates back to the 2nd Century AD because of its highly productive pearl banks and other religious significance.. The Gulf of Mannar has drawn attention of conservationists even before the initiation of the Man and Biosphere (MAB) program by the UNESCO in 1971. With its rich biodiversity of 3600 Species of various flora and fauna part of this Gulf of Mannar has been declared as a Marine National Park in 1986 by the Government of Tamil Nadu and later as the first Marine Biosphere Reserve of India in 1989 by the Government of India.

Organizations like Central Marine Fisheries Research Institute (CMFRI), Zoological Survey of India (ZSI), Tuticorin Fisheries and Research College, ICMAM project of Department of Ocean Development, Government of India, Anna University, Madurai Kamaraj University, Annamalai University, Suganthi Devadasan Marine Research Institute (SDMRI), Wildlife Institute of India (WII) and others have conducted biodiversity assessment studies in the Gulf of Mannar Protected Areas and their studies have confirmed the richness of the marine biodiversity in the Gulf of Mannar region with 104 species of hard corals, more than 450 species of fishes, 4 species of sea turtles, 38 species crabs, 2 species of lobsters, 12 species of sea grasses, 147 species of marine algae, 160 species of birds, 79 species of crustaceans, 108 species of sponges, 260 species of molluscs, 99 species of echinoderms, 4 (5) species of sea horses, 12 species of sea snakes besides the critically endangered Dugong (sea cow) and the endemic balanoglosses. The Gulf of Mannar Marine National Park also supports 12 species of mangroves.

The Gulf of Mannar Biosphere Reserve supports several globally important species such as the critically endangered Dugong (sea cow), all protected sharks (IWPA, 1972) including whale shark, sea horses, balanoglossus, green and hawksbill sea turtles, dolphins, lobsters, pearl oyster, corals, sea cucumbers, star fish, sea grasses and sacred chunks including several endemic species such as the Balanoglossus, sea

grass, crabs and mangroves. The swamp near the Kodandaraman Temple near Rameswaram gives shelter to a flock of about 10,000 Flamingos every year, during the months of December to March along with various other species of waders and wetland birds.

Exploitation of fishery resources in the inshore waters had been the sole occupations for several thousand families living along the coast of Gulf of Mannar for centuries. They have been in such close intimacy with the coastal and marine environment that their life-style, culture and social life all centres around the sea. In this background it was considered important to develop an adaptive management plan for the Gulf of Mannar Marine National Park and Biosphere Reserve with a community based participatory approach for sustainable use and management of coastal and marine resources of this region. This integrated management plan for the period 2007 to 2016 for both Marine National Park and Biosphere Reserve is the first of its kind in India. It is hope that with the experiences of implementing this management plan, the Gulf of Mannar Biosphere Reserve Management and other associated agencies will set a new standard for management of Marine Protected Areas (MPA) in India and South Asian region.

1.2. Background and process of developing the Management Plan

The Government of Tamil Nadu has established the Gulf of Mannar Marine National Park (GOMMNP) under the provision of the Indian Wildlife (Protection) Act, 1972, encompassing the 21 off-shore islands and their surrounding coral reef system in the Bay of Bengal, along the coastal districts of Ramnathapura and Tuticorin in the year 1986. The primary objective of the establishment of the GOMMNP is to conserve the rich marine biodiversity of the Gulf of Mannar region by providing protection and through management and restoration of the degraded marine coral reef system, which have been historically mined and exploited to an unsustainable level.

Advised by the Ministry of Environment & Forests, Government of India, the Tamil Nadu Government has also ratified the formation of a 10500 sq. km. of surrounding seascape and landscape around the GOMMNP as India's and that of South Asia's first Marine Biosphere Reserve – the Gulf of Mannar Biosphere Reserve (GOMBR). The broad guidelines and principle of this biosphere reserve is to safeguard the traditional and eco-friendly nature based livelihood practices of local communities as well as the ecologically fragile Marine habitat within the GOMBR spread over along the 270 kms. Coast line in the districts of Ramanathapuram, Tuticorin, Thirunelveli and Kanyakumari. The Biosphere Reserve extends from Dhanushkoti Island in Ramanathapuram District to Cape Comarin in Kanyakumari district along the four coastal districts and its management activities are to spread into the coastal villages within 10 kms. of the coast line.

Almost all ecological assessment on the current status of the coral reef system in the Gulf of Mannar region by professional agencies have opined that, unless restored, this region will not provide the ecological services and required habitat condition as a marine reef fish breeding ground. Almost 50,000 fisherfolk of the region are dependent on artisanal fisheries based livelihoods in the region and their well being is closely linked to the ecological security of the coral reef ecosystems in the Gulf of Mannar region in Tamil Nadu.

In 2002, assisted by the UNDP and funded through a Global Environmental Facility (GEF) support, the TN Government through a project assigned the task of development of a management regime model for the Gulf of Mannar Biosphere Reserve, to their specially created Agency called the “Gulf of Mannar Biosphere Reserve Trust (GOMBRT)’ in a manner that ensures:

1. The conservation and sustainable utilization of the globally significant coastal and marine biodiversity by various stakeholders in the multiple-use areas of the Gulf of Mannar Biosphere Reserve .
2. Establishment and effective participatory management of the Gulf of Mannar Biosphere Reserve through the application of strengthened protection and conservation programs in the core area and enabled sustainable livelihood development in the Biosphere Reserve as a whole.

While the Gulf of Mannar Marine National Park (GOMNP) is protected and managed by the Wildlife Wing of the Tamil Nadu State Forest Department, the activities in the GOMBR is facilitated, supported and managed by the multi-agency GOMBRT, wherein besides the Tamil Nadu Forest Department, Environment, Fisheries, Animal Husbandry, Rural Development and other government departments of Tamil Nadu, national and local NGOs, CBOs and academic institutions are also involved. The GOMBR Trust is chaired by the Chief Secretary of Tamil Nadu and its functional Chief Executive is a Chief Conservator of Forests of the Tamil Nadu Government. The GEF-UNDP project is operational upto 2008 and through this project it is envisaged to develop a new “community participation” based management model of sustainable development wherein the livelihood options linked to renewable coastal and marine resources are safeguarded.

The GOMBRT assigned the responsibility of developing 10 year Management Plan for GOMMNP and GOMBR to the Wildlife Institute of India addressing the issues of:

- (a) Conservation of Biodiversity and ecological integrity of the GOMMNP and GOMBR through protection, restoration and management of the coral reef systems in the Gulf of Mannar region.
- (b) Sustainable development in the GOMBR region maintaining the ecological integrity of the coastal and marine eco-systems to ensure the wise use of common ecological goods and services for the benefit of the local inhabitants and community.
- (c) Develop a model plan and mechanism of multi-sectoral involvement in managing the globally important fragile coastal and marine ecosystem in India.

The Wildlife Institute of India (WII), after setting in place a process for Management Plan Development initiated the management plan development exercise during January 2006. A team of field researchers led by two experienced WII faculty inventorised the ecological, socio-economic, developmental and threat assessment settings for the region. Based on this inventorized information, the management plan

have been developed through a consultative process. This draft plan was shared with the GOMBRT, GOMMNP and other stakeholders agencies. Analyzing the feed backs from these agencies, the WII finalized the Integrated Management Plan and presented to the State Level Management Plan Development Steering/Advisory Committee in 20th April 2007. The final suggestions after having been incorporated, the WII submitted the Plan to the Gulf of Mannar Biosphere Reserve Trust in the month of September 2007 for obtaining the approval of the Concerned Competent Authority for its implementation.

1.3. Management Plan Development Framework and Guidelines

The Wildlife Institute of India has followed the IUCN-WCPA, Marine Protected Area Planning Process and Planning Guidelines (Annexure 1.1) as the broad general principle for developing the Marine Protected Area Management Plan. The Management Plan Development Guidelines for Protected Areas (Swarkar, 2005) developed by the Wildlife Institute of India was the general guidelines and adoption of the provision of the Wildlife (Protection) Act, 1972 were used developing the Gulf of Mannar Marine National Park. The Biosphere Reserve Management Plan Development Guidelines by the Man and Biosphere Programme of the UNESCO and the new guidelines for regulatory regimes for the Biosphere Reserve by the Ministry of Environment and Forests, Government of India has also been followed in developing the Integrated Management Plan for the Gulf of Mannar Biosphere Reserve and Marine National Park.

1.4. The Process of Management Plan Development

The Gulf of Mannar Biosphere Reserve region being a globally important biodiversity hotspot and harbouring a Marine National Park, the Wildlife Institute of India has followed the following consultative and participatory processes in developing the Management Plan.

1.4.1. Formation of the Management Plan Development Scientific Team.

For inventorization, review of existing and gap area of scientific information, conduct of field research and additional information gathering, interaction with scientific institutions and organizations, stakeholders and managers for the development of the detailed scientific Marine Protected Area specific prescriptive plan, the Wildlife Institute of India formed a core scientific Team which consisted of the following personnel:

Project Scientists

Prof. B. C. Choudhury, Scientist F & Team Leader
Dr. K. Sivakumar, Scientist D

Project Field Researchers

B. M. Praveen Kumar
Kevin Mosses
S. Subburaman

With additional support from WII researchers

K. R. Saravanan
S. John

S. Jeganathan
Basudev Tripathy

1.4.2. Formation of Management Plan Development Review Core Group.

The WII in consultation with the GOMBRT formed a Core Group to periodically review the progress and to comment on the course of action of the Management Plan development. The managers of the Biosphere Reserve and the National Park as well as select scientific institutions working in the region were the members of the Core Group who informally and formally met several times and reviewed and guided the WII team. The Core Group consisted of the following:

B. C. Choudhury, WII Team Leader	- Member and Convenor
Director, GOMBRT	- Member
CF, Virudhunagar Circle, & Director, GOMBR	- Member
Eco-Development Officer, GOMBRT	- Member
Wildlife Warden, GOMMNP	- Member
Dr. K Sivakumar, WII Scientific Team	- Member
Special Invitees (Scientific personnel from MKU, SDMRI, CASMB, TFCR, ICMAM, NIO)	- Invitee

1.4.3. Formation of Management Plan Development Steering/Advisory Committee.

The GOMBRT and WII also mutually constituted an apex State level Steering/Advisory Committee to review the draft prescriptive approaches of the plan and to suggest required changes within the framework of Tamil Nadu Government and Government of India existing policies and guidelines vis-a-vis the practicality of implementing the prescriptions. The Committee consisted of the following and met thrice:

Chief Wildlife Warden, Tamil Nadu	- Chairperson
Trust Director, GOMBRT	- Member
Director, WII	- Member
Two members of GOMBRT	- Members
University representatives	- Member
Wildlife Warden, GOMMNP	- Member
WII Management Plan Team leader	- Member and Convenor
Other invited member as suggested by GOMBRT	- Invited Member

1.4.4. Consultation workshops and Stakeholders meetings

In fulfilment of the basic objective of long term community and scientific organization participation in the management of the Gulf of Mannar Biosphere Reserve, the Management Plan Development process conducted a series of workshops and meetings with stakeholders which included the following:

- a. Stakeholder meeting with Eco-development Committees
- b. Stakeholder meeting with Governmental and Non-Governmental Organizations of the region.
- c. Stakeholders meeting with Scientific institutions of the region.
- d. Consultation workshop with Scientific institutions to review the gaps in research in the Biosphere Reserve region.

1.4.5. Consultation with other experts organizations/Expertises

Several informal consultative meetings were also organised by the WII scientific team with the Forest Survey of India, Chief Naval Hydrographer, India, Survey of India, UNDP, Bombay Natural History Society, M. S. Swaminathan Research Foundation, ICMAM Project at Anna University, Tarapore Aquarium - Mumbai, WWF-Tamil Nadu, WWF-India, Fish Worker Federation of India, SDMRI, Zoological Survey of India, Coast Guard, National Biodiversity Authority, CMFRI, SAC Ahmadabad, ATREE - Bangalore, NIO, MPEDA, etc to seek their professional expertise in the process of development of the scientific and adaptive management plan for the Gulf of Mannar BR and NP.

1.4.6. Review of global model case studies from Marine Protected Areas

A detailed review of some of the best practised global models on several aspects of management of well managed Marine Protected Areas in the world had also been carried out to examine replicability of such models in the Gulf of Mannar Biosphere Reserve region.

1.4.7. Collection of information on Gap Areas.

All the research and management activities which took place in the Biosphere Reserve region were reviewed and identified the gap areas in the respective fields. The identified gap areas are highlighted in the various sections of the Management Plan appropriately.

1.4.8. Fieldwork on assessment of ecological status of the biodiversity

A team of researchers from the Wildlife Institute of India carried out field surveys of various taxa of biodiversity in the Biosphere Reserve areas for a year period and rapidly assessed the status of various taxa group and habitats. Based on the information on distribution and status of various threatened taxa and habitats, this Management Plan suggested various management measures to conserve the biodiversity of the Biosphere Reserve in a better manner.

1.4.9. Review on draft Management Plan

The Draft Management Plan was prepared following the above mentioned processes. The draft plan was first reviewed by the Management Plan Core Review Group and then it was discussed with the State Level Advisory Committee. Based on the suggestions provided by the State Level Advisory Committee, the final draft of the Management Plan was prepared in two parts. Part I contains the management prescriptions for the Marine National Park and the Part II for the buffer zone of the Biosphere Reserve.

ANNEXURE 1.1

Guidelines for Marine Protected Areas. World Commission on Protected Areas of IUCN – The World Conservation Union, Edited and coordinated by Graeme Kelleher, Series Editor: Adrian Phillips. With the support of: Coastal Zone Management Centre, The Hague, The Netherlands. The Department of City and Regional Planning, Cardiff University, Wales, UK, The National Oceanic and Atmospheric Administration, US Department of Commerce, Countryside Council for Wales, UK. **World Commission on Protected Areas Best Practice Protected Area Guidelines Series No. 3. 1999.** *(Full document freely downloadable from www.iucn.org)*

Executive Summary of the Guidelines

Marine Protected Areas (MPAs) are essential to conserve the biodiversity of the oceans and to maintain productivity, especially of fish stocks. Yet at present there are too few MPAs and not many of them are effectively managed. These guidelines set out the various steps a country should take to establish an effective network of MPAs. IUCN has defined an MPA as “any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment”.

There are two ways of establishing MPA systems: either as many relatively small sites, each strictly protected, or as a few large multiple-use areas which contain strictly protected areas within them. To conserve biodiversity, both approaches should occur within an effective programme of ecosystem management covering the marine ecosystem and the land areas that affect it.

From the accumulated technical experience in this field, there is one general lesson which can be drawn. A crucial attribute of an MPA manager is integrity. Some managers have made the mistake of believing that they can fool some of the people some, or even all, of the time. The result is a breakdown in trust. The manager may appear to win a series of battles but in fact the eventual outcome is failure. Another key lesson is that time spent in preparation is an essential investment that will be repaid many times over. Proponents of MPAs have to show demonstrable benefits for stakeholders, and this takes time and diplomacy. Box 1 lists other lessons from experience in establishing and managing MPAs in various situations around the world.

The Guidelines set out the following steps, each being the subject of a separate chapter:

1. Placing MPAs in their wider context. The high degree of linkage between land and adjoining sea, and the inter-connectivity of the oceans, require that MPAs be integrated into management regimes that deal with all human activities that affect marine life. Thus MPAs should be integrated with other policies for land use and use of the sea. It is also desirable for countries to make use of international agreements, notably UNCLOS and CBD. More international support is needed for MPAs and more attempts should be made to establish MPAs on the High Seas.

- 2. Developing the legal framework.** In most countries, a key step will be to establish the legislation needed. This may either be enabling legislation, which allows the administration or communities to establish individual MPAs, or specific legislation establishing an MPA, usually as a large multiple-use area. The various requirements for the legislation are outlined, though the needs and context will differ from one country to another.
- 3. Working with relevant sectors.** Many sectors of human activity affect the coast and the sea, and it is vital for those planning an MPA to work with these sectors from the earliest opportunity. Tourism often has most to gain from an MPA and can generate the greatest economic activity from it. Fisheries is the other key sector, and one with which it is most important to cooperate. Other relevant sectors include aquaculture, coastal development, agriculture, forestry, industry, defence and science.
- 4. Making partnerships with communities and other stakeholders.** MPA management should understand the local communities that will be affected by the MPA and identify potential partners. It must listen to the many interests and seek ways to involve them as participants in resource management. It is recommended to build management partnerships using the collaborative management model, which is outlined in greater detail in Annex 1.
- 5. Selecting the sites for MPAs.** Choosing the location and extent of MPAs involves a different emphasis to that of terrestrial protected areas. In many parts of the world, local people depend greatly on the services and resources provided by natural terrestrial areas. However, the dependence on marine areas tends to be even greater. Some forms of fishing can occur in large areas without threatening the conservation objectives of the MPA because they do not involve habitat modification. This makes it feasible to balance conservation and the needs of local people. Weight needs to be given to events outside the MPA that might affect it, such as pollution. Following these principles, the guidelines propose a rigorous set of criteria for site selection that have been applied in many countries over the past few years.
- 6. Planning and managing the MPA.** Management should be responsive and adaptive, working with local interests in a way that builds support for the conservation objectives. To achieve this, managers should adopt a systems approach, use interdisciplinary teams and follow a clear sequence of decision-making. Most MPA management is about managing human activities, so this must be at the heart of the approach. Suggested contents for a management plan are provided in Annex 2.
- 7. Zoning,** in which various areas are allocated for various uses. This is usually the best way of ensuring strict protection of a core zone as part of a larger, multiple-use area. The stages involved in preparing a zoning plan are outlined in Annex 3.
- 8. Planning for financial sustainability.** Lack of funds is a critical problem for many MPAs. Managers therefore need the freedom to raise funds in as many ways as possible, such as user fees, donations and environment funds, and to retain those funds for management of the MPA. External donors are advised to extend the aid period for protected area projects, so as to help achieve financial sustainability.

9. Ensuring research, monitoring, evaluation and review. Research and monitoring should be firmly orientated to solving management issues. Guidance is given on the planning and development of a monitoring and research programme, with its different emphases in the planning and the implementation phase of the MPA. Most important of all is to use the results of research and monitoring to evaluate and if necessary reorient management.

Chapter 2

Ecological settings and Biological Diversity of the Gulf of Mannar Marine National Park and Biosphere Reserve

2.1. Present Ecological Settings of the Gulf of Mannar Biosphere Reserve

The mangroves, coral reefs and sea grass ecosystems are the three important and sensitive ecosystems in the coastal zone. The GOMBR possesses all these unique ecosystems and has become significant because of the presence of other associated resources such as fishes, sponges, gorgonids, holothurians, pearl beds, chank beds, sea horses, turtles and the sea cow, *Dugong dugon*.

Coral reefs are vital components of ocean ecosystems, providing shelter to nearly one quarter of all marine life forms. They are the breeding and nursery ground for many fin and shellfishes. There are more than 793 - recorded species of corals in the world that support enormous life forms. Reef ecosystems can be compared to rain forests in terms of their biodiversity and density of living organisms. They serve as atmospheric carbon dioxide sinks and act as historical climate recorders. The coral reef ecosystems play an important role in global biogeochemical processes and in the production of food resources in the tropical region. These systems are very sensitive to external impacts both natural and manmade that violate their homeostasis.

The floral components comprises of economically viable species of seaweeds such as *Gracilaria* sp., *Gelidiella* sp., *Caulerpa* sp, *Sargassum* sp. and *Turbinaria* sp. The sea grass communities of this region tops the list of marine flora of India with the highest number of sea grass species recorded, providing important feeding grounds for the endangered *Dugong dugon*.

Many commercial shoaling fishes like sardines, mackerels, anchovies, snappers and pelagic fast swimming forms like Tuna, billfish, sail fishes are found abundant in this region and these form a major fishery. Information regarding environmental settings of the Gulf of Mannar Biosphere Reserve mainly gathered from a study on Gulf of Mannar Biosphere Reserve by Anna University, Chennai.

2.1.1. Topography

Beach

Beaches are extensively developed along the entire coast of Gulf of Mannar except at some places. The shore between Tuticorin to south Sippikulam (2.04 km²), Vaippar River and Gundar River (2.56 km²), Gundar River and Palar River,(2.64 km²), Palar River and Kottakkarai River (2.189 km²), Kottakkarai River and Marakkayarpattanam (2.18 km²) southern coastal parts of the Rameswaram Island (2.91 km²) and the western part of the Rameswaram Island from Pamban to Peikkarumbu are observed as the important beach areas in Gulf of Mannar coast. All along the shore the beach as are

observed to be gently sloping and marked with altered crusts and troughs that are formed due to wave action. There are also good beaches available along the coasts of Tirunelveli and Kanyakumari districts which also forms a part of the Biosphere Reserve.

Spit

Among the various depositional landform features encountered, the formation of spit is a significant feature of recent age. South of Tuticorin coastal area two spit formations have been observed. It appears to have been built by the sediments brought by long shore current during southwest monsoon. As the Gulf of Mannar is on the lee of the northeast monsoon, there is no long shore drift from the northeast that might be the cause for the inward curving of this spit (Ahmad 1972). The southwestern shore of Rameswaram has a tongue shaped spit. SOI toposheet of the year 1969 does not show any spit but recent IRS LISS-III imagery (1998) clearly shows the spit. Hence it may be assumed that these spits are recently formed. It can be explained that the Rameswaram spit may have been the result of littoral current from Palk Bay to Gulf of Mannar during northeast monsoon period.

Beach ridges

Beach ridges are moderately undulating terrain features of marine depositional type, formed during Pleistocene to Recent age, in the plains of Gulf of Mannar coast. In the Gulf of Mannar coastal areas between Mandapam and East of Vaippar River are covered by well-developed beach ridges. There are twelve beach ridges observed in the region. Almost all beach ridges in the study area are parallel to each other, and cover an area of 155.49 km² and trend from east to west and northeast to southwest direction. On the basis of the nature and dispositions of beach ridges, it can be grouped into (i) Beach ridges south of Vaigai River, (ii) Beach ridges between Kotangudi River and Palar River, (iii) Beach ridges between Palar River and Gundar River system, (iv) Beach ridges between Gundar River and Vaippar River and (v) Beach ridges south of Vaippar River.

Swales and backwater zone

Swales and backwater zones are seen between coastal plains of Mandapam and Kottakkarai River; they are branched and arranged in series of linear patterns. They are situated almost parallel to the present coastline. Prominent backwater zones have been observed in the coastal plains between Valinokkam and Vaippar River, Mandapam and Southeast of Tiryppullani near Tinaikkulam. These are divided into two parts by beach ridges. The coastal areas between Mandapam and Tinaikkulam, Valinokkam and Krishnapuram and North of Terku Mukkaiyur and Tukurankulam consist of prominent and wide backwater zones. These three backwater zones are connected by small, linear and narrow swales to the sea by means of few creeks, which supply water from sea to backwater channels during high tide. The basin bed is composed of silt and mud. The adjacent low lying area, as a part of swale zone is used at present for salt production.

Mud flat

Mud flats are wide expanse of deposit of clay, silt, ooze, etc (Davies 1972). The mudflats are observed near Vaippar River mouth, around Valinokkam backwater lagoon, Kallar River mouth and Gundar River mouth. The area covered by mudflat has been estimated to be 14.50 km².

Off shore islands and coral reefs

A chain of 21 low islands has been observed along the offshore region of Gulf of Mannar (Table 2). It extends from south of Rameswaram to Tuticorin. All islands are made up of a calcareous framework of dead reef and sand. They have a low and narrow sandy coast and some of them have rocky coast. Around all offshore islands, well-developed coral reefs have been noticed. Geomorphologically, coral reefs in this area are of fringing type, though some patchy corals are also observed in between Appa Island and Pilliyarmuni Island, and in some areas like Bharathi nagar coast and southeast coast of Kariya Shuli Island. Two islands namely Velanguchalli and Poovarasampatti are now submerged in the seascape.

Table 2.1. Aerial Distribution of Offshore Islands and Types of Reefs and their Areal Extent

Sl. No	Islands	Island Area (km ²)	Coral Reef	
			Reef type	Area(km ²)
1	Van Island	0.245	Fringing type	1.090
2	Koswari Island	0.241	Fringing type	1.474
3	Kariya Shuli Island	0.166	Fringing type	0.702
4	Uppu Tanni Island	0.377	Fringing type	0.644
5	Shalli Island	0.126	Fringing type	0.249
6	Nalla Tanni Island	1.248	Fringing type	1.250
7	Anaipar Island	0.229	Fringing type	0.888
8	Palliyarmunai Island	0.134	Fringing type	0.687
9	Appa Island	0.410	Fringing type	3.612
10	Talairi and Valai Island	1.072	Fringing type	9.268
11	Muli Island	0.170	Fringing type	1.208
12	Musal Island	1.836	Fringing type	27.73
13	Manalli Island	0.353	Fringing type	
14	Manalli Putti Island	0.037	Fringing type	
15	Pumurichan Island	0.187	Fringing type	8.320
16	Kovi Island	0.482	Fringing type	
17	Kursadi Island	0.740	Fringing type	
18	Shingle Island	0.191	Fringing type	1.023
19	Near Bharathi nagar	---	Patchy type	0.131
20	Between Appa Island and Pilliyarmunai Island	---	Patchy type	3.981
21	Southeast of Kariya Shali Island	---	Patchy type	0.969

Wave cut platform

Wavecut platforms are common in the coast of Mandapam, Ramaswami Madam, Pudumatam, Valinokkam etc. At Pudumadam coast, hard and tough sandstone

platform occupies the intertidal zone. South of Valinokkam coast very extensive wavecut platform has been observed and erosional features are widely seen.

Sea cliff and sea cave

Along the coast of Gulf of Mannar cliffs have been observed in Mandapam, Rameswaram, Pudumatam and Appa Island coastal areas. Generally the sea cliff and caves are made up of calcareous sandstone and located at the high water level. Due to intensive action of waves on cliffs, at some places, sea caves are formed. Such caves have been observed near Mandapam coastal area and Southwestern and Southern coastal areas of Appa Island. At some places, these features have been destroyed due to slumping of upper cliff materials.

Waterlogged land

Water logged land is the area where the water is at or near the surface and has been stagnant for most part of the year. Such lands usually occupy low-lying areas, topographically. In the study area around the northern part of Rameswaram Island some waterlogged lands have been observed. In the areas like Pillaikulam, Surantidal and Mangaud, this type of features has been observed. The total water logged land in the study area has been calculated to be 5.96 km².

Strandlines

In the Gulf of Mannar coast from Tiruppullani to Mandapam, eight series of strandlines in curvilinear form have been observed. The general trend of the strandline is in the east to west direction. In the south of Rameswaram area also, curvilinear strandlines have been observed.

Currents

The current in the area are swift. The sea is rough between April and August. During June to August it is very stormy. It is calm during September. October to December months have North east monsoon with occasional gales.

Soil

The soil is typical coastal sand, strewn with shingles in places and there are swamps in places in Van Tivu, Kasuwar Island, Poomarichan Island, Pullivasal Island, Krusadai and Shingle islands. Quick sand is seen in places in Mulli and Krusadai Island.

Geographical/Geomorphological features

The deepest parts of the sea are situated off Valinokkam and off Pamban island. The shallowest part is found north of Tuticorin and extends from Vaipar to Pamban. Some of the geographical features within the Gulf are biologically noteworthy for their rich variety and the support they provide to sustain uniqueness of the living resources.

2.1.2. Climates 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. Rain fall is moderate to heavy during October to mid December with occasional gales. The mean annual rainfall varies from 762 mm. to 1270 mm. The monthly average annual atmospheric temperature varies from 25⁰C to 31⁰C with the maximum and minimum in May and January respectively.

2.1.3. Water Resources

Fresh water is available only in Nallathanni Tivu as the name of island itself specified. Tolerably good water is available in rainy season and winter in Talari Island, Hare Island and Pullivasal Island though not in abundance.

2.2. Biodiversity profile of the Gulf of Mannar Biosphere Reserve

About 3600 species of fauna and flora have been identified in the GOMBR by the Central Marine Fisheries Research Institutes and other organizations. The fauna is said to be one of the richest in the whole of Indo-west pacific region.

2.2.1. Algal Resources

An estimate of algal resources was carried out for the entire Gulf of Mannar's coastal stretch and the standing crop was estimated for the coastal and "off-shore" islands and the values were given in wet weight in tons. As earlier stated, about 160 species are known so far; 40 species are found growing in abundance around the islands.

The algal productive area along the coast line from Mandapam Camp to Kanyakumari is put at 17.125 hectares. The stand crop estimate is about 22,050 tons – within a limited zones of intertidal area for the coastal stretch from Mandapam till Kanyakumari. *Gelidiella acerosa* is the most exploited species. On the coastal belt, the standing crop of large algal patch was maximum in the region from Mandapam to Kilakkarai (Region I) and minimum from Kilakkarai to Mukkaiyur (Region II). The algal production of "offshore" islands and mainland coastal stretches have also been taken into consideration. The contributory factors for the maximum value in the Region I are due to the presence of the many islands of this coastline enhancing the productive intertidal area (8,416 ha.). The minimum productive area is from Tuticorin to Kanyakumari stretch (1,732 ha.). The mean density for the entire coastal stretch (of the Gulf inclusive of its islands) would be about 0.11 kg.m² wet weight. Based on the algae sampled from surface to a maximum depth of 4 meters, the alginophytes were maximum in Region I. The Pamban Pass is well known for its algal wealth; similarity to a lesser extent with Kundagal Point and Puma Channel.

On Krusadai and shingle islands very rich algal beds of *Litho thamnion* (calcareous alga), *Padina*, *Caulerpa* (ten species), *Ulva reticulate*, *Sargassum*, *martensia*, *Clandia*, *anadyomene*, 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 reticulate

Halimeda opuntia

H. tuna

Caulerpa racemosa V. *clavifera*

Pocockiella sp.

Chnospora implexa

Sargassum sp.

Turbinaria conoides

T. ornate

Gelidiella acerosa
Chondrococcus harnemanni

Padina is observed on the shores and lagoons. *Gracilaria lichenoides* is found more on 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 is *Halimeda opuntia*. Also *Caulerpa*, *Sargassum*, *Amphiroa fragilissima*, *Gracilaria lichenoides* form the other dominant species.

2.2.2. Corals

Coral reef system as also the ecosystem of the tropical rain forest, are the most matured marine ecosystems of our planet. They play an important role in global biochemical processes and in the reproduction of food resources in the tropical regions. Coral reefs act as a barrier against wave action along coastal areas thus preventing coastal erosion. In addition, coral reefs protect mangroves and seagrass beds in certain areas, which are the breeding and nursing grounds of various economically important fauna. Coral reefs are also important breeding, spawning, nesting, and feeding areas for many economically important varieties of fishes and other marine organisms. The people living along the coast obtain a considerable proportion of their food and earnings from the productivity of coral reefs. Coral reef ecosystems are very sensitive to external impacts both natural and manmade, which violate their homeostasis (Sorokin 1992). The majority of damage to coral reefs around the world has been through direct anthropogenic stress (Grigg and Dollar 1990). According to Bryant et.al (1998), 57% of the world's coral reefs are potentially threatened by human activity such as coastal development, destructive fishing, over exploitation, marine pollution, runoff from deforestation and toxic discharge from industrial and agricultural chemicals. 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 limestone, effect of current, etc.

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 and Kanagaraj David, 1972). The Government of Tamil Nadu have prohibited the quarrying of corals.

There are about 120 species corals in the Gulf of Mannar alone (Gopinatha Pillai, 1971). They belong to 33 genera. Of this, 110 species grouped in 26 genera are hermatypic. The conspicuous species of corals belong to the families Acroporidae, Poritidae and Faviidae. The corals here are fast deteriorating in the 4 islands off the Chidambaranar coast due to human interference.

A detailed account on the exploitation of corals for using them (in trade of the exploited products) as raw materials in industrial ventures such as cement industries, brick manufacture, masonry work, limekilns, 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 in the Gulf of Mannar due to human interference such as coral mining, greater silt inflow draining from the mainland, destructive fishing practices etc., Silt affects racemose types of corals greater than the encrusting and massive coral types. Loss of vegetation on the coast-line causes extensive siltation. The coral reefs act as breakers and their removal will alter the current pattern along the coastline. They act as coastguard against powerful tidal waves. The reefs on the four islands of the Chidambaranar 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. Hence caution should be exercised against indiscriminate exploitation and loss of forest cover on the coastline causing extensive siltation .

The total coral reef area in Gulf of Mannar is about 61.01km², of which reef area covers 48.18 km², reef vegetation covers 10.15 km² and degraded coral occupies 2.68 km² (Thanilachalam and Ramachandran, 1998).

Sedimentation is a major factor controlling the distribution of reef organisms and overall reef development (Macintyre 1988). The reduced level of light due to suspended sediment in the water column can reduce coral growth (Hubbard et al 1986) and has an impact on natural zonation patterns (Morelock et al 1983). Excessive sedimentation can also discourage the settlement of coral larvae. Most of the studies on the effects of turbidity on corals have concentrated on anthropogenic-increased sedimentation and turbidity. According to Thanilachalam and Ramachandran (1998), nearly 67.2% of the coral reefs in Gulf of Mannar is not in living condition due to sedimentation and turbidity caused by anthropogenic and natural activities. The anthropogenic activities like destructive fishing methods, seaweed collection, commercial shell collection, coral mining, intensive agriculture, changing land use practices, deforestation and industrial waste input etc. and natural activities like monsoon, wave action, ocean current and tides were identified as the agents that increase the sedimentation and turbidity in coastal waters of Gulf of Mannar.

A separate chapter on 'Ecology, review on current status, monitoring and restoration of coral reefs in the Gulf of Mannar Biosphere Reserve' is included in this Management Plan and provides management prescriptions.

2.2.3. The Sacred Chank Beds

The sacred chank *Xancus pyrum* also occurs in the Gulf of Mannar. The sacred chank is found on fine or soft sandy substrates of the Gulf of Mannar waters. They feed conspicuously on polychaetes. The sacred chank *Xancus pyrum* could hold its own against its predators. The chank beds are very productive. The sacred chank *Xancus pyrum* is considered *suo motu* to be "perfect". It has acquired "strength" to stand on its own feet against its own predators in the struggle for existence (Nair and Rao, 1974). The Valampuri chanks (sinistral forms) fetch more than Rs.10,000/- for a perfect chank of 65mm or greater diameter. This sinistral form is used in worship in the Hindu temples, and are in great demand in trade.

2.2.4. The Pearl Banks

The Gulf of Mannar is also famous for its chank and pearl fisheries. They were the state's monopoly. There are about ten pearl banks. The most preferred species of

pearl oyster is *Pinctada fucata*. there are four sps., of pearl oysters. *P. fucata* is abundant off-Tuticorin and the banks of pearls are called in Tamil “*parai*”. It was observed that the spat falls of pearl oysters get periodically replenished by larvae carried by currents from Sri Lankan coasts and the Sri Lankan beds gets transported the larvae from the Indian sides.

The pearl fishing operation is conducted once in several years. The usual season is from November to May. The pearl fishery is of cyclic character. *Perna viridis* is an edible species; other edible bivalves are clams Such as *Meritrix* sps., *Kataloysia* sps., *Anadara* sps., *Donax* sps., etc., The Dentalium beds are seen in the area off-Kurusadai and on this island. The fan shell, *Pinna bicolor* occurs at Pamban and Kundagal point.

The depth of the pearl varies from about 10 to 20 metres. The maximum concentration of pearl banks is found in the region off-Tuticorin and to some extent in between Nalla Thanni Tivu and Valinokkam point. They are pearl banks also in the former island Pandyan tivu environs, where depth does not exceed 7.50mts; at Van Tivu and at Kariya Shuli Tivu, at depths from 11 to 15mts.,

From the region (between 9⁰05' to 9⁰05' N and 78⁰25' to 78⁰45' E) long off Uppu Thanni Tivu, there are shallow channels of uniform depth of about 11mts., favouring pearl bank formations. The region between Tuticorin and Kanyakumari have extensive pearl banks. In fact, the area up to Nalla Thanni Tivu comprising of 8 islands (numbering from 1 to 8), (from new Tuticorin port to Nalla Thanni Tivu) also possesses extensive pearl banks. Off the coast of Terku Mukkaiyur of the mainland and in the environs of Uppu Thanni Tivu, there are pearl banks between 11 and 15 mts.

In the region near Tuticorin, their concentration is found even at depths of about 37 mts., at 78⁰25' E 8⁰47' N. the maximal concentration is along the depth contour of about 16 to 20 mts., Near about Van Tivu and Koswari Tivu, there are pearl banks at depths of 11 to 15 mts., and opposite Kariya Shuli Tivu and Vilangu Shuli Tivu also support pearl banks.

2.2.5. Other Fauna

The Porifera are represented by species belonging to *Tetraxontida* and *Keratosa* (Burton, 1937). Among Coelenterates, Sea anemones, Cavernularia etc., are noticed. The Bryozoan sps., (formerly called Polyzoa) are recorded. The phorionids and Sipunculids have also been recorded. Among the many other groups recorded from here special mention must be made of Polychaetes, Pycogonoids, Caprellids and Echinoderms. Ascidians were recorded besides the encrusting colonies of ascidiozooids by Gravelly. *Esteinascidi thrustonys*, *E.multiclathrata*, *diplosoma* and *Distoma* were also recorded.

Many colored coral fishes, Eels, Melluses (special mudifranches) and stomatopods around here. Sea anemones of different kinds, Planarians, Hydroid colonies, Memertineworms, Polycassebe worms, ear-shells, chitons, octopus, holothurians and ascidians are very common. Siphonophores (*Pysalia utricular* *Porpita veleva*) pelagic gastropods (*Ianthina cubomedusae*, *Lucernorporis*), phyenogonives, polychaet crabs, colonies of Aleyonariaas, Barnacles, Star fishes, sea urchins and hermit crabs are common. Mud skipper *Periothalmus* and *Boleophthalmus* are found in

plenty on the lower branches of the mangrove trees and mudflats fringing the shore. Sea snakes (*Hydrophina* and *Enhidrina*) are also seen here.

Milk fish *Chanus chanus* spawn here in season and the larvae are seen in millions here in the month of March to May.

Balanoglossus, the unique link between the invertebrates and vertebrates which is said to be so rare is seen to occur only near Kurusadai Island. *Chlamydotorax ceylonensis*, *Ptychodera flava* and *Chlamydotorax (Ptychodera) krusadiensis* are reported around the Krusadai Island (Horst, 1932).

Seahorses are fish belonging to the Syngnathidae family which also includes sea dragons, sea moths, and pipe fish. Seahorses are a saltwater vertebrate fish belonging to the order Perciformes, family Syngnathidae, meaning “with jaw”, genus *Hippocampus*, literally “horse of the sea”. The family includes seadragons, pipefishes, and pipehorses, and has existed for at least 40 million years

Most Seahorses are found in coastal waters, typically at depths of 1–15 meters, occurring in relatively sheltered environments among seagrasses, kelp beds, rocky reefs, mangroves and coral reefs. Unfortunately these are some of the most vulnerable of marine environments, highly susceptible to disturbance caused by human activities. Seahorses feed on brine shrimp, tiny fish and plankton. A seahorse sucks in food through its long snout, and is continually feeding. Seahorses have no teeth and swallow live food whole. Seahorses have extremely interesting reproductive adaptations. The males have either marsupial sacks or hemispherical depressions on the abdomen, in which the ova laid by the female are hatched. The males also show great attachment to their young. The sexes do not commonly differ much in colour. Seahorses and other pipefishes are rigidly monogamous. One male and female mate repeatedly and exclusively with each other and these pair bonds are reinforced with daily greetings, occurring shortly after dawn throughout the male’s pregnancy. In the seahorse *Hippocampus whitei*, for example, the female moves to the male’s small home range at the core of her larger home range, passing other males en route, and the pair perform a greeting dance lasting 6 to 10 minutes. In these species, males compete more to obtain mates – and males are larger, more colourful and more conspicuous than females, where there is any difference.

Sea horses are primarily used in traditional Chinese medicine. They are said to cure asthma, skin ailments, relieve heatiness, joint and stomach aches, cleanse the blood, and strengthen the kidneys. Seahorse consumption is surprisingly common among Malay fishing communities. They frequently grill and fry their captured seahorses and eat them as crackers. They also believe that dried seahorses worn with string around the neck of newborns or toddlers or hung in their home, act as omens to dispel evil spirits. Japanese and Korean traditional medicine Which are hundreds of years old believe that Sea horses are credited with having a role in increasing and balancing vital energy flows within the body, as well as a curative role for such ailments as impotence and infertility, high cholesterol, mbric and skin afflictions such as severe acne and persistent nodules. They are also reported to facilitate parturition, act as a powerful general tonic and as a potent aphrodisiac. Traditional Chinese medicine is recognized by the World Health Organization as a valid form of medicine and is accepted by more one-quarter of the world’s population.

Because seahorses live in areas along the coast, the potential for impact from human activities is great. Very few studies have been carried out on wild seahorse populations and, as a result, scientists have no idea how many seahorses live in the wild and do not fully understand the basic biology of the creature. This lack of information makes it extremely difficult to predict how seahorse populations will be affected by exploitation. However, fishers and traders agree that, over a five-year period, exploited populations in Southeast Asia have declined by 15–50% (Vincent 1996). An aquarium and seahorse curio trade also exist but are difficult to monitor.

In the Gulf of Mannar, four species of sea horses occur, most of the seahorses are landed as bycatch of shrimp trawling. In response to a significant increase in international demand, a target fishery for sea horses along the east coast of India in the Gulf of Mannar was started in 1992. India was one of the largest exporters of dried sea horses globally, exporting at least 3.6 tonnes (1.3 million sea horses) annually, and contributes to about 30% of the global sea horse trade. Sea horses are exploited both as an incidental catch (by-catch in trawl nets) and target catch, for export. Presently, the commercial exploitation of sea horses is totally banned in India.

Sea turtles

Four of the seven species of sea turtles found world wide are reported to occur in the Gulf of Mannar Biosphere Reserves (Kar & Bhaskar, 1982; Bhupathy & Saravanan, 2003). These are the olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricate*) and leatherback (*Dermochelys coriacea*). All the four species of sea turtles that occur in these coastal waters are protected under Schedule I of the Indian Wildlife Protection Act (1972), as well as listed in Appendix I of Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) which prohibits trade in turtle products by signatory countries. At present there exists no commercial or international trade of marine turtles or turtle products in India. However, incidental capture in trawls is a well-known cause of mortality for sea turtles and have been reported all over the world (Eckert, 1995; Seidel & McVea, 1995; Hillestard, *et al.*, 1995; Lutcavage, *et al.*, 1997; Oravetz, 1999) and India is not exceptional to this (Bhupathy & Saravanan, 2003; Pandav *et al.*, 1997).

During 1971-76 the percentage of green turtle and olive ridley caught in the Gulf of Mannar and adjoining areas was 89% and <10% respectively (Agastheesapillai & Thiagarajan, 1979) and during November 2001 it was 46% and 48%² but in this study the percentage was 13% and 83% which shows that the proportion of green sea turtles catch declined in this region drastically. The reduction in the green turtle catch could be due to overexploitation as local people prefer this species to other species for food. Since the population of green turtle was smaller in size the people were forced to exploit the olive ridley nowadays (Sivakumar, 2005).

The Dugong *Dugong dugong* is one of the four surviving species in the Order Sirenia and it is the only existing species of herbivorous mammal that lives exclusively in the sea (Heinsohn, 1972). It is a large primary consumer and has considerable potential as a source of protein. The Dugong ranges along the coast of east Africa into the Red Sea, along the coast of southern Asia to as far east as the Solomon Islands, and along the northern coasts of Australia from southern Queensland to subtropical Western Australia (Marsh *et al.* 1999).

Dugong are usually found in calm sheltered, nutrient-rich water less than five meters deep, generally in bays, shallow island and reef areas which are protected against strong winds and heavy seas and which contain extensive sea grass beds. However, they are not confined to only inshore water. There have been sighting near reefs up to 80 km offshore in waters up to 37 meters deep. Studies have suggested that there is a correlation between the sea grass and dugongs abundance (Das, 1996).

Dugong is considered to be rare over most of its range (Bertram & Bertram, 1968). Human exploitation has led to extirpation of the species in several previously inhabited archipelagoes, including Mascarene, Laccadive, Maldives, Barren, Narcondam, Cocos and Christmas Islands around the rim of the Indian Ocean and Lesser Sunda Islands in Indonesia east of Java. The species is listed as vulnerable to extinction at a global scale (Marsh *et al.* 1999). However, Dugongs are still abundant in the shallow seas around tropical Australia, and it is likely that Australia may contain the main reservoir of dugongs in the world, after which comes the coast of United Arab Emirates.

Dugong population in the world is being threatened by human activities such as habitat destruction through coastal developments, pollution, accidental capture in fish nets and poaching (Marsh *et al.* 1999). Shark nets and gill netting are known to be responsible for the drowning of hundreds of dugongs worldwide. A less but major long-term problem is the disturbance in their feeding area by the noisy boat traffic.

In India, the dugong occurs in the Gulf of Mannar and Gulf of Kutch, the Palk Bay and in the Andaman and Nicobar Islands. All these areas have sea grass beds, which are good foraging ground for the Dugongs. The most favored dugong habitats are the Gulf of Mannar. In 1988, Helene Marsh based on the data of Dr. Eric Silas and Mr. Bastion Fernando indicates that 250 dugongs were illegally caught and butchered at the villages of Kilakarei and Peripattinum alone between April 1983 and August 1984 (Marsh, 1988). This information clearly shows that once the Gulf of Mannar had a good population of dugong but due to illegal off take of this species caused the species to be threatened with local extinction.. However, since from 1988 the Tamil Nadu Forest Department initiated awareness campaign to safeguard this species, which was first initiated by Mr. Balakathiresan, I.F.S. and later on it was carried forward. Though, the illegal off take of this species drastically reduced their population, information on current status and distribution is not known in detail.

Other cetacean species

There was no detailed information available on several other cetacean species from the Gulf of Mannar Biosphere Reserve and it required to be compiled.

2.3. The ecology of coastline of the Gulf of Mannar Biosphere Reserve

2.3.1. Rameswaram Coast

The southern coast of Rameswaram island borders a part of the northern section of Gulf of Mannar. The coast is 27 Km long from the lands end, that is starting from Adam's bridge, to Kudugal Point. It is sandy and slopes down suddenly in to the sea at various points. The sea is deeper, about 5 to 7 mts., even near the shore. The shore

line 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 the coral bed is usefull as an anchorage for the fishing trawlers.

2.3.2. Raman Point To Cmfri Jetty

Raman point is the tip of the land of Mandapam projecting into the Pamban bridge. It is a sandy shore pitted intermittently with leiching granite slabs both along the shore and at the intertidal region. The algal forms particularly Sargassum sps. are found in plenty which damp the wave action on the shore. The sea bottom between Kurusadai island and Mandapam shore abounds in coral reef towards the islands and is sandy clayish towards Mandapam end. Mechanized fishing trawlers in large numbers operate from Mandapam and land heavy catch of fish and prawns.

2.3.3. Cmfri Jetty To Pudhumadam

This area includes two major fish landing centres that is Vedhalai and Pudhumadam and a minor fish landing centre, Nochiurani . Large number of mechanized boats and sail boats operate from the shore of Vedhalai. The coast is sandy fringed with coconut plantation. A large quantity of Gracillaria sps., is landed on the coast by the sail boats. This centre is noted for sea weed harvest and export. Boats load of sea weed are landed on this coast are dried and sold to dealers for export.

Two types of fishery exist 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 cuttle fish, large prawn, sea cucumbers, ornamental gastropods and sea weeds are landed exclusively for export purpose. *Holothuria scabra* is solely fished in this area as a consumable item of South East Asian countries known as *bech-de-mer*. *Holothuria atra* is left behind untouched. Hence, is easily found every where.

2.3.4. Pudhumadam To Sethukarai

Muthupettai, periapattanam and Sethukarai are the three major fishlanding centres of this piece of coast. The sea is slightly deeper in this area ranging from 4 m along the coast to 8 m towards the islands. Muthupettai and Periapattanam have both mechanized and sail boats. The main profession is fishery and sea diving. During certain seasons shoreseine nets are operated or migratory fish like seer fish are targeted. Diving for corals and large gastropod shells, large seafans and sea cucumber (*Bech-de-Mer*) is one of their main occupations and the products thus collected have value in the International Market. Sethukarai coast and its intertidal region are very shallow from the coast to a distance of 1 km towards the sea. This is due to the presence of stony corals. *Acropora* and various other corals that have grown to a distance of 2-3 km parallel to the coast to form a 'ridge'.

2.3.5. Sethukarai to Valinokkam

There are two major fishlanding centres i.e. Kilakkarai and Ervadi and one minor centre, i.e. Pallavasalur. In Kilarkkarai fishermen have more number of mechanized boats which cover the entire coast doing trawl fishing. The depth of the fishing area varies from 4-7 m. All along the coast from Sethukarai to Ervadi north, from the seashore to about 200 m into the sea, the sea bottom is covered with coals and lushy

growth of sea weeds. The fisherwomen of both Kilakkarai and Ervadi wait for the tide to recede and harvest *Gracillaria* sp. and other seaweeds and process them for export. The mechanized fishing trawlers extend their fishing area upto Valinikkam. 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 6 m 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 mechanized boats for gillnet operation.

2.3.6. Valinokkam to Sippikulam

This is a long coast with three estuaries and five fishing villages i.e., Kill Mundal, Mcl Mundal, Oppilan, Terku Mukkayur and Vembar. But majority of the population except at Kel mundal, Teuk Mukkyur and Sippikulam(sentence not complete), others are interested in jobs at the major salt factories situated is very along the coast. The landings at Sippikulam is very appreciable since the fish catch includes seer fish, tuna, carangid of very large size.

2.3.7. Sippikulam to Tuticorin

This covers the main fishing areas over the pearl fishing grounds (Parrs) where unbelievably large sized. There are three to four seasonal estuaries present in this stretch. A total of seven fishing villages are located in this stretch, major occupation of these villagers is fishing related activities. Villagers from this region are still involving in illegal coral mining at smaller scale. There are good beaches available in this stretch which were once used by the sea turtle for nesting.

2.3.8. Tuticorin to Kanyakumari

Though the coastal area between Tuticorin and Kanyakumari is densely populated a very rich marine biodiversity and potential sea turtle nesting beaches are available in this region. Good patches of sea weeds are available throughout this coastal line. Oyster banks are also available in some estuarine areas of this coastal region. Sand mining is the major threat to the coastal ecosystem of this region apart from illegal fishing of sea turtles.

2.4. The ecology of the off shore islands in the Biosphere Reserve

The ecological condition of the 21 islands (including two submerged islands) is detailed below.

2.4.1. Van Tivu

In the earlier management plan of the National Park, it was mentioned that of just a few *Prosopis* trees (10 Nos.) and *Salvadora* tree (10 Nos.) were seen sprouting from stumps. However, currently (in 2007) more than 40 grown trees of *prosopis* occur on this island. The ground vegetation has halophytic herbs, creepers and grasses. Degraded sea grass patches are seen near the island. About ¼ area of this island has already become submerged due to the removal of coral reefs. This island does not have most of the vegetation seen on the other 2 islands off Tuticorin coast. The heavy biotic interference due to its nearness to Tuticorin and frequent fires caused by fisherman is the main reason for degradation of this island's biodiversity. There are a few depressions on this island and the mangrove species are absent in this area. The open area of this island has been planted with *Thespesia*, *Pungan*, *Neem*, *Delonix*

alata during 91-92 and they are getting established. There is about 35% survival of planted seedling and hence consolidation and restocking of the area is necessary.

2.4.2. Kasuvar Tivu

Prosopis and *Salvadora* trees are dominant on the terrestrial part of the island. The ground vegetation has herbs, creepers and grasses. Due to excess removal of corals over the last decade, about ¼ of this island is sinking under water. The reclaiming work done during 92-93 has been quite successful as sand has been deposited over the coral debris dumped and the island size has increased. Due to the control exercised in removal of coral material from this island, fresh coral debris and sand accretions are taking place in other portions also and plant succession with ground vegetation and grasses is establishing over the newly built up land portions.

Almost the same vegetation as in Kariachalli island is seen except the absence of a few important species like *Caralluma circarii* etc. In a natural depression, good growth of *Avicenia* species and *Suaeda* are seen although on another depression mangrove species are absent. The Afforestation done during 92-93 has about 40% survival and replacement and restocking with salt tolerant species is being done. *Pithacalobium dulce*, *Vagai*, *thespesia* have come up well (Management Plan 1993-94 to 1997-98).

The area surrounding this island is famous for chank due to good sacred chank beds, which attract near by fishermen to collect the chank here illegally.

2.4.3. Velanguchalli Island

This submerged island looks like a small sand mound due to removal of coral reefs around this island in the past. Currently, good fringing corals have been observed around this island. There are good sea grasses patches in the shallow waters around the island .

2.4.4. Karaichalli Island

This island which had an original area of 16.46 ha ,had only an estimated 12.70 ha in 1993, considered to be due to excessive removal of corals from this island which has resulted in submergence of some portions. This island has scanty vegetation at present consisting of grasses, climbers, few *Salvadora* and few *Prosopis* trees. The detailed floristic survey of this island in October '92 revealed presence of about 54 species of plants mostly of littoral and swamp type. The native flora of this island is the better preserved due to its faraway location and less biotic interference.

2.4.5. Upputhanni Island

This island of around 30 ha area has good natural growth of vegetation. *Thespesia* and *Neem* are the main tree species and are growing from cut stumps. The large depression in the southern side of the island caused by coral mining about two decades back, has stagnation of rain water and sea water and has become a natural heronry for sea birds. There is good growth of *Avicenia* around this depression. There are good deposits of coral debris due to stoppage of coral removal in the last two decades. Patchy and fringing coral reefs are also giving protection to the island shores. There is absence of *Salvadora* on this island. During 91-92 afforestation was done on this island with *Thespesia* and *Vagai*.

2.4.6. Puluvinichalli Island

This has an area of about 6 ha. and fairly good halophytic vegetation. *Thespesia*, *Salvadora* and *Neem* have come up well from cut stumps. There are no mangroves or natural depressions on this island. There has been no afforestation activity on this island so far. There are good fringing and patch coral reefs around this island. There are signs indicative of large pearl oyster beds in the vicinity of this island.

2.4.7. Nallathanni Island

With an area of about 110 ha, it is situated about 2 kms from Mundal fishing village. In about 35 ha. of area planted by the Maraickayar family, there were 1600 coconut and 2000 palmyra palms in 1993 but now (2007) there are around 150 coconut trees and 300 palmyra palms present which are taken care by a lady who takes care the the Muniswaran temple built in this island. Many locals come to this temple for worship by private boats. Every year, in the month of March, this temple festival attracts nearly 200-300 pilgrims from nearby fishing villages. There is heavy growth of *Prosopis* on this island. Big trees of *Tamarind*, *Ficus*, *Thespesia*, *Salvadora* and coconut trees were seen with top portions dried up. As per the instructions of the Chief wildlife warden the coconut trees were left without maintenance which has resulted in a decline of coconut trees in this island. This is the only island where good potable water is available at upto 5' depth in one portion of the island.

2.4.8. Anaippar Island

This has an area of 11 ha. There are good coral reefs and patch coral formations around the island. There are no mangroves along the shore of the island. There are man made depressions with the island where once salt making was done and around this, *Avicenia officinalis* growth is present. The vegetation mainly consists of *prosopis* and occasionally *Salvadora*. There are patches of depressions where rain water and salt water accumulate during monsoons resulting in stagnation. Original stumps of mangroves plants are seen showing the degradation from previous years to the present. human interference was not much on this island though it is near to Valinokkam because of absence of good quality sea weeds and fishes around the island (Management Plan 1993-98). However, lately this island is currently used for drying seaweeds which has been collected nearby areas especially from Nallathani island by the fisher folks.

2.4.9. Valimunai Island Or (Palliyarmunai Island)

This has an area of 6.72 ha, and the present vegetation is mostly of *Salvadora* and a *Prosopis* trees. ground vegetation and grasses is also present to some extent. There are no depressions and mangroves are absent. There are evidences of heavy biotic interference on this island. There is good reef network surrounding the island but the island shores are not being protected with any mangrove vegetation. Occasional patches of *Pemphis acidula* are seen.

2.4.10. Poovarasapati Island

This island is submerged 25 years ago due to excessive quarrying of corals from its surroundings. The area where island was said to be present (09°09'504⁰N 78°45'201⁰E to 09°09'508⁰N 78°45'189⁰E) in the past, is now submerged at a depth of about 1.5Mt during lowtide. This is surrounded by a good growth of corals, sea grass and sea weed beds. A shifting sand mound is present near this island, which is seen during lowtides.

2.4.11. Appa Island

It is in 2 bits which is separated by a sand bar with shallow water permitting crossing on foot between the two bits. The southern part of the island has few *propolis* and *salvadora* trees on it. The main vegetation is *Prosopis* with occasional *Salvadora* and *Thespesia*. There are no mangrove patches and *Pemphis* growth to protect the island shores. One part of the island is of coral base with sand deposition where it is entirely *Prosopis* growth. In the other part due to constant wave action, the sand has been washed away and the underlying coral rocks have been exposed to wave action. There is good coral reef growth in continuation to the island. Recently, *Balanoglossus* and its habitat have been found around this island (WII survey, 2007).

2.4.12. Thalayari Island

It is about an hour by boat from Kilakarai. The general growth is mostly littoral vegetation with a small patch of *Avicenia*. Most of the island shore is protected by *Pemphis acidula* only. *Thespesia*, *Salvadora* and *Pemphis* are the predominant tree species at present.

2.4.13. Valai Island

The Valai island has an area of 10.15 ha. There is a sand bar connecting this to Thalayari island. It has good protection on either side by patchy and fringing coral reefs. The shores are protected mostly by good growth of *Pemphis acidula*.

The vegetation is quite good with *Salvadora* and *Thespesia* as the most predominant species. Ground level halophytic grass and other flora are also good. There are small patches of vacant areas with no tree growth, which can be afforested with *Salvadora*, *Thespesia* and *Neem* in the coming years.

2.4.14. Mullai Island

The area is 1020 ha and the island is protected by both patchy and fringing coral reefs. The vegetation is sparse with mostly ground level grasses, climbers. *Salvadora* and *Thespesia* are present which are seen sprouting from heavily lopped 2 year old stumps. There are two depressions inside the island and around the large depression good growth of *Avicenia avicinalis* is seen. In the other depression *Avicenia* is absent.

2.4.15. Hare Island

This island is frequented by local people. Coconut plantation had been done by the private lease holder. There are natural Palmyra trees also on this island. There are 2050 coconut trees and 1800 Palmyra trees. There are good *Pemphis acidula* growth skirting the periphery. There is a large depression surrounded by mangrove vegetation and which support a heronry where plenty of sea birds congregate. *Prosopis* and other halophytic vegetation are also good. Afforestation has been done on this island during 91-92. There are good patchy and fringing coral reefs around this island.

2.4.16. Manoli Island

This is an island with beautiful mangrove vegetation and *Pemphis acidula* along the periphery. There is good natural vegetation of *Salvadora*, *Thespesia* etc. There are good patchy and fringing coral reefs around this island. There are natural depressions acting as heronries for sea birds. There is a large sand bar connecting Manoli Island to Manoliputti and it has formed in the last two years. It is getting colonized by natural

vegetation. There is another sand bar recently formed on the southern side of this island. The colonization of this sand bar with natural species has not yet taken place.

2.4.17. Manoliputti Island

This is a very small-island separated by a shallow channel from Manoli. There is good live coral growth of both patchy and fringing type around this island. There is fairly good natural vegetation on this island including *Pemphis* and occasional mangrove species.

2.4.18. Poomarichan

The Pullivasal and Poomarichan islands are almost in the form of a horse shoe shape with the land connection during low tides and in this area a good aviary of marine birds like Seagulls, Plovers, Curlews, Terns etc can be seen. Mangrove species like *Rhizophora*, *Ceriops* are also seen in this island. *Pemphis* growth is very good in the intertidal region and it is a major species which is protecting the island shore line from getting eroded..

2.4.19. Pullivasal Islands

The Pullivasal island has a good vegetation at present and the fringes of the island in the intertidal region is has mainly the mangrove associate, *Pemphis* and on the inside, *Prosopis*, *Palmyrah*, *Thespesia* and other miscellaneous species are found. It is found that *Pemphis* growth is very good in the intertidal region and it is a major species which is protecting the island shore line from getting eroded. There are good coral reefs about 10 meters from the Pullivasal Island. Natural regeneration of mangrove is very good and the vegetation is also fairly good.

2.4.20. Krusadai Island

Known traditionally as a paradise for zoological collections, the fauna around this island has been extensively depleted since many decades. *Ptychodora flava*, the enteropneust worm and *Spirula* sp. (Cephalopoda) are unique representatives on this island. There is a old Marine Biological laboratory with few other buildings and a dilapidated old museum. There is good vegetation of Palmyra, *Prosopis* and other natural species like *Thespesia*, *Salvadora* etc. There is good coral reef growth around this island.

There is a new sand bar developed connecting Kundugal point which is 17 ha. in area. There is colonization by ground vegetation and at present grazing by the livestock of fishermen is seen on this sand bar. Planting of *Salvadora* and *Thespesia* and sowing of *Avicenia* seeds will help in afforestation of this sand bar. Fencing the linking portion of this sand bar to prevent livestock entry and planting native species will stabilize this sand bar.

2.4.21. Shingle Island

This has an area of about 13 ha. and has a heavy deposition of coral debris built up year after year. There is no vegetation skirting the periphery. Mangrove growth is seen only in a small depression in the northern corner of the island. There were no tree growth and good vegetation except *Pemphis spp* due to heavy anthropogenic pressure since it is nearer to the shore. Afforestation has been taken up on this island during 93-94. An artificial reef created by dumping of rubble to 1 m height has resulted in trapping the sand and preventing it from getting washed over the live coral

growth seen around this island. Thus natural coral regeneration has been ensured. There are good coral reefs both of patchy and fringing type around this island. Currently, due to plantation several trees dominated by *thespesia* are present here. However, this island seems to be known for open vegetation mainly covered with grasses. Plantation on this island should not be encouraged in future.

2.5. Threat assessment to Biodiversity of Gulf of Mannar National Park and Biosphere Reserve

2.5.1. Fishing

Unscientific and uncontrolled fishing and fisheries related activities are the major threats to the Biodiversity of the Gulf of Mannar Marine National Park.

2.5.2. Poaching of Dugongs, dolphins and Turtles

Killing of dugongs and dolphins (both these are locally called as “Avolia” and “Kadalpandir”) and turtles for sale for meat has reduced currently, 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 and of incidental catches of these by the fishermen are known to still occur.

2.5.3. Coral mining

Due to strict vigilance coral mining in the National Park and Biosphere Reserve has almost stopped, however, southern group of National Park is still used for small scale illegal coral mining by the coastal villagers from Vellapatti, Tharavaikulam and D Savariyarpuram.

2.5.4. Pollution and other hazards

The multitude of mechanized vessels operating in the area leads to pollution of the sea waters by the diesel and oil used by these vessels. Some times explosives are also used by the fishermen, which also causes lot of damage.

The thermal pollution caused by the thermal power station at Tuticorin and the possible effluents from the atomic power at Koodankulam also need to be studied and monitored. Adverse impact of industrial effluents from the various industries located at Tuticorin and along the coastal area also threatening the biodiversity of this region.

The combined effect of so many habitat disruptive and destructive factors operating on the marine ecosystem has progressively diminished the value of the entire ecosystem from various angles.

2.5.5. Sethusamudram Canal Project

The islands are built of a calcareous frame work of dead corals and coral reefs. The coral formations have taken place in the Gulf of Mannar due to the shelter provided on three sides by the Pamban, Srilankan and the Indian coast line. The Sethusamudram canal project across the Pamban may result in change of current patterns and a reversal of all marine factors which may drastically alter the dynamics of the ecosystem. Some of the islands may also be extensively obliterated by the dredging operations and alignment of the Sethusamudram canal. Though, the EIA

study on this project by NEERI predicted that there will not be any damage to the National Park and its biodiversity, it would be better that the Biosphere Authority should be prepared to tackle any kind of disaster caused due to this project, especially unfortunate accidents involving spill of hazardous chemical or oil from vessels using this canal, which may totally damage the ecosystem of the National Park.

2.5.6. Tourism Development on the islands

The department of tourism time and again propose to develop tourism on the islands of the Gulf of Mannar. Any tourism developmental activity on the islands by way of construction of lodges, restaurants, development of water sports etc will effect prevailing ecological balance. Hence, this management plan is not recommending any tourism activities in National Park but tourism zone has been identified outside the National Park (see chapter on tourism).The major ecosystems around these islands are now mostly recovering and any development process here would impede the natural recovery of these ecosystems, hence it is suggested that a few more years be given before considering opening up the islands to tourism, preferably in the next management plan.

2.5.7. Global warming

It is widely accepted that due to global warming the sea level is increasing world wide, therefore, the coral reef ecosystem are suspected to be under severe threat due to global warming and climate changes. In the Gulf of Mannar region, two islands are already been submerged and one of the reason for their submergence might be due to climate change and global warming.

2.5.8. Other possible threats to the Biosphere Reserve in future

1. Sand mining along the coasts
2. Hydro-carbon Exploration
3. Activities of Ports
4. Mineral extraction from sea bed
5. Human migration and demographic changes in the local community.
6. SEZ if any

Chapter 3

Proclamation of the Gulf of Mannar Marine National Park, Biosphere Reserve and Conservation History

3.1 Establishment of the Gulf of Marine Marine National Park

It was the Government of India by their letter No. K. 11011/39/76 FYR (WL) dated 23 November 1976, proposed that the Gulf of Mannar area in the Tamil Nadu coast to be considered for the establishment of India's first Marine National Park. The rationale was based on the fact that the Gulf of Mannar, off the coast of Tamil Nadu, where there are 21 islands mostly of coral origin are very significant from the Zoological point of view. This area is the last refuge of any significance off the Indian coast where the most endangered mammal, Dugong (*Dugong dugon*) occurs. The area also contains the rare and unique Balaoglossus which is a link between invertebrates and vertebrates. The area is also very richly endowed with unique coral formations, marine shells, molluscs and tropical fish associated with coral islands. The playful Dolphins are also seen in this area. Through creation of India's first marine National Park, all these can be protected from irretrievable destruction.

Government of Tamil Nadu vide G.O. Ms. No. 226 Forest and Fisheries, Department dated 3 March 1980 notified the intention of setting up of the Marine National Park in Gulf of Mannar for the protection of Wildlife and its environment. Subsequently vide G.O. Ms. No. 962, Forests and Fisheries Department dated: 10.09.1986 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 5 fathom depth on the seaward side was issued.

Since all the islands except Nallathanni island and Hare island were poramboke lands, the Hare island which belonged to Mandapam Marakayar was purchased by the State Government of a cost of Rs.29,88,216/-, and Nallathani island from Lottampsa for Rs.9,03,138/-. All these 21 islands were then notified as reserve lands under Sec.26 of the Tamil Nadu Forest Act and were proposed to be notified as reserve forests. The intention to notify these islands and the sea around the islands upto 3.5 to 5 fathom depth, as a National park under the provisions of the Wildlife Protection Act 1972 have also been published in the Gazette Notification of Tamil Nadu Government. Draft notification of the islands under Section of the Tamil Nadu Forest Act 1882 has been sent and is under scrutiny. The Forest settlement officer Sivaganga is taking further action under sections 19 to 25 of the Wildlife Protection Act 1972 to constitute these islands and the area around them as a National Park. Actions area being pursued by him/her on this matter.

Establishment of Gulf Mannar Biosphere Reserve

After the concurrence of the Tamil Nadu Governemnt (Telex message NO.75612 / FRV / 88 –3, dated the 24th January 1989) to the proposal of the Government of India for setting of a Marine Biosphere Reserve in Tamil Nadu, the Government of India vide their Notification No. No. 1/6/80-Mannar, dated 4th April 1989, declared the Indian part of the Gulf of Mannar region covering an area of 10500 sq. km as the Gulf of Mannar Biosphere Reserve (GOMBR). It also suggested that the Tamil Nadu Government for preparation of detailed maps of the Biosphere Reserve and to initiate management of the BR as per the Government of India Guidelines. However, there have been no management plan for the GOMBR though the management of the BR was under the direction of the CWLW, TN and implemented by the Wildlife Warden under the supervision of the Southern Regional Wildlife circle at Madurai and later under the supervision of Conservator of Forests, Virudhanagar circle designated as the Director, GOMBR.

Since the GOMBR surrounding the Marine National Park is the area where the local communities are dependent for their livelihood, the Tamil Nadu Government established the Gulf of Mannar Biosphere Reserve Trust (GOMBRT) under the Tamil Nadu Society Registration Act, 1975 vide TN G.O. Ms. No. 263, E&F-FR (V), dated 18.12.2000 as a Special Purposed Vehicle to coordinate and ensure effective inter sectoral coordination and facilitate mainstreaming of biodiversity conservation issues into the productive sector and policy development. Government of Tamil Nadu sought support and assistance of the GEF-UNDP through a project ‘Conservation and sustainable use of the Gulf of Mannar BR coastal biodiversity’. The GEF-UNDP approved this seven year project in the year 2002 at the cost of Rupees 140 crores, of which, the GEF-UNDP contribution was tune of Rupees 40 crores and co-funding from the Government of Tamil Nadu, Government of India and others to the tune of Rupees 100 crores.

Therefore, in addition to the Wildlife Warden, GOMMNP and the Director, GOMBR, the Director, Gulf of Mannar Biosphere Reserve Trust are jointly responsible for protection, management and development of the GOMBR.

While the Gulf of Mannar Marine National Park is managed under the provision of the Wildlife (Protection) Act, 1972, the Indian Forest Act, 1927, Forest (Conservation) Act, 1980, Environmental (Protection) Act, 1986, National Forest Policy, 1988, Coastal Zone Regulation Act, 1992 and Coastal Zone Management Plans of the Tamil Nadu State Government are some of the legal instruments which are supportive and are applicable for protection and management of both the Gulf of Mannar Marine National Park and Biosphere Reserve.

Notification of Gulf of Mannar National park
(G.O.Ms.No. 962, Forests and Fisheries, 10th September 1986)

No.II (2) FRFI/473/87 – Whereas it appears to the government of Tamilnadu that the area , the limits of which are more fully described in the schedule below, by reasons of its ecological , faunal, floral and Zoological association and importance needs to be constituted as a National park for the purpose of protecting Wildlife there in and its environment.

Now, therefore, in exercise of the powers conferred by sub-section (1) of section 35 of the Wild life (Protection) Act, 1972(Central Act 53 of 1972) the Government of Tamilnadu hereby declares his intention to constitute the said area as a National Park.

SCHEDULE

1. Islands, in the Gulf of Mannar, off the east of Tirunellveli district, in the East, Known by the names specified in column (1) of the Table below and within the limits specified in the corresponding entries in columns (2) – (6) there of and he area limited within the boundaries formed by the Latitudes and Longitudes indicated to the points marked in he diagram.
2. Islands, in the Gulf of Mannar, off he coast of Ramanathapuram district, in the South known by the names specified in column (1) of the Table below and with in the limits specified in the corresponding entries in columns(2)-(6) thereof and the area limited within the boundaries formed by the latitude and Longitude indicated the points marked in the diagram.

Name of the island	Area in Ha.	Circumference (m)	Distance from main land (kms)	Latitude	Longitude
Van tivu	16	2015	6 km from Tuticorin	A 8°49'N	78° 11' 30" E
Kasubar island	19.50	2160	7 km from Tuticorin	B 8° 49' N	78° 14' 30" E
Karaichalli island	16.46	1610	15 km from Tuticorin	C 8°55'30" N	78° 18' 30" E
Vilanguchalli	0.95	614	15 km from Tuticorin	D 8° 58' 30" N E 8° 57' N	78° 15' 45" E 78° 15' 45" E
Upputhani island	29.94	2292	8 km from Vember	A9° 2' 30" N	78° 28' 30" E
Puluvnichalli island	6.12	1372	18 km from Vember	B9° 6' 15" N	78° 37' 20" E
Nallathani island	110.00	4700	2 km from Mundal	C 9° 7' 15" N D 9° 5' 35" N	78° 34' 40" E 78° 27' 20" E
Anaipar island	11.00	1605	9 km from Kailakarai	A 9° 7' 30" N	78° 41' 40" E

Valimunai island (Palliarimunai island)	6.72	1170	9 km from Kilakarai	B 9 ⁰ 7' 23" N	78 ⁰ 45' 00" E
Appa island	28.63	4840	8 km from Kilakarai	C 9 ⁰ 9' 20" N	78 ⁰ 51' 30" E
Poovarasampatti island	100m*25m	---	Mid way between Valimunai & Appa	D 9 ⁰ 10' 00" N E 9 ⁰ 10' 00" N	78 ⁰ 52' 30" E 78 ⁰ 59' 45" E
Tailari island	75.15	8338	10 km from Kailakarai	F 9 ⁰ 13' 20" N	78 ⁰ 59' 45" E
Valai island	10.15	1889	-do-	G 9 ⁰ 13' 20" N	78 ⁰ 52' 45" E
Mulli island	10.20	1712	9 km from Kailakarai	HIJ 9 ⁰ 13,25" N I 9 ⁰ 12' 20" N J 9 ⁰ 9' 15" N	78 ⁰ 52' 30" E 78 ⁰ 51' 30" E 78 ⁰ 40' 20" E
Hare island(musal island)	129.04	11520	7 km from Mandapam camp	A 9 ⁰ 10' 00" N B 9 ⁰ 10' 00" N	79 ⁰ 2' 5" E 79 ⁰ 11' 10" E
Manoli island	25.90	2958	6 km from Mandapam camp	C 9 ⁰ 13' 5" N D 9 ⁰ 13' 18" N	79 ⁰ 10' 5" E 79 ⁰ 8' 25" E
Manoputti island	2.34	940	5 km from Manapam	E 9 ⁰ 14' 3" N F 9 ⁰ 14' 5" N G 9 ⁰ 13' .5" N	79 ⁰ 6' 10" E 79 ⁰ 5' 7" E 79 ⁰ 2' 5" E
Poomarichan island	16.58	2500	3 km from Mandapam	AA 9 ⁰ 11' 40" N BB 9 ⁰ 13' 25" N	79 ⁰ 10' 45" E 79 ⁰ 15' 00" E
Pullivasal island	29.95	5520	3 km from Mandapam camp	C 9 ⁰ 15' 5" N D 9 ⁰ 15' 10" N	79 ⁰ 15' 00" E 79 ⁰ 14' 10"
Krusadai island	65.80	5193	3 km from Pamban	E 9 ⁰ 15' 00" N F 9 ⁰ 15' 00" N G 9 ⁰ 15' 10" N H 9 ⁰ 15' 7" N I 9 ⁰ 15' 00" N	79 ⁰ 13' 25" E 79 ⁰ 13' 10" E 79 ⁰ 12' 10" E 79 ⁰ 11' 35" E 79 ⁰ 10' 45" E
Shingle island	12.69	1736	4 km from Pamban	J 9 ⁰ 14' 35" N	79 ⁰ 10' 5" E
TOTAL	623.12Ha	64684 m			

Sector VI : Area between islands 15 to 17 and 18 to 21

A – 9⁰ 13' 35" N. Lat. 79⁰ 8' 25" E. Long

B – 9⁰ 14' 00" N Lat 79⁰ 9' 35" E Long

C – 9⁰ 15' 5" N Lat 79⁰ 9' 15" E. Long

D – 9⁰ 14' 15" N Lat 79⁰ 8' 10" E Long

**No 1/6/80- Mannar
Government of India
Ministry of Environment & Forests**

“PARYAVARAN BHAVAN”
CGO Complex, Phase - II
Lodi Road , New Delhi,
New Delhi – 110 003.
Date: 4th April, 1989

To,
The Chief Secretary,
Government of Tamilnadu,
S. Fort George,
Madras.

**SUB: ESTABLISHMENT OF GULF OF MANNAR BIOSOPHER
RESERVE**

Sir ,

1. The Government of India has identified potential sites for preserving biological diversity with the following broad objectives :
 - Conservation of representative samples of ecosystem.
 - Provision of long – term conservation of genetic diversity in-situ
 - Promotion of basic and applied research work and its monitoring ; and
 - Dissemination of experience for education and training.
2. The Gulf of Mannar represents the unique marine ecosystem in the Indian part of the Gulf situated between India and Sri Lanka . In accordance with the guidelines on the subject, a project document for setting up of Biosphere Reserve in the Gulf of Mannar was prepared by Prof. K.Krishnamurthy, the then Director, Centre for Advanced study in Marine Biology, Annamalai University. This has been considered in detail by the Government of Tamilnadu and the Government of India.
3. In their telex message NO.75612 / FRV / 88 –3, dated the 24th January 1989, the Government of Tamilnadu have conveyed their acceptance of the proposal for setting up of Biosphere Reserve in Gulf of Mannar area. It has, therefore, been decided that the Gulf of Mannar Biosphere Reserve should formally be deemed to have come into being with effect from 18th February, 1989.
4. The Indian part of the Gulf covers approximately an area of 10,500 sq.kms, running southwards and parallel to the main land coastline to a distance of about 170 nautical miles and lies between 78^o 11' and 79^o 15' E longitudes and 8^o 49' and 9^o 15' latitude. It has an area of 21 islands starting from the north most Pamban island to Thoothukudi. The boundary and zonation in core and buffer zones of the Biosphere Reserve are given at Annexure – I . The details of the area to be earmarked for manipulation activities such as aquaculture, etc., will be worked on by the project authorities.

5. The following will be the important aspects of the Gulf of Mannar Biosphere Reserve:

- a. The core and the buffer areas and manipulation activities which may be permitted in the buffer zones will be submitted by the Government of Tamilnadu.
- b. The core zone of the Biosphere Reserve will be kept absolutely undisturbed.
- c. The constitution of the Biosphere Reserve by itself will not, in any way, change the status of legal ownership of the land
- d. There will be a Biosphere Reserve Management council with the composition as shown in Annexure – II
- e. The Government of India will provide financial assistance for approved items for expenditure included in the section and Management plan to be prepared by the Government of Tamilnadu. This may broadly be classified under the following heads:
 - § Survey
 - § Conservation
 - § Protection
 - § Ecorestoration
 - § Education and awareness.
- f. here will be a Research Committee as per the composition shown in Annexure – III
- g. The subject of research and institution identified for the purpos are shown I Annexure – IV
- h. The Government of Tamilnadu will set up a local committee for coordination of he activities of varies departments in the area covered by the Biosphere Reserve.

(K. P. Geethakrishnan)
Secretary to the Government of India

ANNEXURE I & II

Management Council – Gulf Of Mannar Biosphere Reserve

- | | |
|---|------------|
| 1. Secretary, Ministry of Environment and Forests. | - Chairman |
| 2. Joint Secretary(WL), \Ministry of Environment and Forests | - Member |
| 3. Joint Secretary/ FA, Ministry of Environment and Forests | - Member |
| 4. Representative of State Government of Tamil Nadu | - Member |
| 5. Director of Gulf of Mannar Biosphere Reserve | - Member |
| 6. Representative of Botanical Survey of India | - Member |
| 7. Director-in-charge of Biosphere Reserve Programme in the Ministry of Environment and Forests | - Member |

Region 2 – This region comprises six islands between Keelakkarai and Mukkaiyur viz., Upputhanni Tivu, Pullivunnichalli Tivu, Nallathanni Tivu, Anaipar Tivu. Valimunai Tivu and Poovarasampatti Tivu.

The Core Zone – The Core Zone of this region comprises three islands Nallathanni Island, Pullivunnichalli Island and Anaipar Island.

The Buffer Zone – The immediate sea and the following two islands will constitute the

Buffer zone:

- a) Vallimunai Island
- b) Poovarasampatti Island

Region 3 – The main land coastline from Mukkaiyur to Tuticorin extends to about 120Km. This Region lies between Mukkaiyur and Tuticorin comprising four islands, viz., Van Tivu, Kasuvar Tivu, Vilanguchalli Tivu and Karaichalli Tivu.

The Core Zone – The pearl banks near and away from Tuticorin.

The Buffer Zone – the buffer zone will comprise the following four islands:

- a) Van Tivu
- b) Kasuvar Tivu
- c) Karaichalli Tivu
- d) Vilanguchalli Tivu

Region 4 – This region lies between the Tuticorin and Kanyakumari and Extends to about 110Kms.

The Core Zone – The area having pockets of pearl banks and chank beds will constitute “Natural Core Zone”.

The Buffer Zone – The remaining will be buffer zone.

ANNEXURE – III

Composition of Research on Gulf of Mannar Biosphere Reserve

1. Prof.K.Krishnamurthy, Centre for Advanced Studies in Marine Biology, Annamalai University. - Chairman
2. Representative of Tamil Nadu Government - Member
3. Representative of Pondicherry University - Member
4. Representative of Madras University - Member
5. Representative of Madurai Kamaraj University - Member
6. Representative of the Regional Centre of the Central Marine Fisheries Research Institute, Mandapam Camp. - Member
7. Representative of Botanical Survey of India - Member
8. Representative of Zoological Survey of India - Member
9. Representative of the Ministry of Environment and Forests, New Delhi. - Member

ANNEXURE – IV

List Of Research Institutions and Priority areas Identified for Undertaking Research in Gulf of Mannar Biosphere Reserve.

- | | |
|---|------------------------|
| 1. Southern Circle Botanical Survey of India, Coimbatore. | - Floral Inventory. |
| 2. Southern Regional Station Zoological Survey of India. Madras- | Faunal Inventory |
| 3. Pondicherry University (Salim Ali Centre of Ecology) | - Ecological Studies |
| 4. Madras University/ Madurai Kamaraj University/ Annamalai University | - Marine Biology |
| 5. National Institute of Oceanography, Goa | - Mangroves and Coral |
| 6. Regional Center of the Central Marine Fisheries Research Institute, Mandapam | - Fisheries and Corals |
| 7. Bharathidasan University | - Sea grass |
| 8. Center for Brackish Water Aquaculture, Madras | - Fisheries |

3.2. History of conservation and Management of Gulf of Mannar Marine National Park and Biosphere Reserve

3.2.1. Gulf of Mannar National Park

For a long time, the entire region was under the control of the Tamil Nadu state Revenue and Fisheries Departments. It was only after declaration of the Marine National Park in September 1986, the Forest Department took over the management of the islands of Gulf of Mannar in November 1989. From 1990 – 1991 onwards, Annual Management Action Plans were formulated by the Forest Department and activities in the Gulf of Mannar Marine National Park had been regulated.

The first Management plan for the Gulf of Mannar Marine National Park for the period of 1993-94 to 1997-98, was prepared by Thiru K. S. Neelakantan (TN Forest Department, 1994). The Plan proposed a detailed study on all possible aspects of the entire coastal and marine ecosystems, including socio-economic status of the dependent fisher-folk. After 1998, there has been no management plans, for the Marine National Park and management activities have been carried out as per the Annual Plan of Operation prepared by the Wildlife Warden of the National Park from 1999 to 2007.

3.2.2. Gulf of Mannar Biosphere Reserve

After the concurrence of the Tamil Nadu Governemnt (Telex message NO.75612 / FRV / 88 –3, dated the 24th January 1989) to the proposal of the Government of India for setting of a Marine Biosphere Reserve in Tamil Nadu, the Government of India vide their Notification No. No. 1/6/80-Mannar, dated 4th April 1989, declared the Indian part of the Gulf of Mannar region covering an area of 10500 sq. km as the Gulf of Mannar Biosphere Reserve (GOMBR). Suggesting the Tamil Nadu Government for preparation of detailed maps of the Biosphere Reserve and to initiate management of the BR as per the Government of India Guidelines. However, there have been no management plan for the GOMBR though the management of the BR was under the direction of the CWLW, TN and implemented by the Wildlife Warden under the supervision of the Southern Regional Wildlife circle at Madurai and later under the supervision of Conservator of Forests, Virudhanagar circle designated as the Director, GOMBR.

The Tamil Nadu Government also established the Gulf of Mannar Biosphere Reserve Trust in the year 2000 to coordinate and synergize involvement of other sectoral agencies with the Tamil Nadu Forest Department in activities related to sustainable coastal and marine biodiversity conservation through rational utilization and management in the Biosphere Reserve through community participation. Since the establishment of the GOMBRT, activities in the BR have been managed through Annual Plan of Operation prepared by the Trust. After the approval of a GEF-UNDP sponsored project in year 2002, the GOMBRT, all activities in the BR have been carried out by the Trust under the supervision and approval of its 'Board of Trustee' chaired by the Chief Secretary, Government of Tamil Nadu.

The ten year composite integrated management plan for the period 2007-2016 for the Gulf of Mannar Marine National Park and Gulf of Mannar Biosphere Reserve has been developed in the year 2007 by the Wildlife Institute of India facilitated by the GOMBRT and the first Management Plan for a Marine Biosphere Reserve in India.

3.4. Geographic scope of the current Integrated Management Plan and zonations

The geographic scope of the Management Plan encompasses the proposed Gulf of Mannar Biosphere Reserve (GOMBR) and the Marine National Park as the core area within the GOMBR. The GOMBR also encompasses a terrestrial area up to 10 km from the coast line from Dhanuskodi Island on the north-east (Ramanathapuram District) to Cape Comorin in South (Kanyakumari District) covering all along the four coastal districts of Ramanathapuram, Tuticorin, Tirunelveli and Kanyakumari.

Selective control of activities at different zones is proposed in the plan, including both strict protection and various levels of use.

3.4.1. The Core zone (Gulf of Mannar Marine National Park)

Core conservation areas (sites of high diversity, critical habitats of threatened species, and special research areas) in which disturbing/destructive uses are strictly prohibited. This zone can also protect breeding populations of fishes and other organisms for the natural replenishment of neighboring fishing areas such as buffer zone where resource utilization is allowed.

All the 19 islands and 2 submerged island and the sea portions surrounding the islands up to 6.405m (3.5 fathoms) on the bayside and 9.5m (5 fathoms) depth toward the seaward side, which is the National Park area is the Core Zone and the rest of the area of the seascape i.e. up to 20 m depth and the coastal terrestrial areas (10 km from the high tide mark to landward side) will be the Biosphere Reserve and forms the buffer zone for the Marine National Park.

It is observed that by an hindsight, the boundary of the Tuticorin cluster of islands based on quadrates mentioned in the National Park Notification has omitted Karaichalli Island, which has been included into the Marine National Park, accordingly the boundary line was redrawn. Partitioning of the Marine National Park into five clusters of core zones provides options for planning navigation routes, better policing and protection and opportunities for sustainable migration and harvest of resources from the core to the buffer. The total area of the Marine National Park constitutes about 10% of the northern half of the Biosphere Reserve and may only be 4% of the total Biosphere Reserve as a undisturbed, closed and no take area.

Except research, monitoring and restoration of biodiversity, no other activities is proposed to be permitted in the core zone. The strict protection given to the core zone will result in spillover and migration of the faunal wealth to the buffer zone and will be available and can be harvested in sustainable manner by people who directly depend on these resources for their livelihood especially those who live in the buffer zone. It will also help in the economic development and a source of revenue to these coastal districts.

Core zone at present have a good representation of the various marine ecosystems component and are fairly in good condition which need to be strictly protected without major management activities. Research and monitoring, habitat restoration (mangrove restoration, coral reef restoration, seagrass beds restoration, stock enhancement of critically endangered species such as sea horse, holothurians etc.,

removal of invasive species) and protection are the only three activities proposed to be taken up inside the National Park. Plantation of exotic species is to be strictly prohibited on the islands and removal of these exotic species is also prescribed with proper planning.

3.4.2. The Buffer zone - Gulf of Mannar Biosphere Reserve (The Utilisation/Manipulation/Experimental zone)

This zone is proposed to be permitted for local people's use such as fishing and fisheries related activities. The seascape surroundings the islands beyond the limits of the National Park will form the buffer zone i.e. up to 20 m depth in seascape around the National Park and the coastal areas (10 km from the high tide mark to landward side) will form the buffer zone of the Biosphere Reserve. As per the Notification of the Gulf of Mannar Biosphere Reserve the total area of the Reserve is reported to be 10500 sq. km which extend from Dhanuskodi Island to Cape Comorin. However, based on the 20 m depth south-eastern boundary of the Biosphere Reserve the actual size of the Reserve need to be calculated after the Chief Naval Hydrographer provides a detailed map up to 20m depth.

Activities in this zone suggested are:

1. Eco-developmental activities
2. Tourism
3. Permitted eco-compatible fishing
4. Maritime navigation
5. Artisanal fisheries
6. Sea weed collection
7. Shell collection using traditional methods
8. Restoration of habitats/species
9. Mariculture using native species

3.4.3. Eco-developmental Zone (Terrestrial)

Ten kilometer stretch of coastal land starting from the sea shore all along the Biosphere Reserve are identified as the Eco-developmental (terrestrial) zone. This zone is also to be utilised for multiple use as like the Utilization zone.

3.4.4. Restoration zone

Restoration zone— enable damaged areas to be set aside to recover. Both core zone and buffer zone can be used for restoration of habitat/species. All the islands are infested with invasive species. These islands need to be restored to their original state by eradicating invasive species from these islands. Northern group of islands such as Mandapam and Kilakarai groups are proposed to be used for restortation of mangrove habitat during this Management Plan period. Degraded coral reefs in the Southern group of islands need to be restored. Detailed prescriptions are available in the concerned chapters.

3.4.5. Tourism zone

Tourism zone is proposed to be used for various recreational activities (bird watching snorkeling, coral watching etc) to increase the enjoyment and safety of the each

pursuit. Eco-tourism is proposed to be allowed in the Biosphere Reserve. As a part of the value addition to the Eco-tourism in the Gulf of Mannar Biosphere Reserve, around 50 km stretches of land areas around the Biosphere Reserve has also been identified and proposed as 'Tourism Zone for Value Addition' with community participation. All the tourist centers in this area have been assessed and included as potential tourism resources in the Eco-tourism sub plan in this Management Plan. The range of activities that can be permitted or not in each one have been given in Table 3.1.

Table 3.1. Important permissible activities in various zones of the Gulf of Mannar Biosphere Reserve and National Park

		Monitoring Habitat/ Species	Coral reef restoration	Seagrass bed restoration	Mangrove restoration	Endangered Species recovery programs	Coral watching using glass bottomed boat	Snorkeling	Scuba diving	Fishing & crabbing	Research with permit	Navigation	Aquaculture	Stock enhancement of fishes
Core Zone	Mandapam	Y	Y	Y	Y	Y	N	N	N	N	Y	N	N	Y
	Keelakkarai	Y	Y	Y	Y	Y	N	N	N	N	Y	N	N	Y
	Vembar	Y	Y	Y	Y	Y	N	N	N	N	Y	N	N	Y
	Tuticorin	Y	Y	Y	Y	Y	N	N	N	N	Y	N	N	Y
Buffer Zone		Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
Eco- Development Zone		Y	N	N	Y	Y	Y	N	N	Y	Y	Y	Y	Y
Tourism Zone	Water	Y	N	Y	N	N	Y	Y	Y	Y	Y	Y	Y	N
	Land	Y	N	N	Y	N	N	N	N	-	Y		Y	N

3.4.5. Delineation of boundaries

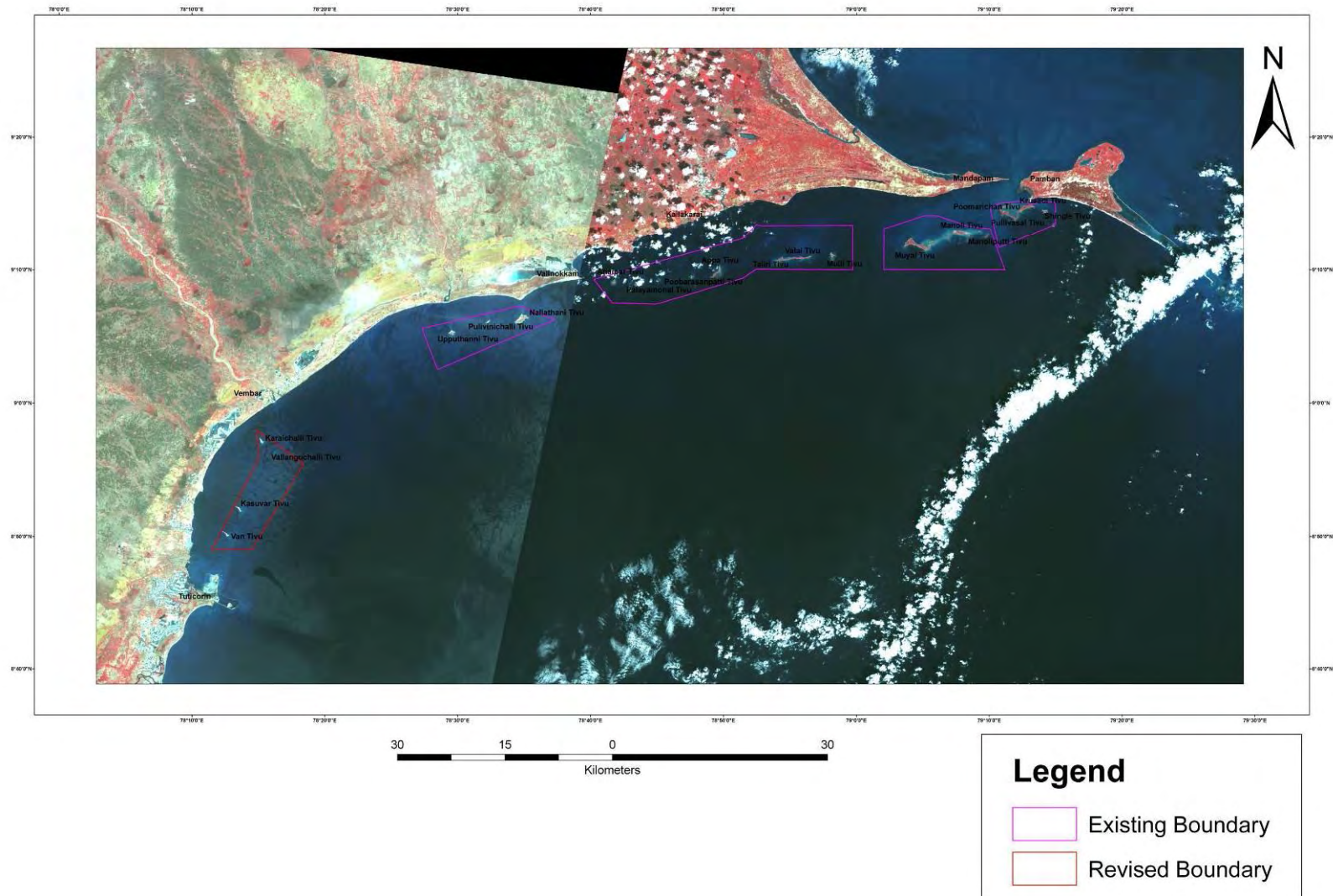
Notification of Gulf of Mannar National Park and Gulf of Mannar Biosphere Reserve need to be reviewed from time to time with respect to sensitivity of the eco-zones and their response to management. It has been proposed in the Management Plan to identify and include EIVs (Entities of Irreversible Value) within the Biosphere Reserve as per the new guidelines of the Ministry of Environment and Forests, Government of India under its programme of Regulatory Regimes in Biosphere Reserve. These EIVs will then be protected as equivalent to core zones.

The boundary demarcation of the Biosphere Reserve, especially the seascape side needs to be reviewed at five years intervals as the bathymetry of the sea tends to change. The boundaries of the National Park 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 as per the Notification. Coloured buoys in every 250 m to 500 m distance for the National Park boundary and buoys with automatic illumination system to alert the vessels along the boundary of Biosphere Reserve needs to be installed in every five kilometer may be considered. Registered fishermen who use trawlers and are not supposed to fish inside the Biosphere Reserve need to be assisted by the Government to install required equipments such as GPS etc to receive the alarm signal if they approach the Biosphere Reserve boundary.

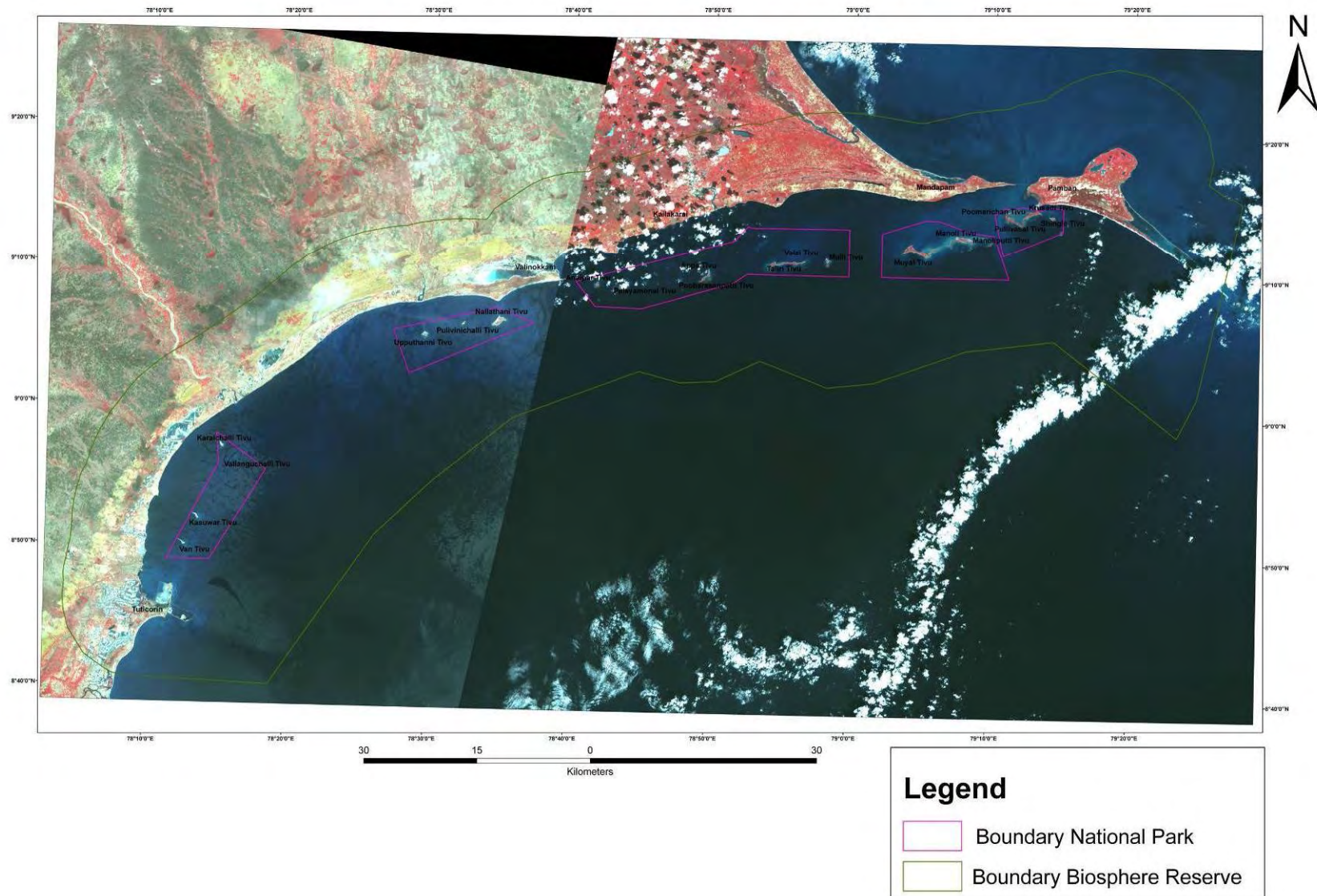
Table 3.2. Activity schedule

Sl.No.	Activity	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1.	Zonation & boundary lineation	√									

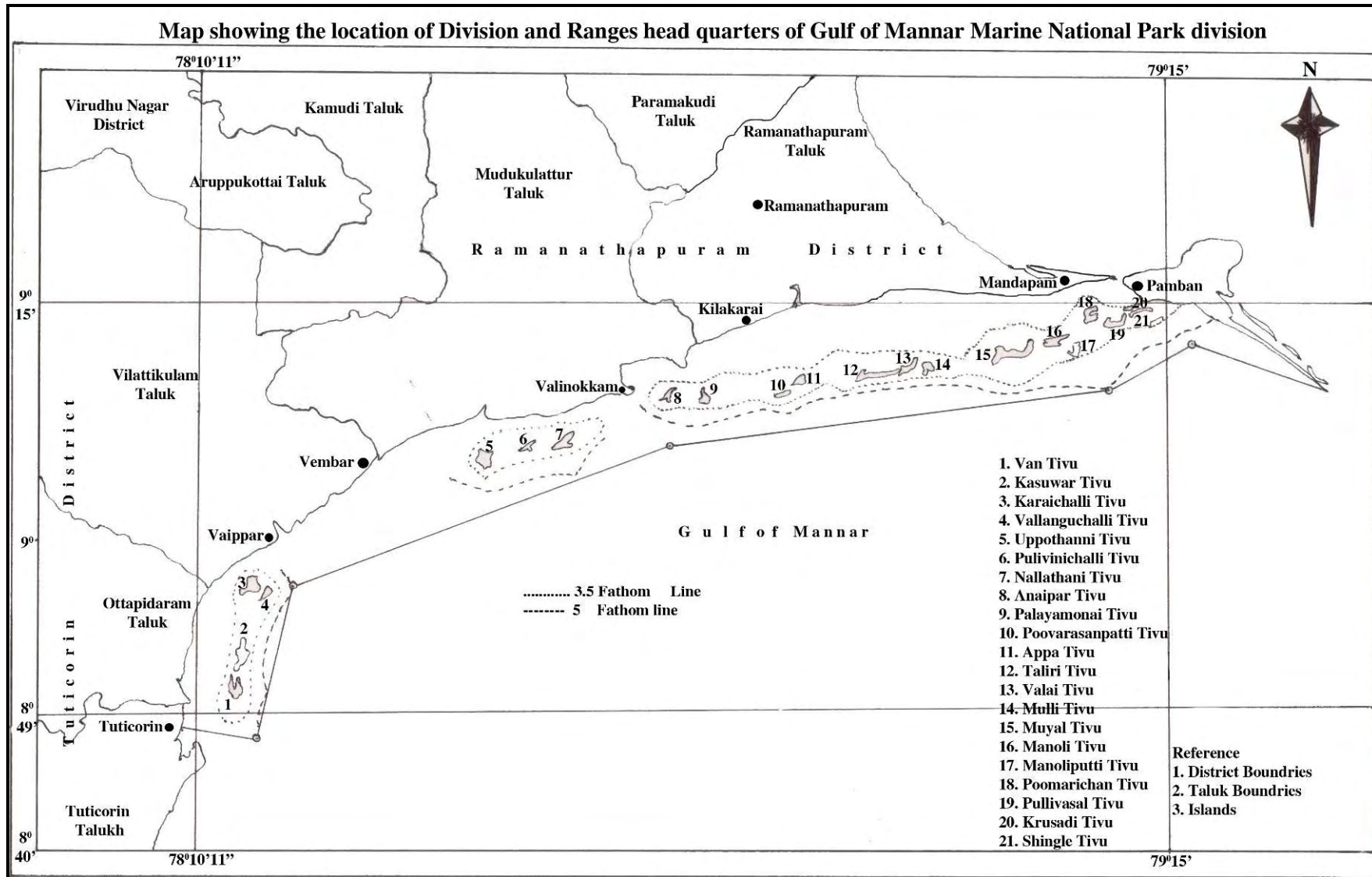
Gulf of Mannar Marine National Park



Gulf of Mannar Marine Biosphere Reserve



Map showing the location of Division and Ranges head quarters of Gulf of Mannar Marine National Park division



Chapter 4

Management Plan for the Marine National Park - the Core Zone of the Gulf of Mannar Biosphere Reserve

4.1. Geographic scope of the Gulf of Mannar Marine National Park

All the 21 islands including 2 submerged in the Gulf of Mannar along the Ramanathapuram and Tuticorin Districts and the sea portions surrounding the islands up to 6.405m (3.5 fathoms) on the bayside and 9.5m (5 fathoms) depth toward the seaward side, is the National Park area and the Core Zone (Map 1). The surrounding seascape i.e. up to 20 m depth and the coastal terrestrial areas upto 10 km from the high tide mark to the landward side is the buffer zone for the Marine National Park.

It is observed that by an hindsight, the boundary of the Tuticorin cluster of islands based on quadrates mentioned in the National Park Notification has omitted Karaichalli Island. After inclusion of the Island and surroundings seascape upto 3.5 fathom depth into the Marine National Park, the total area of the GOMNP comes to 502 sq. km. Partitioning of the Marine National Park into five clusters of core zones provides options for planning navigation routes, better policing and protection and opportunities for sustainable migration from the core to the buffer and harvest of resources. The 502 sq. km area of the Marine National Park constitutes about 10% of the northern half of the Biosphere Reserve and may only be 4% of the total Biosphere Reserve as a undisturbed, closed and no take area.

4.2. Protection measures

Except research, monitoring of biodiversity and restoration, no other activities is proposed to be permitted in the core zone. The strict protection given to the core zone will result in spillover and migration of the faunal wealth to the buffer zone and will be available and can be harvested in a sustainable manner by the people who are directly depend on these resources for their livelihood, especially those who live in the terrestrial buffer zone. It will also help in the economic development and a source of revenue to these coastal districts.

Core zone area at present has a good representation of the various marine ecosystems components and are fairly in good condition which need to be strictly protected without major management interventions. Research and monitoring, habitat restoration (mangrove, coral reef, seagrass beds and stock enhancement of critically endangered species such as sea horse, holothurians etc., removal of invasive species) and protection are the only three activities proposed to be taken up within the National Park. Plantation of exotic species is to be strictly prohibited on the islands and removal of these exotic species with proper planning is also prescribed.

The core zone of the Biosphere Reserve i.e. the Marine National Park and its biodiversity need to be protected strictly from any kind of anthropogenic activities except the activities related to habitat and species restoration and research and monitoring. Therefore, it is important to strengthen the protection force of the Biosphere Authority by having Forest Watchers Headquarters in each island, which is in addition to the existing protection force. Minimum of two forest watchers should be posted in each of the island with a motorboat and communication systems. People who are posted on the island needs to be given special incentives and their stay on the islands should not harm the biodiversity at any level. Minimum accommodation facilities (eco friendly protection huts) may be created in each larger island. Responsibilities of the proposed protection force under the control of the Wildlife Warden need to be extended to other zones of the Biosphere Reserve too. Any violation of the Indian Wildlife Protection Act, 1972 and the Management Plan of GOMBR, any where in the Biosphere Reserve should not be allowed. This should be the responsibilities of the protection force under the Wildlife Warden of the National Park and also by the other staff of the Biosphere Authority

Table 4.1. Existing head quarters and stations of the protection personnel of Gulf of Mannar Marine National Park division

Sl. No.	Name of Division / Range	Head quarters of Division / Range	Forester's head quarters	Forest Guard's head quarters	Forest Watchers head quarters	Mali head quarters
	<u>I. Sanctioned</u>					
1.	Wild Life Warden	Ramanathapuram	-	-	-	-
2.	Forest Ranger, Ramanathapuram	Ramanathapuram	1. Ramanathapuram 2. Thondi	1. Ramanathapuram 2. Thondi 3. Uppar *	-	1. Ramanathapuram *
3.	Forest Ranger, Kilakarai	Kilakarai	1. Kilakarai	1. Kilakarai 2. Earwadi 3. Periyapattinam	1. Earwadi	-
4.	Forest Ranger, Mandapam	Mandapam	1. Mandapam 2. Rameswaram *	1. Mandapam 2. Rameswaram 3. Utchipuli	1. Mandapam	-
5.	Forest Ranger, Tuticorin	Tuticorin	1. Tuticorin * 2. Vembar	1. Tuticorin 2. Tuticorin 3. Vembar *	-	-
	Total	4	7	12	2	1

Table 4.2. Existing network of wireless communication in Gulf of Mannar Marine National Park division, Ramanathapuram

Stock particulars			Particulars of distribution		
Base set	Mobile	Walkie talkie	Base set	Mobile	Walkie talkie
11 Nos	9 Nos	25 Nos	Wild Life Warden Office – 1 No	Warden Jeep - 1 No	Warden Office - 1 No
			Mandapam Range Office - 1 No	4 Range Jeeps - 4 Nos	Ramnad Range - 3 Nos
			Tuticorin Range Office - 2 Nos	CF Office - 1 No	Mandapam Range - 5 Nos
			Kilakarai Range Office - 2 Nos	Stock at Office - 3 Nos *	Tuticorin Range - 6 Nos
			Stock at Office - 5 Nos *		Kilakarai Range - 5 Nos
					Stock at Office - 5 Nos *

* To be distributed to field staff and division office.

Table 4.3. Details of existing patrolling vehicles, boats and other infrastructure in Gulf of Mannar Marine National Park division, Ramanathapuram

Description	Nos
<u>I Boats</u>	
Wooden boat i) At Tuticorin - 32" length	1
ii) At Rameswaran - 32" length	1
<u>II. Out board motor fiber boats</u>	
OBM Fiber boat i) At Tuticorin	1
ii) At Kilakarai	1
iii) At Mandapam	1
<u>III. Jeeps</u>	
i) Wild Life Warden, Ramanathapuram	1
ii) Assistant Conservator of Forests, Ramanathapuram	1
iii) For Kilakarai Range Officer	1
iv) For Mandapam Range Officer	1
v) For Ramanathapuram Range Officer	1
vi) For Tuticorin Range Officer	1

4.2.1 Prescriptions

- i. The Gulf of Mannar Marine National Park is governed by the Wildlife (Protection) Act, 1972, therefore, no resource exploitation and trade related activities other than protection, eco-restoration, research and monitoring have been prescribed. Creation of post of Assistant Conservator of Forests for protection and restoration activities is proposed at Tuticorin and a new Range at Vembar for Vembar group of islands is proposed. Appropriate infrastructure facilities for each protection staff need to be established at the proposed head quarters and other stations mentioned in the Table 4.4.
- ii. In addition to the existing patrolling vehicle and vessels (Table 4.3), it is proposed to procure two faster and bigger sea going vessels with communication systems, arms and first aid kits for patrolling as well as for rescue operation. Budget allotment for these boats should also include the operational and maintenance cost. One boat for Mandapam and Keelakarai groups and another one for Vembar and Tuticorin groups of islands and adjoining Biosphere Reserve areas as proposed.
- iii. In addition to the above, each of the Range must have a patrolling vehicle as well as smaller vessel (speed boat).
- iv. Existing wireless communication facilities are adequate to meet the suggested enhancement of protection network, however, it is proposed to expand the communication/patrolling efficiency by providing minimal infrastructure in each island (such as patrolling hut) for the island watchers. Each of the Island Protection unit should be provided with a small motor boat, walkie talky equipment, spot light, life jacket, camping gear etc.
- v. It is proposed that such protection staff in islands be chosen from amongst the fishermen community who may have lost their fisheries related livelihood because of the establishment of the Marine National Park
- vi. Two more Range Forest Officers are proposed for patrolling and protection in the Biosphere Reserve areas and therefore, one RFO each is prescribed with two

Eco-development Officers. These Range Officers will collect intelligence information from the terrestrial part of the buffer zone and fish landing centers etc. in addition to their other works.

- vii. Creation of a 'Anti-poaching squad proposed as 'Pilot Marine Patrolling and Policing Unit' consisting of Ex-Indian Navy and Coast Guard Personels at the top and middle level and local fishermen at lower level be considered with a special focus for marine habitat and biodiversity protection. This will ensure presence of people with enough marine habitat experience in field. This Unit is proposed to serve under the Wildlife Warden of the Marine National Park.
- viii. Maintanance of data base on offenders

Table 4.4. Suggested head quarters and stations of the protection personnel of Gulf of Mannar Marine National Park

Sl. No.	Name of Division / Range	Head quarters of Division / Range	Forester's head quarters	Forest Guard's head quarters	Forest Watcher head quarters	Mali head quarters
1.	Wild Life Warden	Ramanathapuram	-	-	-	-
2	ACF (Protection & restoration)	Ramanathapuram				
3	ACF (Protection & restoration)	Tuticorin				
4	Forest Ranger, Ramanathapuram (HQ)	Ramanathapuram	3. Ramanathapuram 4. Thondi	4. Ramanathapuram 5. Thondi 6. Uppar	-	2. Ramanathapuram
5	Forest Ranger, Kilakarai	Kilakarai	2. Kilakarai	4. Kilakarai 5. Earwadi 6. Periyapattinam	2. Earwadi 3. Sethukarain	-
6.	Forest Ranger, Mandapam	Mandapam	3. Mandapam 4. Rameswaram	4. Mandapam 5. Rameswaram 6. Utchipuli	2. Mandapam	-
7	Forest Ranger, Tuticorin	Tuticorin	3. Tuticorin	4. Tuticorin 5. Tuticorin 6. Vembar	-	-
8	Forest Rangers, Vembar		1. Vembar 2. Sayalkudi			
9					Two in each island	

Table 4.5. Activities schedule

Major action	Activitiy	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Protection Measures	Recruitment of vacant and proposed staff to enhance the protection measures	√	√								
	Creation of Vembar Range with adequate infrastructure	√	√								
	Procurement of big sea going vessels and patrolling boats	√	√								
	Establishment of small patrolling hut in islands with patrolling boat and communication system	√	√								
	Creation of a Anti-poaching Unit consisting of Ex-Indian Navy and Coast Guard Personals at the top and middle level and local fishermen at lower level	√	√								
	Protection to Biodiversity and its environment	√	√	√	√	√	√	√	√	√	√

Budget (Figures are Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget (Rs.Lakhs)
I	NATIONAL PARK											
1	Administration, Protection & Infrastructure development											
	Recruitment of proposed staff to enhance the protection measures (1 ACF, 4 Foresters, 6 Forest Guards)	30	30	30	33	33	33	36	36	36	39	336
	Establishment of new Range at Vembar for Vembar group of islands, recruitment of two newly proposed RFOs and recurring cost	30	11	12	13.5	14.5	16	17.5	20	21	22	177.5
	Establishment of necessary infrastructure such as office, staff quarter etc for ACFs	20	1	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.4	36.
	Delineation of boundary of NP		60	60	5	5	6	6	7	7	8	164
	Procurement two faster and bigger sea going vessels with communication systems, arms and first aid kits for patrolling as well as for rescue operation	200	20	20	25	25	30	30	40	40	40	470
	Replacement of old boats				10	35	5	5	5.5	5.5	6	72
	Procurement of patrolling vehicles as well as smaller vessels (speed boat) to each Range		50	10	10	11	11	12	12	13	13	142
	Creation of a Patrolling Hut at each island in first two years and then maintenance cost	50	50	5	5	6	6	7	7	8	8	152
	Field equipments at Patrolling Huts including a small motor boat, walkie talky, binocular, GPS, spot light, life jacket, camping gear etc		10	10	2	2	2.5	2.5	25 (New unit)	3	3.5	60.5
	Creation of a 'Anti-poaching Squad proposed as Pilot Marine Patrolling and Policing Unit' consisting of Ex-Indian Navy and Coast Guard Personnel on outsource basis, including maintenance of data base on offenders	4	5	5.5	6	6.5	7	7.5	8	8.5	9	67

4.3. Restoration Measures

4.3.1. Coral reefs of the Gulf of Mannar

4.3.1.1. Historical review of coral studies in the Gulf of Mannar

The earliest known scientific study in the Gulf of Mannar was on the infamous pearl banks of the Tirinaveli coast in 1864, by the British. The sclereterian fauna of Gulf of Mannar was recorded as early as in 1888 by Fotte around Rameshwaram island (Foote, 1888). Brook (1893) recognized 8 species of *Acropora* in Rameshwaram out of which 3 were new. Alcock (1893) published an account of some hermatypic corals around India, Thurston (1894) described the fauna of Gulf of Mannar. Bernard in 1897 mentioned the occurrence of *Montipora divaricata* (now *M. ramosa*.) and *M. foliosa* at Rameshwaram. Gravelly (1927) recorded the sclereterian fauna of Kurusodai island⁵. Matthai (1928) has reported the occurrence of *Symphilla recta*, *S. radians* and *Platygyra lamellina* around Mandapam (Venketaraman.K.,). Sewell (1935) described the reefs of the Indian waters. There is a long gap of around 30 years before which coral reef studies in the Gulf of Mannar were revived in late 60's by C.G.S. Pillai who was the first Indian worker on coral reefs, but apart from studies on taxonomy and general structure of the reefs around the islands, no work on their status had been done. The first status report on the Gulf of Mannar region was carried out by ZSI in 1998 (Venketaraman.2000). Currently there are 5 organizations which are actively carrying out work on coral reef studies and monitoring in the GoM they are ZSI, MKU, SDMRI, CMFRI, SAC and Anna University.

2. Diversity of corals in the Gulf of Mannar based on historical studies

Pillai (1972) recorded 117 species belonging to 32 genera of corals in the Palk bay and Gulf of Mannar and in 1983 recorded 94 species of 37 genera in the Gulf of Mannar and Palk bay region (Pillai 1983, Kumaraguru et al 2006), and in 1986 recorded 92 species of 36 genera of hard corals. In the 1986 paper many problems of synonyms have been solved that have resulted in the vast reduction of species recognized by earlier works by many authors (Pillai 1986, Kumaraguru et al 2006) Patterson et al (2005a) reported 10 species of hard coral off the coast of Tuticorin new to the Gulf of Mannar region, bringing the total to about 104 species. The dominant genera of GoM are *Acropora*, *Montipora* and *Pocillopora* among the ramose forms, *Porites*, *Favia*, *Favites*, *Goniastrea*, *Platygyra* rarely represent massive forms, *Cyphastrea* and *Leptastrea* were very common on all reef habitats. Folioseous corals such as *Echinopora lamellose* and *Montipora foliosa* are scarce due to siltation and quarrying (Venketaraman.2000).

3. Assessment of area and extent of reefs around the islands of Gulf of Mannar

The reefs of the Gulf of Mannar are mainly of fringing and patchy type thriving in very shallow waters (20cm-5m) encircling around most of the 21 group of islands (Usha. et al., 2001; Paterson et al 2005 a)). These 21 islands are divided into 4 groups based on their proximity to the mainland area. These four groups are Mandapam, Keelakarai, Vembar and Tuticorin groups. The Mandapam group consists of 7 islands (Shingle, Kurusodai, Pullivasal, Poomarichan, Manoli, Manoliputi and Musal) the Keelakarai group has 7 (Mulli, Valai, Talairi, Appa, Poorvasanpatti, Vallimunai and

Aniapar) the Vembar group has 3 islands (Nallaithani, Pullivinichalli and Upputhani) and Tuticorin has 4 (Karachalli, Vilanguchalli, Kasuwar and Van). These islands start from the south before Tuticorin and run parallel to the shore and turns towards north till Vembar and then towards the east side ending in Rameshwaram.

3.1 Tuticorin group of islands

1. **Van Island.** Its area is 16.0 ha and circumference is 2015m .it is 6km form Tuticorin. This island is covered with sparse vegetation of low bushes mostly grass and xerophytes plants. Fringing reefs are present on the eastern side of the island at a distance of 500m (Venketeraman et al 2002). 15species of hard corals were recorded in a survey by DOD in 2001(Usha et al 2001).

2. **Kasuwar Island.** Its area is 19.50 ha and circumference is 2160 m. Recently this island eroded and the area becomes only 15ha only. It is 7km form Tuticorin. This Island is having small sand mounds and bushes here and there. The whole island is covered by xerophytic vegetation. Coral reefs are found at the southwest corner of the island at a distance of 500(Venketeraman et al 2002). 14species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

3. **Vilanguchalli Island.** Its area is 0.95 ha an circumference is 614m. it is 15km form Tuticorin, this island is submerged under water now, there are isolated patches of thin reef of corals along south-eastern side of the island(Venketeraman et al 2002). 8 species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

4. **Karaichalli Island.** Its area is 16.46 ha and circumference is 2160m. Recently some portion of the island is eroded and the area is becomes 12.70 ha. It is 15 km form Tuticorin, it is a sandy island thickly set with tall bushes in the center and the western side. The whole island is covered with grasses and small plants at a distance of 500m to 1km from the shore (Venketeraman et al 2002). 25species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

3.2 Vembar group of islands

5. **Upputhani Island.** Its area is 29.94 ha and its circumference is 2292m. it is 8 km from Vembar . It is a big sandy island with plenty of coral rubbles all over. There a few trees, tall bushes, and grasses present in this island. Fringing reefs are present in the mid-eastern portion, rounding south up to the western middle portion at a distance of 150-300m from the island (Venketeraman et al 2002). 16species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

6. **Pulluvichalli Island.** Its area is 6.12 ha and the circumference is 1372 m. It is 18km from Vembar. This island has a good sandy beach, and thick vegetation. This island is surrounded by live coral reef all around except for a small stretch on the eastern side (Venketeraman et al 2002). 17species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

7. **Nallathani Island.** Its area is 110 ha and its circumference is 2700m. It is 2km away from Mundal a place near Vallinokkam. It is one of the larger islands containing

about 4000 coconut trees, Palmyra and other woody trees. Coral reef and coral boulders are present all around the island at a distance of 0.5 km on the southern side and very near to the northern shore (Venketeraman et al 2002). 22 species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

3.3 Keelakarai group of islands

8. **Anaipar Island** .its area is 11.0 ha and circumference is 1605m. it is 9km from Keelakarai . This island is completely covered with shrubs and acacia trees. Live coral reefs are seen near western shore of the island up to a maximum distance of 200m from shore. Dead coral blocks are also found on the southern shore up to a distance of 200m (Venketeraman et al 2002). 30 species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

9. **Valliyarmunai Island**. Its area is 6.72 ha and the circumference is 1170 m. It is a sandy island strewn with coral rubble; completely covered with *Acacia* trees and *Zizyphus jujube* bushes. Coral reefs are present at the southwestern corner of the island at a distance of 200m from the shore. Dead coral stones are found in other regions of the shore (Venketeraman et al 2002). 12 species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

10. **Appa Island** . Its area is 28.63 ha and its circumference is 4840m. it is 8 km from Keelakarai . this island is traversed on the southern side by an intervening coral stone studded sandy flat which is flooded during high tide preventing easy accessibility from the ends , the southern portion of the island is highly elevated(6m) standing on fossilized coral , the northern portion like other islands has an elevation of about 2.5m from the spring tide level. The entire southern side of the island is fringed with live coral reefs. A good number of dead coral stones and boulders are found on the northwest corner of the island that extends up to the distance of 1.5km (Venketeraman et al 2002). 10 species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

11. **Poorvasanpatti Island**. This island is submerged. It lies midway between Appa Island and Vallimunai Island. Live coral reef surrounds this submerged island up to a distance of 100m. Apart from a few massive corals occurring on the eastern side the rest are branching corals, which lie at a depth of 1-2 m (Venketeraman et al 2002). 11 species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

12. **Talaiyari Island**. Its area is 75.15 ha and the circumference is 8338m. It is 100km from Keelakarai .it is elongated island with a linear axis parallel to the shore, the broadest portion of the island is on its western tip. Coral reefs exist very close to the shore along the entire length of the island on northern shore except north western edge. Continuous fringing reefs are found at a distance of 0.75 km all along the southern side (Venketeraman et al 2002). 15 species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

13. **Valai Island**. Its area is 10.15 ha and circumference is 1889m. it is 10 km from the Keelakarai . it is a smaller linear island lying parallel to the mainland and it is connected to Talaiyari island by a channel which is submerged during high tide . The western side of the northern shore has good cover of massive corals as well as

branching coral types. The southern reef is far away from the shore at 3m depth (Venketeraman et al 2002). 11species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001).

14. **Mulli Island.** Its area is about 10.20 ha and circumference is 1712m. It is 9km from Keelakarai. This is a small, sandy island covered with tall shrubs and bushes with a swamp. The northern side of the island is studded with massive corals. Eastern side with low fringing reef continues up to 3m depth. The south reef is 1.25 km from shore and extends up to the western side (Venketeraman et al 2002). 18species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

3.4 Mandapam group of islands

15. **Hare (Musal) Island.** Its area is 129.04 ha and circumference is 11520m. It is 7 km from Mandapam camp. This island is completely covered by thick vegetation of acacia trees, Palmyra, coconut plantations and other trees. Massive corals are found on the southern lagoon in several places as well as in northern side. Fringing reefs are also present at a distance of 1.5km on the south side; this reef continues up to the northern tip of the island (Venketeraman et al 2002). 29species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

16. **Manauli Island.** Its area is 25.90 ha and has a circumference of about 2958m. It is 6 km from Mandapam camp. It is a small island surrounded by mud flats and sand flats exposed during low tide and well covered by trees and shrubs. There are extensive reefs on the southern and northern sides at 250m distance from the shore. Stony corals belonging to both *Acropora. sp* and *Porites.sp* are found in large numbers(Venketeraman et al 2002). 25species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001).

17. **Manaliputti Island.** Its area is 2.34 ha and the circumference is 940m. It is 6km away from Mandapam camp. It is a very small Island separated from the nearby Manauli Island by an extensive flat fully exposed during low tide. Through out this island a patchy distribution of massive coral is present at 500m distance from shore(Venketeraman et al 2002). 13species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

18. **Poomarichan Island.** Its area is 16.58 ha and circumference is 2500m. It's about 5 km from Mandapam camp. This is almost a horseshoe shaped island, with scanty foreshore, surrounded by marshy area and broken coral stones. This island appears as a thickly wooded jungle. Extensive reefs are found on the western and eastern side of the island at a distance of 150m from island shore. On the southern side also a continuous reef exists close to the shore (Venketeraman et al 2002). 12species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

19. **Pullivasal Island** . Its area is 29.95 ha and circumference is 5520m. it is 5 km from Mandapam camp. This island can be approached from Poomarichan island side by crossing the channel separating the 2 islands. This island appears thickly wooded jungle. There are fringing reefs on the southern side at a distance of 200m. Similar patchy distribution is also found in the muddy area on the northern side

(Venketeraman et al 2002). 16 species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001)

20. **Krusadai Island**. Its area is 65.80 ha and circumference is 5,193m. It is 3 km from Pamban and the nearest land is Kundugal point 500m away. The island is completely covered with trees and bushes having many varieties of animal life. A continuous fringing reef is present on the southern side of the islands at 500m distance. The lagoon in this area also contains live coral patches. The northern and eastern sides also have a few patches of *Acropora* sp (Venketeraman et al 2002). 19 species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001).

21. **Shingle Island** - It has an area of 12.69ha with a circumference of 1736m. It is 4 km from Pamban. This island is full of shingle and coral rubble, heaped all along the shore to a height of 0.75 m completely covered by bushes and trees. Fringing reefs are present on the eastern, northern and western side of the island. The corals are mostly of *Acropora* sp. Present 300m from the island shore. Patchy distributions of boulder (massive) corals are found (Venketeraman et al 2002). 15 species of hard corals were recorded in a survey by DOD in 2001 (Usha et al 2001).

4. Status on the area and health of coral reefs in the Gulf of Mannar.

Coral covers in the above mentioned islands have been mainly estimated by various agencies either using satellite data and/or in-situ surveys using line intercept transects between the year 1988- 2003.

Satellite data were first used to map coral reef habitats of Gulf of Mannar in 1988-1990 by SAC Ahemadabad, but the data obtained were of general nature and only described reef habitat. Baseline data for coral reefs of the entire Indian coast has been generated on 1:250,000 and later at 1:50,000 scales using Indian Remote Sensing , Landsat TM and SOPT data, wherein , extent , type of reef and few broad geomorphological zones such as reef flat, mud and sand deposition on the reef, vegetation on reef, etc. were identified (Nayak et al 1992, Bhaguna and Nayak, 1998) .

In 1998 SAC started using LISS-III satellite data of IRS-1C to map the eco-morphological zones of selected reefs in Indian waters. Among these the islands of the Kurusodai reef complex and the Manauli reef complex were chosen for study. This experimental phase was completed in 2000 and currently SAC are in the phase of mapping all the coral reefs of India according to their eco morphological zones.

In 2001 a global coral reef map was prepared using RS & GIS techniques along with other information at scales of 1:1,000,000 and 1:250,000. An atlas of the world's coral reefs has been brought out which carries maps of the entire world's reefs including Indian reefs prepared using navigational charts and updated using satellite data (Spalding 2001) The satellite images of coral reef depict extent of reefs and reef types (Anonymous 2003)

The Institute of Ocean Management, Anna University in 1998, used Survey of India Topographic sheets (1969), IRS LISS-II (1988) and IRS LISS-III (1998) for coral reef mapping in the Gulf of Mannar on a scale of 1:50,000. The classification system used

was developed by the Space Application Center for the national coral reef mapping project in 1994 (Usha et al 2001).The accuracy obtained was 84.82 %.

In 2001, the Integrated Coastal and Marine Area Management Project Directorate, Department of Ocean Development, used IRS ID LISS III data of June 1998 and analyzed them using ERDAS-IMAGINE 8.4 image processing software.

4.1. Findings from 1988-2001

In 1990 SAC recorded 61.39 sq km of reef habitat in the Gulf of Mannar region.

In 1997 SAC and DOD , mapped all the coral reef areas of India and the total reef area occupied by reef and its associate features in GoM was reported to be 94.3 sq km. Reef flat and reef vegetation including algae was estimated to occupy 64.9 and 13.7 sq km respectively.(DOD, SAC,1997 and Mulley et al 2000)

In 1998, Thanilachalam and S.Ramachandran of Institute of Ocean Management, Anna University, mapped the reefs of GoM using remote sensing and reported 61.01sq km of coral reef area , of which reef covers 48.18sq km , reef vegetation covers 10.15 sq km and degraded corals occupiees 2.68 sq km (Thanilachalam and. Ramachandran 1998).

In 2001, the Integrated Coastal And Marine Area Management Project Directorate, the department of ocean development, used remote sensing data and recorded 90.81 sq km of coral reef area around all the 21 islands of the Gulf of Mannar (Usha et al 2001)

Table 1: Remote sensing data of coral reefs of the Gulf of Mannar from 1988 to 2001.

	SAC, Ahemadabad, 1990	SAC & DOD, 1997	IOM,Anna Uni, 1998	ICMAMPD, DOD, 2001
Coral reef area	73.70 sq km	94.3 sq km	61.01sq km	90.81 sq km
Reef Flat	61.39 sq km	64.9 sq km	48.18 sq km	--

Table 2: Arial distribution of coral reefs in gulf of Mannar and its changes observed during the period from 1988 to 1998 (Thanilachalam and. Ramachandran 1998)

Category	Area (km ²)1988	Area (km ²)1998	Changes1988-1998
Reef area	73.70	48.18	-25.52
Reef vegetation	12.31	10.15	-2.16
Degraded reef (Coral mining)	-	2.68	+2.68

Table 3: Assessment of percentage live coral cover for islands of the Gulf of Mannar (Usha et al 2001, Venkataraman and Raghuram. 2006).

Percentage Live Coral Cover For Islands Of Gulf Of Mannar (%)					
Islands	2001(DOD)	2002(ZSI)	2003(ZSI)	Pretsunami '04	Post-tsunami '05
Van island	7	(Reef flat completely eroded) *	(Reef flat completely eroded) *	?	?
Kasuwar island	5	(Reef flat completely eroded) *	(Reef flat completely eroded) *	?	?
villanguchalli	8	(submerged) *	(submerged)*	?	?
Kariyachalli	14	2	3.5	?	?
Uppu thani	26	54.5	33	?	?
Pulivinichalli	38	38.15	29	?	?
Nalla thani	38	39.8	39	?	?
Anaipar	37	45	46.8	?	?
Appa Island	2	55	38.2	?	?
Palliyar munai(vallimunai)	50	40	44.4	?	?
Poovarsan patti		(submerged) *	(submerged) *	?	?
Talairi	16	41	46	?	?
Valai island		55	68.4	?	?
Mulli Island	25	58	62.6	?	?
Musal (Hare) Island	52	26	26.5	?	?
Manoli Island	25	33.5	28	?	?
Manolli-Putti island		40	37	?	?
Poomarichan	14	28	34	?	?
Pullivasal		34	45	?	?
Kurusodai	33	24	37	?	?
Shingle	46	47	20	?	?

* Surveys were not conducted in these islands due to the reasons stated in the box

- The DOD survey was also carried out by the ZSI⁴
- Reefs in Kasuvar and Van islands have turned in to rubble and dead coral due to illegal coral mining by the locals⁶

Table 4: Percentage life forms of the three group of island for year 2002 and 2003(ZSI) (Venkataraman and Raghuram 2006)

LIFE FORM	Mandapam		Keelakarai		Tuticorin	
	2002	2003	2002	2003	2002	2003
ACB	2.5	3.6	3.3	1.7	0	0
CB	7	7	10.2	10.3	15.2	10.25
CF	5.5	0	0	0	5	3.5
CM	14	11.3	18.7	18.9	13	11
CE	0	0	0	5.3	0	0
DC	20	25	19.7	0	0	0
DCA	0	0	0	20.4	25	27
MA	2.5	0	0	0	0	0
S	10	8	7.5	5.4	19.3	12

ACB-Acropora branching; CB-Non Acropora Branching coral; CF-Coral foliose; CM-Coral massive; CE-Coral encrusting; DC- Dead coral; Dead coral covered with algae; MA-Macro algae; S-Sand

4.2 Impact of the 1998 coral bleaching event

Venkataraman(2000)studied the coral bleaching event in the Gulf of Mannar and reported that branching corals were the most affected life form. The overall percentage of coral life forms amounted to 24.67 % and dead coral, rubble and sand amounted to 75.04%. 22 species were known to be affected by bleaching (six branching forms; nine massive coral species; one foliose form) and 15 species (six branching; eight massive and one foliose) were not affected. Acropora branching and branching corals of other genera in the Tuticorin group (vembar and Tuticorin groups included) were completely negligible (<1%) and absent respectively.

In the Keelakarai group of islands between 2002 and 2003 there was a reduction of dead coral (DC) and increase of dead coral covered with algae (DCA), which may be due to either increased eutrophication or reduction in herbivore populations causing turf algae to colonize dead corals .In Keelakarai group the branching *Acropora* coral cover was reduced almost by half between 2002 and 2003. In Tuticorin group there was a reduction in percentage coral cover of non-*Acropora* branching corals by one third. There is a total absence of *Acropora* corals in the Tuticorin group of islands. More over the reef flats on Van and Kasuwar islands have been completely eroded and devoid of any life form Venkataraman.K and Raghuram.K.P.,(2006)..

In 2002-03 there was a severe reduction in the live coral cover of genera such as *Acropora* , *Montipora* , and *Pocillopora* due to illegal coral mining, destructive fishing practices and induced sediment caused by seaweed plucking . Selective mining of *Pocillopora damicornis* has reduced their population size (Venkataraman and Raghuram 2006).Branching forms (CB) such as *Montipora digita* and *Pocillopora damicornis* had more live coral cover than Acropora species (ACB). This maybe due to the fact that the *M.digita* grows profusely in turbid waters and propagates easily by vegetative methods. Sea weed collectors trample on this species breaking them and also stir up the bottom silt. It was found that *Montipora digita* was

colonies were abundant in places where there were human activity (Venkataraman and Raghuram.2006).Foliaceous corals such as *Echinopora lamellose* and *Montipora foliosa* are scarce due to siltation and quarrying (Venketaraman.. 2000). Generally there is a decrease in live coral cover of branching forms in all the islands.

The differences in the live coral cover in for all the islands in the year 2002-2003 were not significant using the t-test. In the ZSI survey of 2003-03 it was observed that the branching coral species have become rare when compared to massive corals. *Acropora Formosa*, *A. rudis*, *A. austerea*, *A. florida*, *A. samoensis* ,*Montipora digita* and *Pocillopora damicornis* were the only branching coral species recorded.Massive coral dominated all the islands. (Venkataraman. and Raghuram 2006).

Table 5:Percentage live coral cover in each island group from 1998- 2006

Island group	ZSI				MKU		SDMRI, Tuticorin.			
	1998 (%)	1998-2002(%)	2002 (%)	2003 (%)	Pre-post tsunami		2002(%)	Pre Tsunami	Post tsunami 05	2006
					Nov 2004 (%)	Jan 2005(%)				
Mandapam group	37.03	36	33.2	32.5	54	39	NA	NA	32.33	36.97
Keelakarai group	17.29	16	49.0	49.7	49	36	NA	NA	46.83	43.58
Vembar Group	18.69#	11 #	33.8#	25.8#	49	38	NA	NA	36.02	31.99
Tuticorin group					42	31	20 approx	NA	40.18	29.34
Mainland patchy reefs of Tuticorin	NA	NA	NA	NA	NA	NA	5* - 80** approx	74	75.92	NA

Source (Venketaraman 2000, Venkataraman and Raghuram 2006, J. K. Patterson Edward et al 2005, Petterson Edward. J.K 2005, Kumaraguru.et al 2005)

Study by ZSI combines Vembar and Tuticorin groups together as Tuticorin group

* Status out side protected waters of the Tuticorin port

** Status within the protected waters of the Tuticorin port

It is apparent that there is an increase in percentage of live coral cover in Kellakarai and Tuicorin group of islands during 2002-03 compared to 1998-2000. The reasons for increased live coral cover maybe due to maximum regeneration and fewer disturbances by locals to coral reefs. The coral reefs of Keelakarai group of islands especially Mulli and Valai had profuse growth of live coral. Pallyiamunnai also of the

Keelakarai group had 40% and 44.4 % live cover in 2002 and 2003. Whereas Tuticorin reefs were found to face permanent damage due to indiscriminate coral mining, sedimentation, erosion and other major threats such as land based pollution from sewage discharge near reef, domestic waste disposal, agricultural wastes and thermal power plant releases (Venkataraman and Raghuram 2006).

According to Kumaraguru et al (2005), the tsunami had a significant but small effect on the corals of the Gulf of Mannar. The coral cover under stress after the tsunami was 6.7 %, which included corals showing partial bleaching or and those infected by pink band disease syndrome. The silt smothered coral cover was 30% damage to corals due to tsunami was 6.7% which included recently killed corals, upturned corals, and broken corals .landscape alterations showed that Shingle, Mulli , Valai, Thalaiyari , Upputhani, Van, Kasuwar and Karaichalli islands experienced more shore erosion compared to other islands. Patterson (2005a) reported a 1 % decrease in coral cover for the whole of Gulf of Mannar. There was no pre-tsunami data provided for the Kellakarai, Mandapam, Vembar and Tuticorin groups of islands and only post tsunami data were published. Only for the mainland patchy reefs of Tuticorin were the pre and post tsunami data given

Table 6: Area of reef habitat of individual islands and Comparison of number of coral species from past to 2001 (Thanilachalam and ramachandran 1998 ,Usha et al 2001)

Area of reef habitat of individual islands and Comparison of number of coral species from past to 2001						
	Islands	Past data - No of coral species(method ology and year unknown)	2001(DOD) - No of coral species(belt transect)	Perce ntage of coral cover, DOD	Area of coral reef in sq km 2001	
					By DOD	Anna uni
Tuticorin group	Van island	28	15	7%	2.5	1.09
	Kasuwar island	31	14	5%	6	1.47 4
	Villanguchalli	21	8	8%	1	?
	Karyachalli	46	25	14%	0.31	0.70 2
Vembar group	Uppu thani	68	16	26%	3	.644
	Pulivinichalli	41	17	38%	1.5	?
	Nalla thani	73	22	38%	2	1.25
Keelakarai group	Anaipar	21	30	37%	5	0.88 8
	Appa Island	37	10	2%	5	3.61

						2
	Palliyar munai (vallimunai)	29	12	15%	6	0.678
	Poovarsan patti	31	11			
	Talairi	51	15	16%	14	9.268
	Valai island	51	11			
	Mulli Island	35	18	25%	7	1.208
Mandapam group						
Mandapam group	Musal (Hare) Island	50	29	52%	1.5	27.73
	Manoli Island	51	25	25%	15	
	Manolli-Putti island	51	13			
	Poomarichan	31	12	14%	4	?
	Pullivasal	31	16			
	Kurusodai	61	19	33%	1.5	?
Shingle	47	15	46%	2	1.203	
Total					90.81	49.74

5. Threats to coral reefs

Venkateraman in 1998 observed that islands closer to the mainland had less coral cover, islands such as Pullivasal , Mulli, Valai, Thalari, Appa , Palliyarmunai , karaichalli and Kasuwar have less percentage of live coral cover which is probably due to anthropogenic factors such as industrialization , pollution and discharge of large quantities of sewage into coastal areas , in addition to the over exploitation of reef resources and illegal mining of corals by the local population (Venkateraman 2002)

5.1.Coral mining

Naganathan et al 2006 recently concluded that there is a vast reduction of coral mining in the Gulf of Mannar region , due to the supreme court stay order and also due to the fisherman realizing the value of reefs after the tsunami, but he also recognized that coral mining still exists in Tuticorin coast especially from three villages Vellapatti , Threspuram and Tharvaikulam. In this area, nearly 220 vallams are operating in these three villages for coral mining, each vallam collects about 4.5 tonnes per day, for a week a single vallam collects about 26 tonnes and 104 tonnes were collected in a single month, On an average ,1248 tonnes of corals were collected every year in a single vallam, and in toto 2,74,560 tonnes of coral were removed from the southern part of the Gulf Of Mannar. (Naganathan and Ramesh 2006). In the past due to heavy coral mining two islands in the GoM namely Valanguchallai and Poorvasanpatti have been completely eroded and submerged. (Venkateraman 2002) .Van Island which was around 50 meters in breadth 15 years ago is now only 6m

because of coral mining (Naganathan and Ramesh 2006). Corals are also mined for the live coral trade for aquariums around the world, mainly small branching corals are targeted especially *Pocillopora damicornis*. (Venkataraman. and Raghuram. 2006) . After the Tsunami in 2004 people have learnt the importance of coral reefs, and currently there is a stay on coral mining by the Honorable Supreme Court vide Item No 32, Court no 2 , case No.892636 dt.17.08.05. (Naganathan and Ramesh 2006).

5.2.Seaweed collection

Seaweed collection was carried out around the islands by both men and women; this is a source of alternate livelihood for fishermen communities. Seaweed collection over coral reefs severely threaten and destroy coral reefs, the plucking of seaweeds cause the release of bottom sediment , more over the sediment is kicked up by collectors who walk over the reef area, this cause sedimentation to increase over the reef smothering corals and also reducing light intensity reaching the coral. These collectors also trample over the corals breaking and killing the coral. Another consequence of this is that it leads to an imbalance in the coral community as certain species propagate vegetatively such as *Montipora digita* (Venkataraman. and Raghuram. 2006) and increase in abundance and become dominant in the region.

5.3. Destructive Fishing Practices.

Bottom trawlers and trap nets for crab and lobster are two of the major destructive fishing practices in the region. Earlier dynamite fishing was carried out and its use has now stopped in the Gulf of Mannar. Bottom trawlers drag their nets on the sea floor and churn up the sea bottom releasing the sediments and causing turbidity, these silt laden waters are carried by currents and wave action over reefs causing stress to the corals by reducing light penetration or smothering the corals with sediment. Bottom trawlers are also now fitted with a wheel at the foot rope (roller madi) which aids in jumping over coral reefs thereby causing damage(Patterson et al 2005a). Venketaraman recorded that some local fisherman use traps made of bamboo over reefs to catch crabs and lobsters, locally know as “kodu”. It is widely used in the Gulf of Mannar. In Ramanathapuram alone there are 3,312 traps which accounts for 39% of the trap fishing in Tamil Nadu. Although the gear is not intrinsically destructive, the process of setting and retrieving the trap is largely responsible for the destruction brought on the reefs. These traps are set by simply lowering them from a boat via a buoyed rope and are often heavy with wooden runners or stones and can destroy entire reefs of branching and foliose corals during the installation and especially removal by pulling the ropes (Venketaraman 2006). During the current survey by WII in jan 2007, trap nets were found placed over reefs in Shingle Island and in Poorvasanpatti Island.



Photo: Trap net at Poorvasanpatti island ,2007

5.4. Sedimentation

Sedimentation affects corals in three ways, photosynthetically, physically and chemically. Reef building corals obtain majority of their nutritional requirements through translocation of metabolites from zooxanthellae (single celled algae) which are present within the tissue of the corals, any reduction in the availability of light will affect coral nutrition, growth, reproduction and depth distribution. Sediments interfere with coral nutrition by coating the feeding surfaces responsible for catching prey items needed to supplement the energy provided by zooxanthellae. While corals do have the ability to cleanse themselves using a combination of mucous secretion and ciliary action, chronic sedimentation may end up in a high energetic cost, adding to the overall impact on the colony. Sediment also physically interferes with recruitment of coral larvae, which require a solid substratum upon which to settle and metamorphose (Venketaraman 2006)

Sedimentation is caused by many sources, both natural and anthropogenic. Some of the anthropogenic causes are already mentioned above i.e. through seaweed collection and also by coral mining; the other sources of sedimentation are from afforestation and removal of vegetation. The cutting of trees and the removal / destruction of vegetation on sand dunes and coast increases erosion by waves, wind and rainfall increases the sediment load in the water. Natural cause of sedimentation is caused mainly by the south west monsoons, which creates waves of large wavelength causing the churning up of the bottom sea floor causing turbid conditions.

5.5. Eutrophication

Sewage is usually a high threat to coral reefs in areas where there is an abundant human population. Corals generally need oligotrophic waters to grow. Sewage contains nutrients and act like fertilizers in the sea causing eutrophication, the result of which is prolific growth of algae which directly compete with corals for space. Algae quickly colonize any free space available over the reef and impede settlement of corals. In some cases turf algae grow over corals killing them. There are around 50,000 households in 47 villages along the mainland coast bordering the marine national park (Venkateraman 2002), these villages are the primary source of untreated sewage in the GOMMNP region, and there are around 6 other small rivers which bring in sewage from the interiors of the mainland into the gulf. The release of sewage

has resulted in heavy load of organics and low primary production, which in turn would drastically affect the growth of the coral habitat (Santhanam and Venkataramanujam, 1996). Agricultural run off is also another source of eutrophication in the marine environment, rainwater run off which runs through agricultural fields dissolve and carry the fertilizers present in agricultural soil and flow into the sea.

5.6. Industrial pollutants

The heated water released from the thermal power plant in Tuticorin increases the coastal water temperature by 3-4°C above ambient temperature and the rate of 'dumping' of fly ash is around 5,000 tonnes / day. The dumping of the ash has also affected the recolonization of *Acropora formosa*. (Balasubramaniam T and Ajmal Khan 2001),

5.7. Natural threats

During Cyclones heavy wave action uproots and breaks corals. In the cyclone of 1969 in the Gulf of Mannar many corals were heavily destroyed and huge areas of reef were buried in sand. The rise of sea temperature also causes mass mortality in reefs. The 1998 mass bleaching event destroyed most of the *Acropora* corals in the Tuticorin group of islands (Venkateraman 2002).

The tsunami of 2004 destroyed 1 – 6 percent of coral reefs in the Gulf of Mannar region (Kumaraguru et al 2005, Patterson 2005)

5.8. Other threats

Some of the other possible threats to coral reefs which are foreseen but not studied in detail are the impact by the Sethusamudram ship canal project, introduction of invasive species and over fishing of herbivores.

Table 7 : Threats Documented During March 2006 and Jan 2007 during the rapid survey of the GOMMNP by the WII – management plan research team.

Islands	Status	Threats documented in 2006 and 2007 surveys								Cumulative threat	Recommendation/ action
		Coral mining	Sea weed collection	Destructive fishing practices	Over fishing	Sedimentation	Eutrophication	Invasive species	Industrial pollutants		
Van	Severe destruction of reef flat, coral cover very low, fleshy algae is relatively high	N. R	H	M	H	L	M	NR	H (fly ash deposited in water)	16	Stricter vigilance, Restoration and Monitoring
Kasuwar		NR	H	M	H	NR	NR	NR	M	10	Control over fishing, Stricter vigilance , restoration, Monitoring
Vilanguchalli	Island submerged	NR	H	M	H	NR	NR	NR	NR	8	Control over fishing, Stricter vigilance and monitoring
Karaichalli	Diverse reef, good condition	NR	NR	L	M	M	L	NR	L	7	Monitoring
Uputhani		NR	M	M	M	NR	NR	NR	NR	6	Control over fishing, Stricter vigilance and

											monitoring
Pulivinichalli	Good corals on reef slope, fleshy algal highly dominant on reef flat	NR	H	H	H	M	H	NR	NR	14	control over fishing. Monitoring
Nalathani		NR	H	H	H	NR	NR	NR	NR	9	Stricter vigilance, control over exploitation and Monitoring
Anaipar		NR	L	M	M	NR	NR	NR	NR	5	Stricter vigilance, Monitoring
Appa island	Low diversity of coral, dominated by only massive corals, water very clear.	NR	H	H	H	L	L	NR	NR	11	Stricter vigilance, natural recovery, Monitoring

Palliyarmunai		NR	M	M	M	NR	NR	NR	NR	6	control over fishing Vigilance and monitoring
Poorvasanpatti	Island submerged, Clear water, good corals, fish biomass high	NR	NR	M	L	L	L	NR	NR	5	Vigilance and monitoring
Talairi		NR	M	H	H	NR	NR	NR	NR	7	Control over fishing, Vigilance and monitoring
Valai		NR	L	M	M	NR	NR	NR	NR	5	Vigilance and monitoring
Mulli		NR	L	L	L	NR	NR	NR	NR	3	Vigilance and monitoring

Musal		NR	L	L	L	NR	NR	NR	NR	3	Vigilance and monitoring
Manoli		NR	L	M	M	NR	NR	NR	NR	5	Vigilance and monitoring
Manolli-putti		NR	L	M	M	NR	NR	NR	NR	5	Vigilance and monitoring
Pomarichan		NR	M	H	H	NR	NR	NR	NR	8	Control over fishing, Vigilance and monitoring
Pullivasal		NR	M	H	H	NR	NR	NR	NR	8	Control over fishing , stricter vigilance and monitoring

Kurusadai		NR	L	H	H	NR	NR	NR	NR	7	Control over fishing, stricter vigilance, and monitoring
Single	Corals diversity moderate, coral cover in patches high, fleshy algae in certain areas high.	NR	M	H	H	H	M	NR	NR	13	Monitoring, stricter vigilance,, natural recovery

NR- Not recorded

L- low

M-medium

H-High

Cumulative threat (High=3; M=2; L=1; NR=0)

The value given is based on the intensity of the collection/ threats observed during our surveys, the value is also given based on direct observations and indirect evidences to the threats where applicable.

6. Suggested Management Prescriptions for coral reefs in GMMNP

Based on the reports/table given above it is clear that none of the data from various organizations can be comparable, this maybe mainly because the sites and methodologies are not the same and the fact that these projects were designed to answer various other academic questions and not to assess the trends of the reefs health, because of this it is proposed that a in-house and out-sourced monitoring plan taken up.

The general consensus reviewing these literatures is that there is severe destruction of coral reef in the Tuticorin group of islands and steps for stricter surveillance and restoration needs to be taken up, branching *Acropora* which is supposed to be the dominant life form group in the Gulf of Mannar is totally lacking or negligibly low in the Tuticorin group.

Options of Management Action

- a. **A stricter Vigilance, Protection and Monitoring-** the current system of management and protection is not enough to guarantee the protection of the sensitive eco systems around the islands from exploitation by fisherman. There is an urgent need for increasing the number of protection guards on the island, there should be a permanent presence of at least two guards with 2 helpers at all times in each island and also the number and frequency of boats patrolling the marine area should be increased. The Area under the Marine National Park especially near and around coral reef areas should strictly be a **No Activity Zone** other than for protection, species/habitat restoration, research and monitoring.
- b. **Natural Recovery monitoring-** Most of the sub-tidal ecosystems in the islands in the gulf of Mannar seem to be in relatively good condition, this is not to say that there have been no disturbances, but that the disturbances have been localised and relatively in a small scale. These include the islands of the Mandapam, Keelakarai and Vembar group and Karyachalli and Vilanguchalli of Tuticorin group. Most of the threats documented in the GOMMNP are due to direct anthropogenic effects such as “sea weed collection”, “destructive fishing” practises, “over fishing in island areas” and “coral mining”, with stricter vigilance of these islands to ensure that no more exploitation takes place; these ecosystems have a very high chance of recovering naturally to their original state. These areas also need to be constantly monitored for progress and plans for a small scale in-house monitoring project on a yearly basis should be taken up for this purpose. A regular out-sourced monitoring project should be taken up for monitoring broad scale threats such as pollution(every year and also seasonally) and also for detailed mapping and diversity studies of corals ,say in a time frame of 3-5 years.
- c. **Assisted restoration monitoring-** The 2 islands of the Tuticorin group especially Van And Kasuwar island are severely destroyed due to direct anthropogenic activities such as dynamite fishing, coral mining and using drag nets over reef areas. The reefs of these two islands are severely degraded and the recovery is slow, there is an urgent need for restoration of the reefs in these 2 islands,. Even if the threats are removed it is likely that the natural recovery

of these reefs would take 10's of years. Projects need to be taken up not only to restore the reefs through transplantation and re location but also artificial barriers be set up to protect the shore line of the islands(see section7 of this chapter).

- d. Coral reefs outside the marine national park- Reefs which are found outside the marine national park, but within the Biosphere reserve should be identified. A professional study into to extant of such reefs and their status need to be done based on satellite data and ground truthing, these areas can be designated as multiple use area and can be especially used for community based activities such as diving, snorkelling and reef watching through glass bottom boat. These reefs can be a good source of education and awareness building on coral reefs.

Management prescriptions

1. Marking permanent monitoring plots for in house monitoring once a year. The GOMBRT and GOMMNP management requires to mark permanent monitoring plots in all fringing reefs and patch reefs around the islands for in-house monitoring at least once a year , preferably during Jan - March
2. outsourcing – a professional and scientific assessment of coral reef status , distribution and abundance , monitor pollution and prepare detail maps once in 5 years (e.g. DOD-ICMAMPD resource information system)
3. Co-ordinate and collate information into an open data database at the GOMBR research and monitoring laboratory.
4. Encourage and facilitate scientific research and monitoring of specific taxon, events and status by professional scientific agencies with their data being documented within the GOMBR database.

7. Restoration of coral reefs

Criteria for justifying restoration

Restoration should generally be the last resort used, it should be done after the careful consideration of the state of the ecosystem and the chances of it returning naturally back to its previous condition before the disturbance. Some of the questions that managers should ask before proposing or considering restoration should be.

1. Has the reef been degraded to the state where it can not perform the services and functions it previously provided?
2. Is the degradation permanent? Is the impact, the result of structural damage or biological damage? Structural damage makes reef recovery highly unlikely by natural process compared to biological damage which has a far greater chance of recovery and also in a relatively shorter period of time.
3. Has the threat causing degradation been removed?
4. Is the area recruitment limited?
5. Is there a right substrate and conditions for recruits to settle?

Need for restoration in the Gulf of Mannar

Among the 21 islands of the Gulf of Mannar the 2 islands of the Tuticorin group especially Van And Kasuwar island are severely destroyed due to direct anthropogenic activities such as dynamite fishing, coral mining and using drag nets over reef areas. In 1998 due to bleaching, *Acropora* branching and branching corals of other genera in the Tuticorin group (Vembar and Tuticorin groups included) were completely negligible (<1%) and absent respectively (Venkateraman 2002). Venkataraman in 2003 recorded that the reef flat in both these islands were completely degraded and there is a total absence of *Acropora* corals in the Tuticorin group of islands (Venketaraman and Raghuram 2006). Patterson et al in 2005 recorded 6.5% of *Acropora* branching corals for the four islands in the Tuticorin Group (Patterson et al 2005a), In our recent survey of select island of the Gulf of Mannar in Jan 2007 the condition of the reef flat Van island still hasn't recovered, there were only sparsely distributed colonies of 2 or 3 species of hard coral on the reef flat and most of the reef flat composed of consolidated rubble covered with sea grass, fleshy algae and *Halimeda sp.* No *Acropora* branching corals were seen in the reef flat area, in the east north eastern side of Van Island, there is a small area of reef mainly consisting of patches of boulder corals, only *Acropora* tabulate corals were found and no *Acropora* branching corals were seen in this area. More over sites in Karyachalli Island seem to have recovered from the bleaching event, and now *Acropora* branching corals represent about 5.5% of the total area or 12% of the live coral cover in this area.

It is clear that the reefs of Van and Kasuwar islands are severely degraded and the recovery is slow and there is an urgent need for restoration,. Even if the threats are removed it is likely that the natural recovery of these reefs would take 10's of years. Natural reefs act as submerged breakwaters and reduce the wave action on the coast, keeping it stable and preventing erosion. Due to the loss of reefs Venkataraman et al in 2002 noted that Kasuwar Island eroded from 19.5 ha to 15 ha

Suggested Restoration

Projects need to be taken up not only to restore the reefs through transplantation and re location but also stabilizing the shore line of the islands by placement of artificial barriers to act as natural reefs . These barriers can serve the purpose of acting as a substrate for transplantation, habitat enhancement for marine life but also for shore line protection. International organisations like Reefball (www.reefball.org), have a high reputation and have worked on many of the reefs in the world, they can be approached for any sort of technical guidance to restoration in this region in collaboration with local organisations such as SDMRI who already have some experience in the field of restoration of coral reefs. Moulds for restoration can be made off coral boulders which have been seized or under govt ownership; coral debris from demolished old houses can also be used. Though the use of coral slabs to study recruitment is known, it is suggested that a study be made on weather such moulds can be made stable enough for restoration work. More information on the restoration techniques used globally for coral reefs can be obtained from “ Handbook of Ecological Restoration, Volume 1&2, edited by Martin R. Perrow and Anthony J. Davy, Cambridge University Press, 2002.”

Restoration techniques for the Gulf of Mannar

In the Gulf of Mannar, restoration by transplantation is practiced by SDMRI on an experimental scale near Van Island outside the marine national park area; experimentation was also done around the patch reef inside and out of the Tuticorin harbour area. The experiment included transplantation of Acropora and non Acropora branching corals and also of certain massive corals, the list of coral species is given in table 1. The over all success rate of transplantation was 75 %. The types of substrate to which transplanted coral colonies were attached through ropes and galvanized wire were globular cement modules, flat cement slabs or attached to small stones and clay pots and place over a natural coral substrate. Of these types the greatest success was found by using Concrete slabs (Patterson et al 2005 b)

Table 1: Species used in transplantation studies by SDMRI in GOM

SNo	Species transplanted
1	<i>Acropora intermedia</i>
2	<i>Acropora cytherea</i>
3	<i>Acropora nobilis</i>
4	<i>Turbinaria mesentarina</i>
5	<i>Turbinaria peltata</i>
6	<i>Montipora Foliosa</i>
7	<i>Montipora hispida</i>
8	<i>Montipora divaricata</i>
9	<i>Potites lutea</i>
10	<i>Favia palida</i>

Table 2 : Suggested Coral Reef Restoration Protocol

Island group	Present status	Action			
		Protection	Natural recovery taking place	Artificial barriers for structural habitat enhancement and shore protection	Restoration of corals through transplantation
Mandapam	Small amounts of biological damage, natural recovery taking place	ü ü ü	ü ü	û	û
Keelakarai	Poorvasanpatti island submerged but reefs around are recovering naturally.	ü ü ü	ü ü	û	ü (lack of Branching corals in Appa island)

Vembar	Small amounts of biological damage, natural recovery taking place	ü ü	ü ü	û	û
Tuticorin	Structural damage to reefs in Van and Kasuwar island, Kasuwar island eroding rapidly, needs restoration.	ü ü ü	ü	ü ü (Van and Kasuwar)	ü ü (Van and Kasuwar)

Recommended in-house coral monitoring protocol for GOMMNP

With coral reef surveys introduced in India 1998 by GCRMN and facilitated by the ICRMN through training and capacity building, the status of Indian corals reefs are being studied by various scientific organizations as well as marine park managers. However, most of these studies have so far been mainly academic. It is for this reason that an in-house monitoring protocol for coral status in the marine protected area is proposed is taken up keeping management and management issues in mind. The academic oriented data produced by scientific organizations is not often available to managers as they are often late in publishing and even if published are tough to interpret by non scientific personnel .Very often the scientific organizations change the basic monitoring protocols to suit their specific research needs and are very fine scaled which may not be the focus of the park management.

It is for these reason that it is suggested that either an in house or out house project for monitoring be done to address the need of managers.

1.1 Levels of monitoring: Fine, Medium and Broad scaled

Fine scale monitoring- Fine scale monitoring projects include detailed monitoring, of pollution and other factors affecting reefs such as sedimentation and global warming, recruitment of corals and fishes, restoration and, diversity studies and changes in fish and coral community structure etc.

Medium scaled monitoring- medium scale monitoring projects include finding live coral cover up to a life form level, and abundance of reef fish surveys. These methods have units that are measured by a length of reef

Broad scaled monitoring- broad scale monitoring use large units that are defined by the time taken to swim them. These are general qualitative studies on the status of the reefs using manta tow or timed fish surveys. They are generally used for mapping and to determine site selection and to find degree of infestation of diseases, out break of crown of thorns, bleaching etc.

It is recommended that fine scale projects be outsourced and medium and broad scale projects be in-house

1.2 Outsourcing of fine scaled monitoring project

A detailed fine scaled scientific monitoring project for the GOMMNP and GOMBR can be outsourced to any one of the few organizations present in India who have a track record of having done work consistently in the area of coral reef studies. These include ZSI, MKU, SDMRI, Reef Watch, and CMFRI. These organizations can be funded to continue work on all the 21 islands and beyond regularly. A fine scale monitoring by professional scientific organizations adds on value to the management both at the national and international level. While most professional scientific organizations can raise money for such studies it will be for the benefit of the management such a outsourced monitoring study be built in into their own programme and be funded.

Monitoring should ideally be carried out by a team in which at least some members have the experience of monitoring the same locations previously. An outsourced monitoring project should normally be for a period of five years with some degree of assurance that the monitoring team will remain same so that inter-observer biased/error is reduced.

The findings of an outsourced fine scaled monitoring in the end should be mandated to provide key findings in as simple as possible language as possible without much scientific jargon and as quickly as possible.

1.3 In house medium and broad scaled monitoring

Medium and broad scaled monitoring surveys can be done directly by the inhouse research personnel themselves, in the case of the Gulf of Mannar, the suggested research unit of the marine park staff themselves can take up such monitoring efforts. Monitoring surveys as described by Wilkinson et. al (1997) and Reef Check (Hodgson et al 2004), are easy to use by non professionals and requires only a small degree of training. These kinds of surveys are reliable and can easily be used by the marine park staff to monitor the reefs and are not very expensive. Also the data analysis is easy to do and is not cumbersome.

Management staff should participate in some form of monitoring to understand the resource they are managing and the need for protecting it. Monitoring is a powerful tool to raise awareness of the problems facing reefs and the need for management among local communities, tourists and management staff. Permanent residents of the community who are trained in diving can also be chosen to start a community based monitoring program. Organizations like the People Action for Development, Vembar, have enough qualified divers to take up such a task, and P.A.D has also recently trained many GOMBRT sponsored people who can be used for such monitoring.

The suggested medium scaled monitoring project should consist of and be taken up for

- For live coral cover- Up to a life form level using Point intercept transects. This would give an estimate of the percentage live coral cover and other substrata in the reef area; constant monitoring would help assess changes in

the reefs and also tell managers if the coral reefs are healthy and improving. Whether threats are damaging corals or whether management actions have been successful.

- Belt transects – for fish and invertebrate surveys. Reef fish surveys (especially for those that have an obligate association to live corals) such as Butterfly fishes. Other benthic invertebrate fauna; especially monitoring important keystone species such as *Diadema sp* (sea urchin) and other commercially important species such as lobsters.

The survey should be carried out yearly, and all 21 islands should be monitored, preferably in the month of Dec and Jan as this is the season where the seas are generally calm in the Gulf of Mannar.

1.3.1. Training and methodology adopted for in house monitoring.

- Refer Wilkinson et al 2004, Reef check 2005 and English et al 1997, for detailed understanding of methodology. Most of the suggested monitoring protocols are based on the reef check methods, as they are the quickest and easiest to use.

1.3.2. Procedure for starting a monitoring program

- Required personnel should be chosen. The number of field personnel per team should be three, one person to be on the boat and to navigate it, and two persons for the underwater field survey. The number of teams can be set depending on the availability of personnel. The entire group of 21 islands can be divided into 3 or 4 zones and hence have 3 to 4 teams. (Note: the same personnel/team should be used to gather data from the same zone for uniformity and reduction in inter-observer bias). One lab personnel should be present for data entry, analysis, interpretation and reporting.
- A small 2-3 day workshop should be held by an academic professional to show the practical aspects of the surveys
- Procurement of gear (list of gear/ equipment needed is given below in Table1)
- Selection of site: Suitable areas for monitoring corals should first be identified, they should be easily accessible, e.g. sites near the breaker zone should be avoided and sites must have easy boat access. Sites can easily be found by analyzing maps and also local knowledge of the reef areas by the forest official themselves can be useful. The area and extent of the reefs around the islands of the Gulf of Mannar has been recently published by ZSI, in the conservation action series 15 (Venketeraman et al 2002).
- Based on the size of the reefs around the island it should be divided into various sites. Larger reef areas should have more sites than smaller reef areas. Sites chosen for monitoring should be marked on a map. Personnel responsible for the field survey should go to the site and mark the general area with a GPS and also note recognizable land marks.

The site chosen should be a representative of the area of interest, and contain the same type of habitat (depth, reef slope or reef crest etc). This is so that inter-island comparisons can be made.

- Based on the structure of reef, the pattern and placement of transects (within the site) should be determined.

For reefs which are evenly distributed from shore to the reef edge, ie the corals are non-aligned then any random point can be taken and a starburst pattern can be used or linear placement. A minimum of 4 x 20 m transects should be done for PIT.

In case the reef has a typical fringing reef structure ie aligned zones; then a minimum of 4 x 20 m transects (PIT) on the reef slope should be done linearly leaving a gap of at least 5 m between transect

Belt transects can be done over a transect length of 100m; here 4 replicates of 20 meters are taken leaving a gap of 5 meters between every replicate. Belt transects for fish surveys need to be done more frequently to get a better understanding of fish abundance and changes.

- The two members of the diving team should first mark the sites for permanent transects using a GPS , the start and end point of the transect should be marked with a surface or sub surface buoys .this is so that repeated surveys can be done over the years over the same area.
- At the time of each survey ie before entering the water, certain physical characteristic of the water should be measured; these are depth, current.
- Temperature, visibility and salinity. Also data on location, site etc should be recorded in a separate data sheet.
- First the belt transects for fishes are done then the benthic invertebrate and coral surveys.
- Similar Depth should be maintained in all sites if possible. Along each depth contour, four 20 m long segments are surveyed to make up one sample. The segments should follow the designated depth contour one after the other, however, segment start and end points **MUST** be separated by a minimum of a 5 m gap. The distance between the start of the first segment and end of the last segment will be $20 + 5 + 20 + 5 + 20 + 5 + 20 = 95$ m. The 5 m gaps are necessary to ensure independence between samples, which is important for statistical analyses. a single 100 m or two 50 m fibreglass measuring tapes can be used which are available from hardware and survey equipment supply stores.

Fish belt transect

- One dive pair should lay out a 100 m transect line (or four 20 m transects separated by 5 m gaps along the specified contour). Once the depth contour is chosen, the start point should be located such that the transect goes through areas of high coral cover (known-bias survey). After deployment, the entire length of transect should be examined to ensure it is linear, not snagged or floating more than 1 m off the bottom. Small temporary floats should be attached to the start and endpoints so that the transect is easy to find. To resurvey the exact transect, permanent rebar stakes or sub surface buoys can be installed so that the site can be located for the next survey. From the start point Compass bearing to the end point and GPS location at the start point is a **MUST**.

- After deploying the transect, the divers should wait 15 minutes away from the transect before starting the survey. This waiting period is needed to allow fish to resume normal behaviour after being disturbed by the divers deploying the transect
- Fishes of commercial importance, such as groupers and butterfly fishes should be surveyed along the 4 transects within 2.5 m on either side of the transect line. . The maximum height above the transect to record fish is restricted to 5 m in the water column.
- Each diver assigned to count fish will swim slowly along the transect counting the fish. The diver will stop every 5 m, and then wait one to three minutes for indicator fish to come out of hiding, before proceeding to the next stop point (fish are counted along the entire length of each 20 m segment. This is a combined timed and area restricted survey: four segments x 20 m long x 5 m wide = 400 m². There are four 5 m gaps where no data are collected. At each depth contour, there are sixteen "stop-and count" points, and the goal is to complete the entire 400 m² belt transect in one hour

Invertebrate Belt Transect

- When the fish belt transect is complete, the invertebrate team survey can then be carried out using the same belt transect as was used for the fish survey. Each belt transect is 5 m wide with 2.5 m on either side of the transect line. The total survey area will be 20 m x 5 m = 100 m² for each segment, times four segments for a grand total of 400 m² for each depth contour. The invertebrate survey is similar to the fish survey; however, the diver does NOT stop every 5 m. It is extremely important to look in cracks and under large coral heads and overhangs to search for cryptic species such as lobsters. The diver should swim slowly along the transect counting the indicator invertebrates. It is recommended that one diver do the fish survey and the other does the invertebrate survey.

Point intercept transect.

- Using the same transect used for the fish and invertebrate surveys the point intercept transects should be done at the same 20 m intervals leaving 5 m between every segment. The substrate type under each 0.5 m of the tape should be noted down. There are about 31 life form categories (substrates) under 11 groups. All these life form categories are designated a code for easy remembrance, these life form categories are listed in Table 2 .A sample data sheet is also given Table 3.
- The percentage cover of each substrate of life form can be calculated using the following formulae.

$$\text{Percentage cover of life form} = \frac{\text{Total no of points of one category}}{\text{Total no of points on transect}} \times 100$$

eg

$$\text{Percentage cover of massive corals} = \frac{\text{Total points of massive corals under transect}}{\text{Total no of points on transect}} \times 100$$

Table : 1 List of equipment needed

<p>1.Snorkel/SCUBA gear, 2.50m fibreglass measuring tape, 3 Underwater writing sheets and pencils, 4 Markers/stakes, Sub-surface and surface buoys, 5 GPS, 6.Underwater compass 7. 1:25,000 scale maps. 8.Underwater camera</p>
--

Table 2: Life form categories (English et al 1997)

Categories	Code	Notes/remarks
Dead coral	DC	Recently dead , white to dirty white
Dead coral with algae	DCA	Coral covered with algae, the coral is stranding but skeletal structure can still be seen
	Acropora	
Acropora branching	ACB	At last secondary branching
Acropora encrusting	ACE	Usually the basal plate of immature acropora forms
Acropora Sub-massive	ACS	Robust with knob or wedge like
Acropora digitate	ACD	No secondary branching
Acropora tabular	ACT	Horizontal flattened plates
	Non acropora	
Non Acropora branching	CB	At least secondary branching
Non acropora encrusting	CE	Major portion attached to substratum as a laminar plate
Non acropora foliose	CF	Leaf like or plate like appearance
Non acropora massive	CM	Solid boulder
Non acropora submassive	CSM	Small colums, knobs or wedge shaped
Mushroom coral	CMR	Free living
Heliopora	CHL	Blue coral
Millepora	CME	Fire coral
Tubipora	CTU	Organ pipe coral
	Other fauna	
Soft coral	SC	Soft bodied corals
Sponges	SP	
Zoanthids	ZN	
Others	OT	Ascidians , anemones, giant clams etc
	Algae	
Algae assemblage	AA	Consist of more than one species
Coralline algae	EA	
Halimeda	HA	
Macro algae	FA	Weedy/fleshy browns,red,etc
Turf algae	TA	Luscious filamentous algae often found with damsel fish territories
	Abiotic	
Sand	S	
Rubble	CR	Unconsolidated coral fragments
Silt	SI	
Water	WA	Fissures deeper than 50cm
Rock	RCK	
OTHERS	DDD	Missing data

Table: Sample raw data sheet.

Date: _____ Location: _____ transect no: _____ visibility hor: _____ vertical: _____ Site: _____ depth: __m Start lat : _____ Long: _____ stop lat: _____ long: _____			
Intercept point	Life form recorded	Intercept point	Life form recorded
0.5m		10.5m	
1m		11m	
1.5m		11.5m	
2m		12m	
2.5m		12.5m	
3m		13m	
3.5m		13.5m	
4m		14m	
4.5m		14.5m	
5m		15m	
5.5m		15.5m	
6m		16m	
6.5m		16.5m	
7m		17m	
7.5m		17.5m	
8m		18m	
8.5m		18.5m	
9m		19m	
9.5m		19.5m	
10m		20m	

Marking Permanent Monitoring Plots: Methodology of marking permanent monitoring plots, present status and distribution pattern of corals in select islands of the GOMMNP- Case study in Jan 2007.

The status of the Gulf of Mannar has been studied over the last decade by various institutions in India, but compilation of the data revealed that there were no concrete results to the current status of the reef or its trends in the past ten years, this was mainly because of inconsistent in methodologies used and sites studied which has varied from organization to organization. Therefore, an appropriate method to monitor the coral reefs from identified sites for a longer period is visualized. Long term monitoring on status and distribution pattern of corals on identified reefs would help us to the success of any management programmes.

How can monitoring programme help the Management?

Monitoring the coral reef can help managers to identify the changes which happening to the reef due to implementation of this management and also take an appropriate action, if necessary. It can also assess the successfulness of the Management Plan.

Aim: To identify and establish the permanent monitoring sites on the coral reefs of the Gulf of Mannar National Park with suitable methods.

Objectives of the monitoring program

The main objective of this monitoring program was to find the percentage coverage of various substrates in the reef area of each island and to establish monitoring plots within them to be surveyed yearly.

Methods

To establish permanent monitoring sites, the point intercept method was used, as it is rapid and less expensive. Transects of 20 m lengths were used and intercept point was fixed at every 0.5 m of the transect. In total there were 40 points in each transect, where the substratum type were categorized based on the life form level as described by English et al in 1997(table1). The number of transects laid varied between 3 to 6 based on the size of the coral reef. The methodology here slightly varies from the one suggested in Appendix 1, All transects were laid parallel to the shore or the reef slope, the transects were mostly placed linearly leaving about 5-10 m gap between the end of one transect and the start of another. Only in the second site of Pulivinichalli Island, where the transects were laid parallel to the shore and also adjacently parallel to each other with about 5 to 10 meters gap between them.

The start and end points of each transect was marked with a GPS. Nails with subsurface buoys were placed on the start and end of each transect. The nails were only driven into old dead coral. If the end point ended over a live coral, then the nail was driven a few meters away on the next dead coral encountered along the same line as the transect. The nails were used as guides so transects can run along the same line in the future. This is done to reduce variability in the data.

Table 1:

Categories	Code	Notes/remarks
Dead coral	DC	Recently dead, white to dirty white
Dead coral with algae	DCA	Coral covered with algae, the coral is stranding but skeletal structure can still be seen
	<i>Acropora</i>	
<i>Acropora</i> branching	ACB	At least secondary branching
<i>Acropora</i> encrusting	ACE	Usually the basal plate of immature <i>Acropora</i> forms
<i>Acropora</i> Sub-massive	ACS	Robust with knob or wedge like
<i>Acropora</i> digitate	ACD	No secondary branching
<i>Acropora</i> tabular	ACT	Horizontal flattened plates
	Non <i>Acropora</i>	
Non <i>Acropora</i> branching	CB	At least secondary branching
Non <i>Acropora</i> encrusting	CE	Major portion attached to substratum as a laminar plate
Non <i>Acropora</i> foliose	CF	Leaf like or plate like appearance
Non <i>Acropora</i> massive	CM	Solid boulder
Non <i>Acropora</i> submassive	CSM	Small columns, knobs or wedge shaped
Mushroom coral	CMR	Free living
<i>Heliopora</i>	CHL	Blue coral
<i>Millepora</i>	CME	Fire coral
<i>Tubipora</i>	CTU	Organ pipe coral
	Other fauna	

Soft coral	SC	Soft bodied corals
Sponges	SP	
Zoanthids	ZN	
Others	OT	Ascidians , anemones, giant clams etc
	Algae	
Algae assemblage	AA	Consist of more than one species
Coralline algae	EA	
Halimeda	HA	
Macro algae	FA	Weedy/fleshy browns,red,etc
Turf algae	TA	Luscious filamentous algae often found with damsel fish territories
	Abiotic	
Sand	S	
Rubble	CR	Unconsolidated coral fragments
Silt	SI	
Water	WA	Fissures deeper than 50cm
Rock	RCK	
OTHERS	DDD	Missing data

Monitoring period

In the Gulf of Mannar, the sea is calm between December to March and the visibility is best, it is suggested that the monitoring be taken up during this period every year.

Site selection:

Sites were selected after swimming from the beach perpendicular to the islands shore over the reef areas. In areas, where the coral reefs was large has been selected for monitoring. The three types of reefs were found in the survey are:

- i) Patch reefs- these are small patches of corals , roughly from a few 10 m across to about 100m length wise, and a roughly few ten m in breath, the patch reefs do not have any normal reef structure such as reef crest , reef slope, etc,. They are basically coral growth on a flat platform composed of mainly sand and coral rubble.
- ii) Coral pinnacles- these are boulder corals, they are isolated coral colonies interspersed with sandy bottom and do not form a definite reef structure, the size of the coral pinnacles are roughly 1-10 m in diameter and may harbour other species of corals , they are generally found off the outer reef edge.
- iii) Fringing reef- these are continuous reefs which fringe along the coast, they have a horizontal zonation and hence have definite reef structures such as rubble zone, lagoon, reef flat, inner reef slope, reef crest and outer reef slope.

Coral pinnacle were not surveyed, only the patch reefs and fringing reefs were chosen for monitoring sites. On patch reefs transect were laid roughly in the middle along its longitudinal axis. On Fringing Reefs the Transects were place on the reef crest or outer reef slope or inner reef slope, parallel to the shore of each island and site

The size and number of transects and the number of sites should be decided based on the size of each zone. Transects should be placed ideally in the center of each zone to remove the bias of the edges between zones. Based on the size of the reefs around the island it should be divided into various sites. Larger reef areas should have more sites than smaller reef areas. Sites chosen for monitoring should be marked on a map.

The site chosen should be a representative of the area of interest, and contain the same type of habitat (depth, reef slope or reef crest etc). This is so that inter-island comparisons can be made.

In total, seven sites have been selected in five islands. Due to lack of time other islands could not sample but it is necessary to identify permanent monitoring sites in all islands.

Start and end points of each Permanent transect marked in each island and site

Shingle Island					
site 1					
	Transect1	transect2	Transect3	Transect4	Transec5
Start Point	09.14.708	9.14.687	09.14.678	09.14.678	09.14.675
	79.14.060	79.14.082	79.14.101	79.14.122	79.14.140
End Point	09.14.695	09.14.683	09.14.686	09.14.674	09.14.671
	79.14.061	79.14.092	79.14.111	79.14.133	79.14.152

Shingle Island						
SITE 2						
	transect1	transect2	transect3	transect4	transect5	transect6
Start	09.14.532	09.14.532	09.14.508	09.14.514	09.14.503	09.14.510
	79.13.796	79.13.806	79.13.819	79.13.847	79.13.864	79.13.882
End	09.14.527	09.14.513	09.14.499	09.14.510	09.14.496	09.14.561
	79.13.807	79.13.813	79.13.823	79.13.855	79.13.877	79.13.894

Appa Islaand					
SITE 1					
	Transect1	Transect2	Transect3	Transect4	Transect5
START	09.09.403	09.09.405	09.09.407	09.09.412	09.09.390
	78.49.706	78.49.716	78.79.702	78.49.682	78.49.652
End	09.09.407	09.09.407	09.09.406	09.09.401	09.09.388
	78.49.729	78.49.711	78.49.699	78.49.661	78.49.641

PULIVINICHALLI					
SITE1					
	transect 1	transect 2	transect3	transect4	transect5
START	09.06.101	09.06.090	09.06.076	09.06.095	09.06.111
	78.31.982	78.31.981	78.31.991	78.31.985	78.31.978
End	09.06.092	09.06.084	09.06.067	09.06.105	99.06.120
	78.31.989	78.31.991	78.31.994	78.31.979	78.31.972

PULIVINICHALLI				
Site 2		transect 1	transect 2	transect3
	START	09.50.959	09.05.953	09.05.942
		78.32.126	78.32.113	78.32.125
	STOP	09.05.958	09.05.955	09.32.939
		78.32.113	78.32.122	78.32.114

Karyachalli					
site1					
	transect 1	transect 2	transect3	transect4	transect5
Start	08.56.997	08.56.994	08.57.012	08.57.039	08.57.067
	78.15.011	78.15.011	78.15.009	78.14.999	78.14.994
End	08.56.989	08.57.004	8.57.022	08.57.049	08.57.056
	78.15.012	78.15.011	78.15.002	78.14.996	78.14.994

VAN			
site1			
	transect 1	transect 2	transect3
Start	8.50.306	8.50.280	8.50.237
	79.12.940	79.12.960	79.12.976
End	8.50.299	8.50.271	8.50.224
	79.12.973	79.12.977	79.12.978

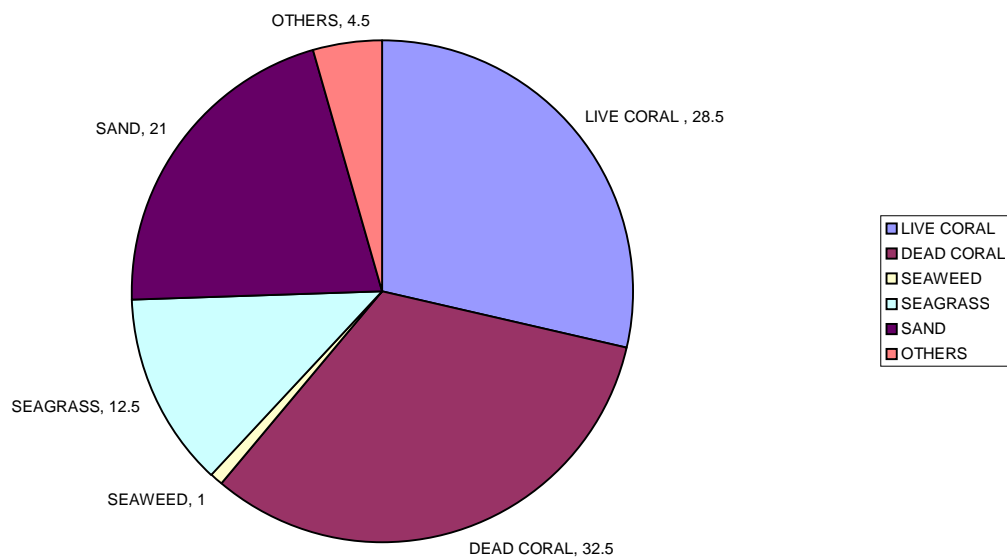
Current status and distribution pattern of corals in representative monitoring sites in selected islands (in 2007):

SHINGLE ISLAND

This island is the easternmost island in the GOMMNP, it lies south of Rameshwaram island and is part of the Mandapam group of islands. Monitoring plots were set up on the northern side and also along the curve of the western shore.

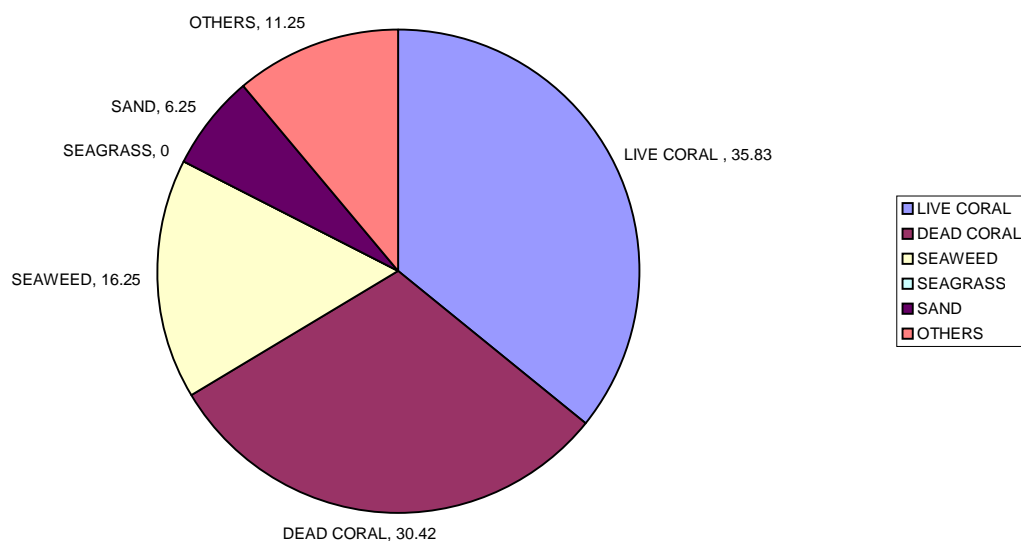
Site 1: The reef monitored on the northern side of the island is of patchy type, the depth was approximately 1.5 -2 m. A total of 5 transects were laid linear to each other and parallel to the coast. This area has mainly *Pocillopora* sp. and *Montipora digita* corals. The live coral cover found in this site is about 28.5 %. No *Acropora* corals were seen in this area. The horizontal visibility was poor at about 2m.

% cover of substrate in the reefs of Shingle Island -SITE 1



Site 2: The reef selected on the western side was of fringing type, the reef curves around the western tip starting from the northwestern side. The site chosen was only 0.5 m deep in low tide. 6 transects were laid linearly and also parallel to the contours of the coastline. This area has lots of *Acropora* branching, *Acropora* tabulate corals and also foliaceous corals, some patches in this area had high coral cover. This site showed having large colonies of both *Acropora* tabulate and foliose corals, some of the *Acropora* tabulate colonies measured were 1.5 to 2 m in diameter. During low spring tide some areas of the reef including live *Acropora* corals were seen exposed. The horizontal visibility was poor with only about 3-4 m. contrasting to the northern side of Shingle; this area did not show any *Pocillopora* corals. The live coral cover for this area was found to be 35.83 %.

% cover of substrate in the reefs of Shingle island -SITE2

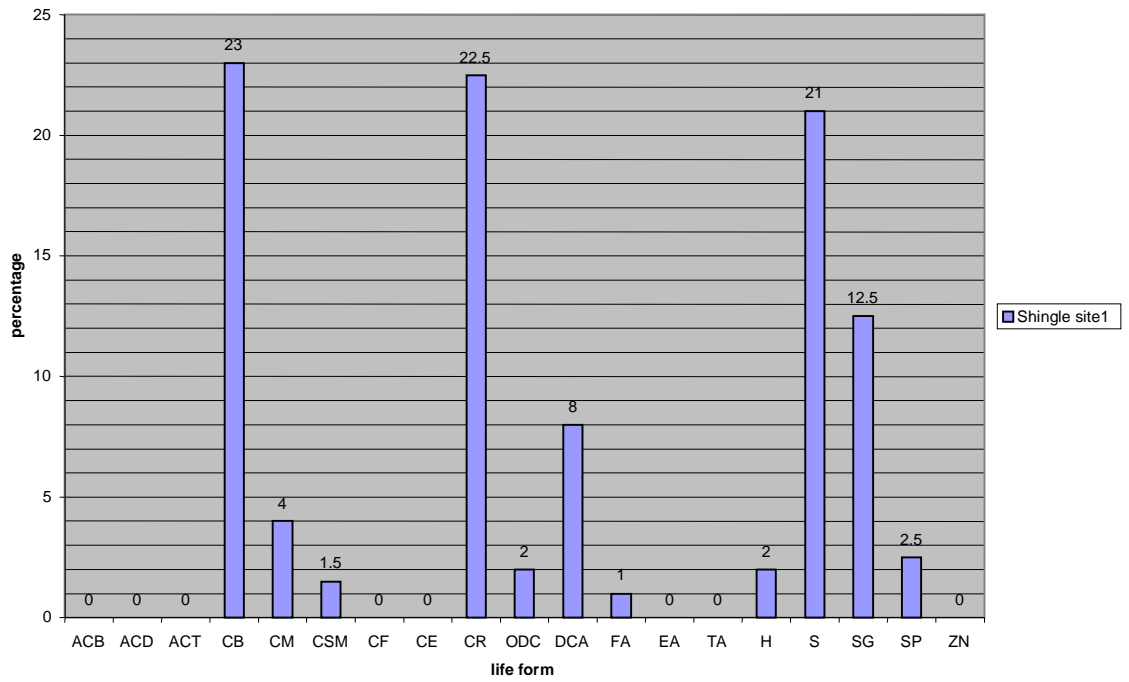


The south western shore showed small patches of dense *Acropora* branching and *Montipora digita* corals hardly 10 meters from the shore at a dept of hardly 30 cm and this trend extended till about 50 from the shore, after which there was only rubble mixed with seaweed as the wave action in this area was very high. No monitoring plots were set up in this area but should be set up in the future. Only 3 species of butterfly fish were found i.e. *Cheatodon collarae* and *Cheatodon octofasiatus*. *Chaetodon trifascialis*

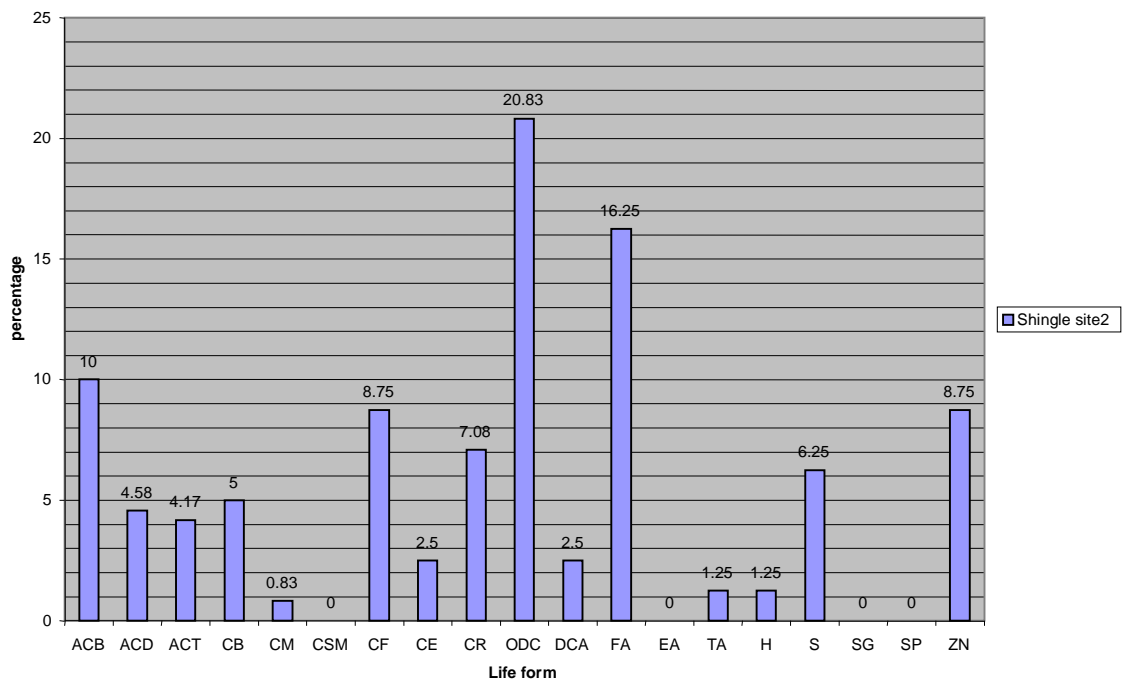


Photo: Reefs of Shingle Island –site 2

% life form cover on the reefs of Shingle island-site1



% of live form cover in the reefs of Shingle island-site2

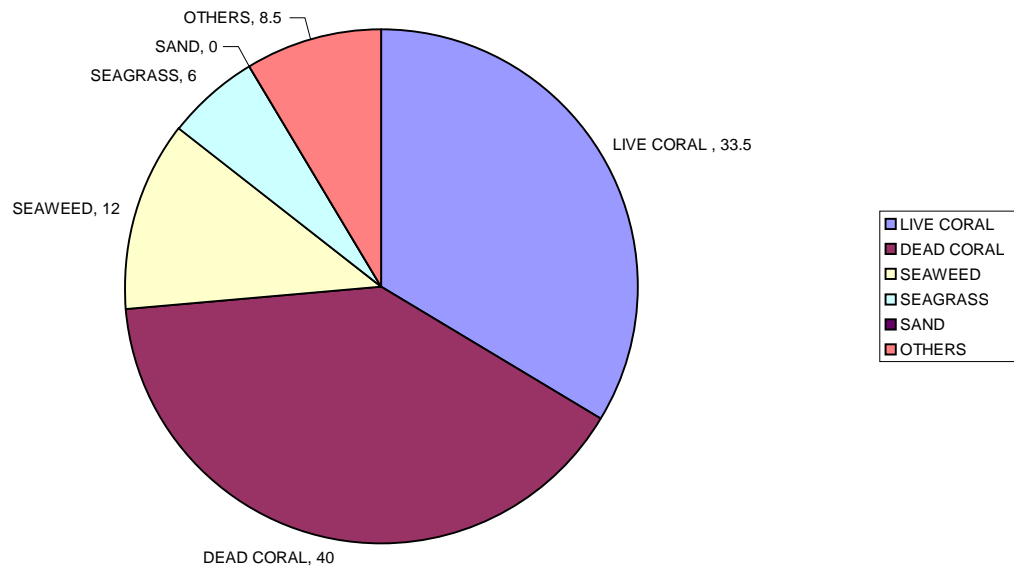


APPA ISLAND

This island is found in the Keelakarai group of islands, the longitudinal axis of this island runs roughly in the Northeast to south western direction. On the south western tip there runs a uplifted ridge made of fossilized coral rock and coral rubble roughly in the east west direction. The area between this ridge and the island forms a lagoon. The site selected was on the southern side of this ridge roughly mid way to the eastern side toward the open sea. A total of 5 transects were laid on this site linearly at a depth of about 2-3 meters and run parallel to the ridge. The area was dominated by massive corals, with certain areas dominated by the fleshy algae *Sargassum sp.* and *Turbinaria sp.* The horizontal visibility varied between 7 – 14 meters based on cloud cover. The live coral cover of this area was found to be 33.5 %.

Only *Chaetodon collorae* species was recorded in this area.

% cover of substrate in the reefs of Appa island - SITE1



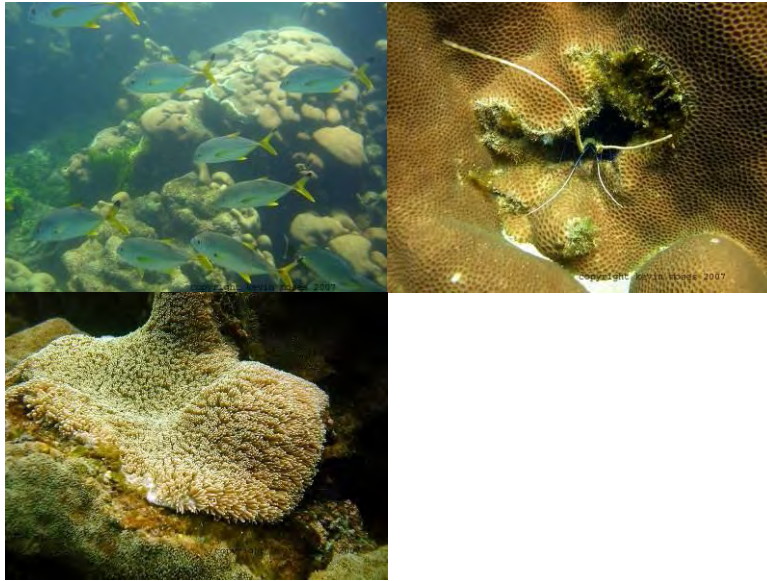
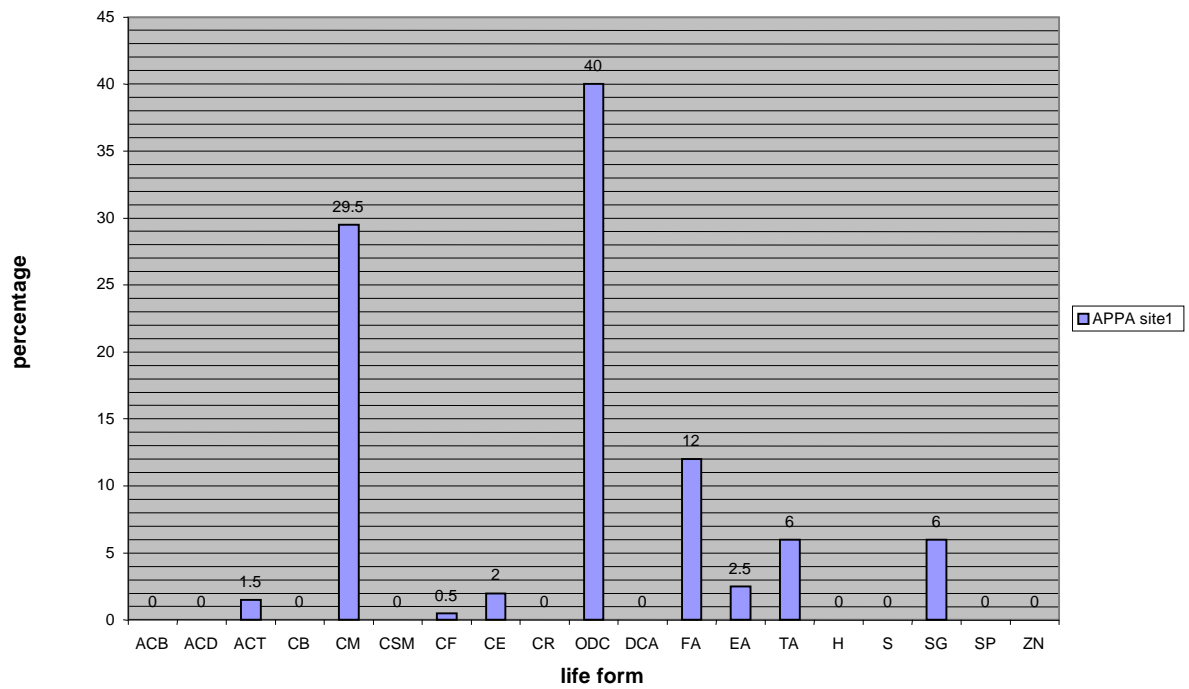


Photo:Reefs of Appa Island

% life form cover in the reef of Appa island-site1



POORVASANPATTI

This island also part of the Keelakarai group is currently submerged, a random swim was done on the northern side of the submerged island and the reefs around this island is healthy and is mainly composed of coral pinnacles rising from a depth of 3 meters, the most common corals were *Porites* sp and *Acropora* tabulate corals, three species of butterfly fishes were found , *Chaetodon auriga*, *cheatodon collarae* and *Cheatodon octofaciatus*. **No transects were laid in this area.**



Photo:Reefs of Poorvasanpatti island.

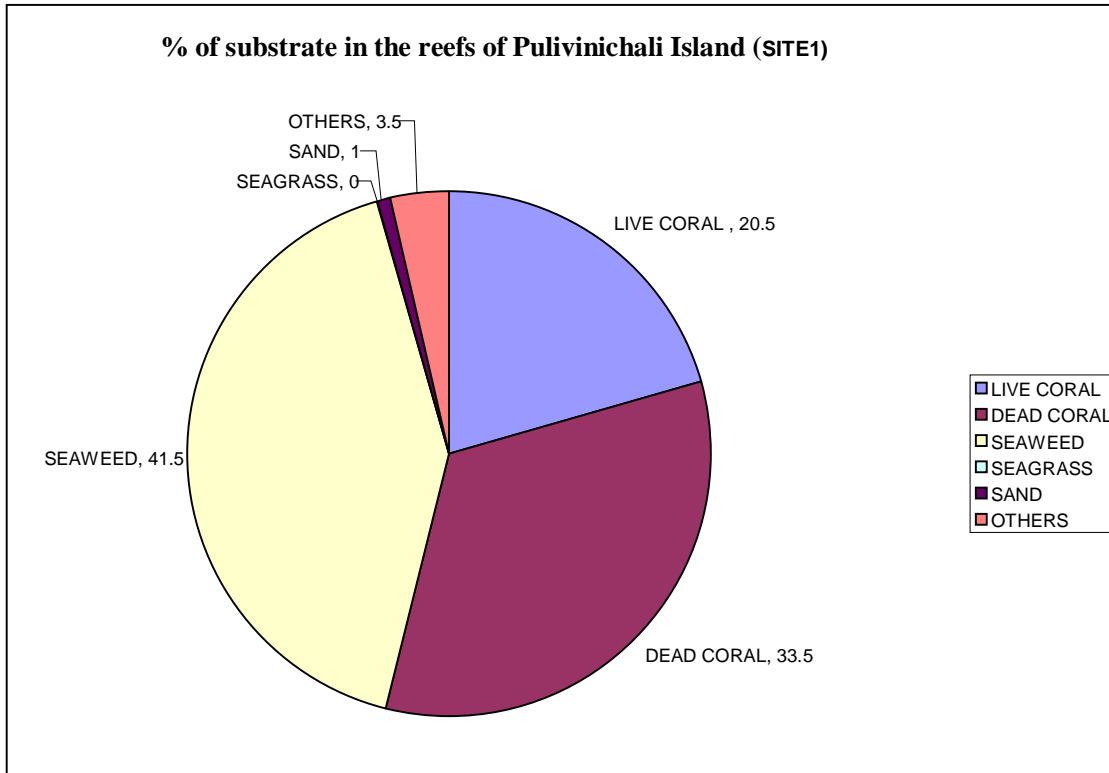
PULIVINICHALLI

This is a smallest island in the Vembar group of islands.

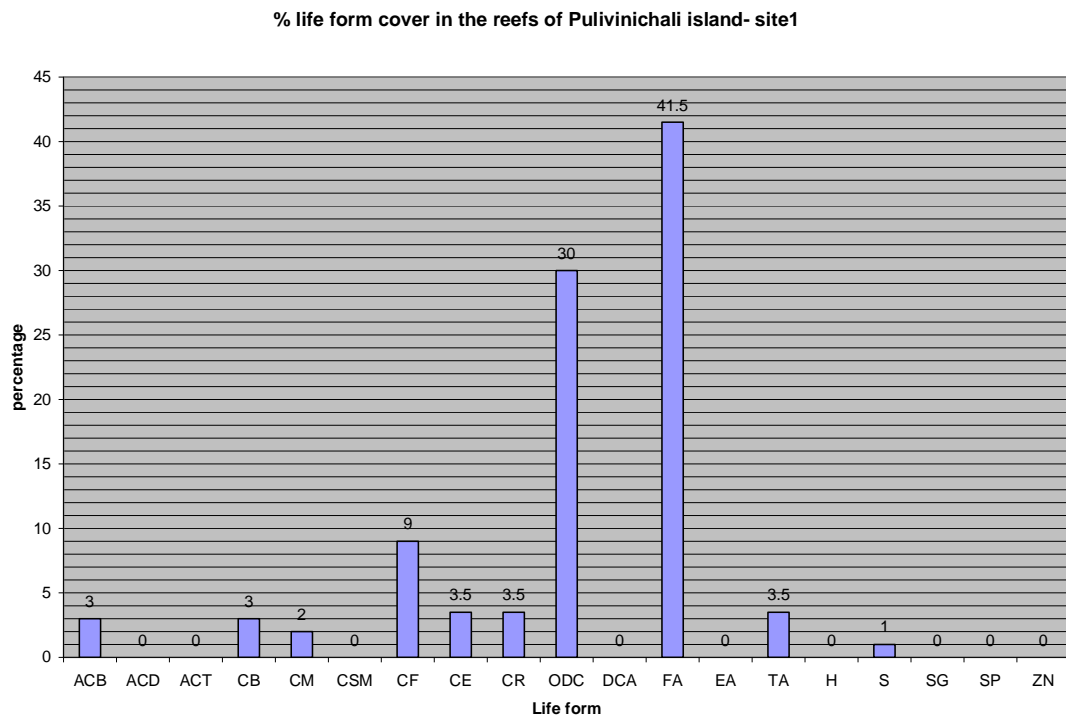
Site 1. Fringing reefs were found on the eastern side of the island, the reef crest and backward reef slope were chosen for monitoring. 5 transects were laid in this area, roughly linear but parallel to each other and parallel to the contours of the reef slope. *Acropora* branching corals and foliaceous corals were the most common in this zone. Seaweeds such as *Turbinaria* sp and *Sargassum* sp were found to be heavily competing with corals in this region for space. About 41.5 % of the substrate was covered with fleshy algae. The live coral cover in this region was 20.5 % only.



Photo:Reefs of Pulivinichalli Island Site 1



The outer reef slope of this reef site was dominated by massive corals and showed more number of species than the reef crest and inner reef slope. This slope was steep, nearly vertical and dropped to a depth of 4 m. This site too needs to be monitored in the future.

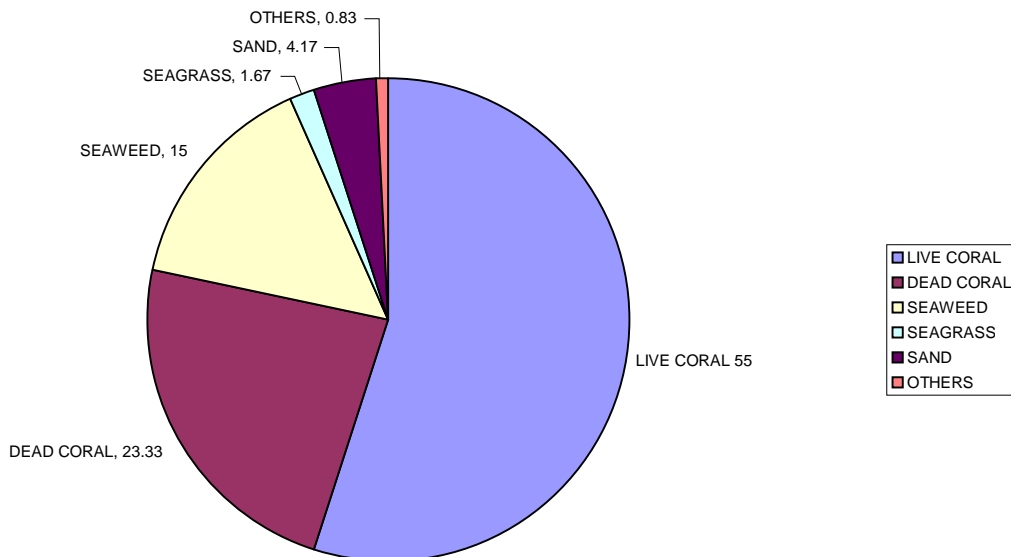


Site 2: The second site was on the southern side of the island approx 100m seaward of the breaker zone, this site was at a depth of about 3 meter and small patch of dense *Acropora* corals were seen here. At this site only 3 transects were laid perpendicular to each other. The live coral cover in this area was found to be high at and entirely dominated by *Acropora* branching coral. The percentage of live coral cover in this region is about 55%

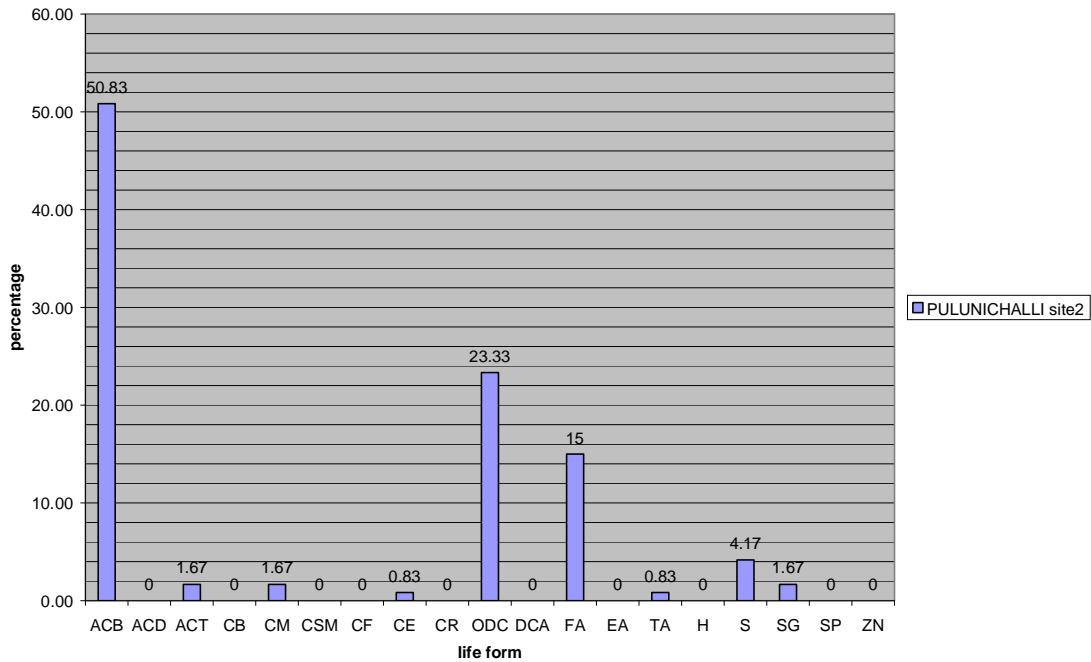


Photo:Reefs of Pulivinichalli site 2

% cover of substrate in the reefs of Pulivinichali island-SITE2



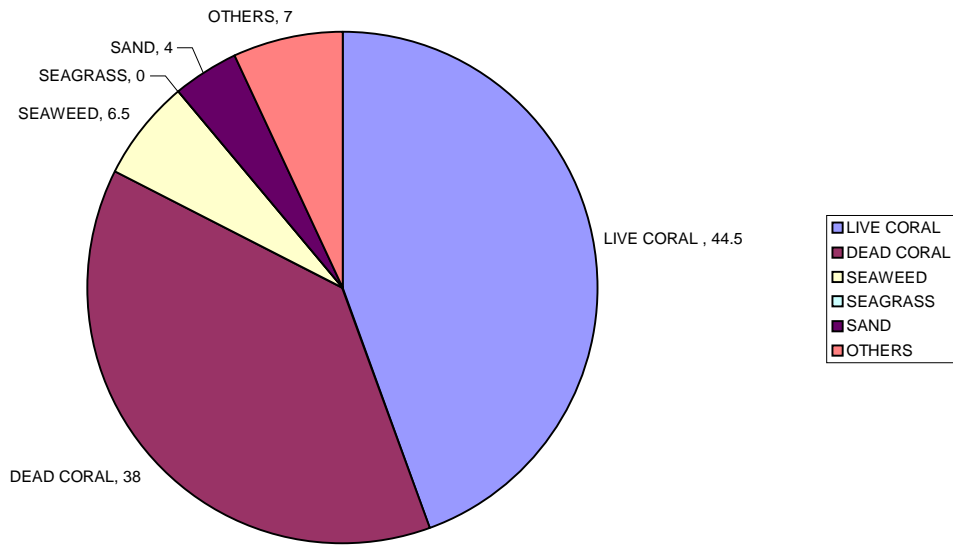
% of life form cover in the reefs of Pulivinichali island- site2



KARYACHALLI ISLAND

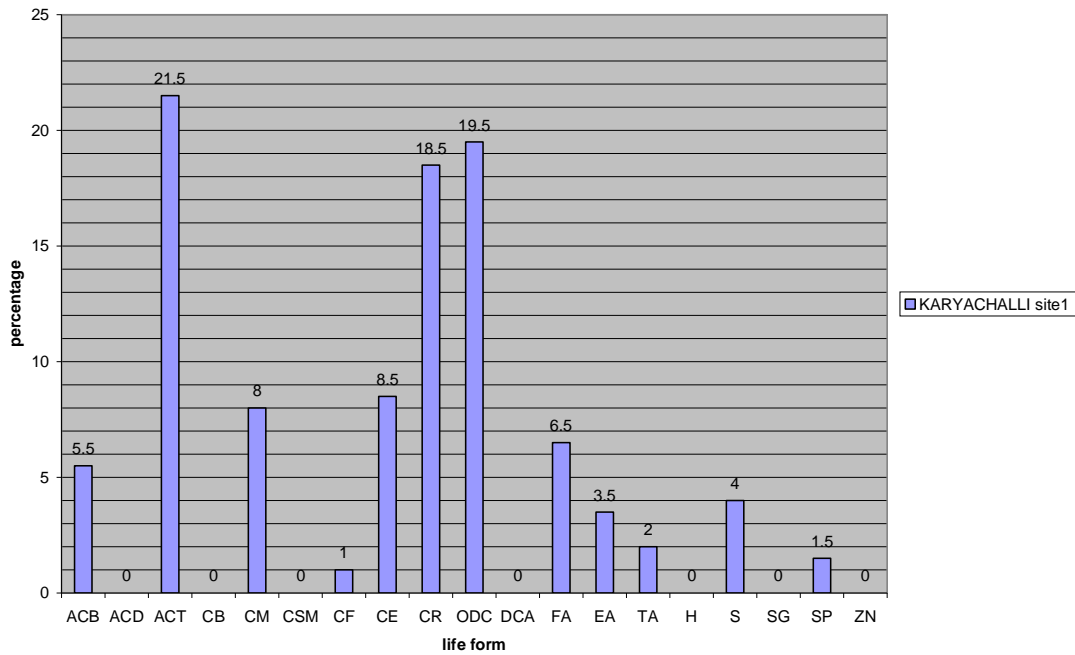
This island is part of the Tuticorin group of islands, there is a good fringing reef on the all around the southern part of the island. Five transects were laid on the South western part of the reef and all transects were laid linearly on the reef crest. The average depth of each transect was less than 1 m. The slope of this reef was steep and drops sharply to about 3.5 m depth. This site had large colonies of *Porites*, *Favia* and *Acropora* branching and tabulate corals. Four species of cheatodontid fishes were seen, *Chaetodon meyeri*, *C. octofasciatus*, *C. collerae*, and *C. auriga*. The percentage live coral cover for this site is 44.5 %.

% cover of substrate in the reefs of Karyachali Island- SITE1



Photos:Reefs of Karyachalli Island

% of life form cover in the reef of Karyachalli island -site1



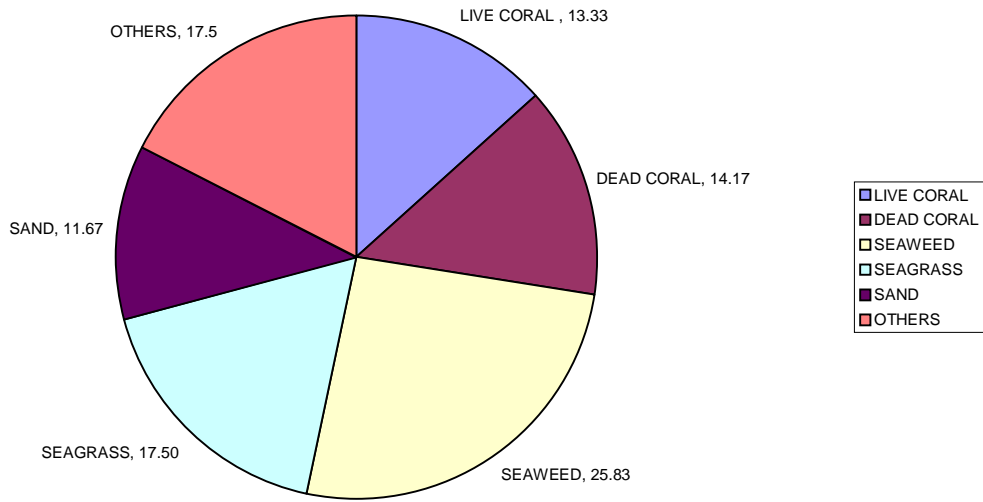
VAN ISLAND

This is the southern and western most islands in the GOMMNP, the western side of the island was surveyed by random swims and it was found that the entire reef flat area has been degraded to rubble. Certain areas of reef rubble have been cemented by coralline algae and there is small patches of recruitment happening in this area. Three transects were laid and placed linearly. The live coral cover was found to be 13 % and this is mainly due to one species of encrusting coral of the genus *Goniopora* found in certain patches.



Photo: Reef flat of Van Island

% cover of substrate in the reefs of Van island- SITE1



% of life form cover in the reef of Van island- site1

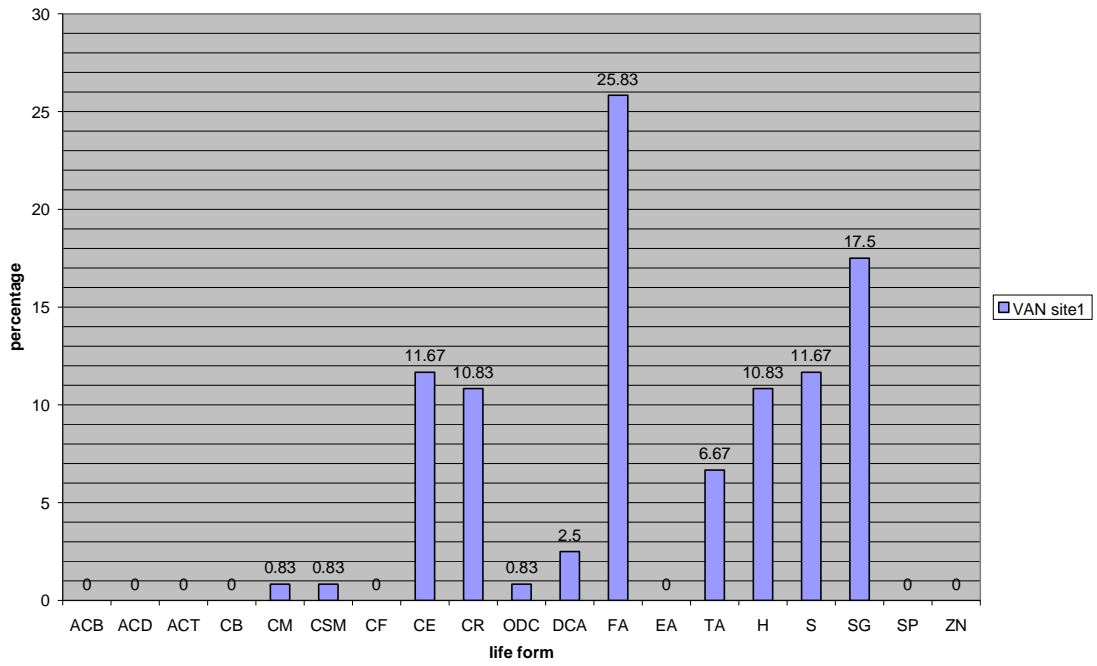


Table2: Present status of the various substrates available on the coral reefs of the permanent monitoring sites.

Percentage of substrate.													
		Live coral		Dead coral		Seaweed		Sea grass		Sand		Others	
		AVG	STD	AVG	STD	AVG	STD	AVG	STD	AVG	STD	AVG	STD
Shingle	Site1	28.5	20.23	32.5	11.59	1	1.37	12.5	27.95	21	23.09	4.5	3.26
	Site2	35.83	16.25	30.42	19.52	16.25	15.79	0	0	6.25	7.54	11.25	20.42
Appa	Site1	33.5	25.90	40	14.14	12	10.95	6	5.76	0	0	8.5	7.42
Pulivinichalli	Site1	20.5	8.37	33.5	9.29	41.5	8.94	0	0	1	2.24	3.5	2.85
Pulivinichalli	Site2	55	11.46	23.33	5.77	15	9.01	1.67	2.89	4.17	1.44	0.83	1.44
Karyachalli	Site1	44.5	12.17	38	12.17	6.5	4.18	0	0	4	1.37	7	3.26
Van	Site2	13.33	18.93	14.17	13.77	25.83	20.82	17.50	13.23	11.67	1.44	17.5	21.79

Present status of coral reefs in the 5 islands surveyed

Among the 7 sites in the 5 islands surveyed, Karyachalli of the Tuticorin group had the highest percentage live coral cover, the lowest coral cover was seen in Van island also of the Tuticorin group The %age coral cover of each island is given in table 2.

Table 3 : Percentage Life Forms Of Each Site.

Percentage Life form in each island site								
	Shingle	Shingle	APPA	PULUNICHALLI	KARYACHALLI	VAN		
Life form	site 1	site 2	site1	site1	site2	site1	site1	
ACB	0	10	0	3	50.83333	5.5	0	
ACD	0	4.583333	0	0	0	0	0	
ACT	0	4.166667	1.5	0	1.666667	21.5	0	
CB	23	5	0	3	0	0	0	
CM	4	0.833333	29.5	2	1.666667	8	0.833333	
CSM	1.5	0	0	0	0	0	0.833333	
CF	0	8.75	0.5	9	0	1	0	
CE	0	2.5	2	3.5	0.833333	8.5	11.66667	
CR	22.5	7.083333	0	3.5	0	18.5	10.83333	
ODC	2	20.83333	40	30	23.33333	19.5	0.833333	
DCA	8	2.5	0	0	0	0	2.5	
FA	1	16.25	12	41.5	15	6.5	25.83333	
EA	0	0	2.5	0	0	3.5	0	
TA	0	1.25	6	3.5	0.833333	2	6.666667	
H	2	1.25	0	0	0	0	10.83333	
S	21	6.25	0	1	4.166667	4	11.66667	
SG	12.5	0	6	0	1.666667	0	17.5	
SP	2.5	0	0	0	0	1.5	0	
ZN	0	8.75	0	0	0	0	0	

Site 2 in Shingle Island has seven out of eight life forms identified in this region. However, Van was represented by just 3 life forms of which coral encrusting takes 90% of occurrence of live corals.

Pulivinichalli site 1, has high densities of Fleshy algae compared to other sites, whether this is due to eutrophication or lack of herbivores is a question that needs to be answered, the biomass of fish generally observed in all the islands were low except for Appa island and Poorvasanpatti.

In Van Island is the only island to have a large percentage of seagrass on its reef area.

After review of the status of coral reefs of the Gulf of Mannar MNP from 1981-2004, The Management Plan Research Team of WII carried out a rapid survey of five representative islands to observe the current status, based on which the management prescriptions have been given in the Plan.

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
2	Coral reefs											
	Vigilance, Protection and Monitoring of coral habitats through Anti-poaching Watchers from nearby villagers (40 persons)		15	15	16	16	17	17	18	18	19	151
	Assisted reef restoration and monitoring (Target 35 sq.km in 10 years)		20	20	45	45	75	75	80	80	85	525
	Monitoring of permanent plots every year, the GOMBRT and GOMMNP management requires to monitor plots in all fringing reefs and patch reefs around the islands through in-house monitoring (preferably during Jan – March).		5	5	6	6	7	7	8	8	9	61
	Outsourcing – a professional and scientific assessment of coral reef status , distribution and abundance and prepare revised maps once in 5 years (e.g. DOD-ICMAMPD resource information system) Co-ordinate and collate information into an open data database at the GOMBR research and monitoring laboratory					50					75	125

4.3.2. Sea grasses habitat of the Gulf of Mannar Marine National Park

4.3.2.1. Introduction

The Gulf of Mannar is well known for its rich diversity of sea grasses along with dugong. Seagrasses are a type of submerged aquatic vegetation, which have evolved from terrestrial plants and have become specialized to live in the marine environment. Various fishes, molluscs, crustaceans, and echinoderms form the predominant associated fauna of the sea grass habitats. Macrofauna mainly comprised of oligochaetes, polychaetes, crustaceans and nematods, while meiofaunal groups mainly consist of turbellaria, nematode and harpacticoida lives in this habitat type (Eiseman et al., 1976). Under normal conditions, seagrasses maintain water clarity by trapping silt, dirt, and other sediments suspended in the water column. These materials are then incorporated into the benthic substratum, where they are stabilized by seagrass roots. However, when sediment loading becomes excessive, turbidity in the water column increases and the penetration of sunlight is inhibited. In extreme cases, excessive sediment loading can actually smother seagrasses. So far, there was no detailed study conducted to know the diversity and status of sea grass beds in the region, however, our observation showed that in many places the sea grass habitats getting degraded due to fishing related activities in this region.

Current status of seagrass beds in the GOMBR

It was estimated that the total extent of seagrass beds around all islands of the Gulf of Mannar Biosphere Reserve was 80.7 km². The species composition of seagrass community in the Gulf of Mannar region include *Enhalus acoroides*, *Halophila ovalis*, *Halophila ovata*, *Halophila beccari*, *Halophila stipulacea*, *Thalassia lemprichii*, *Cymadocea serrulata*, *Cymadocea rotundata*, *Halodule uninervis* and *Syringodium isoetifolium* etc . List of seagrass species present in the Gulf of Mannar Biosphere Reserve is listed in the Table 1. In Gulf of Mannar, the seagrass beds are the ideal feeding ground for the endangered marine mammal, Seacow *Dugong dugon*. Stormwater runoff drains both urban and agricultural areas, and carries with it household chemicals, oils, automotive chemicals, pesticides, animal wastes, and other debris into the sea.

Seagrasses are subject to a number of biotic and abiotic stresses such as storms, excessive grazing by herbivores, disease, and anthropogenic threats due to point and non-point sources of pollution, decreasing water clarity, excessive nutrients in runoff, sedimentation and prop scarring. What effect these stresses have on seagrasses is dependent on both the nature and severity of the particular environmental challenge. Generally, if only leaves and above-ground vegetation are impacted, seagrasses are generally able to recover from damage within a few weeks; however, when damage is done to roots and rhizomes, the ability of the plant to produce new growth is severely impacted, and plants may never be able to recover (Zieman et al. 1984, Fonseca et al. 1998).

Table . Distribution of sea grasses around different isalands of the Gulf of Mannar Natioanal Park. (Source: RISFGM, ICMAM, Chennai – April 2001)

Sl. No		1	2		4	5	6	7	8	9	10	11	12	
		<i>Cymodocea rotundata</i>	<i>Cymodocea serrulata</i>	<i>Syringodium isoetifolium</i>	<i>Halodule uninervis</i>	<i>Halophila ovalis</i>	<i>Halophila ovata</i>	<i>Thalassia hemprichii</i>	<i>Enhalus acoroides</i>	<i>Halophila stipulacea</i>	<i>Halophila decipiens</i>	<i>Halophila beccarii</i>	<i>Halodule pinifolia</i>	AREA OF COVER (KM ²)
1	Shingle island	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	0.21
2	Krusadai island	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	3
3	Manoli and Manoputti islands	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	5
4	Musal island	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	9.5
5	Mulli island	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	2
6	Valai and Tailari islands	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	8
7	Appa island		Y	Y		Y	Y	Y		Y	Y	Y	Y	8
8	Poovarasampatti and Valimunai islands		Y	Y		Y	Y	Y		Y	Y	Y	Y	11.5
9	Anaipar island		Y	Y		Y	Y	Y		Y	Y	Y	Y	14
10	Nallathani islands	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	5
11	Puluvnichalli island	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	1.5
12	Upputhani island		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	2.5
13	Karaichalli island	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	1
14	Vilanguchalli island	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	1.5
15	Kasuar island	Y		Y			Y	Y		Y	Y	Y	Y	3
16	Van island		Y	Y		Y	Y	Y		Y	Y	Y	Y	5
	TOTAL AREA													80.71

Threats:

Although, seagrasses in the Gulf of Mannar Marine National park are subject to a number of biotic and abiotic stresses such as storms, excessive grazing by herbivores, disease, and anthropogenic threats due to point and non-point sources of pollution, decreasing water clarity, excessive nutrients in runoff, sedimentation and prop scarring, the major threats which present in this region are mentioned below:

1. Since the seagrass productivity is highly dependent on ideal salinity, water temperature, and turbidity, which are getting polluted by industrial and domestic wastes, which comes from the near by coastal areas of the Gulf of Mannar National Park.

2. Port and dredging related activities in the region churns up seagrass beds, increasing turbidity and suspended sediments in the water column, which would have a long-term impacts on seagrasses of this region.
3. Use of indiscriminate fishing technology especially trawling on these beds is also expected to harm this habitat.
4. With increased agricultural activity on the nearby landscape is also posing a threat to the sea grass beds because of its pollution.
5. Fishing in the seagrass beds and increase use of fishing vessels on the habitat are also threatening this habitat.
6. Collection of sea grasses for fodder and fertilizers.

Management Prescriptions

1. Mapping of sea grass beds with the information on status of each species using Remote Sensing Technology by the professional agencies is an immediate requirement. Based on the findings, few long-term monitoring plots on the sea grass beds need to be established so that the efficacy of the management actions can be evaluated for long term.
2. Check on pollutions which come from the all kinds of industries and other sources.
3. Prohibition of fishing on the sea grass beds, which falls inside the National Park areas.
4. Extending the present sea grass distributional limit to the historical distributional limit. Habitat restoration of the sea grass beds needs to be initiated with help of nearby professional organizations.
5. Awareness programme in the catchment area regarding the excessive use of pesticide and other chemicals and its impact
6. **Monitoring, evaluation and restoration:** Permanent monitoring plots in different islands need to be marked and the same need to be monitored for its biomass productivity and other associated species in that plots. Restoration experiments with the help of CSMCRI and Restoration technology adopted on a coastal lagoon in the North of Yucatan (Southeastern Mexico) may be consulted here. The agency which would be used for the restoration of this habitat is also requested to consult with 'Chapter 7. Seagrass: in Handbook of Ecological Restoration, Volume 2, edited by Martin R. Perrow and Anthony J. Davy, Cambridge University Press, 2002'.

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
3	Sea grasses Habitat											
	Mapping and monitoring of sea grasses habitat including pollution inside the NP		30		30		40		40		50	190
	Awareness programme in the catchment area regarding sewage & solid waste management, excessive use of pesticide and other chemicals and its impact on marine habitat		5	5	8	8	10	10	12	12	14	84
	Restoration of degraded sea grass habitat (target 20 sq.km)				20	20	60	50	70	60	40	320

4.3.3. Mangrove habitats of the Gulf of Mannar Marine National Park

4.3.3.1. Off-shore mangroves of Gulf of Mannar – on literature

It is generally believed that the off-shore islands of the Gulf of Mannar Marine National Park, historically covered with thick mangrove forest. Available literature are largely supportive to this belief. Perhaps Iyengar's document (1927) is the oldest reference regarding the existence of mangroves in the islands of Gulf of Mannar. His reference has been cited by Krishnamoorthy *et al* (1987) mentioning that luxuriant and diversified vegetation have been observed in Krusadai island with 5 mangrove species. Rao *et al* (1963) have also noticed small patches of mangroves in some of the Mandapam group of islands. The remnants of mangroves as relics in some of the islands have been cited and documented by Krishnamoorthy *et al* (1987). According to Perichiappan *et al* (1995) there are 13 species of mangrove and other halophytes recorded from the islands of Mandapam group. Deshmuk and Venkatramani (1995) documented the status of mangroves and other vegetation of Gulf of Mannar islands and categorized the existing mangroves as endangered. Daniel (1997) reported that mangrove plants were present in 12 islands of Gulf of Mannar, except Anaipar, Appa, Valimunai, Nallathanni, Pulivinichalli, Kariachalli and Van. Kathiresan (1998) documented the presence of 4 mangrove species in Manoli and 2 in Muyal islands. GOMMBR (1997) and ICMAM (2001) were some of the recent document to report the presence of 7 species of mangroves in islands. A checklist by Selvam *et al* (2004) is the very recent record of mangroves and mangrove associates in Gulf of Mannar islands.

Current status of Mangroves in the Gulf of Mannar Marine National Park

A study was conducted by the Wildlife Institute of India, National Institute for Coastal and Marine Biodiversity Centre in 2006 to make an inventory of the mangroves and mangrove associated flora in the off-shore islands of Gulf of Mannar Marine National Park. This study also aimed to provide a detailed description of the present status of the entire mangrove ecosystem in the Gulf of Mannar region and to suggest the conservation, restoration and management requirements.

Methods:

The detailed survey was conducted in all the islands of Gulf of Mannar over a period of three months (January 2006 to March 2006). All islands were accessed from nearest on-shore, and explored by walking along the coast and far interiors of the islands to locate vegetation patches. Due to the differences in shape and other geomorphology of the islands many plots were taken up to record the floral distribution. Following a line transect method (laid perpendicular from the shoreline to the interior) to distance from 50-200m (length differs wherever it is applicable), the mangroves, mangrove associates and other terrestrial flora were recorded. Using the floral descriptions given by Tomlinson (1986) and Kathiresan (2001), the mangrove and mangrove associated species were identified. The other flora of islands were identified using 'The flora of Tamilnadu Carnatic' by Rapinat Herbarium.

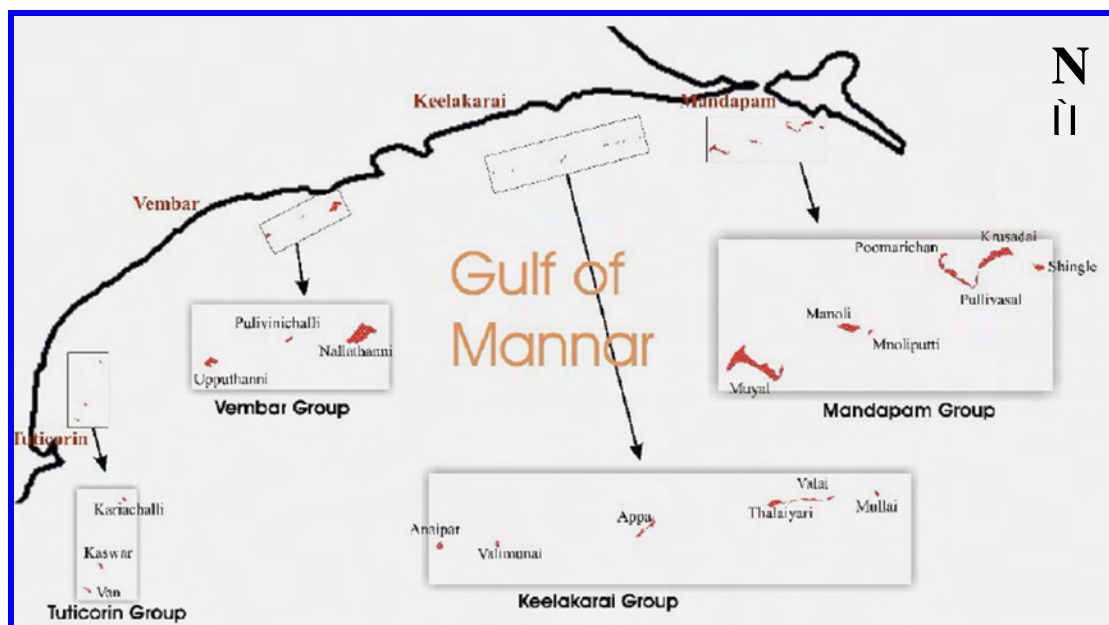
Results

True mangrove flora:

In general Gulf of Mannar islands possess some unique type of mangrove vegetation. In this study, a total of 10 true mangrove species were identified belonging to 6 families of 6 order. The mangrove species *Avicennia marina* is recorded in 14 islands and *Pemphis acidula* is from 13 islands. *Pemphis acidula* is the only species found far interior of the islands where none or occasional drainage for sea water takes place. Both these species have grown luxuriantly all along the periphery and equally dominate each other. The species *Agiceras corniculatum* is found only in Krusadai and similarly *Bruguiera gymnorrhiza* is recorded only in Manoli. However these two species are found in these two islands in very low abundance. *Bruguiera cylindrica* and *Excoecaria agallocha* are shrubby and found mixed within the spaces of *Avicennia marina* mangroves in Mandapam group of islands.

The island Manoli ranks high in having 9 mangrove species and is followed by Krusadai, Pullivasal, Poomarichan and Hare Island respectively. The mangrove vegetation in Manoli is striking for its luxuriant growth and diversity. The islands Valai, Pullimunai, Nallathanni, Upputhanni and Van islands have only one mangrove species each. When the diversity of mangrove vegetation is compared among the island groups, Mandapam group of islands ranked first in high diversity, followed by Keelakarai group. The Vembar and Tuticorin group of islands has very low diversity of mangroves.

Figure: 1. Off-shore mangrove sites of Gulf of Mannar Marine National Park



Map not to scale

Plate: I. On-shore (island) mangroves of Gulf of Mannar Marine National Park



Aegiceras corniculatum



Avicennia marina



Bruguiera cylindrica



Bruguiera gymnorrhiza



Ceriops tagal



Excoecaria agallocha



Lumnitzera racemosa



Pemphis acidula



Rhizophora apiculata



Rhizophora mucronata



Aegiceras corniculatum



Avicennia marina



Bruguiera cylindrica



Bruguiera gymnorrhiza



Ceriops tagal



Excoecaria agallocha



Lumnitzera racemosa



Pemphis acidula



Rhizophora apiculata



Rhizophora mucronata

Table: 1. True mangrove flora recorded in Gulf of Mannar Islands during the study in the year 2006

Species	Islands																		
	Shingle	Krusadai	Pullivasal	Poomarichan	Manoliputti	Manoli	Muyal	Mullai	Vaaail	Thalaiyari	Appa	Puliarmunai	Anaipar	Nallathanni	Pulivinichali	Upputhanni	Kariachali	Kaswar	Van
<i>Aegiceras corniculatum</i>	-	ü	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Avicennia marina</i>	ü	ü	ü	ü	ü	ü	ü	ü	-	ü	ü	-	ü	ü	-	ü	-	-	ü
<i>Bruguiera cylindrica</i>	-	ü	ü	ü	ü	ü	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Bruguiera gymnorrhiza</i>	-	-	-	-	-	ü	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ceriops tagal</i>	-	ü	ü	ü	ü	ü	ü	-	-	-	-	-	-	-	-	-	-	-	-
<i>Excoecaria agallocha</i>	ü	ü	ü	ü	ü	ü	ü	-	-	-	ü	-	-	-	-	-	-	-	-
<i>Lumnitzera racemosa</i>	ü	ü	ü	-	-	ü	ü	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pemphis acidula</i>	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	-	-	-	-	-	-
<i>Rhizophora apiculata</i>	-	-	ü	ü	-	ü	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Rhizophora mucronata</i>	-	ü	ü	ü	-	ü	ü	-	-	-	-	-	-	-	-	-	-	-	-

Luxuriant growth of *Avicennia*, *Lumnitzera*, *Rhizophora* were seen only in Krusadai, Pullivasal, Poomarichan, Manoli and in Manoliputti islands. In these islands, *Avicennia* reaches maximum to 8m in height and *Rhizophora mucronata* to about 7m., but in general these trees are not very tall. Perhaps the height is curtailed due to strong winds lashing here perennially, with greater velocity during monsoons and periodical cyclones, etc. Interestingly, natural regeneration of *Avicennia marina*, *Rhizophora mucronata*, *Ceriops tagal* species by seed dispersal was observed in Krusadai, Pullivasal and Manoli islands of Mandapam group. In other islands though they do exist but have not flourished well.

Mangrove associated flora:

About 24 mangrove associated species were recorded from all the islands. The species *Salvadora persica* and *Sesuvium portulacastrum* were the dominant associate flora found in about 15 islands (Figure 3). Similarly, the species like *Thespesia populnea* and *Scaevola taccada* have been recorded in 13 islands. *Caesalpenia*, *Dalbergia*, *Pandanus*, *Pongamia*, *Salvadora* and *Thespesia* were found distributed well away from the upper reaches of high tide. The grass species like *Aleuopus*, *Fimbristylis*, *Spinifex* and *Tamarix* were recorded at or near the upper reaches whereas halophytes *Salicornia*, *Scaevola*, *Sesuvium*, *Suaeda* occupies the gaps between the mangroves and in exposed areas in the mudflats. *Clerodendrum*, *Ipomoea*, and *Spinifex* covers the periphery of the islands.

An interesting observation is that in hypersaline areas (exposed areas where mangroves already degraded) the halophyte *Salicornia brachiata* is found occupying to maximum extent. Since they are salt loving species, their colonization in these areas is an indication of the nature getting itself repaired.

Other island flora:

About 61 species belong to trees, herbs, shrubs etc. (other than mangroves and mangrove associates), were identified at all islands of the Gulf of Mannar. It was observed that the growth of both the species of *Acacia* is prolific from Manoli to Nallathani islands. Similarly, the invasive species, *Prosopis juliflora* is found distributed in majority of islands.

It was observed that the species *Acacia* and *Prosopis* are competing with each other and seems growing together with some interaction. Both these species have colonized most of the interior portions of Krusadai, Muyal, Thalaisyari and Appa islands. It was said that both these species have emerged only after the islands were opened for cattle grazing. In all islands, no area is found barren without any vegetation. The grass species such as *Aristida*, *Cyanodon*, *Cymbopogon*, *Chloris*, *Cyperus*, *Eragrostis*, *Lophopogon* and *Rottboellia* occupies the open spaces in majority of the islands.

During private ownership of islands Krusadai, Muyal and Nallathani, cattle were allowed to graze on the grass and other palatable vegetation on payment. It was also believed that anthropogenic intervention and frequent visits would also bring some other terrestrial vegetation into these island habitats (Neelakandan, 1999). Some of these islands have been found inhabited until 1990.

Table: 3. Mangrove associated flora recorded in Gulf of Mannar Islands during the study in the year 2006

Species	Islands																			
	Shingle	Krusadai	Pullivasal	Poomarichan	Manoliputti	Manoli	Muyal	Mullai	Vaaail	Thalayyari	Appa	Puliarmunai	Anaipar	Nallathanni	Pulivinchali	Upputhanni	Kariachali	Kaswar	Van	
<i>Aleuropus lagopoides</i>	ü	ü	-	-	ü	ü	ü	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Caesalpenia cristae</i>	-	ü	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Caesalpinia bondoc</i>	-	ü	-	ü	-	ü	-	-	-	-	-	ü	-	-	-	-	-	-	-	
<i>Clerodendrum innerme</i>	-	ü	ü	ü	ü	ü	ü	-	-	ü	ü	ü	-	-	ü	-	-	-	-	
<i>Dalbergia spinosa</i>	-	-	-	-	-	-	-	-	-	-	-	ü	-	-	-	-	-	-	-	
<i>Dendropthe falcate</i>	-	ü	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Ipomoea pes-caprae</i>	ü	ü	ü	ü	ü	ü	ü	-	-	ü	-	-	-	ü	ü	-	-	-	-	
<i>Fimbristylis ferruginea</i>	-	ü	-	ü	ü	ü	ü	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Ipomoea tuba</i>	-	ü	ü	-	ü	ü	ü	-	-	ü	-	-	-	-	-	-	-	-	-	
<i>Pandanus tectorius</i>	ü	ü	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Pongamia pinnata</i> *	-	-	-	-	-	-	ü	-	-	-	-	-	-	ü	-	-	-	ü	ü	
<i>Salicornia brachiata</i>	-	ü	-	-	-	ü	ü	-	-	ü	-	-	ü	-	-	ü	-	-	-	
<i>Salvadora persica</i>	-	ü	ü	-	ü	ü	ü	ü	ü	ü	ü	-	ü	ü	ü	ü	ü	-	ü	
<i>Sarcolobus carinatus</i>	-	ü	ü	ü	-	ü	ü	-	-	-	ü	ü	-	ü	-	ü	-	-	-	
<i>Scaevola plumieri</i>	ü	ü	ü	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Scaevola taccada</i>	ü	ü	ü	-	-	-	-	-	ü	ü	ü	ü	ü	-	ü	ü	ü	ü	ü	
<i>Sesuvium portulacastrum</i>	-	ü	ü	ü	-	ü	ü	-	-	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	
<i>Spinifex litorea</i>	ü	ü	-	ü	-	ü	ü	-	-	ü	ü	-	-	ü	-	-	-	ü	ü	
<i>Suaeda maritima</i>	-	ü	ü	-	ü	ü	-	ü	-	ü	-	-	-	ü	-	ü	ü	-	ü	
<i>Suaeda nudiflora</i>	-	-	-	-	-	ü	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Tamarix troupi</i>	-	ü	-	ü	-	ü	ü	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Thespesia populnea</i> *	ü	ü	ü	ü	-	ü	ü	ü	ü	-	ü	ü	-	ü	ü	-	-	-	ü	
<i>Wattakakka volbulis</i>	-	ü	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

* Species have also been introduced in islands under Social Forestry Scheme

Table: 3. Other vegetations of Gulf of Mannar Islands

<i>Acacia eburnean**</i>	<i>Cyperus cartaneus</i>
<i>Acacia nilotica**</i>	<i>Cyperus rubicundus</i>
<i>Albizia lebbeck*</i>	<i>Emilia scabra</i>
<i>Allotropis cimicina</i>	<i>Eragros unioides</i>
<i>Aloe vera</i>	<i>Eragrostis altrovirens</i>
<i>Aristida adscensiones</i>	<i>Euphorbia tirucalli</i>
<i>Aspargaus racemosus</i>	<i>Ficus benghalensis</i>
<i>Azadiracta indica*</i>	<i>Ficus religiosa</i>
<i>Azima tetracantha</i>	<i>Hoya parasitica</i>
<i>Borassus flabilifer*</i>	<i>Hydrophylax maritime</i>
<i>Buchannania axillaris</i>	<i>Jasminum angustifolium</i>
<i>Bulbostylis densa</i>	<i>Jatropha sp.</i>
<i>Caesalpenia coriasia</i>	<i>Leucas maritincensis</i>
<i>Canavelia virosa</i>	<i>Lophopogon tridentatus</i>
<i>Capparis divaricata</i>	<i>Lumnitzera racemosa</i>
<i>Cassia auriculata</i>	<i>Manilkara hexandra</i>
<i>Cassis abtusa</i>	<i>Merope angulata</i>
<i>Casuarina equisetifolia*</i>	<i>Odian wadia*</i>
<i>Catharanthus roseus</i>	<i>Olex scandens</i>
<i>Chloris barbata</i>	<i>Opuntia monocanthus</i>
<i>Cissus quadrangularis</i>	<i>Phoenix lourerii*</i>
<i>Citroella sp.</i>	<i>Pithicellobium dulce*</i>
<i>Cleome aspera</i>	<i>Prosopis juliflora**</i>
<i>Coccinia grandis</i>	<i>Rottboellia exaltata</i>
<i>Cocus nucifera*</i>	<i>Sporobolus diander</i>
<i>Crotolaria laburnifolia</i>	<i>Tamarind sp.</i>
<i>Crotolaria verucosa</i>	<i>Tephrosia perpurea</i>
<i>Cymbophogon gibarba</i>	<i>Veronica albicans</i>
<i>Cynadaon dactylon</i>	<i>Vigna trilobata</i>
<i>Cyperus arenarius</i>	<i>Ziziphus mauritiana</i>
	<i>Ziziphus xylophyrus</i>

* Introduced into the islands by various Social Forestry Plantation Scheme

** Invasive species a regular status in probability of occurrence in islands

Afforestation programs in islands:

Mangrove afforestation programs have been undertaken in islands like Moyal and Thalayari by the Tamil Nadu Forest Department from 1987-1998. The species like *Avicennia marina* and *Ceriops tagal* were planted by making long trenches. The planted mangroves and the dredged trenches were left as such without regular monitoring and due to this the trench openings have got blocked. In spite of this, Ramachandran (2001) documented that for over a period of 11 years (1987-1998) 14.01 ha area of mangrove increased due to afforestation programs. Under Social Forestry Scheme the species like *Albizia*, *Pithecellobium*, *Pongamia*, *Phoenix*, *Thespesia*, *Borassus*, Tamarind, Coconut, Casuarina and Mango etc. have also been planted in few islands by the Department of Forest, Ramanathapuram. Since *Thespesia* and *Borassus* were native to the island they flourished well, but only few

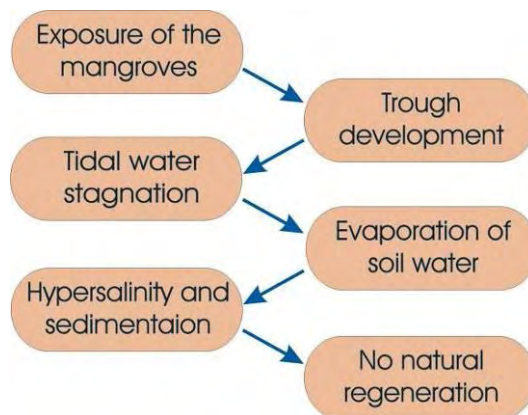
individuals of *Albizia*, *Pithecellobium*, *Phoenix* were found surviving at present. Our observation also conforms that the planted Mango trees failed to survive.

Threats to the Island mangroves:

Our observation documents that presently there is no direct profound threat to mangrove ecosystem in the off-shore Islands. Traces of human settlements are found on Pullivasal, Poomarichan, Manoliputti islands but are not permanent. Activities such as docking of small boats, cooking adjacent to the vegetation were also observed but they pose very little damage. Natural degradation of mangroves has been observed in few islands. The flooding stress, increased anaerobic conditions, hyper salinity and sulfide stress at water-logged area over a period of time has killed mangroves in Poomarichan, Manoli and Thalayari islands. Similarly in the planted mangrove area, due to blockage at the openings of the trenches made a layer of salt crystal have been observed on the soil surface. Dead stumps of *Avicenna marina* in water-logged area of Thalayari have also been observed.



Possible natural mangrove degradation pathway in islands



In addition, both soil erosion and accretion were observed in all the islands; especially at the shoreline the *Avicennia marina* experiences suffocation of pneumatophore due to accretion (south of Upputhanni) and *Pemphis acidula* have been uprooted due to erosion (South of Shingle).

Management Prescriptions

As aforementioned in Mandapam group of islands natural regeneration have been observed in places where they were found degraded previously. Similarly,

colonization of mangrove seedlings has also been observed in newer sites adjacent to the existing mangrove patches. Both these observations clearly reveal that present environmental conditions were conducive for further establishment and the chances of restoration of mangroves is good if proper assistance coincides with natural colonization.

All the islands were thoroughly explored to identify the areas which have the potential to support similar mangroves. Of 19 existing islands, only five islands have enough area for further development of mangroves. However, as mangroves do exist, the possibility of mangrove restoration in the remaining islands needs a thorough study, particularly on entire topography, physico-chemical properties of the substratum in addition to other environmental factors. As the existing mangroves in islands are least disturbed, restoration at degraded sites and their proper management is the need of the time. Natural distribution may sometimes take more time to restore, but artificial restoration at right sites with right species often gives quick results.

Avicennia marina and *Ceriops tagal* have already been planted by applying canal-banking methods in Thalayiari and Muyal islands. Since there is no freshwater source, there is a lack of proper sedimentation which is the basic need to augment mangrove growth. Further, due to the blockage at the opening of canal, there is no proper drainage pattern, and also due to prolonged evaporation, the canal substratum was covered by thick salt-crystal layers. Thus, the growth rate and survival of the planted mangroves beside these canals has a lower probability of success. Since there exists no perfect zonation of mangrove species distribution in these islands, the colonization of propagule and natural regeneration were found irregular. For example, *Pemphis acidula* is found both at the sea-front and far interior of the islands; *Lumnitzera racemosa*, however, was present only in a few islands and its locality is found to unusually compete with some terrestrial flora. This distribution pattern makes it difficult to identify and determine the sites suitable for certain species. Our thorough observation reveals that *Avicennia marina*, *Rhizophora mucronata* and *Ceriops tagal* were the most suitable species for restoration because of their luxuriant growth and customized adaptability to these island environs. That is, there is no need to allow any newer species to occupy; instead, the native species can be established in order to assist the process of natural regeneration.

Natural-cum-Assisted mangrove regeneration:

The natural regeneration of mangrove may be assisted to facilitate the colonization of seedlings/propagule in such a way not congregating at one area. This can be achieved by creating series of mounds in the existing mudflats perpendicular to the shoreline.

Minor topographical alterations at mudflats existing near the mangrove, opening of already dug-out trenches will facilitate the distribution of propagule up to the upper reaches. This also reduces the salinity at the sites where mangroves have degraded due to water-logging and hypersalinity. The available area, suitable locations, its elevation (based on field observation), the need of topographic alteration and the monitoring mechanism have been given below.

POTENTIAL AREA IDENTIFIED	AVAILABLE AREA (HA)	SUITABLE AREA (MUFLATS)	RECOMMENDED SPECIES	SITE ELEVATION	TOPOGRAPHIC ALTERATION	MANAGEMENT NEED AT SITES
Krusadai	15-20	Adjacent to the north-west portion of island	<i>Avicennia marina</i> , <i>Ceriops tagal</i> , <i>Rhizophora mucronata</i>	Little (±0.5m)	Leveling the elevation	Low level (because of natural recovery)
Pullivasal	5-10	Northern shoreline	<i>Avicennia marina</i> , <i>Ceriops tagal</i> , <i>Rhizophora mucronata</i>	Little (±0.5m)	Leveling the elevation	Low level (because of natural recovery)
Muyal	>30	Northern portion of island	<i>Avicennia marina</i> , <i>Ceriops tagal</i> , <i>Rhizophora mucronata</i>	High (±1m)	Opening of inlet	Need for proper drainage in canal
Thailari	15-20	West - Centre portion of island	<i>Avicennia marina</i>	High (±1m)	Opening of inlet	Need for proper drainage in canal
Upputhani	10	South-eastern part	<i>Avicennia marina</i>	Little (±0.5m)	Leveling the elevation	Low level

Note: The available area mentioned is the approximate values based on visual estimate and need to resolve using Remote Sensing, Survey maps and physical measurement.

The above mentioned sites were identified based on the standard criteria prescribed listed out in FAO (1994) mangrove management guideline. Regarding the topographic alterations it was suggested here to go for leveling the elevated parts and irregular surfaces to a gentle slope and opening of inlets to allow drainage.

Being in National Park area, these sites after restoration may not need stringent protection against anthropogenic disturbance. But boards and labels may be established to make aware of the local fishermen who sometime try to dock around these islands. The sites may need a regular monitoring toward the proper drainage in canal, clearance of temporary sand mounds due to wave actions, removal of wrasses etc. will facilitate a better restoration result.

Mangrove Restoration effort journal, on the lines of forestry plantation journal to be maintained in addition to site based boards and labels so as to provide a visual as well as documented monitoring process.

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
4	Mangrove Habitat											
	Natural-cum-assisted restoration of mangrove habitat as prescribed in the Management Plan (Target plantation 100 ha @ 20 ha/year then onwards monitoring the plantation, @Rs.30000/ha)	6	7.5	8.5	9.5	11	2	2	2	2	2	52.5
	Maintenance of mangrove plantation		1.5	2.5	3	3.5	4	4.5	5	5.5	6	35.5

4.3.4. Invasive Species of the Gulf of Mannar Marine National Park

Introduction

Alien invasive species (AIS) are one of the major threats to the ecological and economic well being of the planet (McNeely et al. 2001). AIS may occur in terrestrial, freshwater or marine environments and may be vertebrates (animals with backbones), invertebrates (animals without a backbone) or plants (weeds). AIS are highly adaptable and usually widespread and can live in a wide range of environments. When they arrive in a new area, they have usually left the diseases and predators that would have kept their numbers under control back in their original habitat from where they emigrated.

It is widely known that island ecosystems are particularly vulnerable to AIS, and that their impacts are especially severe (Veitch & Clout 2002). Island species are especially vulnerable to human-induced changes, due to their isolation from other landmasses. This is because island endemics are often less able to adapt to the presence of AIS than species that are more-widely spread. AIS have been identified as one



of the main causes of ongoing declines and extinctions on islands. For example, the accidental introduction of the *Prosopis juliflora* to the islands of Gulf of Mannar National Park seems to be responsible for the degradation of island terrestrial habitats.

The primary focus of concern over the role of introduced species within the Gulf of Mannar Marine National Park ecosystem, especially from the flora point of view are the processes of disturbance and competition. Evaluation of the consequences of introductions requires the formulation of evidence of the affects these processes have. This assessment is difficult due to the lack of historical data. However, it is presumed that species introduced during the 19th and 20th centuries are interacting with native biota. Thus, potential impacts are difficult to discern due to this interaction. Additionally, the island ecology of the Gulf of Mannar has continually changed as a result of intensified land use and modifications due to human pressure in past. These changes alter the conditions of the dynamic relationships between the introduced and native species interactions especially on terrestrial ecosystems. The status of invasive species in both aquatic and terrestrial ecosystems is not known except *Prosopis juliflora*, *Acacia spp.* and *Parthenium*, which occur in almost all the islands.

Current status and impacts of *Prosopis juliflora* on islands biodiversity

Prosopis juliflora, is abundant, and has become a serious range problem on the Gulf of Mannar islands. The carrying capacity of other species on many islands seems to

be seriously reduced due to its tremendous increase of *Prosopis*. In olden days, fishermen use to graze their cattle in these islands. Dissemination of the seeds in cattle dung has been an important factor in this invasion. *P. juliflora* pods are relished by all livestock, which, unlike most other pea pods, do not shed their seeds. The invasive species, *Prosopis juliflora* is found in 13 islands. It was found that there seem to be a competition between the existence of *Acacia* and *Prosopis*. It was also observed that both these species were found growing with an interaction. During private ownership of islands Krusadai, Muyal and Nallathanni, cattle were allowed to graze on the grass and other palatable vegetation payment. It was said that both these species have emerged only after the islands were opened for cattle grazing. Similarly, some of these islands have been inhabited. It was also believed that anthropogenic intervention and frequent visits could also have brought some other terrestrial vegetation into these island habitat (Neelakandan, 1999).

Current status of *Kappaphycus alvarezii*, alien invasive aquatic plant in GOMNP

A study conducted by the Thiagarajar College, Madurai has confirmed the invasion of *Kappaphycus alvarezii* on coral reefs (*Acropora* sp.) in the Kurusadai Island of the GoM. Study also emphasized the need of immediate control measures otherwise it may likely spread to other islands, especially those included in the Mandapam group. It could specifically destroy the branching corals (*Acropora* sp.) which have already reduced to minimum live cover in the reserve due to bleaching in 1998. In future, it may also adversely affect other native marine communities (sea grasses and coral reef fishes) either directly or indirectly. Presently, it reproduces through vegetative fragmentation and may switch over to sexual reproduction by spores under favourable environmental conditions in future. Hence control efforts should be launched soon, before it endangers the marine biodiversity of the GoM.

Management Prescriptions

1. **Eradication of *P. juliflora* and other AIS plants from the National Park:**
 - a. Uprooting and burning plants before fruiting is the best method. This method is quite possible in these islands and hence it is recommended.
 - b. Since the seed of this species has higher dormancy period, it is essential to monitor the seedlings for the period of minimum five years after eradicating all available plants in any given islands. The hard seed may remain dormant for many years and new plants may appear in previously infested areas.
 - c. After initiating the eradication programme the *P. juliflora* Management Areas needs to monitored regularly and if required then the eradication programme needs to be continued.
2. Eradication of ***Kappaphycus alvarezii***: Though the extent of this aquatic weed is less in the Mandam group of islands, it may spread fast, therefore, this weed needs to be eradicated as soon as possible. Manual removal is the only option available at present. Weeds need to collected manually and then burned on the shore of the mainland coast but not on the coast of islands. This process should be continued till all the weeds are eradicated. It is also important to eradicate the same weed from the buffer zone of the Biosphere Reserve simuntaneously.
3. The impact of invasive species on insular fauna & flora is more sever than on the mainland. The Research and Monitoring Center of the Biosphere Reserve Authority is to take up a policy decision on the management of AIS in the

Gulf of Mannar Biosphere Reserve whenever required and implement those actions. The RMC will also facilitate the development of a database on AIS for planning and executing programmes on management of invasives in islands. This database will provide information on exotics introduced in different islands and their impact on the natural ecosystem. It will also provide useful information on the spread of exotics in islands, crucial for evaluating further proposals on impacts of such introductions elsewhere. The RAC of RMC will also evaluate any proposals on introduction. However, the RMC should not allow the introduction of any known AIS into the Biosphere Reserve and they may consider any re-introduction proposal of species, which are naturally occurring, non-invasive and major interest of public.

4. Preventing the introduction of alien invasive species is the cheapest, most effective and most preferred option and warrants the highest priority.
5. Rapid action to prevent the introduction of potential alien invasives is appropriate, even if there is scientific uncertainty about the long-term outcomes of the potential alien invasion.
6. Identify and manage pathways leading to unintentional introductions. Important pathways of unintentional introductions of invasive species to the Gulf of Mannar Biosphere include fisheries, aquaculture, forestry, tourism, trade, shipping, ballast water and construction projects.
7. **Management of other invasive species:**
 - a. So far, there was no detail study on the invasive species of the both aquatic and terrestrial ecosystems of the Biosphere Reserve, which need to be initiated immediately to know their diversity, distribution and possible impact on native biodiversity.
 - b. Removal of all major invasive species from the sea turtle nesting beaches.
 - c. Removal of all invasive species from the National Park area, before that, a detail study is required on the diversity, status, and distribution pattern of invasive species in this region.
 - d. Biosphere Authority with the help of local people the removal operations can be taken up. This will generate the employment opportunities to local communities.
 - e. While removing the invasive species from the sensitive habitats there should not be any damage to the native fauna and flora and also for local communities.
 - f. Existing non-invasive exotic species, which are beneficial for the human being are needs to be contained within the human habitations and these species should not be allowed to spread into the National Park. Offenders must be punished with severe fine.
 - g. It is suspected that there are occurrences of some invasive species in coral reefs and seagrass bed ecosystems, which need to be studied immediately, if any.
 - h. After initiating the eradication programme the Management Areas needs to monitored regularly for invasive species and if required then the eradication programme needs to be continued

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
5	Invasive species											
	Eradication of <i>P. juliflora</i>	6	7	8	9	10	2	2	2	2	2	50
	Eradication of <i>Kappaphycus alvarezii</i>	2	2	2	1	1	1	1	1	1	1	13
	Database on AIS for planning and executing programmes on management of invasives in islands	2			3			4				9

4.3.5. Species of conservation significance and their restoration and recovery plan in the Gulf of Mannar Marine National Park

4.3.5.1. Introduction

Gulf of Mannar harbours a diverse of life forms. If not all, most creatures still experience severe threats from different faces such as illegal extraction, fishing and pollution. Dugongs, Dolphins, Turtles, Corals species, and several other organisms are worthy of the need of significant conservation measures. A list of fauna and flora of Gulf of Mannar Marine Biosphere Reserve has been given in Appendix- I. This list, in detail depicts their scheduled status under the Indian Wildlife (Protection), Act 1972 and it's following Amendments. Their status on the IUCN Red Data Book and CITES Appendix is also given.

It is important to enhance the stock of certain threatened, commercially and sustainably important marine fauna within the National Park. Spill over of these stock enhanced commercial species into the buffer zone of the Biosphere Reserve will be rationally and sustainably harvested, which ultimately improve the livelihood of coastal fishermen and the economy of these coastal districts of the Gulf of Mannar Biosphere Reserve. During current Management Plan period, the following species of conservation importance and sustainable utilization are required to be given special management attention. This stock enhancement programme will expected to be getting the confidence of the local people and hence their pressure on the bio-resources of the National Park would be minimized.

The two categories of conservation and management actions for species recovery/restoration/stock enhancement described are for:

A. Species recovery/restoration programme to improve their endangered category.

Even though, several species of invertebrates and vertebrates within the Gulf of Mannar Biosphere Reserve and Marine National Park are in the Red Data Book of the IUCN and schedules of the Indian Wildlife (Protection) Act, 1972, it is proposed to initiate active species recovery and restoration of a few prioritized species. It is important to realize that such species recovery programmes require highly specialized and trained human resources and professional organizations. The small number of species recovery programme suggested below will also provide opportunities for capacity building of GOMMNP and GOMBR staff, educated youth, local NGOs and other institutions to formulate and initiate similar actions for range of other species, a range of which has been listed out.

- 1. Sea horses & pipe fishes**
- 2. Holothurians**
- 3. Balanoglossus**
- 4. Reef fishes**
- 5. Lobsters**
- 6. Economically important crabs**

B. Stock enhancement of species that are important for subsistence and economic importance to dependent communities.

Commensurate with the traditional dietary spectrum of the local inhabitants and the increasing evidence of a large number of marine fauna entering into the local,

regional and global commercial market, there has been an over exploitation of many such resources. The current status of many marine resources are in a vulnerable state and an increasing number of species are being considered to be taken into the threatened and endangered category and to be provided strict protection. In a situation like this there is drastic decline in the number of species that can be harvested without any legal hindrance. It is, therefore, important that the 'stock enhancement option' for select group of harvestable resources are initiated. Such programmes are proposed to be taken up in the National Park limits where no fishing is permitted. This will provide the replenish stock to grow in a sheltered and protected situations and spill over into the Biosphere Reserve limits where controlled and sustainable harvest by users is permitted. The community at large will view this activity as an effort by the Biosphere Reserve Authority as a positive and supportive action rather than a ban on resource use. Fortunately, for a range of economically important and subsistence level use resources, the technology has been developed with fair degree of extension and technology transfer mechanisms in placed. A few species suggested to be included under this programme can be enhanced after the success of the pilot programmes. A range of species for which such programmes can be initiated is appended. A similar approach of creating livelihood opportunities involving propagation of indigenous marine flora and fauna that are not in the threatened and endangered category have also been suggested in the Eco-development plan chapter.

1. Sea horse & pipe fishes

Seahorses are fish belonging to the Syngnathidae family, which also includes sea dragons, sea moths, and pipe fish. Most Seahorses are found in coastal waters, typically at depths of 1–15 meters, occurring in relatively sheltered environments among seagrasses, kelp beds, rocky reefs, mangroves and coral reefs. Unfortunately these are some of the most vulnerable of marine environments in the Gulf of Mannar, highly susceptible to disturbance caused by human activities. Seahorses feed on brine shrimp, tiny fish and plankton. Sea horses are primarily used in traditional Chinese medicine. They are said to cure asthma, skin ailments, relieve heatiness(acidity), joint and stomach aches, cleanse the blood, and strengthen the kidneys. Seahorse consumption is surprisingly common among Malay fishing communities. They frequently grill and fry their captured seahorses and eat them as crackers. They also believe that dried seahorses worn with string around the neck of newborns or toddlers or hung in their home, act as omens to dispel evil spirits. An aquarium and seahorse curio trade also exist but are difficult to monitor. Due to this the wild populations of sea horses in the Gulf of Mannar was overexploited and presently their status is endangered, therefore, they are protected by the IWPA (1972).

In the Gulf of Mannar, four species of sea horses are occur, most of the seahorses are landed as bycatch of shrimp trawling. In response to a significant increase in international demand, a target fishery for sea horses along the east coast of India in the Gulf of Mannar was started in 1992. India was one of the largest exporters of dried sea horses globally, exporting at least 3.6 tonnes (1.3 million sea horses) annually, and contributes to about 30% of the global sea horse trade. Sea horses are exploited both as an incidental catch (by-catch in trawl nets) and target catch, for export. Presently, the commercial exploitation of sea horses is totally banned in India.

Recovery of sea horse and pipe fishes

Because seahorses live in areas along the coast, the potential for impact from human activities is great. Very few studies have been carried out on wild seahorse populations and, as a result, scientists have no idea how many seahorses live in the wild and do not fully understand the basic biology of the creature. This lack of information makes it extremely difficult to predict how seahorse populations will be affected by exploitation. However, fishers and traders agree that, over a five-year period, exploited populations in Southeast Asia have declined by 15–50% (Vincent 1996). It is believed that the populations of sea horse and pipe fishes in the Gulf of Mannar is under severe threat due to over exploitation. It is important to assess their stock and enhance the same in the National Park areas with help of professional institutions such as CASMS, Annamalai University and CMFRI. Technology for captive breeding of sea horses had been developed by these two organizations with the support of the Ministry of Environment and Forests, Government of India. The same technology may be utilized for the stock enhancement of sea horses in the Gulf of Mannar Marine National Park. Public awareness programme needs to be initiated and people needs to be told about the reason for the declining of sea horse due to over exploitation. Technology to breed the pipe fishes in captivity needs to be developed.

2. Holothurians

Past and present, holothurian have been consumed as a culinary delicacy and as a high quality ingredient in many kinds of medicine, mostly exists in international trade in dried form, known as beche-de-mer (*iriko* in Japanese, *hai-som* in Chinese, or *trepang* in Indonesian). Sea cucumbers have continuously increased supply in international markets, both in tropical and temperate zones. Trends in fishery indicate that the number of producing countries and species in trade has recently increased worldwide and prone to overexploitation because of their limited mobility, late maturity, density-dependent reproduction, habitat preferences and low rates of recruitment. Around 30 species of sea cucumbers have been recorded in the Gulf of Mannar region, of these, 12 species are well known to fishermen .

Holothurians are naturally large and sedentary organisms and fishing techniques do not require sophisticated equipment, these attributes attract the fishermen to harvest some high value species that is seen as a valuable source of income particularly to local fisheries communities in many developing countries. Present fishery systems seem to be open for sea cucumbers resource access and overfishing to supply the demand of commercial merchandiser. Holothurians fisheries are commonly targeting the high value species, which taxonomically are mostly identified in families Stichopodidae and Holothuriidae. Meanwhile, since certain populations of these high value sea cucumbers are in decline, new species are now being collected, adding to the number of commercial species. The Government of India banned the holothurians fishing due to drastic population decline that has been noticed in this group. The Gulf of Mannar once known for major holothurians fishing has lost a majority of its holothurians stock due to overexploitation. It is important to enhance the stock of the holothurians in the National Park because the excretions of holothurians are known to improve the populations of benthic fauna and flora which are important food for several commercially important fishes.

Stock enhancement of Holothurians

Currently, no aquaculture production of sea cucumbers has been reported to FAO by member countries but with current production trends, it can be assumed that sea cucumbers from aquaculture ventures may constitute a large portion of total world production.

Promoting research and development of restocking and stock enhancement in the Gulf of Mannar is urgently required to recover holothurians populations in this region. Most of aquaculturists and researcher work on *Apostichopus japonicus*. *Holothuria scabra* or sandfish seem to be the ideal tropical holothurian most suited to restocking in the western Pacific and Southeast Asian waters (FAO). The two main problems of sea cucumber restocking are the long farming period and the low number of seeds available from the wild. Mariculture for sea cucumbers exists in the Philippines, while a significant effort on resource management will have to be focused on the regulation of harvest, enhancing the natural stock with hatchery-bred individuals has become a feasible option. Same model may be tried in the Gulf of Mannar as a pilot programme with the help of professional agencies such as CMFRI, CASMS, Tuticorin Fisheries College, SDMRI etc.

3. Balanoglossus

Balanoglossus, is the general name given to certain peculiar, opaque, worm-like animals which live an obscure life under stones, and burrow in the sand from between tide-marks down to the abyssal regions of the sea. Balanoglossus *Ptychodera flavo* the unique link between the invertebrates and vertebrates which is said to be so rare is seen to occur only in the Mandapam and Keelakarai groups of islands in the Gulf of Mannar. There is no detail information available on this species regarding their status, distribution and ecology.

Recovery of balanoglossus

First, it is important to know the status and distribution pattern of this species. During this Management Plan preparation exercise, the WII team had discovered new balanoglossus habitats from the Keelakarai group of islands. It shows that the extent of balanoglossus distribution in the Gulf of Mannar Biosphere is not known correctly which needs to be assessed immediately. Protecting their habitats from any anthropogenic activities will help this species to recover. Public awareness programme about this species needs to be initiated.

4. Reef fishes

Reef fisheries are generally at the subsistence level and catches are unrecorded. Wafar (1986) estimates the potential yield to be about 0.2 million tonnes a year, or about 10% of the total marine fish production in India. The Gulf of Mannar in particular is used by many fishermen from the mainland and from Rameswaram Island, especially in winter: catches include parrotfish, carangids and triggerfish; some 2,150 tonnes were taken in 1983 (Salm 1975). However, fast declining of reef fish resources in the Gulf of Mannar has been expressed by the Scientific community who attended the 'National Research and Monitoring Moderation Workshop' at Madurai organized by GOMBRT in December 2006. Recovery of reef fish resources in the National Park

will improve the catches of the fishermen who fish in the buffer zone of the Biosphere Reserve.

Recovery of reef fish resources

It is important to enhance the stock of the reef fishes in the National Park. Before initiating this work, it is necessary to assess the status of stock of reef fishes in this region. It is also important to have a technology to successfully produce the seeds of native reef fishes in hatcheries. Professional institutions such as National Bureau of Fish Genetic Resources, CMFRI, CFRI, TFCRI, CASMS and Tamil Nadu Fisheries Department need to be involved in this programme of stock enhancement of reef fish resources. Release of any exotic reef fishes in the Biosphere Reserve is strictly prohibited.

5. Lobsters

A total of seven species of lobsters are harvested in different coastal areas of India. Of these, *Panulirus homarus* and *P. polyphagus* are the most commercially important and the main fishery of the Gulf of Mannar coasts (George 1968 and Deshmukh 1964). Stock enhancement and fattening of lobsters in this region is expected to improve the livelihood of the coastal fishermen who are fishing in the buffer zone of the Biosphere Reserve. It will ultimately allow the fishermen to understand the importance of the Marine National Park and its protection. Professional institutions such as CMFRI, TFCRI and SDMRI may be consulted for this programme. Artificial habitats designed for lobsters may be created in the buffer zone to enhance the population and prevent fishermen from harvesting in the core zone.

6. Economically important Crabs

A total of 38 crab species belong to 21 genera and five families occur in the Gulf of Mannar Biosphere Reserve, which is 5.6% of Indian crab germ plasm. Of the 11 important commercial crabs in India, six crab species occur in this region. Several species are considered to be becoming rare and threatened, or having reduced over all size because of over exploitation and their habitat destruction. Inter-tidal zone of Gulf of Mannar Marine National Park and the Biosphere Reserve are considered to be good habitats for these crabs in this region. It is important to enhance the stock of economically important crabs in this region i.e. in the core zone of the Biosphere Reserve, which ultimately spill over to the buffer zone where controlled and sustainable fishing is allowed. Professional agencies such as CMFRI and CASMS need to be involved in this programme.

Table: Major actions required to recover certain marine species in the Gulf of Mannar Biosphere Reserve.

Sl. No.	Species	Increased awareness programme based on species status and problems	Enforcement and protection from species removal	Status survey and population estimation	Stock enhancement	Species recovery actions	Protected by	Professional Institutions needs to be consulted
1	Sea turtles	0	0	0		0	IUCN, IWPA, CITES	WII, MCB
2	Dugong	0	0	0		0	IUCN, IWPA, CITES	CMFRI, MKU, WII
3	Sea horses & pipe fishes	0	0	0	0		IWPA	CASMS, CMFRI
4	Lobsters				0			TFCRI, CMFRI, CFRI, CASMS
5	Holothurians	0	0	0	0		IWPA	CMFRI, TFCRI
6	Reef fishes	0		0	0			CMFRI, TFCRI
7	Balanoglossus	0	0	0				TFCRI, SDMRI
8	Sea snakes	0						WII
9	Commercially important crabs				0			CASMS, TFCRI, CMFRI

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
6	Species recovery programme											
	Stock enhancement of Holothurians	1000										1000
	Recovery of balanoglossus	(All the recovery programs should be outsourced to professional institutions on the basis of their Species Recovery Plan Proposals after strict review process on the project mode)										
	Recovery of reef fish resources											
	Stock enhancement of lobsters											
	Stock enhancement of economically important crabs											
	Recovery of sea turtle nesting habitat											
	Recovery of dugong											
	Monitoring and recovery of sea snakes											

4.4. Research, Monitoring and Training in the Gulf of Mannar Marine National Park

Introduction

The purpose of the Gulf of Mannar National Park is to enhance resource protection and preserve the natural beauty and bounty of the marine ecosystems within its boundaries. This can be accomplished by improving our understanding of the National Park environment, resources and qualities, resolving specific management problems, and coordinating and facilitating information flow between the various research institutions, agencies and organizations in the area. Research results will be used for making management decisions about resource protection and to develop and improve education programs for visitors and others interested in the Marine Biodiversity.

The opportunities for marine research within the National Park and Biosphere Reserve are abundant, as seen by past research studies that have provided important baseline information about the area. The diversity of habitat types and communities provides a wealth of opportunities for conducting a variety of research programs. For example, the Biosphere Reserve provides a unique opportunity to engage in both shallow and deep- water marine research without extensive voyages offshore. Studies on the natural processes at the land-sea interface are also feasible due to the accessibility of extensive coastline. Finally, the marine research institutions within the area provide an exceptional resource to draw upon in furthering our understanding, and thus the management of, the Biosphere Reserve's marine resources.

Effective management of the GOMBR requires the inauguration of a research program that coordinates the existing research programs and addresses management issues. The proposed Research Advisory Committee of the GONBR provides a forum for discussion of research programs, addresses management issues, and disseminates research information as widely as possible.

Gulf of Mannar is endowed with a rich variety of marine organisms because the biosphere includes ecosystems such as coral reefs, rocky shores, sandy beaches, mud flats, estuaries, mangrove forests, seaweed stretches and seagrass beds. These ecosystems supports a wide variety of fauna and flora including rare cowries, cones, volutes, murices, whelks, strombids, chanks, tonnids, prawns, lobsters, pearl oysters, seahorses, sea cucumbers and dugong. Though the first observation on pearl banks of this region made in 1864, a large number of research programs in the 19th and first half of the 20th century have brought out inventory information on the variety of fauna and flora found in the Gulf of Mannar region. However, researches have carried out in the second half of 20th century have emphasized more on the fish and fisheries of this region. Some research on the environment of this region was carried out in the later part of the 20th century and at present. Regardless of the numerous pares published on the Gulf of Mannar, emphasis was given to fish and fisheries related research activities and there is no detail information on the status, distribution pattern and ecology of several species and their habitats occur in this region, and also there is no detail study carried out to understand the resource availability and its utilization by the local communities, impact of present fishing activities on biodiversity as well as

the future generations of local communities, which are essential for the biodiversity conservation as well as sustainable utilization of resources by the local dependent communities.

Objectives

The Gulf of Mannar Biosphere Reserve has a lot of opportunities for conduct of integrated research on various aspects of marine science in India. The success of the implementation of the Management Plan of the Marine National Park and the Biosphere Reserve can be studied by conducting a basic applied researches and biodiversity monitoring programs. And the success of the implementation of the Management Plan is also depends upon local participation of Biosphere Reserve Authority and other local populations, who need necessary training and education to carry out basic research and monitoring programs. Hence, this section is included in the Management Plan with following objectives:

- a. Prioritization of research activities in the region.
- b. Protocol for biodiversity monitoring
- c. Human resource development towards basic research and monitoring on marine biodiversity
- d. Guidelines to conduct research activities in the region

Strategies

In 1987, the Ministry of Environment and Forests, Government of India has recommended the '*Indian Marine Biosphere Reserve Authority*' which can successfully manage the important marine biodiversity area using scientific knowledge on this marine ecosystem and its functions as well as components. In this connection, the Gulf of Mannar region will act as a living biological laboratory to address several unanswered questions related to marine biodiversity and its ecological services, which are important for its management. The Biosphere Authority can coordinate and facilitate all marine biodiversity related research activities which then later can be disseminated to all other user agencies of India as well as International. The Biosphere Authority can also facilitate the National Institute for Coastal and Marine Biodiversity, a proposed nodal agency in the field of Indian coastal and marine biodiversity researches by the Ministry of Environment and Forests, Government of India to conduct any training programme related to marine research, monitoring and management.

Creation of research matrix and establishment of marine research and monitoring centre

Although information on finfish fishery, shellfish fishery, aquaculture technique for certain species present in the region and seaweeds of this region are available in detail, there is a need to carry out various basic researches to understand the ecology of certain endemic and endangered species and habitats, which occur in the Gulf of Mannar. There is also a need to conduct various studies to monitor the socio-economic condition of local people who depend on bio-resources of this region, impact of fishing on the biodiversity, impact of present modern fishing practice on the traditional fisherman, sustainable utilization of marine resources, alternate livelihood options, impact of climate change and developmental projects on the biodiversity of

the Gulf of Mannar, etc. Considering all these gap areas in the past research programs analyzed and recommended by various agencies such as

1. MoEF, GOI – 1987 documents on Biosphere guidelines,
2. Participatory workshop organized by GOMBRT-UNDP, January 2006,
3. Commission Study by Kumaraguru *et al.* in August 2006
4. Scientific institutions and other stakeholders meeting organized by the WII in September 2006,
5. Moderation and monitoring workshop organized by GOMBRT-UNDP in December 2006
6. Study conducted by WII

A research matrix has been prepared for the better management of the biodiversity of this region without depriving the rights of people who have been dependent on these resources for a longer period.

4.4.5. Research Matrix:

A total of 45 research programs have been identified in seven thrust areas such as landscapes level, habitat level, species level, technology related, multidisciplinary and management related, ecological restoration, socio-economic and policy related studies. Gulf of Mannar Biosphere Reserve Trust can facilitate these programs as per its priority. Probable funding sources have been identified and also some research institutions have been suggested to carry out these studies. However, it is not necessary that these research programs only supported by these funding sources should be sought after, funds from other sources is also be explored. Same applies in the case of research institutions also.

Important thrust areas	Priority I	Priority II	Priority III	Probable Funding Sources	Suggested Institutions
Landscapes	a. Coral reef status assessment based on ground truthing. b. Status of Intertidal zone and its biodiversity. c. Identification and impact of invasive species in the region.	1. Estuaries and mangroves and its biodiversity including impact 2. Sand dune and sandy beaches and its biodiversity including impact. 3. Anthropogenic and developmental activities driven land use changes and its impact on important habitats 4. Climate change and its possible impact Identification and mapping of pollutant sources and its impact on the ecological processes and biodiversity using indicator species	1. Land based fluvial origin and their impact.	MOEF (GOI), DOD(GOI), GCRM NETWORK, DBT, DST, CSIR, UGC, SACEP, IUCN, UNDP, TN GOVT, TERI, NPCB, TNPCB, ISRO, MPEDA, UNESCO MAB Program, UN Foundation, and others	ZSI, CASMB, CMFRI, WII, MKU, SACON, ANNA UNI, ANNAMALAI UNI, TFCRI, MADRAS UNI, SDMRI, ALAGAPPA, MANONMANIAN SUN UNI, BSI, FSI, MSSRF, BNHS, IERSE, MNS, ATREE, IISC, NCF, CSMCRI, Tata Institute of Social Science, GOMBRT, UNDP, CPREE, NIOT, NIO

Specific habitats	<ul style="list-style-type: none"> a. Seagrass beds including biomass and productivity, associated fauna assessment. b. Status of terrestrial island biodiversity 	<ul style="list-style-type: none"> 1. Mangroves 2. Estuaries and lagoons 			
Specific Species	<ul style="list-style-type: none"> 1. Status, distribution and ecology of Dugong. 2. Status, distribution and ecology of other cetacean 3. Status and stock assessment of elasmobranches. 4. Status and ecology of breeding and non-breeding coral fishes. 	<ul style="list-style-type: none"> 1. Identification, status and biology of endemic marine fauna 2. Identification and status determination of endemic flora 3. Status, distribution pattern and ecology of exploitable mollusks, holothurians and echinoderms 			
Technology	<ul style="list-style-type: none"> 1. Documentation of kinds of fisheries practices and their impacts on habitat and species. 2. Development of silvicultural technology for endemic mangroves. 3. Development of propagation technology for endangered species and habitats 	<ul style="list-style-type: none"> 1. Impact of bottom trawling on coral reefs and seagrass beds. 2. By-catch assessment in different kinds of fisheries practices. 3. Pollution impact of ballast water release in the seascape. 	<ul style="list-style-type: none"> 1. Impact of other fishing technology on biodiversity 		
Multidisciplinary & management related research	<ul style="list-style-type: none"> 1. Economic valuation including ecological services of coral reefs. 	<ul style="list-style-type: none"> 1. Role of coral reefs, mangroves, sea grass beds and intertidal zones as breeding and nursery 	<ul style="list-style-type: none"> 1. Documentation of changes in the demographic profile in the region and their pressure 		

	<p>2. Creation of baseline data on physio-chemical, geological and climatological parameters including primary productivity (NIO)</p> <p>3. Identification of indicator species for evaluation of efficacy of management intervention on ecosystems.</p> <p>4. Identification and establishment of non-violate vegetation preservation plots and coral reef transects for longterm monitoring</p>	<p>grounds of various fauna (temporally as well as spatially).</p> <p>2. Temporal and spatial distribution pattern of migratory fauna in the coastal and marine environment</p> <p>3. Identification of foraging, breeding grounds of migratory fauna including determination of migratory path through use of advanced technology.</p>	in the ecological setting		
Restoration ecology	<p>1. Restoration of coral reefs</p> <p>2. Restoration of mangroves with special reference to endemics</p>	1. Restoration of seagrass beds.			
Socio-economic	1. Determination of socio-economic dependency of user communities on coastal and marine resources versus other resources	<p>1. Gender issues involving resource use and management.</p> <p>2. Development of empowerment mechanisms and models</p>			

	<p>2. Documentation, promotion and extension of eco-compatible alternate livelihood options.</p> <p>3. Identification of various stakeholders and assessment of impact of their activities on the ecological resources</p>	<p>of community based institutions involvement in resource management</p>			
<p>Policy analysis research</p>	<p>1. The efficacy of International, National and State policy and legal instruments in the resource management in GOMBR</p>	<p>mechanism of networking various governmental, non-governmental and communities based institutions in the participatory management.</p>			

4.4.6. Establishment of a Research and Monitoring Centre (RMC)

Research and Monitoring Centre of the Gulf of Mannar Biosphere Reserve needs to be set up with an aim to:

1. Compile existing data to describe the resources and provide baseline information;
2. Encourage continual information exchange among the organizations and agencies undertaking research and making decisions that affect the Biosphere Reserve;
3. Establish a framework and procedures for administering a research program to ensure that projects are responsive to management concerns and that research results contribute to improved management of the National Park;
4. Encourage multidisciplinary studies that integrate research efforts in the coastal, estuarine, near shore, open ocean, and deep sea ecosystems;
5. Coordinate data collection on the physical, chemical, geological and biological resources and processes of the Biosphere Reserve, to target specific information needs and avoid duplication;
6. Initiate a monitoring program to assess environmental changes due to natural and human processes;
7. Identify the range of effects on the environment that would result from proposed or predicted changes in human activity or natural phenomena;
8. Incorporate research results into an Interpretive Education Program in a format useful for the general public; and
9. Evaluate the effectiveness and efficiency of the research program and its integration with resource protection and education objectives.

RMC in the Gulf of Mannar Biosphere could form a vital component of the Biosphere research activities. As suggested by = Deshmukh and Venkataramani (1995), this should not be an additional institute but it could facilitate all the local and national institutions to carry out identified research activities in this region by offering institutional facilities with scientific environment to researchers. RMC is also expected to have a joint collaboration with the National Institute for Coastal and Marine Biodiversity. This research centre could be established in **Keelakarai** where the **Research Biologist** of the Gulf of Mannar Biosphere Reserve will be stationed. Keelakarai, being located in centre, would be an ideal location for RMC as several research institutions located in Tuticorin as well as Mandapam. This research centre should have the research and monitoring facilities such as research boat, scuba diving equipment, GIS cell, GPS, marine lab, underwater photography equipment, and other marine research related gear and crafts. All the staff working in this centre needs to be trained to conduct basic marine research and monitoring programs. RMC will also coordinating with all other four island based monitoring stations which need to be established in four island groups such as Tuticorin, Vembar, Keelaikarai and Mandapam. These Islands based monitoring stations need to be established at island with minimum infrastructure facilities so that researchers could stay there for a shorter period and carry out research or monitoring activities. Same research stations can also used for protection purposes.

4.4.7. Research Framework

Overall, the Biosphere Reserve research program is intended to focus on broadening our scientific understanding of the Marine ecosystems and developing research programs that enhance understanding and provide management with the scientific information necessary to make informed decisions.

4.4.7.1. Long term research programmes

a. Inventorization: It is with a view to continuously carry out inventory of biotic and abiotic components of the Biosphere Reserve. Collection of information will be on meteorology, land use practice, distribution and status of endemic and threatened species using remote sensed satellite information supported by ground truthing. Coral reef status assessment based on ground truthing. Status of Intertidal zone and its biodiversity. Identification and impact of invasive species in the region. Estuaries and mangroves and its biodiversity including impact. Sand dune and sandy beaches and its biodiversity including and its impact. Land based fluvial origin and their impact. Anthropogenic and developmental activities driven land-use changes and its impact on important habitats. Climate change and its possible impact. Identification and mapping of pollutant sources and its impact on the ecological processes and biodiversity using indicator species. Seagrass beds including biomass and productivity, associated fauna assessment. Status of terrestrial island biodiversity, Mangroves, Estuaries and lagoons.

b. Monitoring: Effective management requires an understanding of long-term changes in the status of the resources and their environment. Long-term monitoring is a way to detect and document these changes in environmental quality, ecology, and human activity and determine if changes in management strategies are needed. The primary purpose of the monitoring program will be to detect change, determine its causes, whether natural or anthropogenic, and develop and evaluate management strategies. Overall, the monitoring program will assist in our understanding of the general health of the National Park. This program should include pollution monitoring studies and studies monitoring the population dynamics of species in all habitats within the Biosphere boundaries. Identified indicator species and critical habitats needs to be monitored to detect possible changes. Changes in the relative distribution of these species could indicate natural or anthropogenic threats to National Park resources. Monitoring the natural functions of the land and sea interface, as well as human interruptions of those functions, will contribute to increasing understanding of the relationships between ocean and terrestrial ecosystems. Results of the monitoring program will be applicable to basic scientific research as well as academic, education and applied management goals.

Examples of environmental factors to be monitored include: (1) status and trends of contaminants in Biosphere Reserve; (2) environmental factors, such as wind, sea level, and temperature, collected by coastal stations, offshore data buoys, and satellites; (3) changes in the abundance over various life stages of invertebrates and fish and (4) fluctuations in the abundance of dugong, holothurians, whales, turtles and seabird species in the Biosphere; (5) biological input of organics and fecal coliforms from pinnipeds;

Certain activities and their effects, both individually and cumulatively, should be monitored. These include: (1) commercial vessel traffic; (2) recreational activities; (3)

commercial fishing and nature observation activity; (4) natural and anthropogenic (e.g., sand mining) erosion and sedimentation; (5) fishery/mammal-turtle interactions, such as the coincidental catch of whales, turtles and other mammals in fishing nets; (6) pesticide usage; (7) sewage discharge; (8) dredge spoil disposal; and (9) reoccurring road repair debris side-casting along the coast. Another important component of the monitoring program is the assessment of the effectiveness of management strategies. Once new management strategies have been put in place, usually in response to a detected change in the environment or use of the Biosphere Reserve, monitoring must continue to determine whether the management strategy is having the desired effect. In fact, in most cases, each new management strategy will require the design and implementation of specific monitoring activities to augment the long-term monitoring program envisioned by this plan.

Monitoring the status of corals, seagrass beds, coral reef fishes, terrestrial vegetation, other fish stock and physio-chemical prosperities of water, holothurians populations and dugong need to be monitored. If required, the Wildlife Institute of India will help the Authority to identify 'monitoring plots' in the Park for long term monitoring of above-mentioned biodiversity except the dugong, which need an aerial survey.

c. Status, distribution and ecology of Dugong. Status, distribution and ecology of other cetacean. Status and stock assessment of elasmobranches. Status and ecology of breeding and non-breeding coral fishes.

d. Identification, status and biology of endemic marine fauna. Identification and status determination of endemic flora. Status, distribution pattern and ecology of exploitable mollusks, holothurians and echinoderms.

e. Documentation of kinds of fisheries practices and their impacts on habitat and species. Development of silvicultural technology for endemic mangroves. Development of propagation technology for endangered species and habitats. Impact of bottom trawling on coral reefs and seagrass beds. By-catch assessment in different kinds of fisheries practices. Pollution impact of ballast water release in the seascape. Impact of other fishing technology on biodiversity.

f. Economic valuation including ecological services of coral reefs. Creation of baseline data on phsio-chemical, geological and climatological parameters including primary productivity (NIO). Identification of indicator species for evaluation of efficacy of management intervention on ecosystems. Identification and establishment of non-violate vegetation preservation plots and coral reef transects for longterm monitoring.

g. Role of coral reefs, mangroves, sea grass beds and intertidal zones as breeding and nursery grounds of various fauna (temporally as well as spatially). Temporal and spatial distribution pattern of migratory fauna in the coastal and marine environment. Identification of foraging, breeding grounds of migratory fauna including determination of migratory path through use of advanced technology. Documentation of changes in the demographic profile in the region and their pressure in the ecological setting.

h. Restoration ecology: Restoration of coral reefs habitats. Restoration of mangroves with special reference to endemics. Restoration of seagrass beds. Stock enhancement

of coral reef fishes. Stock enhancement of sea horses. Stock enhancement of holothurians. Stock enhancement of these animals will help the restoring the Gulf of Mannar marine biodiversity and also to the local communities who can later go for harvesting these resources in a sustainable manner.

i. Determination of socio-economic dependency of user communities on coastal and marine resources versus other resources. Documentation, promotion and extension of eco-compatible alternate livelihood options. Identification of various stakeholders and assessment of impact of their activities on the ecological resources.

j. Gender issues involving resource use and management. Development of empowerment mechanisms and models of community based institutions involvement in resource management.

k. The efficacy of International, National and State policy and legal instruments in the resource management in GOMBR. Mechanism of networking various governmental, non-governmental and communities based institutions in the participatory management.

l. Modeling: Three types of modeling activities; numerical simulations, ecosystem models, and statistical models; will be used to interpret data, guide field programs, test hypotheses, and to predict potential outcomes from proposed uses and thereby influence management decisions. Modeling efforts will be based on the information gathered from the baseline, monitoring and experimental studies. As more information is gathered in these endeavors the models will be continuously modified and refined. Modeling efforts can be used to analyze the causes and consequences of ecosystem changes and predict the effects of new and more intense human activity in the area. Unlike the monitoring program, some of these studies may be predictive, short- term and directly targeted to an immediate management issue. Examples of modeling studies include: (1) determining and predicting the effects on sea turtles and marine mammals from boating activity; (2) predicting the flow of an inadvertent discharge (such as a fuel spill) into the Biosphere Reserve; (3) modeling the transport of sediment in the Biosphere; and (4) estimating the impact of the loss of kelp habitats on higher trophic levels. These types of models are useful for determining effective management strategies. Once strategies are in place, monitoring information will determine their effectiveness and be used to refine the model. .

4.4.7.2. Short term researches:

a. The Biosphere Reserve Authority under its research and monitoring programme should take up specific problems posed by the local population for research and should try to find out suitable solutions. These solutions will help attain higher standards of living and may provide avenues for gainful employment to local people. For example, a short term study on the Economic Impact Assessment on the impact of land use pattern changes along the sand dune habitat, etc.

4.4.8. In-house research and outsourced specialized research

RMC should personally involve largely on biodiversity monitoring programs and facilitate the other research institutions to carry out researches other than monitoring, if necessary, other institutions can also be involved in the monitoring programme. Research Officer who is from the strong research background of marine biology and

his team members needs to be continuously sent for the refreshment courses either in India or outside India for updating their knowledge especially in monitoring the marine biodiversity of the Gulf of Mannar and its ecological services to the local communities. The focus of RMC of the Gulf of Mannar Biosphere Authority should not expect to conduct all kinds of marine research programs by its own. Authority can outsource certain research programs which are very important for the conservation of biodiversity and its dependent communities to various concerned research institutions mentioned in the Research Matrix or any other professional institutions.

4.4.9. Coordination, documentation and data base of research information and posting in web page

One of the important activities of the RMC of the Gulf of Mannar Biosphere Reserve Authority is the coordination with all other research institutions, documentations of all the research findings and maintenance of data base, and sharing data base with outside world by posting its own web page 'www.gombra.com'.

4.4.10. Compiling research recommendation for implementation for management

RMC has to also compile all the research recommendations in a simple manner so that everyone could understand. RMC should take the responsibility of monitoring the success of the implementation of various research recommendations suggested by RMC to the Biosphere Authority. RMC should also review the progress of the 'implementation program' by the Authority in every six months interval in its Research Advisory Committee meetings.

4.4.11. RMC Research personnel

4.4.11.1 Research Biologist: One Research Officer, Group A service (equalant to Scientist C) need to be appointed on deputation from the Universities, marine related research institutions for RMC. Deputation period should be three years time period and it may be extended up to two more years. Research Biologist should possess a Doctorate Degree in marine biology with good academic record supported by research publications. He/she should directly report to the Executive Director, Biosphere Authority. Main role of the Research Officer is to coordinate and facilitate all research and monitoring activities in the Biosphere Reserve. Appointment of the Research Officer will be governed by the CSIR Scientific rules. RO should be provided with a four-wheel vehicle, motorboat and other necessary supporting staff and infrastructure.

4.4.11.2 Other research staff: As per the requirement of the RMC could hire the research personnel in the project mode, temporarily, preferably research scholars. These research scholars may be encouraged to pursue higher degree while working in the projects of RMC.

4.4.11.3 Field staff: As per the requirement of each project, field staff could be hired on the temporary basis. RMC should make sure that the majority of the field staff hired in the projects of RMC or others should be from the local communities preferably fishermen.

4.4.12. Capacity building for in-house research and monitoring

RMC should regularly conduct the training programs in the field of coral monitoring using scuba diving, monitoring other marine habitats and species of the coastal and marine biodiversity, management of marine protected area etc. Field staff of RMC should be trained regularly so that they will facilitate various research programs in this region. RMC should seek the help of best resource persons available in India and abroad for its training programs. Expenditure of such training programs may be taken care by the Ministry of Environment and Forests, Government of India, Department of Environment and Forests, Government of Tamil Nadu, and other International and National donor agencies.

4.4.13. Community involvement in research and monitoring

As mentioned earlier, RMC should make all the efforts to appoint local people as field staff of all the projects which could send the message to the local communities that they are also part of all the activities of the Biosphere Reserve Authority. All the research activities of the RMC should be made aware to local communities. Findings of all the research activities, which are related to local communities, need to be shared with them.

4.4.14. Annual research seminar

Biosphere Reserve Authority will conduct an annual research seminar for presentation and review of research activities undertaken by all organizations and individuals. All the members of Research Advisory Committee are expected to participate in this two day seminar. Only during the ARS the new proposals by any organizations including RMC of the Authority needs to be reviewed and approved. All externally funded research proposals which have already been peer reviewed by the funding agencies are to be ratified with the condition that they must make a presentation on their research progress and must provide annual and final completion report copies to the Biosphere Reserve Authority research and documentation centre and data base.

4.4.15. Research Advisory Committee

- | | |
|---|--------------------|
| a. Chief Wildlife Warden, Tamil Nadu | - Chairman |
| b. Director, GOMBRA | - Member Secretary |
| c. VC/Director or his Representative of Anna University, MKU, CASMS | - Member |
| e. IGF (WL) or his representative from MoEF, GOI | - Member |
| f. Director or his representative from WII | - Member |
| g. Director or his representative from SACON | - Member |
| h. National NGOs – BNHS & SDMRI | - Member |
| i. UNDP | - Member |
| j. Wildlife Warden, Marine National Park | - Member |
| k. Director, Pollution Control Board, Tamil Nadu | - Member |
| l. Director, Fisheries Department, Tamil Nadu | - Member |
| m. Director, Department of Environment, Tamil Nadu | - Member |
| n. Three more special invitee by the Chairman | - Member |

4.4.16. Liaison and linkages with funding sources

Based on the various research being carried out in the Gulf of Mannar region by various agencies through external funding sources, the Biosphere Reserve Authority should compile the details of all the funding agencies and share with them the Biosphere Reserve research thrust areas and the research matrix. This will help the Authority to facilitate the research programs with various funding agencies as well as research organizations.

4.4.17. Guidelines for research in the Gulf of Mannar Biosphere Reserve

- 4.4.17.1. All the research proposals to be funded by the Gulf of Mannar Biosphere Authority are to be submitted to the RMC of the Biosphere Reserve Authority, in turn, the RAC of the Authority will review the proposals and give its comments to the Investigator(s) or his/her institutions.
- 4.4.17.2. Other externally funded project proposals, which have already been reviewed by the funding agencies peer reviewers, are to follow the normal procedures. However, the Gulf of Mannar Biosphere Reserve based on their research matrix priority will facilitate the permission process and maintain the information in their data base, so that repetition of such proposals in the same region will not take place.
- 4.4.17.3. Funded project proposals with comments of RAC need to be submitted to the Chief Wildlife Warden, Government of India for permission to work in the Biosphere Reserve. A copy of the letter along with proposal need to be sent to the Director, Gulf of Mannar Biosphere Reserve Authority. The Chief Wildlife Warden is expected to give his/her reply within three months time period from the day of receiving the proposal.
- 4.4.17.4. Any project proposals that involves the handling of Schedule I species of the Wildlife Protection Act, 1972 is required to get the permission of the Additional Director General of Forests (Wildlife), MoEF, Government of India. The Additional Director General of Forests (Wildlife) is expected to give his/her reply within three months time period.
- 4.4.17.5. Investigator(s) of the project should work with RMC of the Authority, however, it does not mean that the Authority should directly involve/interfere in the project activities.
- 4.4.17.6. Investigator(s) of the project should submit the Annual report every year. Failure to submit the report, will lead to cancellation of permission by the Authority.
- 4.4.17.7. Investigator(s) of the project should give presentation of their annual findings in the Annual Research Seminar of the Authority, where the project activities will be reviewed.
- 4.4.17.8. Final report of the each project completed in the region needs to be submitted to the Data base of the Authority and the Chief Wildlife Warden within six month period. As per the guidelines issued by the Ministry of Environment and Forests, Government of India, a soft copy of the report needs to be submitted to the Wildlife Institute of India with data, in turn, WII will keep this document available in online so that other users could be benefited.

4.4.18. Summary prescriptions for research, monitoring and training programme of the GOMMNP

- 4.4.18.1. Major objectives of this chapter are prioritization of research activities in the region, recommend user friendly protocol for biodiversity monitoring, human resource development towards basic research and monitoring on marine biodiversity and Guidelines to conduct research activities in the region.
- 4.4.18.2. A total of 45 research programs have been identified in seven thrust areas such as landscapes level, habitat level, species level, technology related, multidisciplinary and management related, ecological restoration, socio-economic and policy related studies. Gulf of Mannar Biosphere Reserve Trust can facilitate these programs as per its priority.
- 4.4.18.3. Research and Monitoring Center (RMC) of the Gulf of Mannar Biosphere Reserve needs to be set up with aimed to:
- 4.4.18.3.1. Compile existing data to describe the resources and provide baseline information;
- 4.4.18.3.2. Encourage continual information exchange among the organizations and agencies undertaking research and making decisions that affect the Biosphere Reserve;
- 4.4.18.3.3. Establish a framework and procedures for administering a research program to ensure that projects are responsive to management concerns and that research results contribute to improved management of the National Park;
- 4.4.18.3.4. Encourage multidisciplinary studies that integrate research efforts in the coastal, estuarine, near shore, open ocean, and deep sea ecosystems;
- 4.4.18.3.5. Coordinate data collection on the physical, chemical, geological and biological resources and processes of the Biosphere Reserve, to target specific information needs and avoid duplication;
- 4.4.18.3.6. Initiate a monitoring program to assess environmental changes due to natural and human processes;
- 4.4.18.3.7. Identify the range of effects on the environment that would result from proposed or predicted changes in human activity or natural phenomena;
- 4.4.18.3.8. Incorporate research results into an Interpretive Education Program in a format useful for the general public; and
- 4.4.18.3.9. Evaluate the effectiveness and efficiency of the research program and its integration with resource protection and education objectives.
- 4.4.18.3. RMC needs to be established at Keelakarai. A Research Biologist can head this center. RMC will function as per the guidance of the **Research Advisory Committee** of the Gulf of Mannar Biosphere Reserve Authority.
- 4.4.18.4. A detail long term and short term research activities have been identified which needs to be carried out as per the priority.
- 4.4.18.5. In-house research programmes such as monitoring the habitats/species can be taken up by RMC with the help of professional institutions.
- 4.4.18.6. Basic research programmes need to be outsourced but it should be facilitated by the Authority through RMC.
- 4.4.18.7. RMC should help to develop the human resources in the field of 'Management of Marine Protected Areas and its biodiversity'.
- 4.4.18.8. Higher level of community participation is recommended in all the research programmes as per the prescribed above.

- 4.4.18.9. Guidelines for research activities in the Gulf of Mannar Biosphere Reserve need to be strictly implemented.
- 4.4.18.10. Annual Seminar for research and other activities of the Authority in the Biosphere Reserve need to be conducted in every year which should be chaired by the Chairman of the RAC. All the ongoing research and management activities should be reviewed critically in this seminar for carrying further, if required.

ANNEXURE- 4.4.1

Ministry of Environment and Forests, Government of India's Guidelines for Research and Monitoring in the Biosphere Reserve

A research sub-committee at National level advises and oversees implementation of various research projects in designated and potential sites for Biosphere Reserves.

Research and monitoring in each BR is very crucial to understand impact of the management practices on ecosystem health. The universities, colleges, research institutions, non-governmental organizations, etc. are encouraged to formulate and implement research projects in BRs. Such proposals are considered by the Central Government for funding. Various relevant organizations are encouraged to develop innovative, inter-disciplinary research proposals for BRs, including modeling system for intergrading social, economic and ecological data.

Thrust areas for research and monitoring

The R&D inputs should primarily aim at filling the gaps between R&D outputs and their practical application at user level. Innovations on the use of locally available resources or technologies which ensure easy application through maximizing cost benefit ratios will be encouraged.

The following thrust areas are recognized for research and monitoring in BRs:

1. The design of BR requires integrated knowledge on eco-geographical aspects, socio-economic aspects of local communities, magnitude of biodiversity, political and economic factors and categories of people who use the Reserve.
2. Determination of monitoring regimes which include the identifications of indicators, the frequency at which monitoring should be done is an important component of the management of BR.
3. The role of species in the maintenance of ecosystem health and their response to natural and man-made disturbance regime are critical inputs for management of BRs.
4. Ecological rehabilitation of degraded habitats is of prime importance in the maintenance of biodiversity as well as in the sustainable use of landscapes and species for economic benefit of the local communities. Research in the area of ecological restoration should be given priority. This may also include propagation technique for rare endemic species.
5. Valuing of biodiversity may provide the basis for the economic management of the BRs. Consequently, natural resource accounting form an important component of research and development.
6. Identification of appropriate technologies compatible with the goals of conservation and evaluation of environmental and socio-economic efficiency of the identified technologies.

7. Applied researches for increasing the efficiency of food crops, animal husbandry and other domestic sectors that bring down the local pressure on forests.
8. Identification of factors that lead to environmental degradation and unsustainable use of biological resources.
9. Development of alternative means of livelihood for local populations when existing activities are limited or prohibited within the BR.
10. Identification of institutional mechanisms that ensure equitable sharing of benefits from resources available in buffer zone.

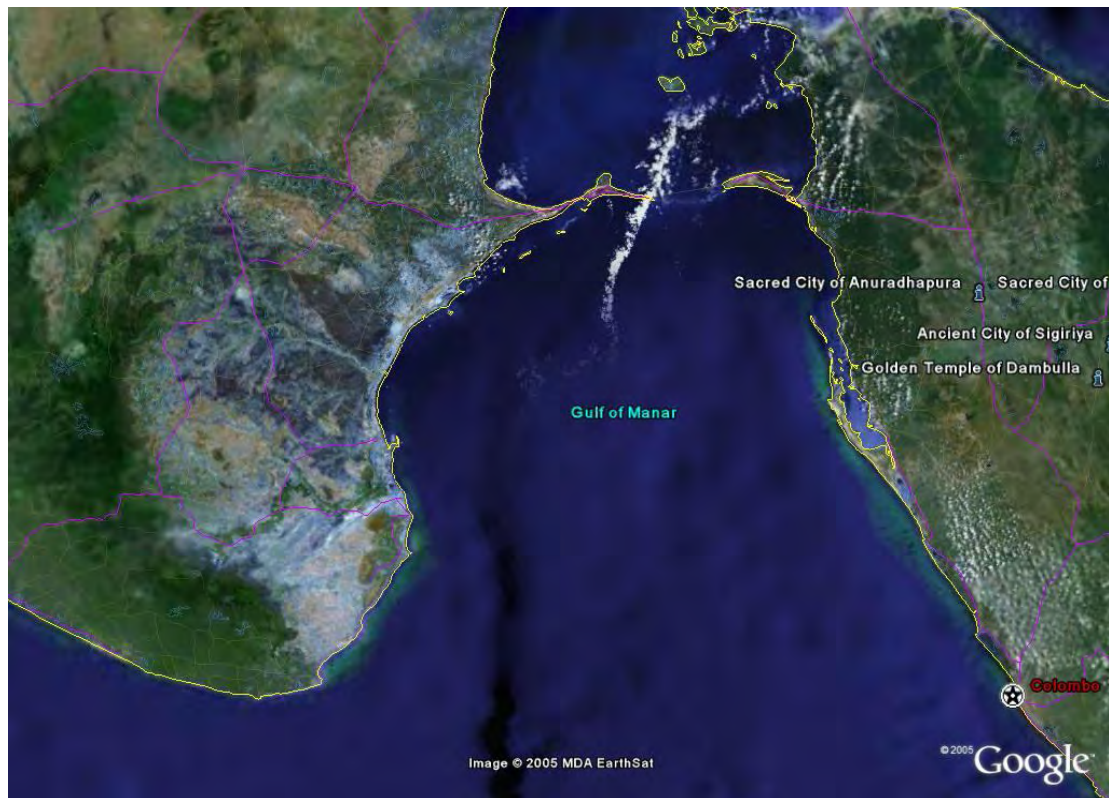
Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
7	Research and Monitoring											
	Formation of Research Advisory Committee of the GONBR											
	Establishment of a Research and Monitoring Centre (RMC) at Keelakarai with all logistic facilities including laboratories, mini-aquarium, vehicle, boats, diving equipment etc	300	500	200	50	60	70	80	90	100	110	1560
	Coordination, documentation and data base of research information, and dissemination of information				10	10	10	10	10	10	10	70
	Establishment of library with books, scientific journals	5	5	1	1	1	1	1	1	1	1	18

	with necessary furniture											
	Recruitment of RMC Research personnel on deputation or temporary basis	20	22	24	26	28	30	33	36	39	41	299
	Participatory capacity building including local community for in-house research and monitoring	10	11	12	13	14	15	16	17	18	19	145
	Annual research seminar	5	5	6	6	7	7	8	8	9	9	70
	Support to research activities	5	5	5	5	5	5	5	5	5	5	50

Plan II

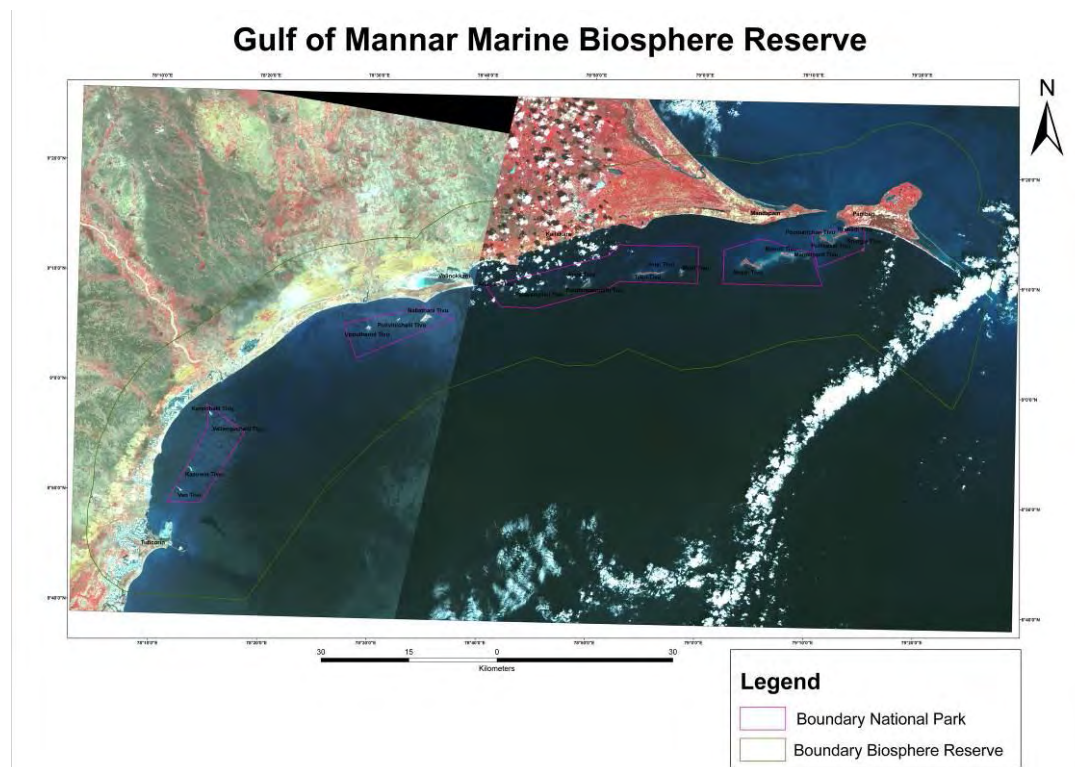
Management Plan for the Gulf of Mannar Marine Biosphere Reserve (2007-2016)



2007

4.0.1. Geographic scope of the Management Plan and zonations

The geographic scope of this Management Plan encompasses the Gulf of Mannar Biosphere Reserve (GOMBR) other than the core zone, which is the Gulf of Mannar Marine National Park. The total area of the Reserve is reported to be 10500 sq. km which extend from Dhanuskodi Island to Cape Comorin. However, based on the 20 m depth south-eastern boundary of the Biosphere Reserve the actual size of the Reserve is to be calculated regularly, as it is vary in nature due to changes in the bethic surface. The GOMBR is also encompasses terrestrial area of up to 10 km from the coast line from Dhanuskodi Island on the north-east (Ramanathapuram District) to Cape Comorin in South (Kanyakumari District) covering all along the four coastal districts of Ramanathapuram, Tuticorin, Tirunelveli and Kanyakumari.



4.0.2. The Buffer zone - Gulf of Mannar Biosphere Reserve (The Utilisation/ Manipulation/ Experimental zone)

This zone is proposed to be permitted for local people's use such as fishing and fisheries related activities in a sustainable manner. The seascape surroundings the islands beyond the limits of the National Park will form the buffer zone i.e. up to 20 m depth in seascape around the National Park and the coastal areas (10 km from the high tide mark to landward side) will form the buffer zone of the Biosphere Reserve. As per the Notification of the Gulf of Mannar Biosphere Reserve the total area of the Reserve is reported to be 10500 sq. km which extend from Dhanuskodi Island to Cape Comorin..

Activities in this zone:

1. Eco-developmental activities
2. Tourism
3. Permitted eco-compatible fishing
4. Maritime navigation
5. Artisanal fisheries
6. Sea weed collection
7. Shell collection using traditional methods
8. Restoration of habitats/species
9. Mariculture using native species

4.0.3. Eco-developmental Zone (Terrestrial)

Ten kilometer stretch of coastal land starting from the sea shore all along the Biosphere Reserve are identified as the Eco-developmental (terrestrial) zone. This zone is also to be utilised for multiple use as like the Utilization zone.

4.0.4. Restoration zone

Restoration zone– enable damaged areas to be set aside to recover. Both core zone and buffer zone can be used for restoration of habitat/species. All the islands are infested with invasive species. These islands need to be restored to their original state by eradicating invasive species from these islands. Northern group of islands such as Mandapam and Kilakarai groups are proposed to be used for restoration of mangrove habitat during this Management Plan period. Degraded coral reefs from the Southern group of islands need to be restored. Detailed prescriptions are available in the concerned chapters. Coral reefs along the mainland especially near the Mandapam, Keelakarai and Tuticorin, also along the Rameswaram Island areas can be restored and used for eco-tourism in future.

4.0.5. Tourism zone

Tourism zone is proposed to be used for various recreational activities (bird watching snorkeling, coral watching etc) to increase the enjoyment and safety of the each pursuit. Eco-tourism is proposed to be allowed in the Biosphere Reserve. As a part of the value addition to the Eco-tourism in the Gulf of Mannar Biosphere Reserve, around 50 km stretches of land and sea areas around the Biosphere Reserve has also been identified and proposed as 'Tourism Zone for Value Addition' with community participation. All the tourist centers in this area have been assessed and included as potential tourism resources in the Eco-tourism sub plan in this Management Plan.

Table. Important permissible activities in various zones of the Gulf of Mannar Biosphere Reserve and National Park

		Monitoring Habitat/ Species	Coral reef restoration	Seagrass bed restoration	Mangrove restoration	Endangered Species recovery programs	Coral watching using glass bottomed boat	Snorkeling	Scuba diving	Fishing & crabbing	Research with permit	Navigation	Aquaculture	Stock enhancement of fishes
Buffer Zone		Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Eco-Development Zone		Y	N	N	Y	Y	Y	N	N	Y	Y	Y	Y	Y
Tourism Zone	Water	Y	N	Y	N	N	Y	Y	Y	Y	Y	Y	Y	N
	Land	Y	N	N	Y	N	N	N	N	-	Y		Y	N

4.0.6. History of conservation and Management of Gulf of Mannar Marine Biosphere Reserve

4.0.6.1. Establishment of Gulf Mannar Biosphere Reserve:

After the concurrence of the Tamil Nadu Government (Telex message NO.75612 / FRV / 88 –3, dated the 24th January 1989) to the proposal of the Government of India for setting of a Marine Biosphere Reserve in Tamil Nadu, the Government of India vide their Notification No. No. 1/6/80-Mannar, dated 4th April 1989, declared the Indian part of the Gulf of Mannar region covering an area of 10500 sq. km as the Gulf of Mannar Biosphere Reserve (GOMBR). Suggesting the Tamil Nadu Government for preparation of detailed maps of the Biosphere Reserve and to initiate management of the BR as per the Government of India Guidelines. However, there have been no management plan for the GOMBR though the management of the BR was under the direction of the CWLW, TN and implemented by the Wildlife Warden under the supervision of the Southern Regional Wildlife circle at Madurai and later under the supervision of Conservator of Forests, Virudhanagar circle as designated as the Director, GOMBR.

Since the GOMBR surrounding the Marine National Park is the area where the local communities are dependent for their livelihood, the Tamil Nadu Government established the Gulf of Mannar Biosphere Reserve Trust (GOMBRT) under the Tamil Nadu Society Registration Act, 1975 vide TN G.O. Ms. No. 263, E&F-FR (V), dated 18.12.2000 as a special purposed vehicle to coordinate and ensure effective inter sectoral coordination and facilitate mainstreaming of biodiversity conservation issues into the productive sector and policy development. Government of Tamil Nadu sought support and assistance of the GEF-UNDP through a project ‘Conservation and sustainable use of the Gulf of Mannar BR coastal biodiversity’. The GEF-UNDP approved this seven year project in the year 2002 at the cost of Rupees 140 crores, of which, the GEF-UNDP contribution was tune of Rupees 40 crores and co-funding from the Government of Tamil Nadu, Government of India and others to the tune of Rupees 100 crores.

Therefore, in addition to the Wildlife Warden, GOMMNP and the Director, GOMBR, the Director, Gulf of Mannar Biosphere Reserve Trust are responsible for protection, management and development of the GOMBR.

While the Gulf of Mannar Marine National Park is managed under the provision of the Wildlife (Protection) Act, 1972, the Indian Forest Act, 1927, Forest (Conservation) Act, 1980, Environmental (Protection) Act, 1986, National Forest Policy, 1988, Coastal Zone Regulation Act, 1992 and Coastal Zone Management Plans of the Tamil Nadu State Government are some of the legal instruments which are supportive and are applicable for protection and management of both the Gulf of Mannar Marine National Park and Biosphere Reserve.

The Tamil Nadu Government also established the Gulf of Mannar Biosphere Reserve Trust in the year 2000 to coordinate and synergize involvement of other sectoral agencies with the Tamil Nadu Forest Department in activities related to sustainable coastal and marine biodiversity conservation through rational utilization and

management in the Biosphere Reserve through community participation. Since the establishment of the GOMBRT, activities in the BR have been managed through Annual Plan of Operation prepared by the Trust. After the approval of a GEF-UNDP sponsored project in year 2002, the GOMBRT, all activities in the BR have been carried out by the Trust under the supervision and approval of its 'Board of Trustee' chaired by the Chief Secretary, Government of Tamil Nadu.

The ten year composite integrated management plan for the period 2007-2016 for the Gulf of Mannar Marine National Park and Gulf of Mannar Biosphere Reserve has been developed in the year 2007 by the Wildlife Institute of India facilitated by the GOMBRT and the FIRST Management Plan for a Marine Biosphere Reserve.

**No 1/6/80- Mannar
Government of India
Ministry of Environment & Forests**

**“PARYAVARAN BHAVAN”
CGO Complex, Phase - II
Lodi Road , New Delhi,
New Delhi – 110 003.
Date: 4th April, 1989**

To,
The Chief Secretary,
Government of Tamilnadu,
S. Fort George,
Madras.

**SUB : ESTABLISHMENT OF GULF OF MANNAR
BIOSPHERE RESERVE**

Sir ,

The Government of India has identified potential sites for preserving biological diversity with the following broad objectives :

- *Conservation of representative samples of ecosystem.*
- *Provision of long – term conservation of genetic diversity in-situ*
- *Promotion of basic and applied research work and its monitoring ; and*
- *Dissemination of experience for education and training.*

The Gulf of Mannar represents the unique marine ecosystem in the Indian part of the Gulf situated between India and Sri Lanka . In accordance with the guidelines on the subject, a project document for setting up of Biosphere Reserve in the Gulf of Mannar was prepared by Prof. K.Krishnamurthy, the then Director, Centre for Advanced study in Marine Biology, Annamalai University. This has been considered in detail by the Government of Tamilnadu and the Government of India.

In their telex message NO.75612 / FRV / 88 –3, dated the 24th January 1989, the Government of Tamilnadu have conveyed their acceptance of the proposal for setting up of Biosphere Reserve in Gulf of Mannar area. It has, therefore, been decided that the Gulf of Mannar Biosphere Reserve should formally be deemed to have come into being with effect from 18th February, 1989.

The Indian part of the Gulf covers approximately an area of 10,500 sq.kms, running southwards and parallel to the main land coastline to a distance of about 170 nautical miles and lies between 78^o 11' and 79^o 15' E longitudes and 8^o 49' and 9^o 15' latitude. It has an area of 21 islands starting from the north most Pamban island to Thoothukudi. The boundary and zonation in core and buffer zones of the Biosphere Reserve are given at Annexure – I . The details of the area

to be earmarked for manipulation activities such as aquaculture, etc., will be worked on by the project authorities.

The following will be the important aspects of the Gulf of Mannar Biosphere Reserve

- a. The core and the buffer areas and manipulation activities which may be permitted in the buffer zones will be submitted by the Government of Tamilnadu.*
- b. The core zone of the Biosphere Reserve will be kept absolutely undisturbed.*
- c. The constitution of the Biosphere Reserve by itself will not, in any way, change the status of legal ownership of the land*
- d. There will be a Biosphere Reserve Management council with the composition as shown in Annexure – II*
- e. The Government of India will provide financial assistance for approved items for expenditure included in the section and Management plan to be prepared by the Government of Tamilnadu. This may broadly be classified under the following heads:*
 - § Survey*
 - § Conservation*
 - § Protection*
 - § Ecorestoration*
 - § Education and awareness.*
- f. There will be a Research Committee as per the composition shown in Annexure – III*
- g. The subject of research and institution identified for the purposes are shown in Annexure – IV*
- h. The Government of Tamilnadu will set up a local committee for coordination of the activities of various departments in the area covered by the Biosphere Reserve.*

(K. P. Geethakrishnan)
Secretary to the Government of India

ANNEXURE I & II

MANAGEMENT COUNCIL – GULF OF MANNAR BIOSPHERE RESERVE

1. Secretary, Ministry of Environment and Forests. - Chairman
2. Joint Secretary(WL), \Ministry of Environment and Forests - Member
3. Joint Secretary/ FA, Ministry of Environment and Forests - Member
4. Representative of State Government of Tamil Nadu - Member
5. Director of Gulf of Mannar Biosphere Reserve - Member
6. Representative of Botanical Survey of India - Member
7. Director-in-charge of Biosphere Reserve Programme in the Ministry of Environment and Forests - Member

Region 2 – This region comprises six islands between Keelakkarai and Mukkaiyur viz. Upputhanni Tivu, Pullivunnichalli Tivu, Nallathanni Tivu, Anaipar Tivu. Valimunai Tivu and Poovarasanpatti Tivu.

The Core Zone – The Core Zone of this region comprises three islands Nallathanni Island, Pullivunnichalli Island and Anaipar Island.

The Buffer Zone – The immediate sea and the following two islands will constitute the Buffer zone:

- a) Vallimunai Island
- b) Poovarasanpatti Island

Region 3 – The main land coastline from Mukkaiyur to Tuticorin extends to about 120Km. This Region lies between Mukkaiyur and Tuticorin comprising four islands, viz., Van Tivu, Kasuvar Tivu, Vilanguchalli Tivu and Karaichalli Tivu.

The Core Zone – The pearl banks near and away from Tuticorin.

The Buffer Zone – the buffer zone will comprise the following four islands:

- a) Van Tivu
- b) Kasuvar Tivu
- c) Karaichalli Tivu
- d) Vilanguchalli Tivu

Region 4 – This region lies between the Tuticorin and Kanyakumari and Extends to about 110Kms.

The Core Zone – The area having pockets of pearl banks and chank beds will constitute “Natural Core Zone”.

The Buffer Zone – The remaining will be buffer zone.

Annexure – III

**COMPOSITION OF RESEARCH ON GULF OF MANNAR BIOSPHERE
RESERVE**

- | | |
|--|------------|
| 1. Prof.K.Krishnamurthy, Centre for Advanced Studies in
Marine Biology, Annamalai University. | - Chairman |
| 2. Representative of Tamil Nadu Government | - Member |
| 3. Representative of Pondicherry University | - Member |
| 4. Representative of Madras University | - Member |
| 5. Representative of Madurai Kamaraj University | - Member |
| 6. Representative of the Regional Centre of the Central
Marine Fisheries Research Institute, Mandapam Camp. | - Member |
| 7. Representative of Botanical Survey of India | - Member |
| 8. Representative of Zoological Survey of India | - Member |
| 9. Representative of the Ministry of Environment and Forests,
New Delhi. | - Member |

ANNEXURE – IV

LIST OF RESEARCH INSTITUTIONS AND PRIORITY AREAS IDENTIFIED FOR UNDERTAKING RESEARCH IN GULF OF MANNAR BIOSPHERE RESERVE.

1. *Southern Circle Botanical Survey of India, Coimbatore.* - *Floral Inventory.*
2. *Southern Regional Station Zoological Survey of India, Madras-* *Faunal Inventory*
3. *Pondicherry University (Salim Ali Centre of Ecology)* - *Ecological Studies*
4. *Madras University/ Madurai Kamaraj University/ Annamalai
University* - *Marine Biology*
5. *National Institute of Oceanography, Goa* - *Mangroves and Coral*
6. *Regional Center of the Central Marine Fisheries Research
Institute, Mandapam* - *Fisheries and Corals*
7. *Bharathidasan University* - *Sea grass*
8. *Center for Brackish Water Aquaculture, Madras* - *Fisheries*

So far, there was no management plan prepared for the buffer zone of the Gulf of Mannar Biosphere, however, the Gulf of Mannar Biosphere Reserve Trust on the recommendation of Government of Tamil Nadu and the UNDP has been successfully carrying out various eco-developmental and biodiversity conservation related activities in the Biosphere Reserve area of the Ramanathapuram and Tuticorin districts.

5.1. Pollutions and Management of their possible impact on the Gulf of Mannar Biosphere Reserve Ecosystems

5.1.1. Introduction

Since the new Tuticorin port became operational, the coast of Gulf of Mannar Biosphere region is experiencing an accelerated growth in the rate of industrialization especially in the districts of Tuticorin and Tirunelveli. Due to bloom in the culture fisheries activities which gradually replaced the traditional salt pans in this region has also changed the ecology and morphology of the coasts which has caused serious damage to the maintenance of water quality, traditional fishing, and loss of coastal habitats and benthic life (Easterson, 1998).

The utility of benthos in pollution monitoring to ascertain the health of estuarine and marine environment has been in vogue since the classical study by Wilhelmi (1916). There are several reasons why the benthos are used as indicators of ecosystem change. Firstly, the life history of benthos especially their longevity provides long term exposure to toxic substances, secondly, they live in close contact with sediments which enhances their intimacy with many pollutants and lastly the infaunal organisms reflect the situations not only at the time of sampling but also during yesteryears. These view points have been highlighted well by Kolkwitz and Mansson (1908), Forbes and Richardson (1913) and Gaufen and Tarzwell (1952). These investigations led to the development of the indicator organism concept which is the presence of a particular species or a group of species in a given locality that reflects the state of a particular environment. Among benthos, the well studied group polychaetes qualify the most of the traits of an ideal indicator organism since they constitute well over half of the organisms in and on the bottom and thus give a good indicator of benthic conditions.

Pollution can affect an estuary in four major ways: 1) oxygen depletion (e.g. from sewage), 2) chemical accumulation (e.g. toxic organic compounds, petroleum products, heavy metals), 3) spills (e.g. oil. spills) and 4) thermal pollution (e.g. heated effluent from power plants). (Ganapathi, 1975).

Almost all the estuaries/rivers in the four districts of Gulf of Mannar Biosphere Reserve opens into the sea and influenced by the tidal water of Gulf. None of them belongs to perennial water source. Most of the river mouths in the Gul of Mannar remain closed during dry seasons, especially May to August. Due to lack of continuous flow of freshwater, the entire river mouth and its adjacent mudflats are dominated by the tidal flush and hence heavily influenced by high salinity conditions.

Reclamation of the coastal habitats for developmental activities, dumping ground for garbage, conversion of salt pans into aquaculture farms, in addition to the anthropogenic disturbances, the setting up of shrimp farms along the coast of estuaries in GOM has also become a matter of great concern. Due to delicious taste, universal acceptance, high unit value, quick growth rate, short culture period, high returns on investment and insatiable demand, shrimp farming had spread its root in India. With the recognition by Government of India as an extreme focus sector and with the patronage of government agencies and financial institutions, shrimp farming picked up fast. But due to lack of planning, there was unregulated growth leading to social

resistance and outcry by environment groups regarding degradation of habitats and erosion of livelihood opportunities. It was reported that due to shrimp farming, the biota has changed and many species have disappeared (Johnston, 1976; Varshney; Amaral & Costa, 1998 and Govindan, 1995). The aftermath of industrialization, urbanization and increase in population resulted in the release of discharges to the immediate ecosystem, which causes the deleterious effects as one of the exigent and perplexing problems of the coastal environment (Folke and Kautsky 1992; Pillay, 1992 and Gajbhiye, 1995). Coastal waters of Gulf of Mannar has also reportedly become polluted due to activities in ports and harbors, sewage discharge from human settlements along the coast and industrial effluents. Disposal of wastewater and industrial effluents into the estuaries and oceans has also increase the organic pollutant load in the coastal environment (Jayamani,2002).

A major outcome of increasing industrial water use has been the increase in conflict between local communities and the industry on issues ranging from water pollution to water scarcity. In areas where there is water scarcity, industries are under tremendous pressure from community and government alike to reduce water use (Murugan, 1989). Depletion of groundwater by industries, supply of water meant for irrigation to industries, preferential treatment given to industries by the government are some of the major reasons for the conflict between industry and community over water use (Zingde and Desai, 1980; Zingde and Sabnis, 1994).

Some chlorinated compounds used in herbicides and pesticides are toxic to marine organisms and may be bio-accumulated in the coastal food chain. Pathogens such as faecal coliforms and viruses may pose a human health issue for swimming and the consumption of seafood. Hotspots include areas around sewage outfalls, industrial areas, intensive agriculture and areas that are poorly flushed by tides such as coastal lakes and lagoons (Kennish, 1992 and Frouin, 2000).

Anything that happens to a river in its catchments can have an impact on the estuary. A river flowing through farmlands can become polluted by pesticides, herbicides and nutrients from fertilizer. Soil eroded from badly farmed or overgrazed lands will also be washed into estuaries after heavy rains. This excessive silt load has the effect of filling up the estuary and in some cases resulting in the estuary mouth closing. Silt smothers animals and reduces light penetration so that plants are unable to grow except in very shallow water (Stone and Reish, 1965; Senthilnathan, 1990).

Benthic organisms as pollution indicators

Benthos - Benthic invertebrate communities are integral components of all kinds of aquatic ecosystems. The benthos – those organisms that live on or within sediments – influence sediment and bottom-water chemistry, alter sediment organic content and structure and serve as major prey species for crustaceans and fish. Although freshwater and estuarine benthos perform similar ecological functions but their composition is quite different. Estuarine benthos typically includes polychaete worms, amphipods, crustaceans and molluscs.

Benthic organisms have long been recognized as an integral part of coastal ecosystems and have been used as biological indicators of water quality for assessing the effects of industrialization and urbanization in various parts of the world (Pearson

and Rosenberg 1978). As many as research works has been done on benthic organisms as an indication of various pollution in both the water and soil substratum. Because of their intact life system with these media and of its sedentary life style, they very well suite to this typical studies. Most of the studies concluded the presence and dominance of certain benthic species is an indication of relevant pollution threat in particular site. Levin (2000) describes the concept of indicator species is an attempt to use the presence and or dominance of certain species on the basis of the indicators taxon concept in a sample or area to characterize the degree of community change or pollution effects. Indicator species may belong to polychaetes, crustaceans, molluscs or to any other animal groups promptly represented in the samples. Often polychaetes were used as an indicator species (Levin, 2000) because they are often exposed to high concentration of pollutants both in their food and in the ambient milieu. Polychaetes in general are more opportunistic in their potential to colonize stressed environments (Rhoads and Morse, 1971; Pearson and Rosenberg, 1978).

Most of the studies conducted in India are on polychaetes whereas studies on molluscs and crustaceans as biological indicators of pollution is lacking. Even though research on some benthic communities of Uppanar, Vellar, Coleroon do exists along Tamil Nadu coast, studies especially on pollution indication is negligible.

The basic concept of utilizing the indicator species to gauge pollution status is being described below. Indicator organisms are used primarily to identify rather than to measure environmental changes. The cause for these changes may be the result of varying mixture of pollutants or of unknown causes. In stress condition the more sensitive organisms will be eliminated and successful species increase in numbers to dominate the community. These species while indicating pollution help in evaluating the effect of pollution.

Determination of pollutant status in the estuaries using benthic organisms as indicators in the Gulf of Mannar Biosphere Reserve coastal areas

The purpose of this study was to document the existing benthos (benthic organisms) of the estuaries, creeks and lagoons of Gulf of Mannar coast in order to monitor the pollution status.

Sampling sites and descriptions:

The estuaries, creeks and other coastal wetlands of along Gulf of Mannar coast was sampled for this benthic survey. It forms totally about eight such sampling sites along this coast starting from Rameswaram to Kanyakumari. The list of sampling sites, their physical characteristics and source of pollutants in four districts along the Gulf of Mannar Biosphere Reserve coast is given in Fig. 1 and Tables 1, 2 and 3.



Fig. 1. Estuarine/river sampling sites of GOMBR coastal areas, Tamil Nadu

Table 1. Site description of estuaries/ivers along the Gulf of Mannar Biosphere Reserve (based on visual observation)

Estuary/River	Water color	Soil type	Oyster bed	Seaweed	Sea grass bed	Mangroves
Kanjirangudi estuary	Grey	Clayey	N	N	N	Y
Valinokkam estuary	Grey	Clayey	N	Y	N	N
Vembar river	Grey	Sandy	N	N	N	N
Vaipar river	Grey	Clayey	N	N	Y	Y
Pazhayakayal estuary	Brown	Clayey	N	Y	Y	Y
Punnakayal estuary	Brown	Clayey	N	Y	Y	Y
Veerapandipattinam estuary	Brown	Sandy-clay	N	N	N	N
Nambiyar river	Grey	Sandy	N	N	N	N

Note: Y- Yes, N – No

Vaipar and Punnakayal estuarine complexes have traces of seagrass beds especially near their openings (Table 1). Seaweeds and other algal mats were recorded in the waters of Punnakayal estuarine complex.

Table 2. Sampling sites and site descriptions

District	Sampling site: Estuary/river	Position	Status of estuary mouth	PP	AR	IS	DS	AF	SP	SM
Ramanathapuram	Kanjirangudi estuary	N09°14'712" E078°49'985"	Open	N	N	N	Y	Y	N	Y
	Vallinokkam estuary	N09°10'189" E078°38'275"	Closed	N	N	N	N	Y	Y	N
	Vembar river	N09°04'754" E078°22'887"	Closed	N	N	N	Y	Y	Y	Y
Tuticorin	Vaipar river	N09°01'787" E078 °15'015"	Closed	N	N	N	N	Y	Y	N
	Pazhayakayal estuary	N08°39'593" E078°06'846"	Open	Y	Y	Y	Y	N	Y	Y
	Punnakayal estuary	N08°38'237" E078°07'418"	Open	Y	Y	Y	Y	N	N	Y
	Veerapandi Pattinam estuary	N08°30'240" E078°07'530"	Closed	N	Y	N	Y	N	N	Y
Kanyakumari	Nambiyar river	N08°14'886" E077°48'249"	Closed	N	Y	N	Y	N	N	Y

Note: Y- Yes, N – No

PP - Power Plant

AF - Aquaculture Farm

AR - Agriculture run-off

IS - Industrial Sewage

DS - Domestic Sewage

SP - Salt Pans

SM – Settlements

Table 3. Sampling sites and source of pollutants in estuaries/ivers along the Gulf of Mannar Biosphere Reserve

Estuaries/Creek	Pollution type	Source
Kanjirangudi	Organic	Aquaculture effluent
Valinokkam	Organic and brine water	Aquaculture effluent and Saltpan
Vembar	Brine waters	Saltpan
Vaipar	Brine water	Saltpan
Pazhayakayal	Brine water	Saltpan
Punnakayal	Organic	Agricultural runoff
Veerapandipattinam	Organic	Sewage
Nambiyar	Organic	Agricultural runoff

As mentioned in the Table 3, the site Veerapandiyapattinam is influenced heavily by sewage pollution, because of urbanization. Vast areas in and around Pazhayakayal, Vaipar, Vembar and Valinokkam were converted as salt pans.

Methodology

Sample collections were undertaken during October, 2006 within the coastal regions of Gulf of Mannar region. All the sites were chosen to sample wherever estuaries, creek or lagoon exists along the coast, totally eight such sites were sampled (Fig. 1). Some of the primary criteria include the proximity to mouth opening, proximity to existing vegetation, proximity to shoreline, depth, freshwater inflow, and bottom sediment type etc. for documentation and details about the sites were supplemented. Pictures of the few sites sample along the Gulf of Mannar Marine Biosphere Reserve coastal areas of Tamil Nadu, deployment of sampling grab and sieving at the sites are shown in Figs. 2-8.

Three, and sometimes four, grab samples were taken at each site using a small (0.025 m²) Peterson grab. Samples were collected at depths ranging between 1-2m. Samples were placed in plastic containers, fixed with 5% formalin, stained with Rose Bengal, covered and labeled with site identification. Upon return to the laboratory, all samples were decanted and sieved through a 0.5mm sieve. Materials retained on the sieve were examined under a dissecting microscope and all organisms were removed and placed in labeled glass vials. Samples were later transferred to 70% ethanol and identified. Species identification were made using standard identification key/tools provided by Fauvel (1930), Fauvel (1953), Day (1967), Shanmugam et al. (1998), Lyla et al., (1998) Rajagopal et al. (1998) and Srikrishnadhas et al (1998) for benthic organisms of Indian coastline. To the maximum, organisms were identified to species, but the majority of identifications were only to genus. This level of identification was adequate for a preliminary study, given sampling and time constraints. It is recommended that long-term monitoring include species-level identification in order to provide a more detailed record of the sites.

Results:

In this study, a total of 122 species have been identified from 8 sampling sites of Gulf of Mannar Marine Biosphere Reserve area, Tamil Nadu. Among these, polychaetes are the dominant species and are followed by Crustaceans, Molluscs (Table 4). Off 122 species identified, 47 polychaetes, 34 crustaceans, 33 molluscan belong to 21, 18

and 15 families respectively. In addition to this, 8 species of benthic organisms belonging to other animal groups have also been recorded. A list of all benthic organisms identified in this study is presented separately in Appendix 1.

Table 4. Taxonomy and occurrence of identified benthic organism during this study

Animal groups	Order	Family	No. of species	Percentage
Polychaetes	1	21	47	38
Crustaceans	5	18	34	28
Molluscs	6	15	33	27
Others	-	-	8	7

Diversity indices:

The parameters such as species abundance, density, similarity and diversity indices together with environmental qualities were often used to evaluate the possible pollution effects on the fauna. The same was applied to assess the pollution status of the respective site in which they dwell. Univariate diversity indices of the sampling sites were presented in Table 5.

Table 5. Univariate statistics of the sampling sites

Sample sites	Total species	Total individual	Species richness	Evenness	H' diversity index
Kanjirangudi	44	1420	5.924	0.9371	3.546
Valinokkam	28	1460	3.706	0.8663	2.887
Vembar	20	1300	2.65	0.9099	2.726
Vaipar	20	1160	2.693	0.8651	2.592
Punnakayal	55	1860	7.173	0.9258	3.71
Pazhayakayal	56	1840	7.316	0.8808	3.546
Veerapandipattinam	46	1660	6.069	0.8846	3.387
Nambiyar	23	1220	3.096	0.8542	2.678

Pollution indication:

Since research reports on mollusc and crustaceans as indicators of estuarine pollution is very limited, it is difficult to identify and categorize the sites based on these animal groups. Much literature is available regarding the indication of pollution using polychaetes as indicator organisms. Abdul Azis and Nair (1982), Remani et al., (1983) and Sunilkumar and Antony (1994) listed out several polychaete species as an indicator of pollution from Cochin backwaters. Similar studies have been carried out by Raman and Ganapathi (1983) and Ajmal Khan et al., (2004) along the east coast of India. Ajmal Khan and Murugesan (2005) have listed out the polychaetes species of entire Indian coast and their importance in the studies of pollution indication. Some of the indicator species enlisted after thorough studies conducted in highly polluted areas was considered to identify and sort the sampled areas in this study. Since no other

species other than polychaetes are listed as indicators, a comparison of sites having similar organisms was first sorted out. The procedure was then applied to identify the crustaceans and molluscs based on their existence associated with polychaete indicator species.

Following above mentioned procedure, the listed polychaetes were categorized into three groups based on pollution threats viz. abundant in high pollution areas, medium, low polluted areas and occurrence of some species in virtually non polluted areas (Table 6).

Table 6. Polychaete species recorded in various pollution studies in south Indian coast

Abundant in polluted sites	Recorded in medium polluted sites	Recorded in non-polluted sites
<i>Capitella capitata</i>	<i>Dorvillea articulata</i>	<i>Cossura delta</i>
<i>Branchiocapitella singularis</i>	<i>Lumbriconereis polydesma</i>	<i>Diopatra neapolitana</i>
<i>Dendronereis aestuarina</i>	<i>Lumbriconereis simplex</i>	<i>Laonome indica</i>
<i>Lycastis indica</i>	<i>Lumbrinereis latreilli</i>	<i>Lepidonotus tenuisetosus</i>
<i>Nereis sp</i>	<i>Nephtys polybranchia</i>	<i>Polydora armata</i>
<i>Paraheteromastus tenuis</i>	<i>Owenia fusiformis</i>	<i>Phyllodoce malmgrani</i>
<i>Polydora ciliate</i>	<i>Sthenalis boa</i>	<i>Spiochaetopterus costarum</i>
<i>Prionospio polybranchiata</i>	<i>Sternaspis scutata</i>	
<i>Prionospio cirrobranchiata</i>		
<i>Schphoproctus djiboutensis</i>		

Source: Grassle and Grassle (1976); Abdul Azis and Nair (1982); Remani et al. (1983); Raman and Ganapathi (1983); Sunilkumar and Antony (1994); Ajmal Khan et al., (2004) and Ajmal Khan and Murugesan (2005)

By thorough refinement in the recorded species from this coast, respective sites were selected to identify the existence of other associated polychaete species and it is then applied to identify associated molluscs and crustaceans of that sites. The mollusc and crustacean species found associated with polychaete indicator species were used to trace out the occurrence of similar mollusc and crustacean species in other (expected) sites. Based on this comparison technique, we have identified and enlisted a group of polychaete, molluscs and crustaceans as indicator species with respect to pollution status of the sites (Table 7).

Table 7. Species recorded in highly polluted areas of Tamil Nadu coast

Polychaetes (22)	Crustaceans (11)	Molluscs (5)	Others (3)
<i>Dendronereis aestuarina</i>	<i>Ampithoe ramondi</i>	<i>Cerithedia cingulata</i>	Polyclad
<i>Branchiocapitella singularis</i>	<i>Aapseudes chilensis</i>	<i>Katylisia opima</i>	Foraminiferans
<i>Capitella capitata</i>	<i>Calanus sp</i>	<i>Meretrix meretrix</i>	Mysids
<i>Diopatra neapolitana</i>	<i>Clibanarius sp</i>	<i>Modiolus metcalfi</i>	
<i>Eunice sp</i>	<i>Corophium sp</i>		
<i>Glycinde oligodon</i>	<i>Corophium triaenonyx</i>		
<i>Heteromastus similis</i>	<i>Eriopisa sp</i>		
<i>Lepidonotus tenuisetosus</i>	<i>Grandidierella sp.</i>		
<i>Lumbriconereis latreilli</i>	Isopod		
<i>Lycastis indica</i>	Lucifer		
<i>Nephtys polybranchia</i>	<i>Quadrivisio bengalensis</i>		
<i>Nereis sp</i>	<i>Tanaeus sp</i>		
<i>Owenia sp</i>			
<i>Paraheteromastus tenuis</i>			
<i>Prionospia cirrobranchiata</i>			
<i>Prionospia polybranchiata</i>			
<i>Prionospio pinnata</i>			
<i>Pulliella armata</i>			
<i>Sthenelais boa</i>			
<i>Thalehasapia tenuis</i>			
<i>Tharyx sp.</i>			

Note: **boldface** –indicator species recorded earlier to this study

Table 8. List of kinds polluting industries along sampling sites in four districts along the Gulf of Mannar coast

District	Sampling site: Estuaries	Status: Estuarine mouth	Pollutant sources from Catchments area	Indicator species - Benthic polychaetes	Heavy metal content of polychaete indicator species	Dominant polychaete indicator species in polluted area	Level of pollutants
Ramanathapuram	Kanjirangudi estuary	open	AF, DS	<i>Heteromastus similis</i> , <i>Lumbriconereis latreilli</i> , <i>Lumbriconereis simplex</i> , <i>Nephtys polybranchia</i> , <i>Nereis</i> sp. <i>Pulliella armata</i> , <i>Thalehasapia tenuis</i>	<i>Lumbriconereis</i> sp. <i>Nephtys</i> sp. – Organic materials	<i>Lumbriconereis</i> sp. <i>Nephtys</i> sp.– sewage pollution	Low
	Vallinokkam	closed	SP, AF	<i>Eunice</i> sp. <i>Heteromastus similis</i> , <i>Nephtys polybranchia</i> , <i>Nereis</i> sp. <i>Pulliella armata</i> , <i>Thalehasapia tenuis</i>	<i>Eunice</i> sp.- Magnesium	<i>Eunice</i> sp. – Salt pans	Low
	Vembar river	closed	SP, DS, AF	<i>Eunice</i> sp. <i>Lumbriconereis simplex</i> , <i>Nephtys polybranchia</i>	<i>Nephtys</i> sp – Chloride	<i>Nephtys</i> sp.– Salt pans	Low
Tuticorin	Vaipar river	closed	SP, AF	<i>Lumbriconereis polydesma</i> , <i>Lumbriconereis simplex</i> , <i>Nephtys polybranchia</i> , <i>Eunice</i> sp.	<i>Lumbriconereis</i> sp. – Potassium, Magnesium	<i>Lumbriconereis</i> sp. – Aquaculture farm	Low
	Pazhayakayal estuary	open	PP, DS, SP, IS, AR	<i>Lumbriconereis simplex</i> , <i>Eunice</i> sp., <i>Nephtys polybranchia</i> , <i>Sternaspis scutata</i> , <i>Nereis</i> sp.	<i>Sternaspis scutata</i> – Zinc, Nickel and Cadmium	<i>Nereis</i> sp., <i>Sternaspis scutata</i> – Industrial area	Medium
	Punnakayal estuary	open	PP, DS, AR, IS	<i>Heteromastus similis</i> , <i>Nephtys</i> sp. <i>Nereis</i> sp. <i>Prionospio polybranchia</i>	<i>Nereis</i> sp., - Chromium, Copper	<i>Nereis</i> sp., <i>Prionospio</i> sp., - Agriculture run-off	Medium
	Veerapandipattinam estuary	closed	DS, AR	<i>Lumbriconereis latreilli</i> , <i>Prionospio polybranchia</i> , <i>Nereis</i> sp. <i>Sternaspis scutata</i> , <i>Thalehasapia tenuis</i> , <i>Pulliella armata</i>	<i>Lumbriconereis</i> sp. <i>Nephtys</i> sp. – Organic materials	<i>Lumbriconereis</i> sp. <i>Nephtys</i> sp.– sewage pollution	Medium
Kanyakumari	Nambiyar river	closed	DS, AR	<i>Heteromastus similis</i> , <i>Lumbriconereis simplex</i> , <i>Nephtys polybranchia</i>	<i>Lumbriconereis</i> sp.– Organic materials	<i>Lumbriconereis</i> sp. <i>Nephtys</i> sp.– sewage pollution	Low

Note:

PP - Power Plant; AF - Aquaculture Farm; AR - Agriculture run-off; IS - Industrial Sewage; DS - Domestic Sewage

Source: Abdul Azis and Nair (1982); Remani et al. (1983); Raman and Ganapathi (1983); Sunilkumar and Antony (1994); Ajmal Khan et al., (2004) and Ajmal Khan and Murugesan (2005)

The kinds of pollutant sources from catchment areas have been identified by this studies and type of heavy metal content of benthic polychaetes were categorized (Table 8). Based on the above mentioned categorization technique using indicator species of polychaete and presence of associated crustacean and molluscan species, all the sampling sites in this study have been classified into four groups viz. High, medium, low and very low in pollution (Table 9). This table has been finalized after thorough comparison with the collected data table (see Table 3) through visual observation at the sites.

Table 9. Sampling sites categorized under different pollution status based on benthic polychaetes recorded

High (0)	Medium (3)	Low (5)	Very low (0)
	Pazhayakayal	Kanjirangudi	
	Punnakayal	Nambiyar	
	Veerapandiyanpatnam	Vaipar	
		Valinokkam	
		Vembar	

Since not enough literatures are available regarding the pollution source and status of these sampling sites except few, our discussion is only based on the presence and density of indicator species. According to this classification, species recorded in Valinokkam indicates no pollution threats observed. In Pazhayakayal, areas having high density of crustacean populations are an indication of presence of tolerant species to some pollutants such as agricultural fertilizers and to some organic effluents. Whereas in Vaipar, and Vembar having comparatively very low individuals of crustaceans species. Pazhayakayal areas represents having high densities of molluscan species is also an indication that these species do occur in polluted areas.

In comparing the polychaete and crustacean species recorded in high polluted areas with that of present study reveals that some other species may also tolerates in the high polluted areas. The presence of polychaete species such as *Diopatra neapolitana*, *Eunice sp*, *Glycinde oligodon*, *Heteromastus similis*, *Lepidonotus tenuisetosus*, *Prionospio pinnata*, *Pulliella armata*, *Thalehasapia tenuis*, *Tharyx sp*. and crustacean species *Ampithoe ramondi*, *Calanus sp*, *Clibanarius sp*, *Eriopisa sp*, *Grandidierella sp*, *Quadrivisio bengalensis*, *Tanaeus sp*, molluscan species such as *Cerithedia cingulata*, *Katelysia opima*, *Meretrix meretrix*, *Modiolus metcalfi* and *Umbonium vestiarium* may also be taken into consideration to categorize the sites based on pollution. Even though, *Cerithidea sp*. and *Meretrix sp*. are found abundant in mangrove regions, it was reported to be tolerant for various pollutants. Absence or low diversity in certain areas is not an indication of non polluted areas. Rather, the animal would not be able to withstand the higher pollution limits. Hence such areas should be considered as polluted areas as well.

Management actions for pollution control and abatement

1. A policy level decision to ban untreated industrial pollutants and sewage release into the Gulf of Mannar Biosphere Reserve is proposed to be taken up with the State Pollution Control Board.

2. All industries including Ports in the Gulf of Mannar region should be addressed and facilitated to prepare, submit and implement an Environmental Management Plan (EMP). Identify highly causative polluting industries in the region and necessary actions required for developing Environmental Management Plan for review and implementation. This needs to be taken up with the State Pollution Control Board.
3. It is proposed to prepare an ecological hotspots and fragile heritage maps along the coast of Gulf of Mannar Biosphere Reserve using the information provided in the Management Plan and to suggest a) no industry zone and b) permitted kind of industry zone.
4. Liaise with Tamil Nadu Pollution control Board and hasten the development of regulations for discharge of industrial effluents into the coastal waters with respect to
 - a. Regulation of volume of effluent discharge (treated) – where effluents can be treated.
 - b. Regulation of volume of effluent discharge (untreated)
 - c. Control the number of the industries
 - d. Control the volume of effluents per industry
5. It is proposed to initiate plantation around polluted saltpans for desalination: *Salicornia sp./Avicenia sp.* may be considered for this purpose.
6. The acid wash from shell craft industries, solid and waste water from ice factories and sea food processing centers are now considered as localized pollutants in Gulf of Mannar areas, however, these pollutants may become a major one if no regulation on such kind of industries and their waste discharges.
7. Since intensive aquaculture farm would bring localized ecological changes due to high output of nutrients like nitrates, phosphates and organic matter which in turn limit long term production and closure of the farm, detailed assessment of potential adverse ecological effects and carrying capacity of aquaculture farms and of the ecosystem into which the effluents are discharged needs to be assessed.
8. Proposed RMC of the Authority should be equipped with capability to monitor pollution levels and establishment of sampling station and share information with the TNPCB and polluting industries in every six months time period.
9. Establish and empower community based estuary management committees, councils, agencies and enhance the community to identify a variety of issues and problems.

And in collaboration with various research organizations and TNPCB, develop a Pollution Abatement Plan for this region.



Fig. 2. The grab sampling at a mangrove region



Fig. 3. Kanjirankudi Estuary



Fig. 4. Vallinokkam Estuary



Fig. 5. Vaipar Estuary



Fig. 6. Veerapandipatnam Estuary



Fig. 7. Nambiyar Estuary



Fig. 8. Sieving

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
1	Management of Pollution											
	A policy level decision to ban untreated industrial pollutants and sewage release into the Gulf of Mannar Biosphere Reserve is proposed to be taken up with the State Pollution Control Board											
	All industries including Ports in the Gulf of Mannar region should be addressed and facilitated to prepare, submit and implement an Environmental Management Plan (EMP).											
	Identification of highly causative polluting industries in the region and necessary actions required for developing Environmental Management Plan for review and implementation. This needs to be taken up with the State Pollution Control Board – outsource to professional institution	10					10					20
	Preparation of an ecological hotspots and fragile heritage maps along the coast of Gulf of Mannar Biosphere Reserve using the information provided in the Management Plan and to suggest a) no industry zone and b) permitted kind of industry zone – outsource to professional institution	20					20					40
	Enhance the green cover in the buffer zone especially on polluted saltpans with suitable plants (Target 3000 ha in 10 years time period @Rs.30000/ha)	900										900

5.2. Protected marine species Trade in the Gulf of Mannar biosphere reserve region

5.2.1. Introduction

Gulf of Mannar is rich in marine biodiversity. The Marine biosphere reserve is a chain of 19 + 2 (submerged) islands starting from Danushkodi to Kanyakumari. Gulf of Mannar Marine Biosphere Reserve is the first of its kind in India and in South East Asia. This biosphere includes ecosystem likes coral reefs, chank beds, oyster beds, sea grass and seaweed beds providing an ambient environment for the marine fishes and other vertebrates and invertebrates to thrive. This ecosystem supports a wide spectrum of marine flora and fauna of taxonomic and economic importance.

The Gulf of Mannar has been rigorously exploited and the benthic habitat crushed by the mechanized bottom fishing net movement, curios collecting and by other anthropogenic factors together with contamination caused by domestic and industrial wastes. All such activity here has harshly affected both the environment and biodiversity of this region, which has made the coastal and marine ecosystem imbalanced.

Even though the Indian Wildlife (Protection) Act, 1972, gives legal protection to the endangered marine species such as coral and certain seashells, Coral and seashell collection is still going on from this region. The illegal trade of these protected species are providing large scale profits to traders and middle men and job opportunities to the rural communities, but at the same time is creating serious ecological problems too.

Objective

An assessment survey of illegal trade of protected marine flora and fauna was taken up by the National Institute of Coastal and Marine Biodiversity institute of wildlife institute of India during the year 2006 with the objective of documenting the extent and location of such trade, the involvement of the local community in the trade and the trade pattern of marine flora and fauna of this region and to examine the possible methods for its control and management. The study was initiated during March, 2006, and continued up to August, 2006.

Methodology

Major tourist centers such as beaches, pilgrimage centers, along with major fish landing centers were surveyed for illegal seashell and coral trade. Number of shops selling seashells and both protected and non protected ; Average price; morphometry of the protected shells etc was noted. Shell traders in various places were also interviewed to collect information of the origin of the products.

Uses of Seashells and corals

- Marine mollusks and corals are traded as curios and artifacts
- Operculum of shells are used for making incense sticks
- ‘Mother of pearl’ is used as jewellery
- It is also traded to furnish marine aquarium
- Base of some Ointments are extracted from some shells

By-Catch

Historically Danushkodi, Rameswaram, Keelakarai and Tuticorin were the major chank collection areas of the Gulf of Mannar region. By the advent of mechanized trawlers in early sixties to the Indian coast has changed the face of both chank and fin fishery in Gulf of Mannar. The Mechanized bottom trawling became widespread all along the trawlable coastal grounds of Indian waters and was established as one of the most dominant fishing technique. Majority of the seashells which constitute the benthic community was affected by the bottom trawling.

Chank diving as an occupation and a main source of income for chank divers was thus transformed to an alternate income activity, As for the trawl owners due to the by catch of these shells along with other fishery recourse such as shrimps and lobsters this created additional income. This created an over exploitation of the Shell fish resources. Chank diving is going on in the Fishing villages of Pudumadam, Keelakarai etc. of Gulf of Mannar region. Majority of the Chank divers are in Tuticorin.

Total of 62 marine fish landing centers are present from Danushkodi to Kanyakumari (eastern part). All of these landing centers are dominated by the mechanized fishing vessels. Out of these only 14 landing centers operate Bottom trawling and the extent of seashell landing as by catch and trash fish is more. Only during the fishing off season these trawlers are off work which is only 45 days a year. The Need for the targeted resources have tiled a way for indiscriminative bottom trawling along the Gulf of Mannar coast with an eventual consequence of enormous depletion of low value high volume benthic biota.

Seashell and coral trade centers

Seashells and corals from the Gulf of Mannar region are collected from nearby offshore areas of Rameswaram, Tuticorin and Kanyakumari. The collection centers are given in (table. 1 & Fig. 1.) district wise.

Table 1. Major seashells and coral collection centers district wise

Ramanathapuram district	Tuticorin district	Tirunellveli district
Danushkodi	Vembar	*Tiruchendur
*Rameswaram	Vaipar	
Pamban	Tuticorin	
Mandapam	Veerapandipattinam	
Vedhalai	Kulashekarapattinam	
Keelakarai	Kayalpattinam	

* Major shell markets after Kanyakumari

Among these shell and coral collection centers Rameswaram and Tuticorin dominate. The 21 islands of Gulf of Mannar harbors a plethora of marine life forms and most are harvested. Shells and coral collection is carried out in good numbers around

Keelakarai region also. Tuticorin region is famous for live coral collection for marine aquarium trade.

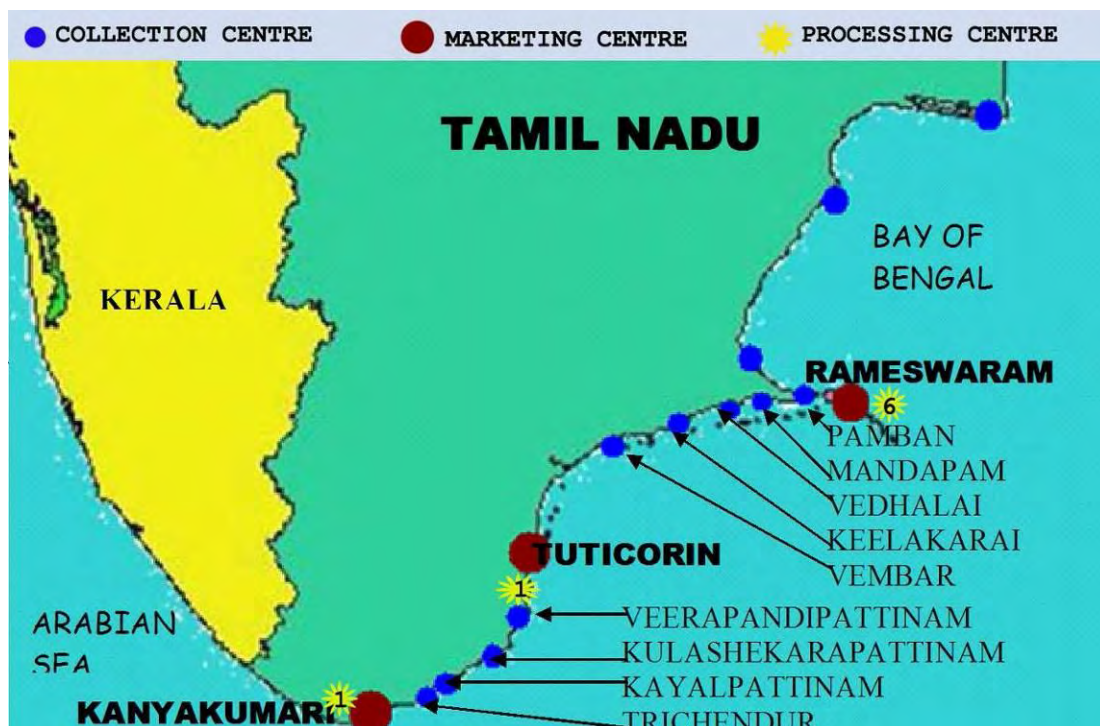


Fig. 1. Major seashells and coral collection and marketing centers in Gulf of Mannar

Trade pattern

The seashells are collected for local, national and international level markets. Locally sea shells are collected from chank divers. Shells are also collected from traditional and mechanized fisher folks. Near shore shells are collected by skin divers and traditional fisher folks. Deep sea species are collected from the trawlers.

The raw shells thus collected are then chemically processed, flesh and operculum are removed polished and transported to markets nationally and internationally. The raw shell processing shells are situated in Kanyakumari and Rameshwaram

Along with the shells which are having aesthetic value, operculum and flesh is as also used locally. **(Fig. 2)**

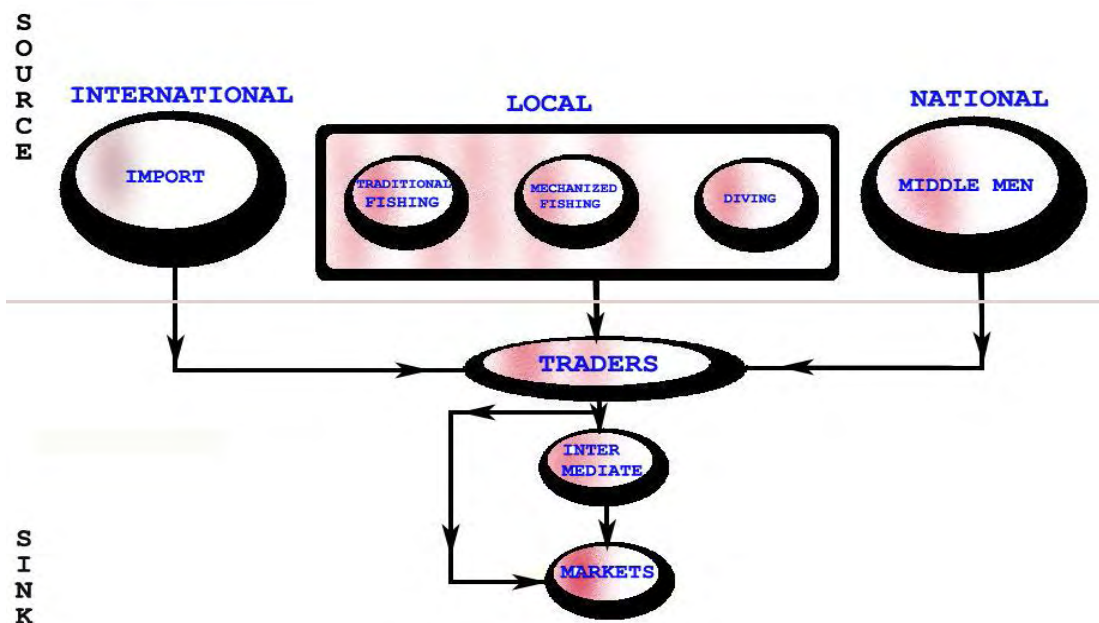


Fig. 2. Flow chart showing the trade pattern

Seashells and corals thus collected from the Gulf of Mannar along with Andaman's, Lakshwadweep and from Tanzania are sent to all most all parts of India. The trade route is given in Fig. 3. It is however unknown how and where the import of raw shells are reaching from Tanzania, Philippines and from Bay islands

The starting point of all shell and coral trade is from Rameswaram. From here only seashells and corals are sent to all part of India. Major markets out side the Gulf of Mannar region are given in Table. 2

Table 2. Shell trade centers out side Tamilnadu

Kerala	Karnataka	Goa	Gujarat	Andhra Pradesh	Orissa	West Bengal	Assam	Uttaranchal
Kovalam Fort-cochin	Gokarnam	Calangute Anjuna Vagator Colva	Dwaraka Somnath Diu	Vishakpattinam	Chandipur Puri gopalpur	Kolkata	Guwahati	Haridwar Hrishikesh

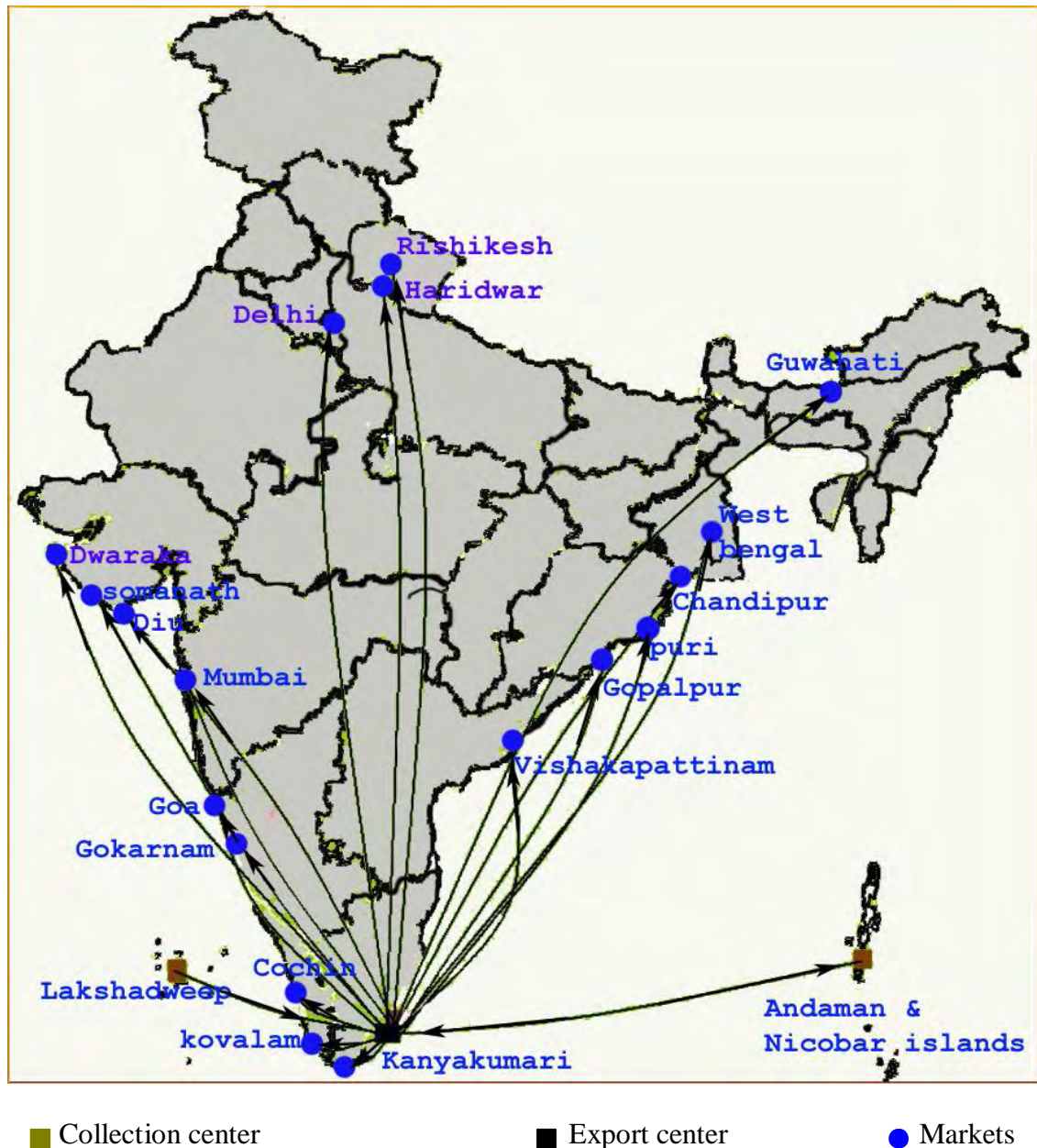


Fig. 3. Seashell and coral trade route in the country

Rameswaram

Thirty-four fish landing centers starting from Rameswaram to Vembar hauls a major share of the fishery resource of Gulf of Mannar.

Shell trade is dominating in this area. As a pilgrimage center, Rameswaram attracts both shell traders and tourists. Veteran divers collect shells; they free dive into the depths up to 10 meters and collect shells. Sacred chank (*Xancus pyrum*) is collected both by free diving as well as by trawlers. Sacred chank is having devotional significance also. Shop owners either collect these shells from these divers, or get through intermediaries. Other shells and corals are sold as novelties and curios. There

are nearly 42 shell traders present in and around Rameswaram. But only few shops sell protected seashells.

Major species that dominate in trade are *Cassia cornuta*, *Cypreasis rufa*, *Lambis sps*, etc. Coral species are dominated by *Acropora sps*: (**Table 3.**) The rate of these shells and corals depend up on the size and availability of the organism in the surrounding areas.

Rameswaram even though is a major pilgrimage area, is not a major seashell market. Seashells and corals with the shell traders are coming from Gulf of Mannar, Marine National Park, Andaman and Nicobar Islands, Lakshwadweep and seashells are imported from Tanzania also. There are around 6 seashells exporters in Rameswaram. Nearly 50 People are working under each exporter. This includes cleaning, polishing, and other associated works etc. Around 60,000 (sixty thousand) to 80,000 (Eighty thousand) fisher folks are engaged in the various process of fishing and shell collection out of 1,17,000 total fishermen population (Tamil Nadu Marine fisher folk census, fisheries dept: 2000) Target as well as incidental catch is also seen in this region. The Shell collection in this area is seasonal. From Rameswaram the shells are sent to almost all parts of India.

Table 3. Endangered species (shells & corals) from Rameswaram

Sl no	Name of the place	Number of shops	Number of protected Mollusk species traded	Quantity of protected mollusks in Numbers	Number of coral species traded	Quantity of protected corals in Numbers
1	Rameswaram	45	6	60-70	2	30-50

S. No.	Name of species	Local name	Average height	Average length	Maximum length (wild) in Cm	Value in Rs/-	Status in market
Corals							
1	<i>Acropora branching</i>	Stag horn coral	--	--		30-100	Average
2	<i>Acropora digitate</i>	Digitate coral	--	--		30-100	Average
Molluscan							
1	<i>Cassia cornuta</i>	Mattuthalai	10-15	17-22	35	150-200	Average
2	<i>Cypreasis rufa</i>	Pine apple shell	6-8	10-12	18	100-300	Average
3	<i>Lambis chiragra</i>	Spider conch	5-8	18-22	25	75-250	Average
4	<i>Lambis crocata</i>	Spider conch	3-5	10-15	15	30-70	Average
5	<i>Fasciolaria trapezium</i>	Horse conch	6-8	10-15	30	10-50	Common
6	<i>Trochus niloticus</i>	Top shell	5-8	--	15	75-200	Average

Only few protected species reaching market is attaining its maximum size, most others are under sized. (**Fig. 4**)

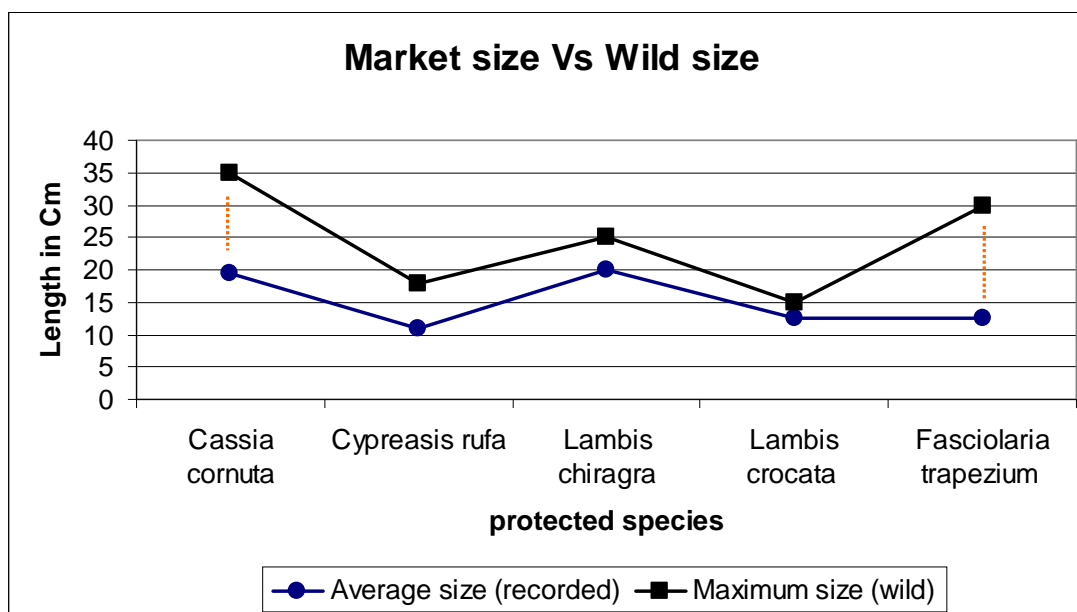


Fig. 4. Comparison of Average market size with maximum wild size- Rameswaram

Thoothukudi

Thoothukudi is major seashell and coral collection and processing center. No domestic market persists in this area. Nearly 40,000 (forty thousand) fisher folks are engaged in the business of fishing and shell collection out of a total population of 69,000 (sixty thousand) (Tamil Nadu Marine fisher folk census, fisheries dept: 2000). Majority of the sacred chank (*Xancus pyrum*) divers are from this part, they go to Danushkodi and Rameswaram for chank diving. Seashells collected from the islands are then processed and sent either to Rameswaram, Trichendur or to Kanyakumari. Here also seashells are imported from Tanzania, Philippines and Maldives. Echinoderm collection is also going on here.

Windowpane oysters (*Placenta placenta*) are fished here for pearls and for making decorative articles. This bivalve is enlisted in Schedule IV of the IWPA.

Protoreaster lincki commonly known as red general star or red spined star that is relatively larger in size of up to 30cm. is collected at Tuticorin and processed in huge quantities for ornamental purpose and also for curios along Kalavasal area. It is collected by skin diving and sells at a cost of Rs 1-1.50/-. Vendors of Kanyakumari, Rameswaram, Keelakarai and Chennai collect the dried starfish. During peak season an average of 200-300 pieces are collected. (MFIS # 187, 2006)

Tiruchendur

Tiruchendur is a famous near shore pilgrimage center between Tuticorin and Kanyakumari. Nearly five to six seashell trade shops are operating in this area. The seashells which are in trade here are not protected by the Wild life Protection Act, but even this trade can promote illegal seashell trade of protected mollusks and corals

Kanyakumari

In the southern most tip of mainland; Kanyakumari is bug-ridden with the illegal shell traders. This is the largest seashell and coral market in the whole country. As a pilgrimage centre, tourists used to come regularly and that nourishes shell trade here. Majority of the protected seashell and corals are available in Kanyakumari. The traders are well aware that, these shells are protected but still they are pursuing the illegal trade. Coral trade is also going here. People buy corals as Novelties as well as to decorate the Aquariums. Corals price range from Rs, 20 to 1500/-.

There are nearly 65 vendors in Kanyakumari; out of that, two vendors are exclusively selling corals. Here sea shell such *Cassia cornuta*, *Cypreasis rufa*, *Lambis* dominates (**Table 4.**). Here also shells are collected from Gulf of Mannar marine national park, Andaman and Nicobar Island, Lakshwadweep etc. No collection persists in Kanyakumari. Livelihood of plenty of people is dependent on the processing and other associated activities of seashells. Only one exporter was identified here having a large processing centre.

Table 4. Endangered species (shells & corals) from Kanyakumari

Si no	Name of the place	Number of shops	Number of protected mollusk species traded	Quantity of protected mollusks in Numbers	Number of corals species traded	Quantity of protected corals in Numbers
1	Kanyakumari	75-100	10	>500	>5	>300

S. No.	Name of species	Local name	Average height	Average length	Maximum length (wild) in Cm	Value in Rs/-	Status in market
Corals							
1	<i>Acropora branching</i>	Stag horn coral	--	--		30-150	Common
2	<i>Acropora digitate</i>	Digitate coral	--	--		30-150	Common
3	<i>Boulder</i>	-	--	--		50-1500	Rare
Mollusks							
1	<i>Cassia cornuta</i>	Mattuthalai	10-15	17-22	35	150-200	Common
2	<i>Cypreasis rufa</i>	Pine apple shell	6-8	10-12	18	100-300	Common
3	<i>Tridacna maxima</i>	Giant clam	--	--	35	300-500	Rare
4	<i>Nautilus pompilus</i>	Chambered nautilus	--	--	20	250-300	Average
5	<i>Lambis chiragra</i>	Spider conch	5-8	18-22	25	75-300	Common
6	<i>Lambis crocata</i>	Spider conch	3-5	10-15	15	30-70	Average
7	<i>Lambis truncatus</i>	Spider conch	6-8	20-25	37	200-300	Average
8	<i>Fasciolaria trapezium</i>	Horse conch	6-8	10-15	30	10-50	Common
9	<i>Trochus niloticus</i>	Top shell	5-8	--	15	75-200	Average
10	<i>Tudicula spiralis</i>		2-3	6-8	9	30-50	Rare

The wild size of protected seashells is much more when compared to the stage which they are sold in the seashell markets. Only few species, that too only few in number are reaching their maximum wild size. Market demand force the traders to unload the under sized shells to the market. Most of the time under sized seashells has more demand and are expensive too. (**Fig. 5**)

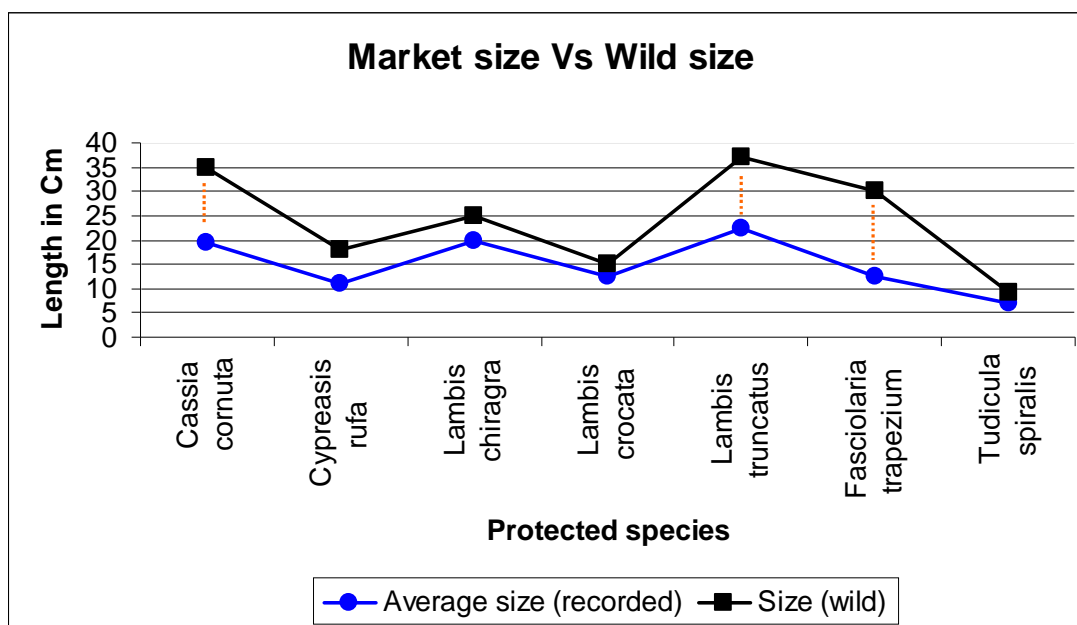


Fig. 5. Comparison of Average market size with maximum wild size- Kanyakumari

Promotion of alternative source of livelihood

NGOs are promoting these seashell artifact industries as an alternative source of livelihood for the poor fishermen communities in places like Kanyakumari and Rameswaram. This is done as a novel idea so as to reduce the anthropogenic impact on the sea during fishing and to create a substitute source of income by the family members other than the head who is engaged in the fishing activities. Special training programmes are given to the selected peoples from the rural and fishermen communities and the art of making artifacts; cleaning and processing of raw seashells are taught to them. As majority of the local community and NGO leaders are totally unaware of the Marine Protected species enlisted in IWPA, this type activities can create adverse outcomes. Currently, seashells are purchased from the traders by NGOs, and classes are given to make artifacts out of that. This is not involving any protected species in it, but this kind of activities can promote the protected species trade in future. Involving the NGOs to educate trawler owners and artifact making people about the present status of protected species may result in some degree of control on the illegal trade.

Marine Ornamental fish trade

The “marine aquarium fishes” referred to as “marine ornamental fishes” also in recent years are known to be abundant in tropical seas particularly in the regions where the sea is rich in corals, sea grass, seaweeds and also in the regions which have rocky bottom.

The marine ornamental fish trade also nurtures the illegal trade of protected species. Marine ornamental fishes are not protected. However, the trades of marine ornamental

fishes are having its own side effects on the endangered species. This ornamental fishes are found in coral reef environment, collection of these ornamental fishes can damage the reef due to malpractices like using drift nets, stepping on coral etc. Over exploitation and indiscriminative exploitation can disturb the balance in the association of different organism leading to a great loss of biodiversity and environmental degradation.

To set up a marine aquarium, filters are required. The present day UG filters use fine powdered coral rubles as the base of filtration. In marine aquarium; sponges, corals and seashells are also used for decorative purposes.

In Gulf of Mannar Biosphere reserve marine ornamental fish collection is taking place mainly in Keelakarai and in Mandapam. Fishes are mainly collected by skin diving using small scoop nets. Along with marine ornamental fishes Sea anemones are also collected. Mainly collected species are *Amphiprion Sps* (Clown fishes), *Pterois sps* (Lion fishes), *Cheatodon sps* (butterfly fishes) etc. All these collected marine ornamental fishes are then transported to the traders in Keelakarai, from were they are exported.

Live corals which are used in marine aquariums are collected from Tuticorin region of Gulf of Mannar.

Holothurian trade

Holothurians (sea cucumbers) even though protected under schedule I of Indian wildlife (protection) Act, 1972 trade is continuing in Gulf of Mannar regions. Species of *Holothuria scabra* (Vellai attai) and *H. atra* are mainly collected by skin-diving from a depth of 1-5 m along with ornamental fish and seashells. Sea cucumbers which enters in the trawl nets are also used .Major area of collection includes Mandapam, Keelakarai, Vembar and Tuticorin.

The export route is not clearly known, but the collected sea cucumbers are home dried and are handed to a middle man in the village, through him only all trade is taking place

The dried sea cucumbers known as *beche-de-mer* are a delicacy in south East Asian countries.

Fishermen engaged in this activity are well aware that these species are protected and illegal trade can attract heavy fine and punishments, they still continue this because of huge profits from this business. From fishermen point of view sea cumber numbers are not dwindling, but increasing.

Indian EXIM policy

Indian EXIM (Export and import) policy clearly mentions that any animal or animal derivatives that has been listed in Indian wild life (protection) Act, 1972 cannot be exported or imported from and to India. In spite of this India is a major seashell importer from Tanzania. 75% of seashells from Tanzania is exported to India. (Kathryn Tanner, 2006). Among this what percentage of protected sea shells are included is not clearly known. Besides Tanzania seashells are imported from Philippines and Maldives also.

Conclusion

Major domestic seashell and coral market is operating from Kanyakumari. All corals and seashells are reaching here from Gulf of Mannar, Andaman's, and Lakshadweep. Rameswaram was found to be the center of all domestic seashell trade in India. To meet the demand shells are even imported from Tanzania, Philippines and Maldives. According to Kathryn Tanner, 2006: India ranks first among the seashell import from Tanzania and accounts 75% of the total production. This raw shells imported are then processed either in Kanyakumari, Rameswaram or Thoothukudi and exported to other countries.

Local tourists dominate among the buyers than the foreign tourists in all parts. This might be due to the fear of getting caught during customs checking in airport for handling biological specimens.

Demand for the products derived from the protected species also contributes for their exploitation. Some places these are not a target fishery, but these protected species come as by-catch (Incidental catch). Unawareness of the people who are engaged in this and the people who are buying these illegal goods are also another reason for this illegal trade.

By promoting the trade of marine aquarium fishes along with the shell artifacts industry, the pressure on the protected species can increase. As there is no other Livelihood option, fisher folks are forced to pursue these illegal activities.

Prescriptions

1. A detailed stock assessment of seashells which are included in the IWPA, should be done so as to know the present status
2. As incidental catches are difficult to prevent, proper mesh size for the gears should be maintained in the mechanized fishing vessels
3. awareness should be given to Chank divers and seaweed collectors to not collect any protected sea shells during diving
4. Proper knowledge should be given for the community engaged in this business
5. Hoardings and advertisements regarding the protected species should be displayed in all tourist and pilgrimage centers so as to aware customers
6. License should be made compulsory for selling of seashells.
7. NGOs should be discard to promote seashell artifact making as a lively hood options

- 8.** Legal Marine aquarium ornamental fish trade can nurture illegal trade, so well before promoting marine aquarium fish trade, these aspects has to be monitored.
- 9.** Enforcement should be tightened
- 10.** Creating market to traditional handicrafts and promoting natural products market all over the globe instead of seashell artifact promotion, can create employment opportunities in this field.
- 11.** Alternative source of lively hood such as, pearl culture, lobster and crab fattening, sea weed culture, Micro algae culture and eco tourism initiatives can bring down this illegal trade.



Collection of sea cucumber by the local fisher folks –Keelakarai



Marine Ornamental fish collected and bagged for further transport

APPENDIX-I

List of Landing Centers in the Gulf of Mannar operating Bottom trawlers

Kanyakumari District (Eastern Part)

Si No	Name of the Landing centre	Trawl netters	Gill netters / Others
1.	Arokiyapuram	.	+
2.	chinnamuttom	+	+
3.	Vavathurai	+	+
4.	Kanyakumari	+	+
5.	Kovalam	+	+

+ Presence . Absence

Thirunellvely District

Si No	Name of the Landing centre	Trawl netters	Gill netters / Others
1.	Kooduthazhai	.	+
2.	Kootapanai	.	+
3.	Uvari	.	+
4.	Koothankuli	.	+
5.	Idinthakarai	.	+
6.	Perumanal	.	+
7.	Kootapuly	.	+

+ Presence . Absence

Tuticorin District

Si No	Name of the Landing centre	Trawl netters	Gill netters / Others
1	Vembar	+	+
2	Periyasamipuram	.	+
3	Keezhvaipar	.	+
4	Sippikulam	.	+
5	Patinamaruthur	.	+
6	Tharuvaikulam	+	+
7	Vellaipati	.	+
8	Theresapuram	.	+
9	Tuticorin north (Harbor)	+	+
10	Tuticorin south	.	+
11	Ratchanyapuram	.	+
12	Pazhyakayal	.	+
13	Punnakayal	.	+
14	Kombuthurai	.	+
15	Singhithurai	.	+
16	Veerapandipattinam	+	+
17	Jeevanagar	.	+
18	Amalinagar	.	+
19	Alanthalai	.	+
20	Kulashekarapatnam	.	+
21	Manapadu	.	+
22	Periyathazhai	.	+

+ Presence . Absence

Ramanathapuram District

Si No	Name of the Landing centre	Trawl netters	Gill netters / Others
1	Danushkodi	.	+
2	Muhindrayayar sathiram	.	+
3	Naduthurai	+	+
4	Kundukal point	.	+
5	Sinna palam	.	+
6	Thoppukadu	.	+
7	Pamban	+	+
8	Thekkukadal karai sathram	+	+
9	Vedhalai	.	+
10	Seeniyappa dharga	.	+
11	Pudumadom	.	+
12	Thalaihoppu	.	+
13	Muthupettai	.	+
14	Thoppu valasai	.	+
15	Periyapattinam	.	+
16	Kalimankundu	.	+
17	Pallivasal padu	.	+
18	Sethukarai	.	+
19	Pakkiriyappa padu	.	+
20	Keelakarai	+	+
21	Bharathi nagar	.	+
22	Chinna erwardi	+	+
23	Sadi muniyan valasai	+	+
24	Valinokkam	.	+
25	Mundhal	.	+
26	Mookayoor	.	+
27	Naripayoor	.	+
28	Rosema nagar	.	+

+ Presence . Absence

Kanyakumari (Eastern part)	Tuticorin	Ramanathapuram
1. chinnamuttom	1. Vembar	1. Naduthurai
2. Vavathurai	2. Tharuvaikulam	2. Pamban
3. Kanyakumari	3. Tuticorin harbor	3. Thekkukadalkarai sathram
4. Kovalam	4. veerapandipattinam	4. Keelakarai
		5. Chinnaerwadi
		6. Sadai muniyan Valasai

A Total of 62 marine fish landing centres of which 14 landing centre operates trawl nets

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
3	Prevention of trade on protected species											
	A detailed stock assessment of seashells which are included in the WPA, should be carried out so as to know the present status (outsource to professional institutions)				10					10		20
	Awareness programme targeting Chank divers and seaweed collectors (outsource to NGOs)	10	10	10	10	10	10	10	10	10	10	100
	Creating market to traditional handicrafts and promoting natural products market all over the BR instead of seashell artifact promotion (30 villages/year through revolving fund credit)					15	15	15	15	20	20	100
	Alternative source of livelihood such as, pearl culture, lobster and crab fattening, sea weed culture, Micro algae culture (with help of State Fisheries Department) and eco tourism (with help of State Tourism Department) initiatives to bring down the illegal trade	50	50	50	60	60	60	70	70	70	80	620

5.3. Restoration Measures

5.3.1. Restoration and management of sea grass ecosystem of the Gulf of Mannar Marine National Park and Biosphere Reserve

Dugong conservation is nothing but seagrass habitat conservation and management in the Gulf of Mannar Biosphere Reserve. Since the major portion of the sea grass beds are located in the buffer zone where multiple use is also permitted, the fragile sea grass habitats has already been damaged heavily due to indiscriminate fishing activities. It is proposed to initiate action to restore those degraded sea grass habitats in the Biosphere Reserve and simultaneously it is also proposed to take up conservation awareness programme among fishermen communities addressing the value of sea grass habitats with respect to fin and shell fish breeding as well as dugong.

Management Prescriptions:

1. A detailed mapping of sea grass beds with the information on the status of each species in the Biosphere Reserve is needs to be prepared using latest satellite imageries.
2. Prevent the further decline of sea grass beds by eliminating the causes of decline such as pollution, indiscriminate fishing etc.
3. Extending the present sea grass distributional limit to the historical distributional limit.
4. Prohibition of trawling fishing on the sea grass beds.
5. Awareness programme in the catchment area regarding the excessive use of pesticide and other chemicals and its impact.
6. Restoration experiments with the help of CSMCRI and Restoration technology adopted on a coastal lagoon in the North of Yucatan (Southeastern Mexico) may be consulted here. The agency which would be used for the restoration of this habitat is also requested to consult with 'Chapter 7. Seagrass: in Handbook of Ecological Restoration, Volume 2, edited by Martin R. Perrow and Anthony J. Davy, Cambridge University Press, 2002'.

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
	Restoration of habitats											
4	Sea grasses habitat											
	Mapping of sea grass beds with the information on status of each species in the Biosphere Reserve is needs to be prepared using latest satellite imageries	This has already been initiated by the GOMBRT which needs to be followed up										
	Restoration and monitoring of sea grass habitats in the BR	Based on the findings of ongoing research on this subject supported by the GPMBRT				20	20	5	5	5	5	60

5.3.2. Conservation, restoration and management of mangrove habitats in the on-shore region of the Gulf of Mannar Biosphere Reserve

On-shore mangroves of Gulf of Mannar Biosphere Reserve – on literature:

Reports on the mangroves and its associated vegetation of Gulf of Mannar Islands and on-shore are very limited. Rao et al (1963) noticed only small patches of mangroves in Pamban. Perhaps this is the oldest document on mangroves of this area. Blasco (1975) reported that existence of large patches of mangrove along Tamilnadu coast about 100 years ago which also includes the on-shore area of this Biosphere Reserve. Similarly, Jayaseeli and Murugan (2002) pointed out the presence of large patches of mangroves in Punnakayal some decades back. No other literature is available regarding mangrove existing along this Reserve but few records of mangroves adjacent to some polluted sites along the Gulf of Mannar coastline does exist (Manikandavelu and Ramadhas, 1991; Senthil kumar and Patterson Edward, 2002).

A study was conducted by the Wildlife Institute of India, National Institute Coastal and Marine Biodiversity Centre at Kanyakumari to inventorise the on-shore mangrove vegetation and habitat in the Gulf of Mannar Biosphere Reserve. This study also aimed to provide a detailed description about the present status of the mangrove habitat with supplementary information about potential areas for development, conservation and management.

Methodology:

A detailed survey was conducted all along the coastline of Ramanathapuram, Tuticorin, Tirunelveli and Kanyakumari of Gulf of Mannar Region for a period of two months (March 2006 to April 2006). The coastal areas were identified using locally available district maps. All type of on-shore wetlands such as river mouths, estuaries, salinas and backwaters have been marked out referring the available sources and accessed. Each sites were explored by walked along the shoreline and far interior up to the maximum reaches to locate existing or relics of mangrove vegetation. Since all the sites were mentioned (in literature) as having monospecific stand of *Avicennia marina* no line transect or any other method was followed but explored to a distance from 100-200m to document the nature of distribution and the health of the existing mangrove patches. An assessment of the anthropogenic pressures, impact and the prospect of mangrove restoration in these areas were also assessed.

Result:

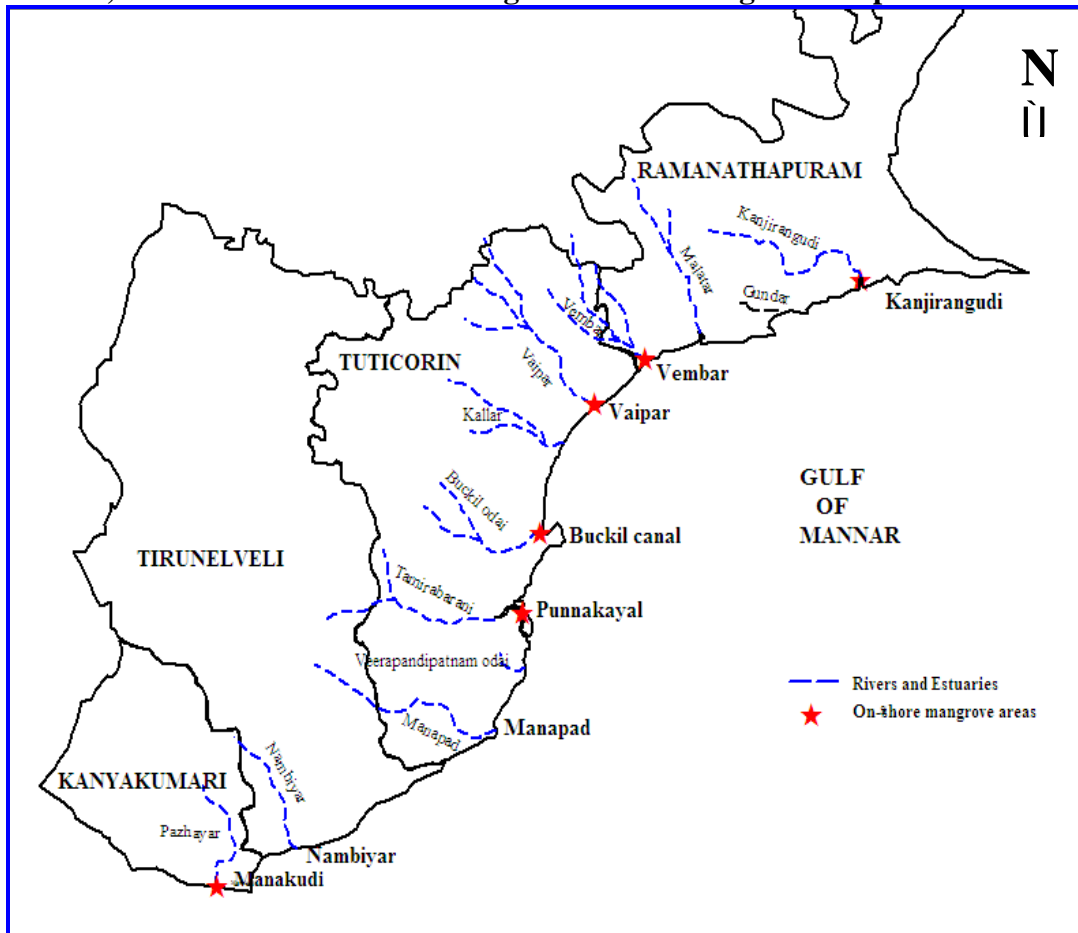
Riverine-estuarine areas of Biosphere Reserve:

About 13 typical riverine-estuarine and canal have been recorded along coastline of the Biosphere Reserve. Among them only Kanjirangudi of Ramnathapuram; Vaipar, Buckil odai, Punakayal-Pazhayakayal complex of Tuticorin and Manakudi of Kanyakumari district had water flow whereas the remaining were found dried (during the study period). The Guddar, Mallatar, Vembar, Vaipar, Manapad and Nambiyar were found to be rain-fed, but it was reported there had been water flow before two decades. At present, in Nambiyar and in Manapad there is very little flow of water due to rainfall in monsoon.

On-shore rivers, estuaries and canals of Gulf of Mannar Biosphere Reserve

1. Kanjirangudi
2. Gundar
3. Mallatar
4. Vembar
5. Vaippar
6. Kallar
7. Buckil odai
8. Pazhayakayal
9. Punnakayal
10. Veerapandipattinam
11. Manapad
12. Nambiyar
13. Manakudi

Rivers, estuaries and on-shore Mangroves areas along the Biosphere Reserve:



Map not to scale

Almost all the rivers of four districts of Gulf of Mannar Biosphere Reserve opens into the Bay of Bengal except Manakudi (opens into Arabian Sea). Only Punnakayal estuarine complex and Manakudi has the perennial water source and the remaining were drained annually during monsoon. Most of the river mouths will be remain closed during dry seasons, especially May to August. Due to lack of continuous flow of freshwater, the entire river mouth and its adjacent mudflats of open sites are dominated by the tidal flush and hence heavily influenced by high saline conditions.

On-shore Mangroves of Biosphere Reserve:

Among four coastal districts of Gulf of Mannar Biosphere Reserve, as aforementioned, Ramanathapuram, Tuticorin and Kanyakumari districts have mangrove distribution. Along these districts patches of mangroves were observed in Kanjirangudi, Vaipar, Buckil odai, Punnakayal-Pazhayakayal complex and in Manakudi estuaries. In all these sites, *Avicennia marina* is the dominant species. Also patch of *Pemphis acidula* in Punnakayal-Pazhayakayal complex of Tuticorin, *Rhizophora mucronata* and *Acrostichum aureum* were recorded in Manakudi of Kanyakumari district. The distribution of mangroves present on-shore of these districts were described in details below

Pamban – Kundukal point: a small patch of mangroves was recorded at the western part of the Rameswaram, near Pamban in Ramanathapuram district. The existing mangrove is on an open back swamp with mudflat at the seafront. The mudflat is frequently inundated with very low energy tidal waves. *Avicennia marina* is naturally distributed along this mudflat.

Kanjirangudi estuary: This is an open mouth estuary located near Sethukarai in Ramanathapuram district. Freshwater flows only during monsoon but because of open mouth the entire area was influenced by tidal inundation. The estuarine waters have largely been utilized for aquaculture practice nearby. *Avicennia marina* is the only mangrove species found along the muddy shoreline of the estuary and its distribution extends upto a 1.5 km distance from the coast.

Vaipar: The location is at far north of Tuticorin district. The historical background of this area reveals that once the river receives continuous freshwater flow. Presently, water can be seen in only in the split areas of about a kilometer distance from sea. The existing mouth is very wide with two split ends but is being closed by a thin streak of sand bar. It was observed that during spring tides tidal water seeps into the river. *Avicennia marina* is the only mangrove vegetation found with stunted growth. One of the split riverine channels has been converted into the saltpan and the high saline brine was discharged out aside the river. This has changed the substratum hard and unfit for the growth of vegetation. Present status of mangrove at this site is critically endangered due to lack of tidal inundation.

Buckil odai: This is the backwater area in Tuticorin coast with several patches of *Avicennia marina* fringing along the shoreline. However the vegetation is denser, the trees were with stunted growth. Various reasons may be attributed for this stunted growth. The watercourse receives brine discharge from saltpans and sewage from the nearby settlements. Similarly, mixing of industrial effluents and dumping of ETPP wastes have also been observed. All these detrimental pollutants might have a cumulative influence on the growth; however the exact cause should be determined before it is too late.

Punnakayal-Pazhayakayal estuarine complex: It is an important estuarine area located at 15km south of Tuticorin coast. Several forked-split branches of river Tamirabarani opens into the Gulf of Mannar leaving many small isles of slightly elevated mudflats. The estuarine complex presently has two open mouths and a thin strip of sand bars interfering temporarily. Comparatively very thick mangroves have been recorded here fringing the shoreline of the mudflats. Trees to a height of 4-5m have also been recorded only in the northern portions. Interestingly, the mangrove

Pemphis acidula is found distributed at the southern parts of Punnakayal. No records are available so far regarding the occurrence of this species in the mainland. Similarly this is the only area in the mainland having seagrass beds inside the estuarine waters.

Manakudi: Manakudi estuary lies just 9 km west from Kanyakumari, receives freshwater from Pazhayar regularly through out the year. Along with *Avicennia marina*, this site has a thick patch of *Rhizophora mucronata* and *Acrostichum aureum* just interior. *Rhizophora mucronata* is said to be introduced during 1994-95 (Ravikumar *et al.* 2003).

Mangrove afforestation programs along the coastline:

Mangrove afforestation programs have been undertaken at four sites in three districts of this coastline. The sites, total area planted, parties involved, species used, methods followed and the current status were given in details below.

Table: 1. Mangrove afforestation efforts along the coast of Gulf of Mannar Biosphere Reserve

Mangrove afforested sites	Year	Department/NGO	Area (ha)	Species	Method	Current status
Kundakal point	2005	Tamil Nadu Forest Department	~5	<i>Avicennia marina</i> , <i>Ceriops tagal</i> , <i>Rhizophora mucronata</i>	Parallel canal banking	Only few saplings of <i>Rhizophora mucronata</i> survives
Kanjirangudi	2005	Tamil Nadu Forest Department	>1	<i>Ceriops tagal</i>	Parallel canal banking	Only few saplings survives
Punnakayal	2004-2005	Tamil Nadu Forest Department	30	<i>Avicennia marina</i>	Fish bone canal	>25% success with stunted growth
	2006	PAD	~20	<i>Avicennia marina</i>	Fish bone canal	Very recently planted
Manakudi	1994-1995	Unknown	2	<i>Rhizophora mucronata</i>	On elevated mudflat	Well flourished

The planted *Ceriops tagal* and *Avicennia marina* were almost found dead in the Kundakal point, whereas *Rhizophora mucronata* stand still with 2-3 pair of leaves, this might due to the capacity of the propagule which can support its own life for a year in any type of substratum. Other interesting observation is that at this site, stagnation of inundated water is frequent and very often the seedlings were submerged. Because of the length, the *Rhizophora* seedling escapes from desiccation. Similarly, the reason for the failure of *Ceriops tagal* establishment in Kanjirangudi can be attributed to the higher elevation of canals which were not drained even during highest high tides. Very recently in Punnakayal, the Department of Forest underwent *Avicennia marina* plantation to about 30ha at the elevated sites following Fish-bone canal method. At present only ~30% of the planted mangrove was thriving and the remaining were found dead due to the desiccation. Blockages were found at most of the corners of canal, due to over siltation and sliding of heaped mud which were dredged previously.

Silt deposition, soil erosion, root exposure of growing *Avicennia marina* sapling in dredged canal at Punnakayal

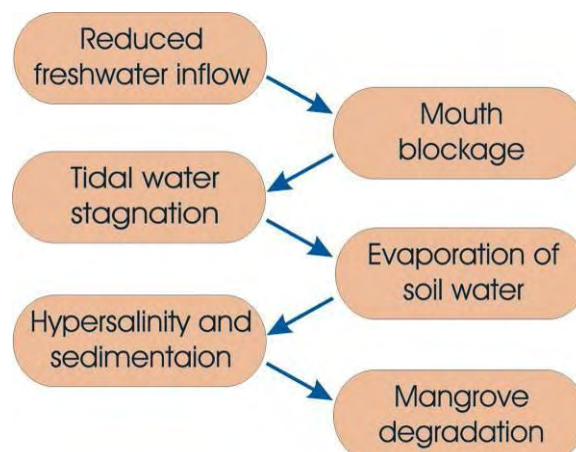


The PAD (NGO) very recently (2006) started planting *Avicennia* using same method and proposed to monitor the site for a longer period for its successful establishment.

The present status of natural mangrove habitats:

The off-shore mangroves are of monospecific *Avicennia marina* stands with stunted growth (average height of 1.5m) in all the sites. In general the on-shore mangrove ecosystem is also found degraded in some areas. Dead stumps and relics of mangroves were recorded at many study sites such as Kanjirangudi and in Vembar (already degraded). Manikandavelu and Ramadhas (1991) documented the mangroves situated near Thermal Power Station in Tuticorin area is polluted with nitrogenous nutrients. The available nitrogen, phosphate level were recorded higher amounts. Similarly, Senthil kumar and Patterson Edward (2002) found the mangrove waters of both Tuticorin and Punnakayal were polluted, also the Punnakayal waters have been highly contaminated with sewage discharge. Other than these pollution factors, formation of high-salinity in the low lying area between the exposed mangrove patch are the other reasons for further degradation. In addition, lack of tidal flushing and blockage of the mouth due to increased rate of sedimentation may be the other reasons. Solid waste dumping, discharge of Municipal sewage and industrial effluents were observed in Tuticorin mangroves whereas in Vaipar, brine water from the saltpans were released directly into the nearby mangrove area.

Mangrove degradation pathway in riverine-estuarine areas



Along this coast, there has been a reduction of fresh water flow over a period of time, which has had a telling impact on the growth and survival of mangroves. Reduction in freshwater flow also led to the reduction of sediment supply and in turn on nutrient. In due course of time, entire geomorphology and topography of this region would have been changed in such a way not to support or suitable for growth and survival of mangroves. Other than chemical properties, physical factors such as topographical alteration, elevation of mudflats due to blockage near mouth, silt deposition due to runoff immediately after the monsoon are detrimental to the mangrove ecosystem. As a consequence of temporary blockage of mouth, the mangroves in Punnakayal thrived for certain period and in due course of time would have degraded gradually. Similar case would have had happened both in Vembar and in Vaipar, where relics of mangroves were observed at far reaches.

On-shore mangrove restoration and management:

Establishment of mangroves at the on-shore regions of Gulf of Mannar Biosphere Reserve can be presumed with an approach of protection and substantial production. Even though mangroves do exist, our observation reveals there is a need for development of mangrove ecosystem. Whatever may be, the prime intention is to increase the mangrove cover all together in the jurisdiction of Biosphere Reserve.

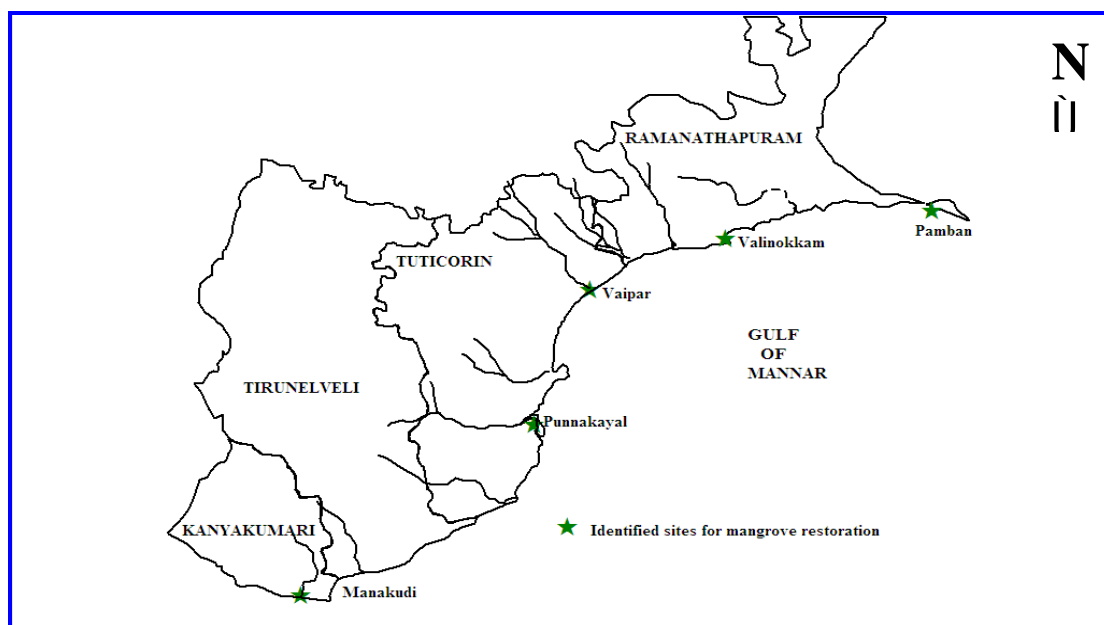
Based on some of the important factors which were prescribed in the standard criteria (FAO, 1994) to identify the potential area for mangrove restoration, 5 such areas have been identified suitable for mangrove restoration.

POTENTIAL AREA IDENTIFIED	AVAILABLE AREA (HA)	SUITABLE AREA (MUDFLATS)	SITE ELEVATION	TOPOGRAPHIC ALTERATION	MONITORING
Kudukal point	5	Entire backswamp	No elevation	Need – raising mounds	Need to maintain mound height
Valinokkam	10-15	Periphery of the stream	No elevation but closed	Inlet opening	Regular for inlet closure
Vaipar	15-20	Periphery and in islet mudflat	No elevation	Mouth opening	Regular for inlet closure
Punnakayal	>30	The periphery of islets and mudflats	High elevation ($\pm 1m$)	Need for leveling elevations	Need to maintain canal slopiness
Manakudi	>20	Interior to the estuary	No elevation	No need	No need

Note: The available area mentioned is the approximate values based on visual estimate and need to be resolved using Remote Sensing, Survey maps and physical verification by the concerned coastal Forest Divisions and Ranges.

Among the identified area, Vallinokkam is a coastal wetland, lying 35km south of Keelakarai. Traces of mangrove relics have been identified at the periphery of the wetland. Presently, it is used as the temporary pond to store pumped sea water for solar saltpan. The other is Vaipar, which already have mangrove patches but in very critical condition. The mouth needs to be opened immediately to bring back the growth normal; otherwise the existing patch will go off very soon. The areas which have already been dredged needs little alterations and other areas need intensive topographical grading such as canal dredging with suggested modifications.

Identified areas for mangrove restoration along the coast in the Gulf of Mannar Biosphere Reserve



Map not to scale

Here in Gulf of Mannar region the sea is very calm in most of the seasons and even the kinetic energy of the wave is comparatively optimal and similarly, the tidal height is in range between 0.6-1.2m. Normally, here the amplitude reaches 0.85m in spring tide and reaches to the minimum of 0.2m in neap tide. In addition to this, entire coast experiencing the diurnal tidal cycle, thus will keep the identified/proposed restoration area wet. The wave energy, the tidal amplitude and tidal cycle are favorable factor suitable for mangrove restoration even near the seafront mudflats such as near Pamban and in Punnakayal if proper methodology prescribed below is followed. Since there is no regular freshwater flow, canal-banking method would not be supportive to the growth of mangroves in Kanjirangudi, whereas in Punnakayal estuarine complex, it will work well if the freshwater flow is diverted to drain the canals properly. It was suggested here to go for minor alteration such as reduction of elevation by removing the dumped soil between the feeder canals in Kanjirangudi will reduce the salinity gradient in due course. This would probably facilitate the distribution of the native species found fringing along its shoreline.

Suitable species:

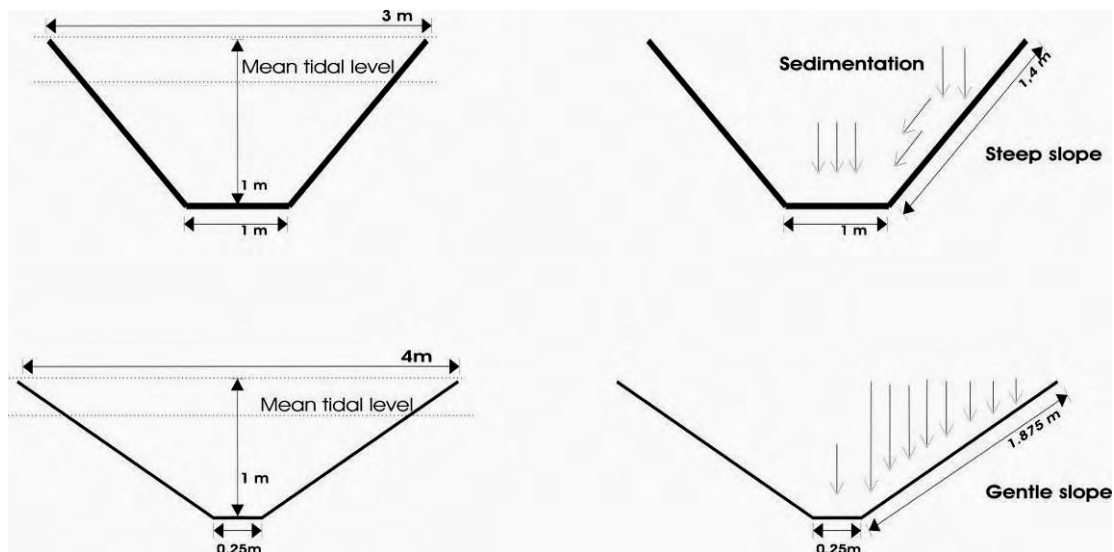
As far as on-shore is concerned, *Avicennia marina* is found in almost at all mangrove areas of the Biosphere Reserve. Due to absence of pristine mangrove ecosystem, sturdy species such as *Avicennia* will be suggested at this stage. Introduction of species new to this region may invites some strange situation like species invasion and related problems in near future or it may not withstand the newer environment and finally leads to the failure of the restoration program. After successful establishment of the native species, the soil substratum will be stabilized and then the other prescribed species can be introduced. But, species like *Rhizophora* and *Ceriops* have recently been introduced in in Pamban and Kanjirangudi respectively. If above mentioned practice were followed both the *Rhizophora* and *Ceriops* can be used for restoration at the majority of the sites. However, a prior thorough assessment of the site with regard to various environmental characteristics in addition to the requirements of the species to be introduced may avoid failures. In most of the

restoration project, the proposed sites were allowed to colonize by the halophytic herbs for a period of several months or even for two years. Since these salt-loving herb species, extracts enough salt and reduces the salinity of the soil. This reduction in soil salinity facilitates the developing mangrove in future.

Needed trench modifications:

By the observations made in already trenched canals and by various other details recorded, some modifications while trenching and its consequences have been discussed hereunder. Canals should be dredged in degraded areas to facilitate the flow of tidal water to bringing down the soil salinity and to create favorable conditions for planting. Usually the feeder canals were made with the dimension of 1:1:3m in bottom width, depth and surface with respectively. Similarly for the distribution canal the dimension is little lesser the abovementioned values. In both the condition the slope is very steep and the area available for plantation is susceptible to slide down to the bottom. Due to availability of enough flat bottom, steep inclination of the sides results in siltation and the canal bottom need to be de-silted frequently. This siltation may also in due course of time reduced proper flushing and sometime even gets block near loose soil areas. In this dimension, the surface area for plantation is being reduced than that of originally available area, i.e., if a canal dredged to a length of 10m, then the surface area available for plantation will be 28.8sq.m.(total area dredged=30sq.m).

Dimensions of canal in use and modification to be made to minimize the problem



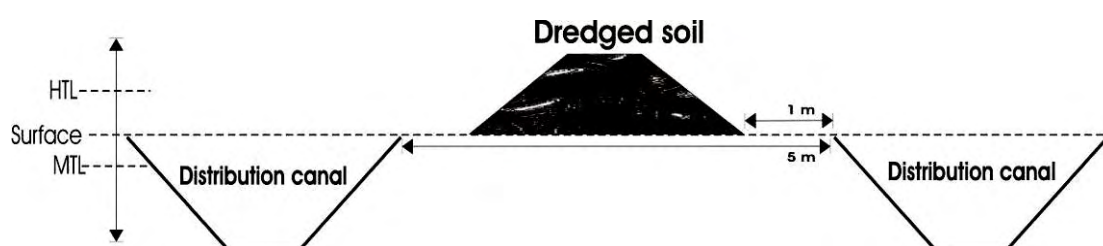
Rather, some modifications have been suggested here to increase the surface area, to reduce the rate of sedimentation and to avoid the soil-slip etc. The bottom width needs to be minimized to 0.25m, this allows the canal to have a gentle slopeness of the sides and increase the surface from top to bottom. The slant sides provide enough area for plantation and also results in even deposition of silt. Comparatively, the available rooting medium will also be increased and this facilitates the growth of the planted seedlings. Most importantly, colonization of soil-dwelling organisms will be more in gentle slant substratum than very steep.

Benefits of the modification of canal dimension:

- Gentle slopiness suitable for plantation
- Increased surface area availability
- Facilitated area faunal recruitment
- Reduced erosion due to slopiness

Usually the dredged soils were heaped at the surface edges of the canal itself. This soil often washed during spring tides and settle down back in to the canal. This makes the whole effort of canal dredging to dissipate. It was suggested here to heap the soil at least 1m away from the edge or if possible far away from the site.

Suggested mode of disposal of dredged soil



On-site nurseries:

It is advisable to set a nursery to raise the mangrove propagules near or adjacent to the proposed restoration site. Long strip of mounds in the inundated area running parallel to the creek may be created using the dugout soil substratum should be treated as nursery beds. Both, sowing the propagules or plunging them into the substratum may be practiced for this type of nursery establishment. These on-site nurseries foresee the details about adaptability and growth of the developing seedling at the site. Similarly, if it is proposed to use already raised seedlings from outside, the seedling to be planted may be kept adjacent to the site for 2-3 weeks where regular inundation takes place. Keeping the seedlings (in polybags) which were nursed outside the proposed site will make the seedling to adapt to the newer environs. For example, the wave energy, tidal amplitude, the nutrient flux and so on will facilitate the seedling to prepare to that environment.

Mangrove plantation:

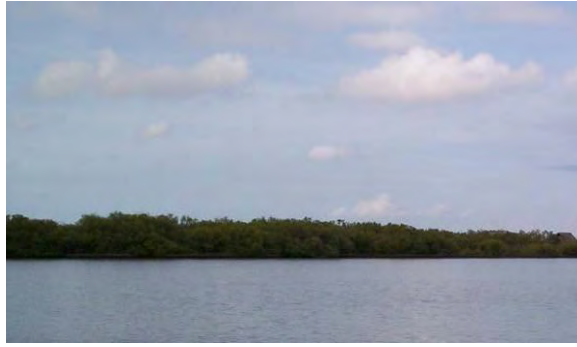
Direct plantation of propagules and transplantation of the raised seedling needs special attention. Usually mangrove plantation should be carried out during onset of monsoon because; availability of freshwater will facilitate the growth of the planted seedling. As far as our study area is concerned, November and December months are very suitable. Plantation program should always coincide with and within fruiting seasons of the mangroves located nearer to the proposed site. It would be better if the planting program was scheduled during the time of maturity of the seeds of the selected species. This is in contrast with the fact that the right season will be very-well read by the parent trees best for seed dispersal.

Monitoring and maintenance of sites after restoration:

Several immediate actions are needed once after the proposed sites have been restored. The important actions are..

- Monitoring the growing mangrove species as a function of time to know the status of successful establishment and suitability of the sites selected.
- Monitoring the growth characteristics such as seedling density, diameter increment, height, node production and stem structure etc. provide enough evidence in relation to the impact of that environment on developing species.
- Recording the failure of seedlings, weed infestation, pests, diseases and debris accumulation provide scientific reason for failure and facilitates the remedial actions to minimize or completely tackle the problem in the future restoration programs.
- The restored sites need to be maintained from grazing, cutting, fishing etc. at least to a period of complete establishment by fencing entire or required areas.

Pictures of on-shore mangroves



Mangroves of Kanjirangudi



Mudflat and adjacent mangrove in Vaipar



Mangroves in Tuticorin backwater



Mangroves in Punnakayal

Previous on-shore mangrove restoration at different sites



***Ceriops tagal* plantation in Kanjirangudi**



Canal banking plantation in Pazhayakayal



Parallel canal banking tried in Pamban

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
5	Mangrove Habitats											
	Natural-cum-assisted restoration of mangrove habitat as prescribed in the Management Plan (Target plantation 1000 ha @ 100 ha/year, @Rs.30000/ha)	300										300
	Monitoring and maintenance of mangrove sites after restoration	4	4	4	5	5	5	6	6	6	7	52

5.3.3. Species of conservation significance and their recovery plan

Even though, several species of invertebrates and vertebrates within the Gulf of Mannar Biosphere Reserve are in the Red Data Book of the IUCN and schedules of the Indian Wildlife (Protection) Act, 1972, it is proposed to initiate active species recovery and restoration of a few prioritized species. It is important to realize that such species recovery programmes require highly specialized and trained human resources and professional organizations. The small number of species recovery programme suggested below will also provide opportunities for capacity building of GOMBR staff, educated youth, local NGOs and other institutions to formulate and initiate similar actions for range of other species, a range of which has been listed out.

- 1. Sea turtles**
- 2. Dugong**
- 3. Economically important crabs**
- 4. Sea snakes**

1. Sea turtles:

Four of the seven species of sea turtles found world wide are reported to occur in the Gulf of Mannar Biosphere Reserve. These are the olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and leatherback (*Dermochelys coriacea*). All the four species of sea turtles that occur in these coastal waters are protected under Schedule I of the Indian Wildlife Protection Act (1972), as well as listed in Appendix I of Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) which prohibits trade in turtle products by signatory countries. At present there exists no commercial or international trade of marine turtles or turtle products in India. However, incidental capture in trawls is a well-known cause of mortality for sea turtles and have been reported all over the world and the Gulf of Mannar is not exceptional to this. Turtles are being harvested in the GOM area for meat near Tuticorin.

During 1971-76 the percentage of green turtle and olive ridley caught in the Gulf of Mannar and adjoining areas was 89% and <10% respectively and during November 2001 it was 46% and 48% but in 2004 the percentage was 13% and 83% which shows that the proportion of green sea turtles catch declined in this region drastically. The reduction in the green turtle catch could be due to overexploitation as local people prefer this species to other species for food. Since the population of green turtle was smaller in size the people were forced to exploit the olive ridley in recent days. It is necessary to recover the green species population in the Gulf of Mannar region as it has an important ecological role in the seagrass and coral reef ecosystems.

Recovery of sea turtles in the Gulf of Mannar Biosphere Reserve:

Beach management and hatchery programmes are proved to be the better methods to recover the sea turtles around the world (GOI-UNDP Project Manual). The same programme may be tried in the Gulf of Mannar Biosphere Reserve both on islands and mainland coasts. A detail manual has jointly been prepared by MoEF (GOI), UNDP, WII and MCBT on this subject can be used. Wildlife Institute of India may be

approached to help the Authority to initiate a programme of this kind in the Gulf of Mannar Biosphere Reserve.

2. Dugong

The Dugong *Dugong dugong* is one of the four surviving species in the Order Sirenia and it is the only existing species of herbivorous mammal that lives exclusively in the shallow coastal waters with sea grass beds. It is a large primary consumer and has considerable potential as a source of protein. Dugong are usually found in calm sheltered, nutrient-rich water less than five meters deep, generally in bays, shallow island and reef areas which are protected against strong winds and heavy seas and which contain extensive sea grass beds. However, they are not confined to only inshore water. There have been sighting near reefs up to 80 km offshore in waters up to 37 meters deep. Dugong is considered to be rare over most of its range including the Gulf of Mannar due to exploitation for meat and habitat destruction. A less but major long-term problem is the disturbance in their feeding area by the noisy boat traffic.

In 1988, Helene Marsh (Marsh, 1988) quoted the data of Dr. Eric Silas and Mr. Bastion Fernando indicates that 250 dugongs were illegally caught and butchered at the villages of Keelakarai and Peripattinum alone between April 1983 and August 1984. This information clearly shows that once the Gulf of Mannar had a good population of dugong but due to poaching of this species , the population is now under threat. Catches were higher in Palk Bay between Devipattanam and Pamban on Rameswaram Island than in the Gulf of Mannar between Musal and Appa Islands and the mainland (Marsh 1988). Though, the illegal take of this species has drastically been reduced , the information on current status and distribution of this species is not clearly known. It is understood that a small scale of poaching on this species is still continuing along the Keelakarai and Sethukarai coasts . Though laws and awarness has reduced poaching in this region,many of these dugongs are still caught accidentally when they are traped and drowned in fishing nets,

Recovery of Dugong in the Gulf of Mannar

Currently, there is no technology available to recover this species through *excitu* conservation methods. However, recovering their habitat i.e. sea grass beds and avoiding poaching will help this species to recover. There maybe a migration of dugong between India and Sri Lanka through Palk Bay which is shallow water (Jones 1976). If we could restore the degraded seagrass beds in the Gulf of Mannar Biosphere Reserve then we may expect the arrival of dugong to the Biosphere Reserve. It is important to identify the critical dugong habitats and their status in the Gulf of Mannar. Encourage and support members to collate and document information on habitat disturbance and loss (e.g., seagrass dieback) and poaching. Education, including formal education, public awareness and training is critical for promoting sustainable development and improving the capacity of the people to address dugong conservation and management issues. Both formal and non-formal education is indispensable to changing people's attitudes so that they have the capacity to assess and address their dugong conservation concerns. Professional institutions such as WII, MKU, SDMRI and CMFRI may be consulted for this programme.

3. Economically important Crabs

A total of 38 crab species belong to 21 genera and five families occur in the Gulf of Mannar Biosphere Reserve, which is 5.6% of Indian crab germ plasm. Of the 11 important commercial crabs in India, six crab species occur in this region. Several species are considered to be becoming rare and threatened, or having reduced over all size because of over exploitation and their habitat destruction. Inter-tidal zone of Gulf of Mannar Marine National Park and the Biosphere Reserve are considered to be good habitats for these crabs in this region. It is important to enhance the stock of economically important crabs in this region i.e. in the core zone of the Biosphere Reserve, which ultimately spill over to the buffer zone where controlled and sustainable fishing is allowed. Professional agencies such as CMFRI and CASMS need to be involved in this programme.

4. Sea snakes

Sea snakes are considered to be the most successful marine reptiles in the world. 12 species of sea snakes have been reported in the Gulf of Mannar region. Of which, nine species are true sea snakes i.e. belong to the family Hydrophiinae. Studies shows that the sea snake population in Indian seas are declining. It is understood that, incidentally captured sea snakes are released back into sea but in several occasions the incidentally captured sea snakes are killed by the fishermen due to fear. In this connection, a public awareness programme for fishermen in the Gulf of Mannar region is useful to conserve these species using posters etc.

Table: Major actions required to recover certain marine species in the Gulf of Mannar Biosphere Reserve.

Sl. No.	Species	Increased awareness programme based on species status and problems	Enforcement and protection from species removal	Status survey and population estimation	Stock enhancement	Species recovery actions	Protected by	Professional Institutions needs to be consulted
1	Sea turtles	0	0	0		0	IUCN, IWPA, CITES	WII, MCB
2	Dugong	0	0	0		0	IUCN, IWPA, CITES	CMFRI, MKU, WII
3	Sea horses & pipe fishes	0	0	0	0		IWPA	CASMS, CMFRI
4	Lobsters				0			TFCRI, CMFRI, CFRI, CASMS
5	Holothurians	0	0	0	0		IWPA	CMFRI, TFCRI
6	Reef fishes	0		0	0			CMFRI, TFCRI
7	Balanoglossus	0	0	0				TFCRI, SDMRI
8	Sea snakes	0						WII
9	Commercially important crabs				0			CASMS, TFCRI, CMFRI

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
6	Species Recovery Programme											
	Recovery of Dugong in the Gulf of Mannar	500 (Outsource to professional institutions and State Fisheries Department whenever required)										500
	Recovery of Sea Snakes											
	Stock enhancement of economically important crabs and lobsters											

5.4. Interpretation, Education, Eco-Tourism And Visitors Management Action Plan

5.4.1. Introduction

Interpretation and imparting Conservation Education on the importance of coastal and marine environments and its biodiversity for visitors and local communities of the Gulf of Mannar Biosphere Reserve is considered to be an important activity of the Management Plan. Only through a clearer understanding of the importance of coastal and marine ecosystem, the citizen, planners, administrators, younger generation and stakeholders will ensure and support conservation and protection of the Gulf of Mannar Biosphere Reserve and the Gulf of Mannar Marine National Park. For this, a comprehensive interpretation, extension, education and awareness conservation programme is proposed for the GOMBR and GOMMNP. This will include setting up of State of Art Interpretation Center, Information Centers, way side information kiosks, state of art marine aquarium, information signages, hoardings, brochures, leaflets, films, audio-visuais, innovative and interactive, unattended and attended services and use of print, electronic, traditional and time tested extension and educational media through competent and trained professional educated interpreters.

The proposed state of the art **Marine Conservation Interpretation cum Education Center (MARCONI)** and Information centers are required to be established at important entry points as well as at urban sites that will provide the visitors and other users a safe, visually coherent, appropriately sequenced and enjoyable experience with a focus on conservation education through exhibits and self guided activities. Signs and exhibits, when designed, fabricated and installed in such centers will welcome, orient and educate visitors to the facilities and the resources of the Biosphere Reserve and National Park. Through the signage's, exhibits, brochures, leaflets and other medias, the visitors will be better informed about how to enjoy their visit and how to manage their activities within the geographic limits and beyond the Biosphere Reserve without impacting the ecological integrity of the area. Most visitor questions and expectations needs to be anticipated and answered by the interpretive facilities and programmes so that personal contact with the Interpreters and Educators of the Biosphere Reserve Management are minimal. Only through such comprehensive interpretive programme the visitors will respect the purpose and objective of the GOMBR and GOMMNP.

5.4.2. Interpretation cum Education Center

Main Theme of the interpretation center: 'Window to the Gulf of Mannar Biosphere' anchored by an elderly local fisherman (or) the Dugong as the focal species of the Reserve.

The interpretation cum conservation education centre needs to be located at one of the important locations of the Biosphere. Rameswaram (Mandapam) would be appropriate sites for such a centre. The centre would serve the education and awareness needs of both the visitors to the Gulf of Mannar Biosphere and for the villagers living in and around the Biosphere. At present there are only a few visitors

to the Biosphere Reserve, however, in future, the visitors can be school children, wildlife enthusiast, college students, pilgrims, researchers, bird watchers, coral watchers, scuba divers, teachers, adventurers, and casual visitors.

The interpretation cum education centre exterior design and placement should welcome visitors and set the tone for the experience inside. The placement should make it visually obvious but not obtrusive to the visitors. The building exterior should visually complement the natural surroundings.

Upon entering the conservation education centre, visitors will be greeted at the reception desk in the alcove. Behind the desk on the wall would be the location map of the Gulf of Mannar Biosphere Reserve with different zones, which would give the visitors a clue as to where they are. Leaving the alcove, the visitors would enter the larger exhibit room through the right entrance, where exhibits are on display. The text in the panels would be minimum and would be bilingual i.e. Tamil and English.(hindi should also be included cause currently most of the tourist are pilgrims from the northern part of India)

Some of the following sub-themes have been recommended in the Interpretation cum education center. Each panel may be having one sub-theme within it. However, it is up to the concerned agency that will be establishing this center, to decide and finalize the sub-themes.

Sub-theme 1: Biophysical setting of the Gulf of Mannar Biosphere Reserve

The panel would depict the various ecosystems of the Gulf of Mannar Biosphere Reserve like coral ecosystem, seagrass ecosystem, mangrove ecosystem, terrestrial ecosystem etc. Ecological processes associated with BR like precipitation, mean monthly minimum and maximum temperature, monsoon types, evaporation rate, minerals cycles etc, should also need to be demonstrated in this panel.

Sub-theme 2: Aquarium

Although a separate scientific aquarium is proposed for the Biosphere, it is suggested to have a small aquarium in the Interpretation center too. The live exhibit would include reef fish and other flora and fauna of Gulf of Manna Biosphere Reserve. The area is rich in marine biodiversity. Around 170 species of ornamental fishes have been recorded in this region, of these a few fishes can be kept in the aquarium at the conservation education centre. The importance of fish fauna in this region and the prospect of fisheries would also be depicted so that the local people are aware of why and how to protect this region so that they can continue their fisheries activities forever.

Sub-theme 3: Mammalian and reptile fauna

Endangered fauna found in the area would be depicted and their habitat requirements and threats to the species would be discussed. The panel would also discuss about dugong, whales, other cetacean and sea turtles and sea snakes and importance of their conservation and methods adopted for conservation,.Information like how to keep safe distance from poisonous sea snakes etc can also be included

Sub-theme 4. Flora

Gulf of Mannar is rich in both aquatic and terrestrial flora. For example, importance of sea grasses, sea weeds, mangrove etc can be discussed in this panel.

Sub-theme 5: Unique fauna and flora of the Gulf of Mannar

There are several endemic fauna and flora occur in this region which need to be discussed in this panel. For example, balanoglossus, endemic mangrove species, endemic sea grasses etc should be mentioned with their unique importance of not being found anywhere else in the world

Sub-theme 6: Culture

The area is surrounded by villages with fisherman communities, agriculture farmers. The panel would depict the local people's dependency on the BR and would also suggest alternatives to counter the severe anthropogenic pressure. This panel would be in the form of diorama.

Sub-theme 7: Avifauna

A combination of islands with mud flats and mangroves habitats makes the BR an ideal waterfowl habitat. Large numbers of both migratory and resident birds have been recorded in this area. The panel would depict pictorially the migrant and resident birds and their behavior. Calls of birds would also be included in the panel to make it interactive for visitors and the children coming to the conservation education centre.

Sub-theme 8: Historical account on the GOMBR

Historical account of this region can be kept in this panel. Relationship between the 'Ramayana' and GOMBR, information about Sethu Kings etc.

Sub-theme 9: Important places in and around the GOMBR

Important places in and around the Biosphere Reserve can be discussed in this panel. For example, Rameswaram temple, Thanuskodi, Tuticorin etc.

Sub-theme 11: Association between local community and Biosphere Reserve

Sub-theme 10: Management

The panel would describe the management issues and also describe the initiatives taken by the Biosphere Authority.

Interactive Display

In the centre of the hall there would be an interactive display on Geo hydrology and Water Quality. Effluent from the industries located nearby is drained into the sea. The display would depict the water quality and also talk about what happens to the ecosystem when the water is contaminated and how it affects humans and the biodiversity of the area.

Video

The centre would have a Plasma wall mounted display screen on which films on the BR and other related issues are on screen for the audience.

Entrance/Orientation Kiosk

The entrance sign kiosk will house a detailed map of the BR, showing boundaries, indicating “you are here” and pointing out major points of interest. The kiosk will also list the rules to be followed while on the visit to the BR.

The kiosk will be so placed that all visitors to the BR will have to pass through the kiosk. Thus the kiosk can also be the site for entry permit and holding area for the visitors.

Pathway Directional Signs

In order to regulate the flow of visitor’s pathway directional signs should be placed at regular intervals so that the visitors are aware which way to go. The signs should lead them to all the major facilities that are available for the visitors such as toilets, drinking water, boat ghat, conservation education centre and the exit.

Professional organizations such as CEE, WWF-India, WII or CPR Foundation may be approached to establish the interpretation cum education center at GOMBR .

Publications

All publications should have a masthead so that the viewer can know which department has produced it. This would also a means of publicity for the area and the department. All the publication must be in bilingual i.e. Tamil and English. Following publications for the area are proposed:

- * Park Brochure
- Checklist of Birds
- Checklists of various marine animals
- * Plant identification guide
- * Posters
- * Outreach Material

Publications can be priced and the money generated can be ploughed back through village eco-development committee. The revenue can be used for replenishing the stock of publications and also maintaining the conservation education centre.

Park Brochure

The brochure would consist of all the information that would be required by a visitor for planning the visit and also what one can expect to see in the area. The brochure would also have the Things to remember i.e. what one is allowed to do on the trip within the BR and what is prohibited. It would also give information on the timings and the period when the BR would be open for visitation.

Outreach Material

Since all kinds of visitors are expected to visit the BR, therefore it is important to reach out to them through publications and other means.

These materials can be used during special events day such as Annual Day of BR (18th February), World Environment Day 5th June, Wildlife Week 2-8th October and Wetland Day 2nd February. Special events increase public awareness of an environmental issue and motivate people to participate by focusing their attention on a particular issue.

The materials can be activity booklets like draw and color, sheets or cards. The material produced has to be in Tamil and in easy to understand language. The activity booklets can be used by school children and on successful completion of the activity they can be given a 'Certificate', which would motivate the children to learn more about their surrounds. *Environment clubs* or *National Green Corps* too can be formed in schools and colleges located around the BR and activities can be undertaken in the clubs.

Audio-Visual

Films are an important media of mass communication and it works well in rural settings where very few people are literate. Series of 20 minutes film on the BR, its importance, threats and its mitigation can be prepared with strong visual content. The commentary can be in Tamil for use in the villages but English commentary can be superscripted for use in the Conservation Education Centre. The film should be professionally done on DG Beta Pro Formats and sound recorded on DAT (Digital Audio Tape). The DVD is easy to handle and maintain. Not only this, now most of the rural areas one can find DVD players through which the films can be shown on television screen for small audience and through LCD projector for large audience. This documentary film on GOMBR in Tamil can also be telecasted through local cable TV networks, State Tourism Hotels TV networks, Private Hotels TV networks, etc.

Information Centers

It is proposed that information centers for visitor of the Biosphere Reserve need to be established in following five places.

1. Kanyakumari
2. Tuticorin
3. Ramanathapuram
4. Madurai and
5. CWLW- Chennai

All the information centers should have a larger display of the Biosphere Reserve map. Information center should provide all the necessary information to visitors regarding how to reach the BR, different facilities available for the visitors at BR. and Information regarding biodiversity of BR etc. All publications related to Biosphere Reserve should be kept in these information centers. If necessary, these information centers may be attached with district tourism information center but it should be in the above mentioned locations only.

Table 5.1: Media message matrix for interpretation and conservation education.

Activities and Messages	Information center	Interpretation center	Hoardings	Tran slides	Way-side Kiosk	Brochures, posters, stickers, post cards, leaflets	Orientation Films & Audiovisuals	Touch and Feel Explorations (students)	Nature Guides	Outreach programmes	Field guides	Organized safaris	Marine aquarium & museums	Organized cruise	Quizzes, competitions, seminars etc	Nature trails & beach walk	Board walks	Watch towers	Check lists	Website (www.gombr.com)	Others (Souvenir shop, Environmental Day etc)
Informing and Welcoming visitors to facilities and activities within Reserve	0	0	0	0	0	0	0		0		0		0							0	0
Making visitors understand the ecological process and importance of flora and fauna	0	0			0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
Do's & Don'ts & to be a eco-visitors	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Land, people,	0	0			0				0												

customs and Traditions																					
Visitors and tourism resources	0	0			0	0	0		0		0		0	0				0		0	0
Assistance in visitation planning	0	0				0			0		0		0	0						0	0
Conservation orientated activities	0	0			0	0	0		0		0		0	0						0	0
Visitors survey and feedback	0	0																		0	0
Nature club, Green club and Nature camps activities	0	0				0	0													0	0

Table 5.2: Deployment of various interpretive materials at important locations

	Hoardings	Tran slides	Electronic display	Information Kiosk	Brochures, posters & leaflets	Information on visitor resources	Copies of orientation films (CD)	Advertisements	Audiovisual programme	Website link	Television clips
New Delhi		TN Bhawan & TN State GH		TN Bhawan, TN State GH	TN Bhawan, TN State GH		TN Bhawan, TN State GH				
Chennai		Airport		CWLW Office	CWLW Office, GOI Tourism Office		CWLW Office		CWLW Office		
Madurai	BRA Director Office, Railway station	BRA Director Office, Airport	BRA Director Office	BRA Director Office	BRA Director Office, TN Tourism Information Center	BRA Director Office	BRA Director Office		BRA Director Office		
Ramanathapuram		WLW Office, EDO Office, Railway Station	Railway Station	WLW Office, EDO Office	WLW Office, EDO Office	WLW Office, EDO Office	WLW Office, EDO Office		WLW Office, EDO Office		
Tuticorin	Railway station & Bus stand	Airport		Information Centre (IFC)	ACF and EDO Offices, IFC	ACF and EDO Offices, IFC	ACF and EDO Offices, IFC		IFC, EDO Office		IFC

Kanyakumari	Bus stand	Railway station	TN Tourism Office	Information Centre (IFC)	TN Tourism Office, IFC	IFC	IFC				IFC
Tirunelveli	Bus stand	Railway station									
Virudunagar					CF Office						
Tiruchendur	Temple										
Rameshwaram	Temple				TN Tourism Office						
Mandapam	Interpretation Centre (IC), CMFRI	IC	IC	IC	IC, CMFRI	IC	IC, CMFRI	IC	IC	IC	IC, CMFRI
Kilakarai	RMC		RMC	RMC	RMC	RMC	RMC		RMC	RMC	RMC
Pamban	Aquarium (AQM)	AQM	AQM	AQM	AQM	AQM	AQM	AQM	AQM	AQM	AQM
Trivandrum		Airport			Airport Tourism Desk						
Tourism Information centers of TN and GOI					0						
National Dailies, magazines, Television, AIR								0			
Other National & International NGOs										0	
Incredible India, TN Government Website, All tourisms websites, NIC, WII & MoEF website, UNDP website										0	

5.4.2. Eco-Tourism And Visitors Management

1. Introduction

The coastal landscape and seascape in the Gulf of Mannar Biosphere Reserve historically has been a major tourist destination of South India and in Tamil Nadu in particular. Of the four coastal districts in which BR is located, the northern most district of the Ramanathapuram and southern district of Kanyakumari attracts the largest number of tourists, a majority of which are religious tourist. Most of the tourists visiting Kanyakumari are interested in the 'tri-sea confluence' at the Cape Comorin. And, the tourists who visit the Rameswaram are interested in the Ramanathaswamy Temple and nearby temples. However, the four districts along the Biosphere Reserve has a lot of tourism interest resources which are placed at Annexure at the end of this chapter.

A study conducted by MSSRF in 1994-96 revealed that an average of 13,53,134 tourists visit the Ramanathapuram district who're mostly visiting the district for the Ramanathaswamy temple in Rameswaram and few other temples around this place followed by Kanyakumari and Tiruchendur with an yearly average of 10,80,371 and 9,38,629 people respectively.

The coastal and marine habitats of the Gulf of Mannar and Palk Bay have also been favourite visiting sites for academic purposes by students, researchers and scientists studying biology, marine sciences, ecology, oceanography, geography and coastal geomorphology. After the creation of the GOMMNP which encompasses the offshore islands and surroundings coral reef systems, there has been a restriction on tourism commensurate with provision in the Indian Wildlife (P) Act, 1972. However, all eco-tourism prospect assessments have recommended reef based tourism as the highest opportunity in the Gulf of Mannar (MSSRF-UNDP-GEF study, 1988).

SWOT Analysis for development for tourism:

SWOT analysis shows that the existing flow of tourist as a huge market, the biodiversity, wildlife, islands, beaches, heritage sites, warm climate and religious sites of National importance as some of the major strengths. The study also identified long standing national and state research institutions as well as creating of the GOMBR as an added strength. The traditional seafaring local community and their handicrafts, tourism infrastructure including connectivity by air (Tiruvananthapuram, Madurai, Tuticorin), rail (Madurai, Tuticorin, Ramanathapuram, Rameswaram, Kanyakumari, Tiruchendur, Nagercoil) and huge network of roads are also biggest strength for tourism promotion.

Civic and industrial pollution in relatively monotonous landscape, high volume of biological sample collection related vandalism, untrained human resources and safety standards, lack of tourism protocol and management, interpretive facilities and infrastructure from the Gulf of Mannar Biosphere Reserve Management as well as poor coastal roads and drought situation in the region is considered as the weakness of the region from tourism point of view.

Development of eco-destinations, restoration of habitats and prospect of eco-tourism products based on natural attributes in the region along with the available markets

locally, regionally and globally has been identified as opportunities. The increased attention of the state, country for infrastructure development has also been considered as an opportunity and need to be strengthened.

The study considers increased industrial and civil pollutions, depletion of biodiversity, ground water and unplanned development in the region as major threats for tourism promotion.

For purposes of eco-tourism development in the Gulf of Mannar Biosphere Reserve region, the geographic scope has been extended up to a 50 km limit from the coast

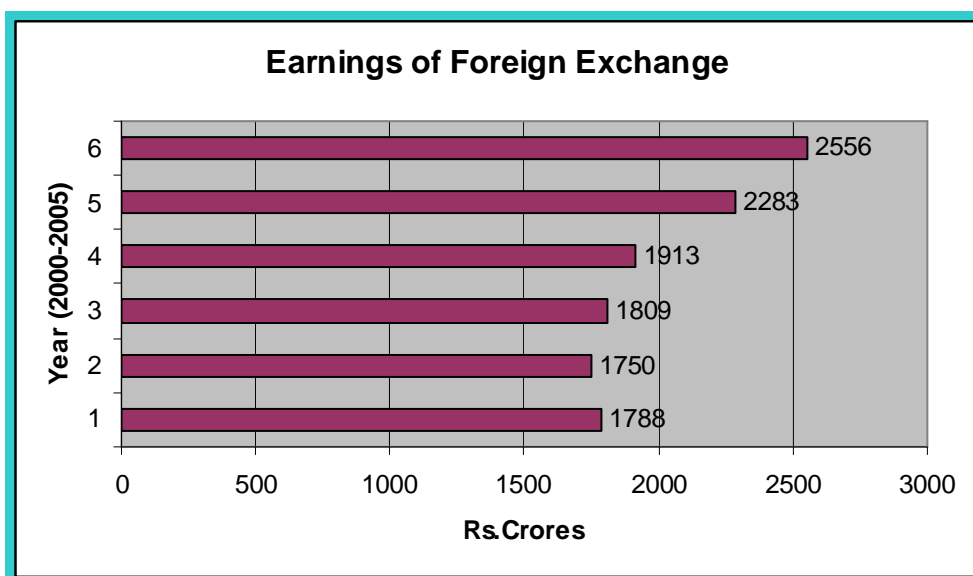
2. Objectives

- a. To promote wildlife education
- b. To promote conservation awareness
- c. For the National Park promotion and gather public support and lobby for the National Park and Biosphere Reserve.
- d. To promote the species conservation programme
- e. To generate employment opportunities for those who lost employment due to protected area.
- f. Off setting tourism pressures from other protected areas.

Present status of tourism in the Gulf of Mannar biosphere reserve:

Out of four districts bordering the Gulf of Mannar Biosphere reserve, only Kanyakumari and Ramanathapuram districts seems to attract tourists in more numbers. The tourists visiting these districts are mainly interested for religious reasons. Most of the tourists visiting Kanyakumari are interested in the 'tri-sea confluence' at the Cape Comorin. And, the tourists who come to Rameswaram are interested in the Ramanathaswamy Temple and nearby temples.

A study conducted by MSSRF in 1994-96 revealed that an average of 13,53,134 tourists visit the Ramanathapuram district who're mostly visiting the district for the Ramanathaswamy temple in Rameswaram and few other temples around this place followed by Kanyakumari and Tiruchendur with an yearly average of 10,80,371 and 9,38,629 people respectively.



Source: Government of Tamil Nadu Department of Economics and Statistics Statistical Hand Book 2005.

During the year 2001 Tamil Nadu occupied the third rank in both domestic and foreign tourist arrivals to India. According to a survey conducted in the year 2005, Tamil Nadu has moved on to the second position in attracting foreign tourists. In the case of domestic tourists, Tamil Nadu continues to occupy the third position. Efforts are being taken to reach the first position in the arrival of tourists, both foreign and domestic.

CLASSIFICATION OF TOURISTS

The Department of tourism, Tamil Nadu have classified tourists visiting Tamil Nadu as:

- a) **Leisure Tourists** These tourists have only one aim; to enjoy the vacation. They normally come along with their families to visit hill stations, Beach resorts and wildlife sanctuaries.
- b) **Pilgrim Tourists** The trip of pilgrim tourists to Tamil Nadu is solely meant for fulfilling certain spiritual aspirations. After achieving this, they do not hesitate to visit nearby Tourist centers. They are mostly Senior Citizens.
- c) **Heritage Tourists** Tourists of this category restrict their visits to Historical sites, Heritage monuments and the like.
- d) **Adventure Tourists** The tourists in this category are normally youth who love to go on trekking or play air/water sports.
- e) **Business Tourists** Executives from leading private firms, public sector undertakings, multinational companies, etc. visit Tamil Nadu throughout the year to attend seminars, conferences, conventions or General body meetings. Once the business session is over, these executives take a break and visit tourist centers.

f) **Medical Tourists** These tourists are normally drawn from other states in India and abroad. Attendants accompany them. After getting discharged from the hospitals, they visit tourist centers for recuperation.

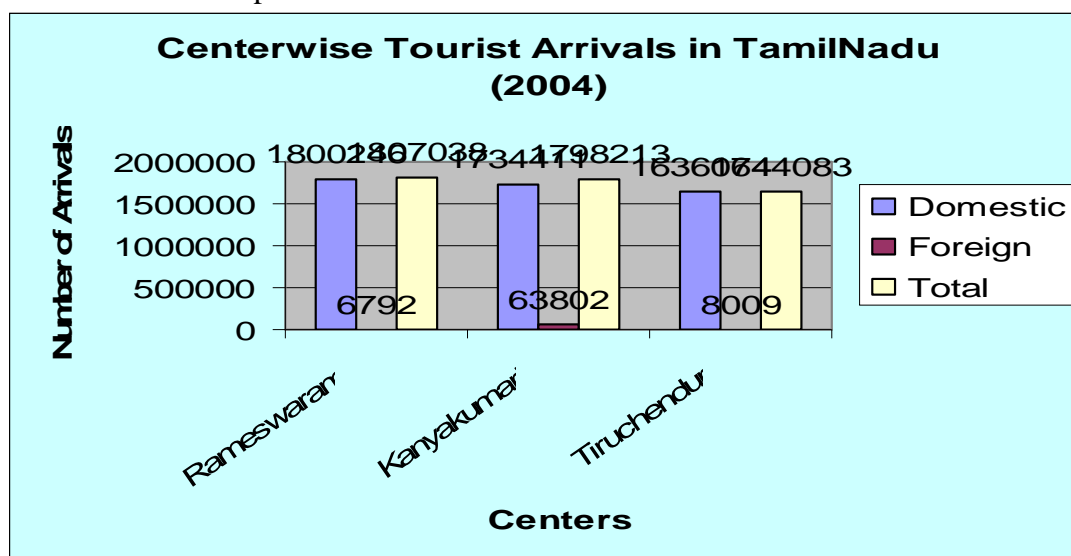
g) **Academic Tourists** The tourists in this category are generally students and research scholars from educational institutions who combine their study tour with tourism. Tourism Department extends concession in entry fee for students visiting Poompuhar Tourist Complex, Sound and Light Show, Madurai and Kattabomman Memorial Fort, Panchalankurichi.

h) **Social Tourists** This category of tourists visit Tamil Nadu to celebrate festivals with their kith and kin, participate in or organize fairs and festivals and attend to social functions. Such tourists make it a point to visit tourist spots after fulfilling their main objective.

Tourism Resources in the Region:

Out of 35 identified places of tourist interest, 21 are Religious places (15 temples, 5 churches and 1 mosque), 7 are Archaeologically/Historically important, 12 beaches (recreational), 6 places important for Wildlife tourism (Sanctuaries), only 1 place suitable for adventure tourism, 1 place for health tourism, 6 museums etc.,

Significance of these places is discussed here, looking into the possibilities of ecotourism in those places.



Source: Government of Tamil Nadu Department of Economics and Statistics Statistical Hand Book 2005.

Tourism Resource Inventory:

Various places of tourist interest in the four districts bordering the Gulf of Mannar Biosphere Reserve (falling within 50KM from shore land-ward side) are listed in the tables

Table 5.3. Tourism resource checklist for Ramanathauram District along the coast (50KM landward) of Gulf of Mannar Biosphere Reserve.

RMD	Ramanathaswamy Temple, Rameswaram Place Code: RMD/Rel/1	Oruyur Place Code: RMD/ Rel/8	Earwadi Dargha Place Code: RMD/Rel/9	Ruins of British buildings, Danushkodi Place Code: RMD/HH/1	Keelaselvanur -Melaselvanur Bird Sanctuary, Keelaselvanur Place Code: RMD/WL/1*	Mental Asylum, Earwadi Place Code: RMD/Hea/1	Glass bottomed boating, Mandapam Place Code: RMD/Rec/1*#	Marine Aquarium,CMF RI, Mandapam Place Code: RMD/MA/1	Pamban Rail scissors bridge, Pamban Place Code: RMD/Oth/1
	Kodandaraman Temple, Rameswaram Place Code: RMD/Rel/2			Sethupathy Raja Palace, Ramnad Place Code: RMD/HH/2	Vettangudi Bird Sanctuary, Vettangudi Place Code: RMD/WL/2*		Danushkodi beach Place Code: RMD/Rec/2*#	Marine Aquarium, TNFDC, Mandapam Place Code: RMD/MA/2	
	Darbasayanam, Thirupullani Place Code: RMD/Rel/3				Chitrangudi bird sanctuary Place Code: RMD/WL/3*		Kushi beach, Ariyaman Place Code: RMD/Rec/3*		
	Sethukarai Place Code: RMD/Rel/4						Pudumadam beach Place Code: RMD/Rec/4*#		
	Uttarakosamangai Place Code: RMD/Rel/5						Valinokkam beach Place Code: RMD/Rec/5*#		
	Navabhashanam, Devipattinam Place Code: RMD/Rel/6*								
	NainarKovil Place Code: RMD/Rel/7								

Suggested Eco-tourism destinations for community involved tourist activities.

Table 5.4. Tourism resource checklist for Tuticorin district along the coast (50KM landward) of Gulf of Mannar Biosphere Reserve.

DISTRICT	RELIGIOUS			HERITAGE/ HISTORICAL	WILDLIFE	ADVENTURE	HEALTH	RECREATI ONAL	MUSEUMS/ AQUARIUMS
	Temples	Churches	Mosques						
TTK	Sankara Rameswarar Kovil, Tuticorin Place Code: TTK/Rel/1	Panimayamat ha Church, Tuticorin Place Code: TTK/Rel/4		Veerapandya Kattappomman Memorial Fort, Panchalamkurichi Place Code: TTK/HH/1	Blackbuck Sanctuary, Vallanad Place Code: TTK/WL/1 *				
	Senthil Nathan Temple, Tiruchendur Place Code: TTK/Rel/2	Manappad Place Code: TTK/Rel/5 *#		Birth place of V.O.Chidambaram Place Code: TTK/HH/2					
	Srivaikuntam Place Code: TTK/Rel/3	Kappal Matha Church, Ovari Place Code: TTK/Rel/5							

Suggested Eco-tourism destinations for community involved tourist activities.

Table 5.5. Tourism resource checklist for Tirunelveli district along the coast (50KM landward) of Gulf of Mannar Biosphere Reserve.

DISTRICT	RELIGIOUS			HERITAGE/ HISTORICAL	WILDLIFE	ADVENTURE	HEALTH	RECREATIO NAL	MUSEUMS/ AQUARIUMS
	Temples	Churches	Mosque s						
TNL		Kappal Matha Church, Ovari Place Code: TNL/Rel/1			Koonthankulam Bird Sanctuary Place Code: TNL/WL/1				

Suggested Eco-tourism destinations for community involved tourist activities.

Table 5.6 Tourism resource checklist for Kanyakumari district along the coast (50KM landward) of Gulf of Mannar Biosphere Reserve.

DISTRICT	RELIGIOUS			HERITAGE/ HISTORICAL	WILDLIFE	ADVENTUR E	HEALTH	RECREATIO NAL	MUSEUMS/ AQUARIUMS	OTHERS
	Temples	Churches	Mosques							
KK	Kumariamman Temple, KK Place Code: KK/Rel/1	St.Xavier's Church, Nagercoil Place Code: KK/Rel/4	Peer Mohamed Dargha, Tuckalay Place Code: KK/Rel/5	Padmanabhapuram Palace, Tuckalay Place Code: KK/HH/1	Bio-diversity Park, Udayagiri Fort, Nagercoil Place Code: KK/WL/1	Ulakkai Aruvi Waterfalls, Ulakkaiaruvi Place Code: KK/Adv/1	Maruthuval Malai, KK Place Code: KK/Hea/1	Kanyakumari Beach, KK Place Code: KK/Rec/1	Govt., Museum, KK Place Code: KK/MA/1	Vivekananda rock memorial Place Code: KK/Oth/1
	1500yr old Siva Temple, KK Place Code: KK/Rel/2			Vattakottai Circular Fort, Vattakottai Place Code: KK/HH/2				Chothavillai Beach Place Code: KK/Rec/2	Kamarajar Mani Mandapam, KK Place Code: KK/MA/2	Tiruvalluvar Statue, KK Place Code: KK/Oth/2
	Suchindrum Place Code: KK/Rel/3							Sanguthurai Beach Place Code: KK/Rec/3		Mathur hanging bridge, KK Place Code: KK/Oth/3
								Muttom Beach Place Code: KK/Rec/4		Pechiparai dam, Pechiparai Place Code: KK/Oth/4
								Tiraparapu Waterfalls Place Code: KK/Rec/5		Mukkadal dam, Mukkadal Place Code: KK/Oth/5
								Marthur Hanging Bridge Place Code: KK/Rec/6		

Suggested Eco-tourism destinations for community involved tourist activities.

Source: Government of Tamil Nadu Department of Economics and Statistics Statistical Hand Book 2005.

Table 5.7: Tourism resource checklist of Kanyakumari District

Place	District	Tourist Attractions	Significance	Accessibility	Season	Infrastructure existing
Kanyakumari	Kanyakumari	Gandhimandapam	Historical	Kanyakumari		
	Kanyakumari	Kamarajar Mani Mandapam	Historical	Kanyakumari		
	Kanyakumari	Govt., Museum	Historical	Kanyakumari		
	Kanyakumari	Tiruvalluvar Statue	Historical	Kanyakumari		
	Kanyakumari	Vivekananda Memorial	Historical	Kanyakumari		
	Kanyakumari	1500Year old temple of Lord Siva	Religious/Historical	Kanyakumari		
	Kanyakumari	Kumari Amman Temple	Religious	Kanyakumari		
Suchindrum	Kanyakumari	Vishnu's Temple	Religious	8km from Nagercoil		
Nagercoil	Kanyakumari	St.Xavier's Church	Religious	Nagercoil		
	Kanyakumari	Nageraja Temple	Religious	Nagercoil		
	Kanyakumari	Mathur Hanging Bridge - Longest trough bridge in Asia	Nature based	25 km from Nagercoil		
Pechiparai	Kanyakumari	Pechiparai Dam	Nature based	25km from Nagercoil	Dec-Apr	Water Sports-Pedal boating & Bird watching
Tirparapu	Kanyakumari	Tirparapu water falls	Nature based	30km from Nagercoil		Water Sports-Pedal boating & Bird watching
Mukkadal	Kanyakumari	Mukkadal Dam	Nature based	25km from Nagercoil		
Ulakkaiaruvi	Kanyakumari	Ulakkai aruvi water falls-trecking	Nature based	25km from Nagercoil		Trecking trail and a bathing platform
Sanguthurai	Kanyakumari	Beach	Nature based	10km from Kanyakumari		
Muttom	Kanyakumari	Beach	Nature based	16km from Kanyakumari		Rest houses on the beach
Chothavilai	Kanyakumari	Beach	Nature based	10km from Kanyakumari		
Vattakottai	Kanyakumari	Vattakottai circular fort	Historical/Archaeological	6km from Kanyakumari		
Udayagiri	Kanyakumari	Udayagiri fort- now converted into a biodiversity park with few deers	Historical/Nature Based	16km from Nagercoil		
Tuckalay	Kanyakumari	Tuckalay Palace	Historical/Archaeological	30km from Nagercoil		

Place	District	Tourist Attractions	Significance	Accessibility	Season	Infrastructure
Rameswaram	Ramanathapuram	Ramanathaswamy Temple	Religious Importance	58km from Ramanathapuram	January	
		Kodandaraman Temple	Religious Importance	30km from Rameswaram	January	
		Pamban Rail Scissors Bridge	Openable bridge connecting	40km from Ramanathapuram		
Mandapam	Ramanathapuram	CMFRI Marine Aquarium		40km from Ramanathapuram		
		TNFDC Marine Aquarium		40km from Ramanathapuram		
Ariyaman	Ramanathapuram	Kushi beach	Beach	40km from Ramanathapuram		A water sports
Earwadi	Ramanathapuram	Sultan Ibrahim Syed Aulia's Tomb	800yrs old tomb also attracti	30km from Rameswaram	Feb-Mar	Few private L
		Mental assylum				
Tirupullani	Ramanathapuram	Darbha sayanam,Vishnu's temple	Religious Importance	30km from Rameswaram		
Sethukkarai	Ramanathapuram	A bridge believed to be built by Lord Rama	Religious Importance	30km from Rameswaram		
Uthirakosamangai	Ramanathapuram	Nataraja temple	Religious importance/	35km from Rameswaram		
Devipattinam	Ramanathapuram	Navabhashanam	Religious importance	40km from Ramanathapuram		
Nainar Kovil	Ramanathapuram	Nainar kovil	Religious	40km from Ramanathapuram		
Oriyur	Ramanathapuram	Oriyur Church	Religious	60km from Ramanathapuram		
Ramanathapuram	Ramanathapuram	Sethupathy Raja Palace	Historical/Archaeological	Ramanathapuram		
Danushkodi	Ramanathapuram	Danushkodi	Religious, Historical, Nature b	90km from Ramanathapuram	January	
Valinokkam	Ramanathapuram	Beach	Nature based	40km from Ramanathapuram		a watch tower
Pudumadam	Ramanathapuram	Beach	Nature based	50km from Ramanathapuram		
Selvanur	Ramanathapuram	Keela Selvanur-Mela Selvanur Bird Sanctuary	Nature based			
Chakkarakottai	Ramanathapuram	Wetland	Nature based	5km from Ramanathapuram		
Tuticorin	Tuticorin	Panimayamatha Church	Religious	Tuticorin		
		Sivankovil	Religious	Tuticorin		
Tiruchendur	Tuticorin	Subramanya temple	Religious/Nature based	Tiruchendur		
Manapad	Tuticorin	Roman Catholic Church- Cross said to be brought from Jer	Religious	18km from Tiruchendur		
Panchalamkurichi	Tuticorin	Remnants of Kattappomman's fort	Historical/Archaeological	18km from Tuticorin		
Ottapidaram	Tuticorin	Birth place of VO Chidambaram	Historical/Archaeological	20km from Tuticorin		
Ettayapuram	Tuticorin	Bharatiyar Mani Mandapam	Historical/Archaeological			
Vallanad	Tuticorin	Vallanad Blackbuck Sanctuary	Nature based	37km from Palayamkottai on NH7		A watch tower
Nanguneri	Tirunelveli	Perumal Kovil	Historical	31km from Tirunelveli on NH7		
Ovari	Tirunelveli	Kappal Matha Church	Religious	53km from Kanyakumari		
Koonthankulam	Tirunelveli	Koonthankulam Bird Sanctuary	Nature based			

Tourism zone

Zoning is an essential part of all protected area management plans, from the tourism point of view resource use should be based on the use levels of each zone and its conservation importance, it would be better to use the buffer zone of the of Reserve for tourism. Important tourism places have been identified and described above. These identified places can be developed and used for tourism and tourism related activities. In addition to the above mentioned places, the coral reef area around the Rameshwaram Island can be used for coral viewing and other marine related recreational tourism activities. Mandapam can be developed as an important tourism site from where these coral reefs can be assessed by glass bottomed boats.

Finance (predicted income and expenditure, possible funding source, collaborations and tie-ups)

Budgeting is a very essential part of any organized activity. Tourist flows and activities should be organized while entering the reserve. On entering the reserve boundaries, visitors should be made to register themselves by paying a nominal entrance fee, which could be used for maintenance and procurement of infrastructure etc.,

Assuming an average of 4,949,334 visitors per year (*Source: Government of Tamil Nadu, Department of Economics and Statistics: "Statistical Hand Book 2005"*) to this area were charged an amount of Rs.25.00 each towards entry fees, it will generate an annual income of Rs.12,37,33,350. This could be used for maintenance and procurement of tourism related equipment and infrastructure. Among such equipment, few can be given to tourists for hiring. This equipment includes snorkelling gear, scuba gear, swimming gear etc., for divers, binoculars for bird watchers etc. Income to the reserve can also be generated through boat fares and other entry fees for various tourist spots where applicable.

Funding for initial establishment of tourism related infrastructure like accommodation complexes, roads, boat jetties, procurement of boats etc., can be acquired from the Department of Tourism, Tamil Nadu. A part of the investment can also be acquired by lending few places where recreational centers could be established on lease to private entrepreneurs.

Information for visitor center (open and closed season, maintenance periods, annual work plan on a monthly calendar basis)

Open and closed seasons of the reserve's tourist areas can be informed to the public through a wide range of public information systems like Media (electronic and print), internet etc., information on this can also be made available to the public through the printed brochures available in the tourist information centers of the reserve.

An annual work plan on monthly calendar basis is very much necessary to organize an ecologically sustainable as well as tourist friendly experience. The annual work plan should be fabricated, keeping in mind, the various ecological processes that are more likely to happen in this area like Turtle nesting, breeding of various migratory species

like whales, Dolphins, birds, fishes etc., seed distribution of important floral species like that of mangroves etc., The closed seasons for these areas can be made used for the maintenance of the area such as setting-up or repair of the infrastructure etc., This information should also be made available to the tourists in an understandable manner through printed brochures so that it can be easy for them to plan their tour accordingly.

Daily work plan (visitor hours, routé designation, number of boats/vehicle flow to various sites of interests)

Hours of visitation should be planned based on the activities, a tourist wishes to be involved in like bird watching, turtle walk, whale watching, mangrove site visiting, diving etc., For example, bird watching would be better when done during mornings and late afternoons, turtle walks would be fruitful during nights, diving during the day time etc., for this, a tourist entering the reserve might be required to fill-in the details at the time of his entry into the area itself stating their objective of visit. This plan should also include the limitations on the number of visitors or visitors' boats being operated per day, which has to be decided by the park management based on the sensitivity of the area.

Interpretation Center with audio-visual room

The reserve's interpretation centers may be set-up at three main places like Mandapam, Tuticorin and Kanyakumari. These interpretation centers should be set-up in such a way that their main focus should be on educating people about the significance of the area and bringing awareness among the public through a variety of devices. An audio-visual room should be established at each of these interpretation centers with latest possible equipments with videos about the biodiversity and the need for conservation, the park's expectations from the visitors etc., the videos and information brochures should be in Tamil, Hindi and English languages separately so as to make different types of visitors easy to understand. Video CDs and other printed material should be made available to the public which could promote the concepts of Biodiversity conservation and sustainable use of resources.

Marine aquarium

Marine aquariums can help managers of any protected area in building-up of curiosity and subsequent awareness about the conservation and sustainable use of resources. Marine aquariums can also be useful to the public as well, by acting as a means of recreation and education. These kind aquariums could also be made useful by managers by exhibiting in such a manner which can depict the negative impacts of human interference into the natural ecosystems' processes.

Two small scale marine aquariums already exist in Mandapam, one belonging to the CMFRI and another, belonging to the TNFDC. However, these aquariums don't have the impact nor imaginative interpretation to educate visitors about the ecology and importance of the marine and flora and fauna vis-à-vis the Gulf of Mannar region. One of the world's best marine aquarium is located in Townsville, the Head Quarters of the Great Barrier Reef Authority in Australia. No visitor to the Brisbane-Townsville – Cairns – Darwin region of Queensland and Northern territory will miss an opportunity to visit this aquarium. This aquarium not only provides a window to the diversity of the marine flora and fauna but also the wonders of reef systems as

well as the professionalism in which the Great Barrier Reef Management Authority manages this system.

It is in this context, a **World Class State of Art Aquarium** is suggested to be established in the Rameswaram Island perhaps in Pamban. This way the new aquarium will not pose any competition with the Heritage Museum and aquarium of the CMFRI and the new small scale aquarium of the TN FDC. It is suggested that the Tamil Nadu Government through a Global Tender seek 'Expression of Interest' of interested and experienced corporate sectors and or global consortium to invest and construct a world class aquarium on a 'Build, Operate and Transfer (BOT)' basis. With an annual tourist inflow of two million people which is expected to grow even higher, the prospect of such a facility getting back its investment in a short span of time can not be over emphasized. The well known global marine aquarium specialists are the Great Barrier Reef Management Authority of Australia, The Sea World of USA, Ocean Park Foundation of Hong Kong and the Singapore Aquarium.

Publicity for visitors orientation (production of maps, brochures, curios, sale centers, T-shirt, caps etc)

Publicity is a very important tool to send the desired message into the public. Publicity makes communication with masses a lot easier. Park managers can make use of a wide range of options available for publicizing the theme of conservation and sustainable use of resources like media (print as well as electronic), information boards along the road sides etc., Internet can also be used to publicize this concept.

For the better management of any protected area, satisfaction of its stakeholders is a very important factor. Fisher folk, being the major stakeholder group of the area, their benefits should be given equal importance along with the conservation so as to gain public support for better management of the reserve. Fisher folk can be involved in maintaining the sale centers which sells various products to the tourists, whose inherent theme would be promotion of the park's biodiversity, its significance, conservation and sustainable use. These products may include printed T-shirts, caps, various handicrafts like baskets and mats made from palm leaves etc., The sale of these products should also aim at promoting or getting people to know about the local traditions and culture. These sale centers can be set-up at major tourist spots, by local communities for whom, the financial aid can be given through subsidized loans. This can also be a good option for alternative livelihood for those who are interested to leave fishing.

Visitors management guidelines

Conducting tourism can be beneficial to the park authorities only when organized in a proper manner. Visitors should be asked to enter their details like their origin, duration of stay, their expectations from their visit to this area, and few other questions which can give an idea of their level of understanding about the need for conservation. This helps the management to categorize visitors and lead them accordingly. This also enables the management on how to educate people about the key concept of the park. On entering the reserve, after their registration, they can be handed information brochures which includes what on the park authorities expect the visitors to do during their stay. A list of Dos and Don'ts should be included in these brochures. All visitors should be made well aware of their responsibility

towards the park. Feed back forms are also to be handed over to the visitors so as to enhance the better management of the reserve.

Infrastructure:

Necessary accommodation facilities, roads, road transport, jetty, boats, scuba and snorkel equipment, private rooms, security force with necessary life saving equipments need to be established in each site.

Human resource and capacity building

Plans should identify and fulfill needs of the staff involved in tourism sub-plan. Capacity building is an important determining factor for success of any protected area management plans. Staff should be given enough training not only to organize sustainable tourism, but also to react to any accidents taking place in the reserve. Issues for such training should include components like visitor safety, search and rescue etc.

Apart from this, staff should also be trained in the fields of biology and conservation which would get them a better understanding of what they are doing and why. Training can be obtained from any localized research institutions in the reserve.

Community involvement

The conservation philosophy that has traditionally been used in the past in the creation of national parks has been a closed protection model. Parks were designed on the assumption that they were free from human influences. Large areas of land were set aside for protection. In non-populated areas, this system has advantages. The challenge in East Asia is that in many potential locations where parks were to be designated, people were already living in some part of the area, and human influences were present. Using a traditional model, park agencies inform local communities of the specific park boundaries and tell them which activities are permitted and which are no longer permitted. Much attention is given to regulations and enforcement. In the traditional model very little consideration is given to the interests of communities in and around protected areas (Kim, Kang & Kim, 1999). Often no efforts are made to involve local people in the planning and management of the area, even though many regulations imposed by the park staff have an impact on the livelihoods of the residents. The results include poor relations between government park staff and local communities, confrontations, and lack of support for conservation activities. One example of an alternative to the rigid conservation-focused traditional approach to protected areas is the biosphere reserve. Like national parks and other protected areas, one of their official functions is to protect genetic resources, the environment, the flora and fauna, etc.(conservation function). Biosphere reserves also have two other functions that address the human dimensions of park-human interactions. They are designed to facilitate sustainable development in socio-cultural, ecological and economic terms (development function) and to assist research, monitoring, environmental education and training, and information exchange related to issues on sustainable development at the regional, national and global levels (logistic support function).

Nature based tourism will only be sustainable if the support of the local communities are obtained. This can be attained by making them aware of nature's potential to support the tourism industry, through which the lively hood of these communities

could be generated. Multiple-use planning would be more successful when needs of local people are allowed to be expressed and understood. Local people should be made involved in the tourism plans of the reserve by opening sale-centers of locally made handicrafts showing the local tradition and culture. They may include baskets and mats made out of palm leaves, printed T-shirts which illustrate the history and culture of this area, caps, and other curios and souvenirs. They can also be made involved by allowing them to operate boating, dive operations and other recreational activities.

Visitor survey

Periodic survey of visitors will help management to get a clear idea of visitor needs and market trend, which would enable park managers to offer tourists what they expect. Feedback forms should be obtained from the tourists comprising questions like what they have expected before entering the reserve. Their expectations on their next visitation, suggestions to the park management for better management of the area etc., this kind of periodic surveys will help authorities in keeping a track on the market trends and visitor psychology.

Guide and guide training

Tourists should be posted at important spots with place of religious/archaeological / historical importance. These guides, if selected from the local community, this program would be a useful tool for local economic boost. Guides must be properly trained like providing them with basic foreign language skills, a focus on environmental interpretation, conversation techniques etc., Contents and time frame of this guide training course may be modulated in collaboration with local/international tour operators, Tourism Department officials, Environmental conservation groups etc.,

Networking with other tourism organizations.

Networking of the reserve's tourism plans with other tour operators (local and international) enables the park management to not only attract tourists from far away places, but also in organizing plans in a better manner and upgrading themselves to the existing trends.

MoUs can be obtained from the bordering state's Tourism Departments. Stalls should be kept in the tourism festivals of the other districts of the state for a better publicity. Focus should be on the Biological and cultural wealth of the area.

Activities (adventure, beach, bird watch, cetacean watching, diving and coral viewing):

A clear code of conduct should be written on the permissible activities of the visitors of the reserve, which can prevent the conflicts between the visitor and the management. Boards displaying Dos and Don'ts should be kept at places wherever is applicable.

Taking the advantage of the resources available, a wide range of activities can be organized in the reserve. For example:

- Ulakkaiaruvi, a natural waterfall in the Kanyakumari district, can be promoted as a good trekking site.

- This area has good sandy beaches with calm waters at various places like Danushkodi, Mandapam, Pudumadam, Seeniyappa Dargha, Valinokkam etc., could be promoted as good destinations for recreational tourism where water sports complexes with speed boating, water skiing etc., can be organized by involving local fishermen communities.
- Bird watching is one sector which can attract lot of tourists from all over the world during winter months into this area. There are four bird sanctuaries present in this reserve which can serve good for this purpose. Setting up of basic infrastructure like interpretation centers, watch towers, place for parking vehicles etc., Pedal boating may be permitted where possible.
- Activities like diving and Coral viewing could not be conducted in this area. However, divers can be entertained if taken to the Palkbay side near Mandapam. Glass bottomed boating is already being done at this place. This needs to be publicized more intensively. Snorkeling and diving can also be conducted here provided the tourists are accompanied by trained divers of the reserves tourism related staff. Local people can be involved in these activities (contradicts the table below ,diving depth not very good in these suggested areas proper areas are to be surveyed ,plus these activities are seasonal).

Activities to be prohibited for tourists:

- Dumping of non-biodegradable wastes on the beaches should be prohibited. Separate dust bins for biodegradable and non-biodegradable wastes should be placed on the beaches.
- A trained diver should accompany the visitors while diving and snorkeling to minimize the destruction to the ecosystem and also to reduce the risks of any accidents.
- Sounding vehicular horns should be prohibited in the areas of bird watching.

Prescriptions (Eco-tourism)

A. Suggested Coral reef based eco-tourism

- i. No tourism and its related activities will be allowed inside the Core Zone of the Biosphere Reserve i.e. in the Marine National Park.
- ii. Eco-tourism can be allowed in the buffer zone of the Biosphere Reserve
- iii. As a part of the value addition to the Eco-tourism in the Gulf of Mannar Biosphere Reserve, around 50 km stretches of land and sea areas around the Biosphere Reserve has been identified as 'Value added tourism zone'. All the tourist centers in this area have been assessed and included in the Management Plan for visitors to benefit more.
- iv. Visitors/Tourists need to be guided to all the available tourism resources in the Biosphere Reserve as well as in the 'Value added tourism zone' of the Biosphere Reserve.
- v. Places for coral reef watching have been identified and given in the below table. BR Authority should prepare a detail eco-tourism plan for each site mentioned in the table with the high level participation of local communities.

Place	Location	Activities		
		Coral watching using glass bottom boat	Snorkeling	Scuba diving
Keelakarai	Inside BR		Ö	
Sethukarai	Inside BR		Ö	
Tuticorin	Inside BR		Ö	Ö
Pamban	Outside BR	Ö	Ö	
Mandapam (Palk Bay side)	Outside BR	Ö	Ö	Ö
Rameswaram Island Palk Bay side (other than Pamban)	Outside BR	Ö	Ö	

B. Establishment of State of Art World class Marine Aquarium at Pamban (Rameswaram Island).

- a. Global tender for Expression of Interests for this aquarium on BOT basis by the Tamil Nadu Government.

C. Value addition to Eco-destinations

- a. A series of nature and wilderness based destinations have been identified. With innovative and imaginative upgradation and value addition by the GOMBRA, these sites can evolve into major eco-tourism destinations. It is strongly suggested that these value added eco-destination sites are managed by Community Based Organizations (CBO). A world class model value added eco-destination ‘The Fire Fly Sanctuary in Malaysia’ is classic example.

D. Beach tourism

- a. A number of under utilized but excellent beaches along the Gulf of Mannar Biosphere Reserve coastline have been identified. However, it is strongly urged that these beach developed as ecologically sound leisure recreation destinations with great degree of focus on conservation related activities. For this reason a series of sea turtle hatcheries (a model programme of the SABAH Wildlife Management Authority is appended), beach walk programmes, sand dune based nature trails and backwater, lagoon and swamp tours are suggested to be developed. All these activities are low-tech and through training and capacity building can be very well managed by local educated youths. The prospect of ‘Home stay’ for eco-tourist may also be examined as this region has a host of tradition, culture, festivals, art, handicrafts and cuisine to be shared with visitors.

E. Experimental guided safaris (tour circuits)

- a. With Kanyakumari at the southern end, Rameswaram at the northern end and Tuticorin at the center at least two or three low-volume guided safaris with a mixed range of tourism destinations can be

experimented. For this local entrepreneurs are to be promoted with participation of local educated youths. Three pick-up points and terminals suggested are

- i. Day 1: Madurai – Ramanathapuram – Mandapam – Pamban – Rameswaram (halt) – Day2: Temple visit – Danuskodi lands end – coral watch - Madurai
- ii. Day 1: Trivandrum – Padnabapuram – Kanyakumari (halt) – Day 2: Circular Port – Wind mills – Koodenkulam Power Plant – Manapadu back water and Church – Uvay - Tiruchendur (halt) –Day 3: Tuticorin – coral watch – swamp and lagoon – Mandapam – Rameswaram (halt) – Day 4- Danuskodi – Pamban – Ramanathapuram – Madurai
- iii. Day 1: Tuticorin – coral watch – swamp and lagoon – Mandapam - Rameswaram (halt) – Day 2 - Danuskodi – Pamban – Ramanathapuram – Madurai
- iv. Day 1: Tuticorin – coral watch – swamp and lagoon — Tiruchendur (halt) - Manapadu backwater and Church – Kanyakumari - Trivandrum
- v. Day 1: Tuticorin – coral watch – swamp and lagoon — Tiruchendur (halt) - Manapadu backwater and Church – Uvay – Koodenkulam – wind mills – Kanyakumari (halt) Day 3: Manakudi estuary – Suchindram – Padnabapuram palace - Trivandrum

F. Capacity building and Guide Training

- a. To gradually implement the suggested eco-tourism related activities with community participation it is important to identify and empower CBOs. The success of many of these activities will depend on availability of trained man power in the form of guides. The suggested guide trainings are to be targeted to matriculates (SSLC), intermediates (HSLC) and graduates. The following guide trainings are suggested
 - i. Reef watching , skin diving, snorkeling and glass bottom boat viewing training modules to be developed and trained by GOMBRA and PAD
 - ii. Reef watching and scuba diving training modules to be developed and trained by GOMBRA and PAD
 - iii. Nature and cultural guides training modules to be developed and trained by GOMBRA and other identified professional organizations such as ATREE, WWF, BNHS etc.

ANNEXURE 5.1:
TOURISM RESOURCES IN AND AROUND THE
GULF OF MANNAR BIOSPHERE RESERVE

RAMNAD

RELIGIOUS TOURISM

RMD/Rel/1:

RAMANATHASWAMY TEMPLE: Ramanathaswamy temple here attracts both Sivites and Vishnavites of among Hindus.



Season: People visit this place through out the year. The main festival is during Pongal, in January every year. Visitation also peaks during April and May.

Other Attractions:

Gandhamathana Parvatam: Foot prints of Lord Rama can be seen in this temple. It is believed that, it was from this place, where Lord Rama stood and selected a suitable place for construction of Sethu bridge.



RMD/Rel/2:

KODANDA RAMAN TEMPLE: Situated on the way to Danushkodi at a distance of 30km from Rameswaram. It is believed that, Vibhishana, the younger brother of Ravana was enthroned here by Lakshmana.



Accessibility: Rameswaram is an Island situated on the north eastern side of the Gulf of Mannar. Nearest town is Ramanathapuram (58km).

Airport: Nearest airport is at Madurai (168km). Daily flights by Indian Airlines and Jet Airways comes here from Mumbai and Chennai.

Railhead: Trains come daily from Chennai and Madurai to Ramnad and Rameswaram. Railway is now being upgraded to the broad gauge and hence, trains aren't available now.

Bus Station: Regular bus service from all over the state is available to Ramnad and Rameswaram.

RMD/Rel/3:

DARBHASAYANAM: The Vishnu Temple here is dedicated to Lord Adi Jaganathaperumal.

Accessibility: It is 64 KMs from Rameswaram on the way to Sethukkarai.



RMD/Rel/4:

SETHUKKARAI: A place of mythical importance, *Sethukkarai* (meaning the Sethu Coast) is an important pilgrim centre having religious significance owing to the belief that Lord Rama is said to have constructed a bridge from here over the sea waters to reach Sri Lanka. It is a hallowed place for Hindus as they conduct their religious rites in this place.



Accessibility: It is situated at a distance of about 68 kilometers from Rameswaram
Airport: Nearest airport is at Madurai (110km from Ramnad). Daily flights by Indian Airlines and Jet Airways comes here from Mumbai and Chennai.
Rail head: Nearest Railway station is Ramanathapuram.
Bus Station: Regular bus service is available from Ramanathapuram.

RMD/Rel/5:

UTHIRAKOSAMANGAI: There is an ancient Siva temple, where the presiding deity, Lord Nataraja is carved in Emerald. This emerald idol is kept encapsulated in a paste of sandal wood to protect it from cosmic radiation, which is revealed only during special worships.



The temple s architecture is really breath taking. A chain to hang bell and its main slab was carved out of a single stone. Surrounding the chain, the supporting slab was carved with 12 sun signs. Uniqueness to this temple is a lion s statue, having a stone sphere in its mouth, which is also carved out of a single stone.

Season: Annual 'Arudhra' festival in December attracts a large number of devotees.

Accessibility: this village is situated at a distance of 20km from Ramnad.

Airport: Nearest airport is at Madurai (110km from Ramnad). Daily flights by Indian Airlines and Jet Airways comes here from Mumbai and Chennai.

Rail head: Nearest Railway station is Ramanathapuram.

Bus Station: Regular bus service is available from Ramanathapuram.

RMD/Rel/6:

NAVABHASHANAM: A coastal village is also known as Navashabashanam. It is believed that Lord Rama worshipped Navagraha here. The temple near by here is dedicated to Devi, who is said to have killed the demon Mahishasura at this spot. Hindus perform religious rites for their forefathers here.

Season: Most of the pilgrims coming to Rameswaram will be visiting this place also. So, the visitation to this place follows the trend occurring in Rameswaram



Other attractions:

A temple of Sri Adi Jegannatha Perumal situated near the Navabhashanam where, it is believed that Lord Rama has worshipped the Perumal is also famous at this place.

Possibilities of Ecotourism:

The Mangrove swamp present beside the temple can be allowed to be viewed. Being an important area for birds to nest and breed during the season, it has a potential to attract a good number of bird watchers.

Board-walk method can be adopted in the swamp and a watch tower can be built at this swamp for nature lovers.



Accessibility: This is a coastal village situated northeastern side of Ramanathapuram at a distance of 30km.

Airport: Nearest airport is at Madurai (110km from Ramnad). Daily flights by Indian Airlines and Jet Airways comes here from Mumbai and Chennai.

Rail head: Nearest Railway station is Ramanathapuram.

Bus Station: Regular bus service is available from Ramanathapuram, Madurai and Trichy.

RMD/Rel/7:

NAINAR KOVIL: This village named after the temple Nainar Kovil, is situated at a distance of 30KM from Ramnad on the Ramnad- Sivaganga State high way. Lord Siva is the main deity here. There's an interesting story behind this temple's name. Once, a dumb girl was gifted with speech by Lord Siva who was pleased by her worship. The first word to come out of her mouth was *Nainar*. One more thing which keeps this temple so unique is its architecture. A chain to hang bell along with the main slab was carved out of a single stone. Sivaratri is the main festival for this temple. This temple is one among the five holy lingams, *Pancha Lingam*.



Accessibility: This village is situated on the northwestern side of Ramanathapuram at a distance of 30km.

Airport: Nearest airport is at Madurai (110km from Ramnad). Daily flights by Indian Airlines and Jet Airways comes here from Mumbai and Chennai.

Rail head: Nearest Railway station is Ramanathapuram.

Bus Station: Regular bus service is available from Ramanathapuram.

RMD/Rel/8:

ORIYUR: Oriyur is one of the most revered pilgrim centers for Christians the world over as it is home to the martyrdom of St. John De Britto, a Portugese Jesuit better known as Arul Anandar. It was in this place that the saint was beheaded in 1693 and the sand dune is said to have turned red, believed to be stained by the blood of the saint. Here, one can see a magnificent shrine with its Portugese façade that contains a captivating statue of Arul Anandar offering his neck in humble submission to the executioner.

Season: Devotees from other dioceses and districts visit the shrine on specific dates. In February they come from Dindigul, while in June, they hail from Karunguli and Nagapattinam. During September more than 25,000 pilgrims visit this shrine and offer prayers and offerings. In October another 25,000 pilgrims arrive from the neighboring Sivagangai district and in December pilgrims from Madurai and Melur visit the shrine. Throughout the year, thousands of pilgrims from Sakthikulangara the only

parish in Kerala dedicated to the St. John De Britto come to seek blessings. This is also a favorite place for foreign tourists. Thus, the tourist potential is tremendous and perennial that can be exploited to the maximum extent possible.

Accessibility:

Airport: Nearest airport is at Madurai (110km from Ramnad). Daily flights by Indian Airlines and Jet Airways comes here from Mumbai and Chennai.

Rail head: Nearest Railway station is Ramanathapuram.

Bus Station: Regular bus service is available from Ramanathapuram.

RMD/Rel/9:

EARWADI DARGHA: The tomb of Sultan Ibrahim Syed Aulia, who came from Arabia *via* Cannanore, is about 800 years old. Pilgrims from far off countries like Srilanka, Malaysia and Singapore visit this tomb.

Season: Santhanakoodu Festival is celebrated in February—March attracts thousands of pilgrims.

Possibilities of Ecotourism:

The landing centre and boat building yard at Earwadi landing centre can be converted into a place of experience tourism for visitors.

Accessability: this coastal village is situated at a distance of 30km from Ramnad on the Ramnad – Tuticorin road.

Airport: Nearest airport is at Madurai (110km from Ramnad). Daily flights by Indian Airlines and Jet Airways comes here from Mumbai and Chennai.

Rail head: nearest railway station is Ramnad.

Bus Station: This place is well connected by road with Tuticorin, Ramnad, Madurai and even Chennai.

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HERITAGE/HISTORICAL TOURISM

RMD/HH/1:

DANUSHKODI: This is a fishing village situated on the northeastern tip of the Rameswaram Island, 40km from Rameswaram. Ruins of Church and other government buildings constructed during the British rule present here can be of archaeological value. The marsh here also harbors different migratory birds coming from Europe and Australia during October to January every year.



Possibilities of Ecotourism:

- A bird watching centre, with some basic infra structure like a watchtower and an interpretation centre can be established in Danushkodi.
- The ruins of old buildings can be declared as heritage site, which can attract a good number of tourists.
- A water sports complex like water skiing, speed boating etc., can be established in Danushkodi.
- Eco-friendly resorts along the Danushkodi beach can also be built with the involvement of local communities.

RMD/HH/2:

SETHUPATHY RAJA PALACE: In the early 15th Century the present territories of Ramanathapuram district comprising of taluks Tiruvadanaï, Paramakudi, Kamuthi, Mudukulathur, Ramanathapuram and Rameswaram were included in Pandiyan Kingdom. For a short period, this area was under the Chola Kings when Rajendra Chola brought it under his territory in 1063 AD. In 1520 AD., the Nayaks of Vijayangar took over this area under their control from the Pandiyan dynasty for about two centuries, Marava chieftains-Sethupathis who were Lords under Pandiyan Kings and reigned over this part (17th century). At the beginning of the 18th century, family disputes over succession resulted in the division of Ramanathapuram. With the help of the King of Thanjavur in 1730 A.D. one of the chieftains deposed Sethupathy and became the Raja of Sivaganga. Acting upon the weakness of the Nayak rules, the local chieftains (Palayakarars) became independent. Raja of Sivagangai, Sethupathy of Ramanathapuram was prominent among them. In 173 (date wrong), Chand, a Sahib of Carnatic, captured Ramanathapuram. In 1741, the area came under the control of the Marattas and then under the Nizam in 1744 AD, Nawab's rule made displeasure in the mind of those chieftains. That made them declare the last Nayak as ruler of Pandiya Mandalam against the Nawab in 1752 AD. By that time, throne of Carnatic had two rivals, Shanda Sahib and Mohamed Ali, and this district was part of Carnatic. The British and French supported Chanda Sahib and Mohamed Ali respectively. It paved the way for series of conflicts in the southern part of the continent.

In 1795, the British deposed Muthuramalinga Sethupathy and took control of the administration of Ramanathapuram. In 1803 Mangaleswari Nachiyar was made the Zamindar of Sivagangai After passing of Queen, the Marudhu Brothers took the charge by paying regular revenue to the East India company. In 1801 the Marudhu Brothers of Sivaganga revolted against the British in collaboration with Kattabomman of Panchalamkurichi. Colonel Agnew captured Marudhu Brothers and hanged them and made Gowri Vallbah Periya Udaya Thevar as Zamindar of Sivaganga. After the fall of Tippu Sultan, British took the control and imprisoned the Nawab. In 1792 the Zamindari system was abolished and a British Collector was appointed for administration.

In 1910, Ramanathapuram was formed by clubbing portions from Madurai and Tirunelveli district. This district was named as Ramanathapuram. During the British period this district was called "Rannad". The name continued after independence. Later the district was renamed as Ramanathapuram to be in conformity with the Tamil Name for this region.

The palace of Sethupathy Rajas, situated in Ramanathapuram town is now under the control of the Archaeological Department of Tamil Nadu Government.

WILDLIFE TOURISM

RMD/WL/1:

MELASELVANUR BIRD SANCTUARY: This is an important area of breeding for many of the migratory birds coming from Europe and Australia during the winter months every year. Grey pelican and painted stork are among the birds visiting this place.

Season: November-March/April.



Possibilities of Eco-tourism:

Given a proper publicity and necessary infrastructure, this has potential to attract many tourists from all over the country during the season. A watch tower and an interpretation center should be built. Poaching can be prevented by putting-up a fence around this area. If this is not feasible, a canal should be dug to prevent poachers and grazing animals to enter this area.

Accessibility: This is situated at a distance of about 35KM from Ramanathapuram.

RMD/WL/2:

KANJIRANGULAM-CHITRANGUDI BIRD SANCTUARY: This is situated at a distance of about 5KM from Mudukulathur (24KM from Ramanathapuram) in Ramanathapuram district. It covers an area of around 150Ha. Cormorants, Egrets, Herons, Teals, Pelicans etc., visit this area.



RMD/WL/3:

VETTANGUDI BIRD SANCTUARY: This 38 Ha bird nesting area is situated at a distance of about 11KM from Thiruoathathur in Sivagangai District.

HEALTH TOURISM

RMD/Hea/1:

EARWADI MENTAL ASSYLUM: Mentally challenged people from all over the country come here to get treatment. It is believed that some super natural power residing here is responsible for treatment of these people.

RECREATIONAL TOURISM

RMD/Rec/1:

GLASS BOTTOMED BOATING, MANDAPAM: The Glass bottomed boating facility available at Mandapam is now being maintained by village Panchayat administration, Mandapam. People can avail this facility to view corals present on the Palk Bay side of Mandapam. This is the only one existing in the reserve of this kind which can give recreation as well as education to the public.

RMD/Rec/2:

DANUSHKODI: Refer to RMD/HH/1.

RMD/Rec/3:

KUSHI BEACH: This vast sandy shore fringed with Cassuarina plantations is situated on the Palk Bay side, on the Ramnad- Mandapam road in Ariyaman. A private entrepreneur is maintaining an amusement park for the tourists offering swimming, pedal boating, and other water sports inside the complex. This is an ideal place for picnics, also offering short boat rides now. Water sports can be started here.



RMD/Rec/4:

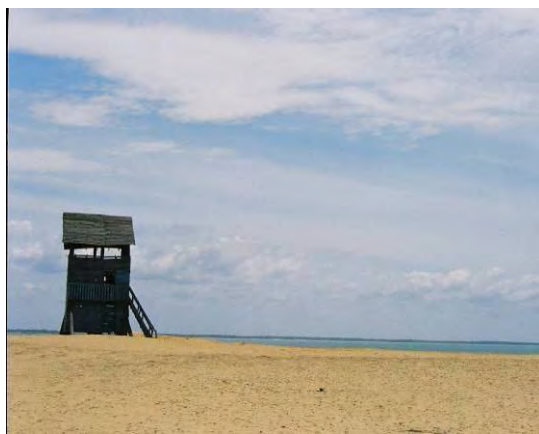
PUDUMDAM: Pudumadam is a coastal fishing village with a vast sandy shore fringed with Casuarina plantation. The calm waters of this shore can offer good recreation for tourist like swimming, snorkeling, light water sports like fast boating, water skiing etc.,



RMD/Rec/5:

VALINOKKAM: This is a coastal village with a vast sandy shore and a patch of rocky shore with basic tourism infrastructure like a watch tower and few resting cottages are present.

Season: January to August is ideal to visit this place.



Possibilities of Ecotourism:

- A water sports complex and an eco friendly resort can be established here involving local fishermen communities.

Accessibility: This village is situated at a distance of about 40km from Ramnad on the Ramnad – Tuticorin road.

Airport: Nearest airport is at Madurai (110km from Ramnad). Daily flights by Indian Airlines and Jet Airways comes here from Mumbai and Chennai.

Rail head: The nearest railway station is Ramnad.

Bus Station: it is well connected by road with regular bus service from Ramnad and Tuticorin.

Other places of the district which can offer recreational tourism are beaches of *Seeniyappa Dargha* (40km from Ramnad), *Pudumadam* (45km from Ramnad) and *Kanjirangudi* (6km from Tirupullani). All these beaches are vast and the calm waters here can offer recreation to the tourists in the form of swimming and snorkeling and other light water sports with the involvement of local communities.

MUSEUMS/AQUARIUMS



RMD/MA/1:

MARINE AQUARIUM, CMFRI: A marine aquarium is being maintained by CMFRI, Mandapam, which had a good number of visitors during past but now, due to lack of proper maintenance, visitation has dropped significantly. However, this still has a potential to attract tourists if maintained properly.

RMD/MA/2:

MARINE AQUARIUM, TNFDC: On the Mandapam-Rameswaram highway, a marine aquarium has been set-up by the Tamil Nadu Fisheries Development Corporation in the compound of Office of the AD (Marine), Mandapam. This is gaining popularity very quickly. On expanding it slightly, this can support even more tourist visitations here. However, interpretation is the only thing lacking here. This could be overcome by employing someone who has knowledge to explain tourists about the fishes here. Information to tourists can also be given through printed brochures and sale of CDs.

OTHERS

RMD/Oth/1:

PAMBAN RAIL SCISSORS BRIDGE: This 2.06km long bridge connects the island of Rameswaram with the mainland. The specialty of this bridge is that it can be opened like a pair of scissors when large vessels needs to pass through the Pamban strait.



TOOTHUKKUDI

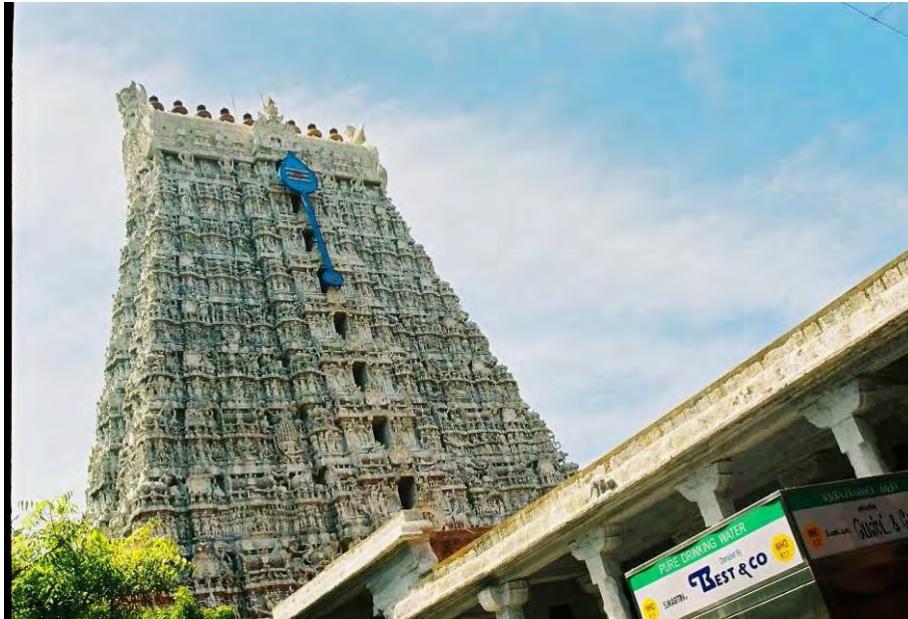
RELIGIOUS TOURISM

TTK/Rel/1:

SANKARA RAMESWARAR KOVIL: This temple is commonly called as '*Sivan kovil*'. This is believed to be very powerful and hence, tourists from far away [places of India come to visit this place very year in the month of January.

TTK/Rel/2:

SENTHILNATHAN TEMPLE: Tiruchendur is very popular for the seashore temple of Lord Subramanian. The temple tower and the sculptures of the temple are worth seeing. It is also ideal for sea bathing.



The temple is one among the six abodes. Lord Subramanya, after defeating Soorapadma came to this place and offered his prayers to Lord Siva. That victory is still celebrated by the pilgrims here during the Tamil Month 'Aippasi' as a festival.

Possibilities of Ecotourism: The vast sandy shore beside this temple can be made use as a site of recreation.

Accessibility: Tiruchendur is situated on the east coast of Mannar, southern to Tuticorin. . It is 40 KMs from Thoothukudi.

Airport: Nearest airport is in Madurai or Thiruvananthapuram.

Rail head:

Bus Station: It can be reached from Chennai, Madurai, Tirunelveli, Courtallam and Kanyakumari by bus.

TTK/Rel/3:

SRIVAIKUNTAM: Temple of Lord Venkateswara is present here, at a distance of 80KM from Tuticorin. The deity is commonly called as '*Kallar Piran*'. Being one among the *Nava Tirupathys*, this temple attracts a huge number of tourists every year in the month of May.

TTK/Rel/4:

PANIMAYA MATHA CHURCH: A famous Church named as "PANIMAYA MATHA" (Lady of Snow) is here. It was built by Portugese in 1714



Season: Feb – Mar.

Accessibility:

Airport: Tuticorin is the nearest airport.

Rail head: Daily trains from Chennai and Bangalore used to come here but, were stopped now due to the up gradation of the track.

Bus Station: This town is well connected by road with busses coming from all over the state.

TTK/Rel/5:

MANAPPAD:It is also located on the sea-shore of Bay of Bengal about 18 Km, from Tiruchendur. An ancient Roman Catholic Church is here where the Cross is said to have been brought from Jerusalem. This Church is also associated with St. Xavier, the famous missionary from West. Since there are other small temples here this place is called as "Chinna Jerusalem" (Small Jerusalem).

Possibilities of Ecotourism: The vast sandy shore beside this temple can be made use as a site of recreation.

HERITAGE/HISTORICAL TOURISM

TTK/HH/1:

PANCHALAMKURICHI: This is a small but historic village from where, the great warrior Katta Bomman Known as "*Veerapandiya Kattabomman*" raised his voice against the British regime in the 17th Century A.D. The existing memorial fort was constructed by the Government of Tamil Nadu in 1974. Sri Devi Jakkammal Temple, the hereditary Goddess of Kattabomman, is located near the fort. The cemetery of British soldiers are seen near the fort. Within the memorial Hall, there are beautiful paintings on the walls depicting the heroic deeds of the saga. The tourists can easily get a good idea about the history of the momentous period from that. The remnants of the old fort is protected by the Archaeological Survey of India. At Kayatar, very near to Tirunelveli , there is another memorial for Kattabomman. It is the place where he was hanged. This was built in 1974. The visitors can see this during the hours of 8-00 to 1-00 PM and 2-00PM to 6-00 PM. The temple for their family goddess Jackammal is nearby to it. His name is "*Vee. Veemaraja alias Jegaveera Pandya Subbramania Kattabomma Durai*" Bommu means the God Sastha Ayyanam Swamy. The British gave the sentence of death by hanging to Kattabomman and others on charges of treason, for their role as freedom fighters.

Accessibility: This village is 3km from Ottapidaram and 18km from Tuticorin.



TTK/HH/2:

OTTAPIDARAM: Ottapidaram continues to be a Tourism centre for Freedom fighters, since it is the birth place of the great patriot V.O.Chidambaranar. His house has been converted into a memorial and is preserved by the government of TamilNadu.

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WILDLIFE TOURISM

TTK/WL/1:

VALLANAD BLACKBUCK SNCTUARY: A sanctuary, the Vallanad Blackbuck Sanctuary (declared under Indian Wildlife (Protection) Act 1972, Sec.18 (1)) is present on the Tuticorin – Kanyakumari road in the Tuticorin district, covering an area of 1641Ha. Apart from Blackbuck, other animals of significance here are, Spotted deer, Macaques, Jungle cats, Mongoose, Hares etc.,

TIRUNELVELI

RELIGIOUS TOURISM

TNL/Rel/1:

KAPPAL MATHA CHURCH: A small church for St. Mary which was under the control of pastors of Goa mission existed here. In course of time, in 1903, this church was converted into a school. On important occasions as per the wishes of the people, festivals were conducted and prayers were offered to her. There was a custom among the young maidens to go to the nunnery in the night and sleep there. On one such occasion they saw a bright light surrounding this Selvamatha statue even though nobody lit a candle. Many people of Uvari witnessed this light which was there for over an hour. This incident occurred on 18th September which is celebrated as a festival. People used to keep the statue in a chariot and come around this town to bestow the blessing of Mary to the people of Uvari. Due to sea erosion the old church got damaged. Therefore the people decided to construct a new church for which the foundation stone was laid down by Fr. Thomas in 1970, 25th January and the work was finished on 1974. This church designed as a ship, is called Kappal Matha church after its design. It is beautiful church facing the blue sea. The waves rolling near this church gives us an impression that this ship shaped church is sailing on the sea which is a feast to eyes.



WILDLIFE TOURISM

TNL/WL/1:

KOONTHANKKULAM: A tiny village in the far south, Koonthankulam in Nanguneri Taluk of Tirunelveli District is emerging as a new favorite for migratory birds. It may soon be catapulted into the list of popular water bird sanctuaries in the country. This village is sparsely populated. Migratory birds start coming by December end and fly away to their northern homes by June or July after they lay eggs, hatch them and the young ones grow old enough to fly with the older ones. About 35 species of birds visit this calm but congenial village for breeding. Birds such as Painted Storks migrate here from North India and East European Countries. Similarly the Flamingoes also fly-in mainly from the Rann of Kutch also lay, hatch and rear their young ones in the village.

Season: December – June/July.

Accessibility: It is just 38kms. away from Tirunelveli and is in the nearby Nanguneri Taluk.

Airport: Madurai/Trivendrum.

Rail head: Tirunelveli

Bus Station: Tirunelveli.

KANYAKUMARI

RELIGIOUS TOURISM

KK/Rel/1:

KANYAKUMARI BHAGAVATHI AMMAN TEMPLE: Kanyakumari derives its name from Goddess Kanyakumari Amman, the presiding deity of the area. The most prominent temple, the Kumari Amman, is dedicated to the goddess Parvathi as a virgin. The temple situated at the edge of the ocean for Goddess Kanyakumari has the legendary account that once Banasura, the demon king got supremacy over Devas and meted out cruel punishment to them. The Devas performed a Yagna pleading to annihilate the evils. Goddess Parasakthi came to Kumari in the form of a virgin girl and began her penance. Meanwhile Lord Shiva fell in love with her and arrangements for the marriage were made in the midnight a particular day. Now the Devine sage Narada realised that their marriage would destroy the chances of annihilating Banasura because he could be killed only by a virgin. When Lord Shiva was on his way to Kanyakumari from Suchindrum at Valukkamparai 5 kms south of Schindram, Sage Narada assumed the form of a cock and crowed falsely heralding the beak of dawn. Thinking that the auspicious time for the marriage was past, Lord Shiva returned disappointed. The Goddess too decided to remain virgin after that. Then, when Banasura attempted to win the Goddess by force, she killed him with her Chakragudha, and relieved the suffering s of Devas. Then she resumed her penance and remained virgin.

KK/Rel/2:

1500 year old SIVA'S TEMPLE: This temple dates back to the 5th century, is believed to be the first temple of South India.

KK/Rel/3:

SUCHINDRUM: This holy place is located on the bank of the river Pazhayar, adjoining fertile fields and coconut groves and the temple is dedicated to Sri Sthanumalayan. The word denotes Siva, Vishnu and Brahma. As Sthanu represents Siva, Mal represents Vishnu while Ayan represents Brhamma i.e. Siva, Vishnu and Brhamma in one form Lord Indra had been cursed and had to seek immediate redemption. He came to Gnana Aranya as this place was then called and offered worship to Lord Shiva. Relieving Indra of his curse, Lord Shiva granted him of his wish that the place where he attained purification should henceforth be called Suchindrum. Another story goes to say that the Trimurthys i.e. Brhamma, Vishnu and Shiva, cajoled by their divine consorts came down to the earth to test the chastity of Anusuya, wife of sage Athri at Gnana Aranya. The Gods for this misadventure had to suffer a curse from the Rishipatni and to undergo the purification process, before they could be restored to their former glory. Suchindrum means the place where Indra attained *Suchi* i.e., purification. The Sthalapurana has it that Indra suffered a curse from sage Gowthama, when he stealthily cast amorous glances at Ahalya the wife of Gowthama.

It is said that Thanumalaya Swamy temple is the only shrine dedicated to the Trinity in India. The present structure of the temple is the work of a number of persons spread over a number of centuries. It is a complex of many beautiful structures constructed at various times and is one of the best specimens and a store house of the Dravidian style of art and architecture.



Season: Pilgrims coming to Kanyakumari will visit this place and hence, this follows the same trend of visitorship as Kanyakumari.

Accessibility: Suchindrum is a small village about 12 km. from Kanyakumari and about 7km from Nagercoil.

Airport: Trivendrum, at a distance of 85km is the nearest airport.

Rail head: Nagercoil is the nearest railway station, at a distance of 7km from here.

BusStation: Nagercoil is well connected with frequent bus services from Chennai, Trivendrum, Bangalore and the rest of Tamil Nadu.

KK/Rel/4:
ST.XAVIER'S CHURCH:



St.Xavier, an outstanding and dedicated priest visited the coastal areas of Tamil Nadu from Goa, he never missed the opportunity of visiting Kottar in Kanniyakumari district which was a celebrated commercial centre at that time. During his stay at Kottar, he used to worship St. Mary in the small temple. He was popularly known as Valiya Pandaram among the people of Kottar. While he was at Kottar, he averted the invasion of Padagas on the people of Venad which was appreciated by the king, who became closer to the Priest. In recognition of Xavier's services, the king allotted a land to him for the purpose of constructing a catholic church at Kottar. There was already a church in 1544 in the same place, where the St. Xavier s church stands now. The church records show that the church was built in the year 1600 A.D. In the year 1865, the Church was enlarged and the shrine of our lady was also renovated and vaulted over. In 1930, the church was raised to the status of a Cathedral. In 1942, in commemoration of the fourth centenary of the arrival of St.Xavier in India, a beautiful tower to the saint, a grotto to Out Blessed Mother and a small shrine to St.Ignatius who sent him to India were constructed in the Cathedral premises. In 1955, the church was further extended and the chapel of Our Lady was incorporated into the enlarged church. The Church of St. Xavier enjoys a great fame as a place of miracles from early times.

Season: The annual festival is celebrated during the month of November—December lasting for 10 days.

Accessibility: Nagercoil is the district head quarters, which is well connected by road and by rail.

Airport: Trivendrum is the nearest airport, at a distance of 65km.

Rail head: Nagercoil is connected with various places by frequent trains.

Bus Station: Busses from all over TamilNadu and from Trivandrum and Bangalore comes to Nagercoil frequently.

KK/Rel/5:

PEER MOHAMED DARGHA: There is a durha named Peer Mohamed Oliyullah Durha at Thuckalay named after the great philosopher Mohamed Appa, who was born in Tenkasi of Tirunelveli District. After spending sometime in spiritual pursuits in Peermedu of Kerala State he came and stayed at Thuckalay. Being a Tamil poet of great eminence, he wrote many books on philosophy. He had intimate relationship with the Kings of Chera dynasty. It is said that he laid foundation stone for the Padmanabhapuram Granite Fort. The Anniversary of the great philosopher poet is celebrated every year on a grand scale on the full moon day in the month of Rajap. Both the people of Kerala and Tamil Nadu attend the celebrations on large numbers irrespective of their caste, creed and religion.



Accessibility: The ancient historical town Padmanabhapuram is one of the four municipalities in the district is 55 Km. south of Trivandrum, about two km. east of Thuckalay and 35 km. from Kanyakumari on the Trivandrum-Cape Comerin road.

Airport: Trivandrum is the nearest Airport.

Rail head: Nearest rail heads are Nagercoil and Trivandrum.

Bus Station: This place is well connected by busses coming from Trivandrum, Kanyakumari and Nagercoil.

HERITAGE/HISTORICAL

KK/HH/1:

PADMANABHAPURAM: This town is surrounded by a fort with an area of 187 acres. The ancient capital of Travancore is thought to be constructed before AD 1601. The palace with an area of seven acres is situated in the very centre on the Padmanabhapuram Fort, amidst hills, dales and rivers. The palace which is situated in Kanyakumari District is under the control of a Curator of the Archaeological Department, Government of Kerala. The fort which was built with mud originally was dismantled and reconstructed with granite by Maharaja Marthanda Varma. The height of the walls varies from 15 to 24 according to the inclination of the ground.

Entrance Hall: - The entrance to the main edifice is controlled by another ornamental gateway with retainers for watch and ward. The gabled entrance has wooden ceiling profusely ornamented with lotus medallions. The most striking feature of the entrance is the clock-tower which is one of the oldest in India erected in 1832 A.D. and still continues to be in working order. The first floor the Poomuham has a council chamber or Mantrasala which is meant for holding discussions with ministers and prominent citizens. The floor off this hall, which is polished with the admixture of coconut shell ashes, eggs fermented in molasses and lime reflects the figure like a mirror. Next to the Mantrasala is the Dancing Hall which was used exclusively for the members of the royal family. Adjacent to the Council Chamber and to the south of dancing hall is the dinning hall called Uttupura , with two floors (the ground and the first) each measuring roughly 78 by 6 metres and it would accommodate about 2000 people at a time. Feeding of about 2000 poor persons, it is said, was done here every day and so the king was called Dharmaraja.



UPPIRIKA MALIKA: The most attractive building in the whole palace is the Uppirika Malika which consists of three storied. Uppirika is the abbreviated term of Muppirika which means the residence of the eldest member of the family. A wooden cot is erected on the top most floor in the belief that Lord Vishnu the chief deity. The first floor contains a wooden cot made of 64 medicinal plants, on which Maharaja used to sleep. The medicinal cot was presented to Maharaja Marthanda Varma by the Dutch East India Company in 1750, as a mark of friendship.

THE NAVARATHRI MANDAPA: To the west of the Zuppirika Mandapa is the Navarathri Mandapa which is a spacious hall of exquisitely beautiful granite pillars with drooping pendants reminiscent of the Nayakar style of architecture. In the Navarathri Mandapa, performances of Bharatha Natya and musical recitals took place in the royal presence.

KK/HH/2:

VATTAKOTTAI: Vattakottai, a granite fort six kilometres northeast of Kanyakumari cape, forms the terminal of a line of ramparts known as the South Travancore lines built by Marthanda Varma to serve as defence for Nanjil Nadu. It is rectangular in shape and covers an area of about three and a half acres. The fort is enclosed by walls 25 to 26 feet high, including the parapet, 29 feet thick at the front, 18 feet at the corners and 6 feet at the rear. The portion running into the area is the most strongly built under the orders of De Lannoy during the reign of Mathandavarma (1729-58). About 1810 A.D. the British forces under the command of St. Leger marched into Nanjilnad through the Aramboly pass and demolished the defence lines. The small river by the side of the fort, and the green vegetation all around add to the scenery of the fort and has now become a holiday resort and picnic centre.



It is said that there is a subway or tunnel about four feet width, supposed to connect the padmanabhapuram palace. Now the tunnel has been closed. On the northern side of the fort is found a slop to being the canon from the lower to the upper part of the parapet of the fort. There is well of about 6m diameter. The whole wall around the fort

is repaired and fresh mortar is being applied. Literary or epigraphical evidences are not in store to know much about Vattakotai. However, from the evidence left by the fort itself, it may be presumed that his fort was the military base to protect the Kumari port which was a rich pearl harbour. Since the emblem of the Pandya Kings was Fish and we find this emblem in some of the places of the fort, it can be safely concluded that the Pandya Kings had control over this fort for sometime. Next to Vattakottai, we can see the traces of a light house in Leepuram being called so after Colonel Lee who has destroyed most of the Kadukkarai Kanyakumari Fort in 1806. This is a picnic spot, the sea is calm and suitable for bathing.

Season: This is one place which doesn't seem to follow any seasonality in visitorship of tourists. Tourists come here all round the year. During the month of January, pilgrims who've visited the Sabarimalai, come here to take a holy dip in the '*Tri-Sea Confluence*' at Kanyakumari. An increase in the numbers is also seen in the summer months of April and May.

Possibilities of Ecotourism:

- The Sanguthurai beach, Chothavilai beach and the Muttom beach are the popular beaches around Kanyakumari at a distance of around 10-15km from Kanyakumari. These are suitable just for a day's recreation and hence, ecofriendly restaurants involving some localities can be started here.

Accessibility: Kanyakumari, the southern most tip of the Indian Peninsula is well connected by rail, road and by air from various locations in India.

Airport: Trivandrum, at a distance of 85km is the nearest airport.

Rail head: Trains come from various important stations like Chennai, Howra, Delhi, Bangalore etc., frequently. Nagercoil is one town which is also well connected by trains. This is at a distance of 19km from Kanyakumari.

Bus Station: Kanyakumari is well connected with frequent bus services from Chennai, Trivandrum, Bangalore and the rest of TamilNadu.

WILDLIFE TOURISM

KK/WL/1:

UDAYAGIRI: The fort was rebuilt in the reign of Marthandavarma, the Venad King, during 1741-44. Under the supervision of De Lannoy, the Belgian General, who served as the Chief of the Travancore army; East India Company's troops were stationed there till the middle of the 19th century. Foundry for the manufacture of guns, mortars and cannon balls were also established within the fort under the supervision of the General. In the early days, the fort was of strategic importance. Prisoners captured in the campaign against Tippu were confined in this fort for sometime. It is further said that a brass gun 16 ft. long bored as a 22 ponder, found in the fort could not be removed even for a few yards by a large number of people, even with the help of 16 elephants. A village has come up in front of the fort. The people, who live here, are mostly agriculturists. A few of them are engaged in trade. Pottery making is the chief Industry among a section of the people. Now, the District Administration, with the help of Forest Department has set up a Biodiversity Park over here. Tourists can see deer, ducks, fountains, birds and over 100 varieties of trees inside the fort.

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ADVENTURE TOURISM

KK/Adv/1:

ULAKKAI ARUVI: This is a natural waterfall situated in Azhagiapandipuram village of Thovalai Taluk. Water is available in this water fall in the summer season. Many tourists come here for bathing and to enjoy the nature. The pathway to this waterfall lies in the Reserve Forest.



HEALTH TOURISM

KK/He/1:

MARUTHUVA MALAI: This is also known as the Marunthu Vazhum Malai the abode of medicinal herbs, forms from part of the Western Ghats. According to tradition, the Maruthuva Malai is a fragment of the Sanjeevi Mountain, a piece of which fell down here, and it was carried by Hanuman from Mahendragiri to Srilanka for healing the fatal wounds of Lakshmana, the brother of Rama, the epic hero. It stretches for more than a km, reaching a height of 800 feet at the highest point. It is about 11km. from Nagercoil and 7 km from Kanyakumari.

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RECREATIONAL TOURISM

KK/Rec/1:

KANYAKUMARI BEACH: This is is of the most highly visited beaches of India. Being the southern most tip of Indian peninsula, people from all over the world come here to look the tri-sea confluence at this point. Pilgrims also visit this place after finishing their pilgrimage to Sabarimalai.



KK/Rec/2:

CHOTHAVILAI BEACH: This beach is about 10 Kms from Kanyakumari, is one of the best natural beaches of the district. The beach has shallow water and High sand dunes on the back ground. The District Administration has through its own funds and through the funds of MPLAD scheme, put up rest shelters, kudils and a view tower over here for the benefit of tourists. The tourists can reach the beach through the newly laid coastal road which is a very beautiful drive along the sea-coast.



KK/Rec/3:

SANGUTHURAI BEACH: Sanguthurai is a beautiful beach resort and is very convenient for the local Population of Nagercoil. It is only about 10 kms from the city.

Unfortunately no infrastructure facilities were available in this beach. The district administration has now sanctioned a project for putting up of a children's park, seating facility, open huts (Kudils) with Terracotta roofs and lighting facility at the beach at a cost of Rs.6.00 lakhs. The entire work has been completed. It is also proposed to put up a few shops for Women Self Help Groups at the site, which can provide eatables to the on coming tourists at the beach side.



KK/Rec/4:

MUTTOM BEACH: The famous beach at Muttom is located about 16 kms from Nagercoil and 32 kms from Kanyakumari. Muttom is famous for its beautiful landscaping and high rocks dipping into the sea at the beach-side. The sun set view point at Muttom is one of the most Panoramic view points in the district. Another attraction of Muttom is the century old light-house built by the British. However so far this beautiful beach has always been unsafe for the tourists since the rocks on which tourists go to see the sea view are slippery and a number of fatal accidents have

occurred over the past few years. The district administration, decided to put protective stainless steel fencing across the entire dangerous areas and also to put up small open huts at the rock tops for the tourists to sit and watch the massive sea waves leisurely with protection from sun and rain. The fencing work and the small huts have already been completed to the delight of the tourists who mob the beach in hundreds during week ends. Sitting benches have also been constructed in a circle for the elders to chit-chat, relax and enjoy the sun set. Seeing the response of the tourists, the district administration has sanctioned for the construction of a toilet complex, a small shopping complex and a children's park at a cost of Rs.11.60 Lakhs and there are plans to undertake sculpture - works across the rocks to add to the ambience of the area.

KK/Rec/5:

TIRPARAPU: The Kodayar makes its descent at Tirparappu and the water fall at this place is about 13km. from Pechiparai dam. The river bed is rocky and about 300 ft in length. The water falls from a height of nearly 50 feet and the water flows for about seven months in a year. The whole bed above the falls is one rocky mass which extends up to a distance of about quarter of a kilometer upstream where the famous Thirparappu weir has been constructed for supplying water to the paddy fields. On either side of the river, on the left bank of the river in between the water falls and the weir, there is a temple dedicated to Siva enclosed by strong fortification. The District Administration has recently constructed a swimming pool for children over here which is very popular among the children. There are also few boats available for the recreation of tourists.



MUSEUMS/AQUARIUMS

KK/MA/1:

GOVERNMENT MUSEUM, KANYAKUMARI: This museum depicts the history of Kanyakumari and peoples' life style. For some reasons, this attracts Keralites mainly.

KK/MA/2:

KAMARAJAR MANIMANDAPAM: Another monument **Kamarajar Manimandapam** was raised and dedicated to Late. Sri Kamarajar, The freedom fighter, Former Chief minister of Tamil Nadu, President of Indian National Congress. He was popularly known as Black Gandhi among the masses and king maker during congress regime. This monument was constructed where his ashes were kept here for public to pay homage before immersion into the sea.

OTHERS

KK/Oth/1:

VIVEKANANDA ROCK MEMORIAL: This is another place in Kanyakumari which attracts large number of tourists. As its name implies, it is essentially a sacred monument, built by the Vivekananda Rock Memorial Committee to commemorate the visit of Swamy Vivekananda to Shripada Parai during 24th, 25th and 26th December 1892 for deep meditation and enlightenment. From very ancient times, the rock has been regarded as sacred place. In Puranic tradition, it has been known as Sripada Parai: meaning the rock, that has been blessed by the touch of Shripada feet of the Goddess. On the rock, is a projection similar in form to a human foot and a little brownish in complexion, which has traditionally, been revered as a symbol of Shripadam. According to legend, it was on this rock that Goddess Kanyakumari did Tapas. The memorial consists of two main structures, viz (i) Vivekananda Mandapam and (ii) Shripada Mandapam.

VIVEKANANDA MANDAPAM: This 180 - 11 ½ X 56 Mandapam consists of

- (1) Dhyana Mandapam, i.e., Meditation Hall with six adjacent rooms
- (2) Sabha Mandapam or the Assembly Hall including Pralima Mandapam (statue section) two rooms, a corridor and an open Prakaram round the Sabha Mandapam
- (3) Mukha Mandapam (Portion) and
- (4) the Front Entrance steps with two rooms and a corridor below the steps.

SHRIPADA MANDAPAM: This square hall consists of

- (1) Garbha Grahana i.e., (Sanctum Sanctorum)
- (2) the Inner Prakaram
- (3) the Outer Prakaram and
- (4) the Outer Platform all around.

Both the Mandapams are so designed that the vision of Swamiji in the statue would be seen direct towards the Shripadam.



KK/Oth/2:

TIRUVALLUVAR STATUE: Thiruvalluvar is the immortal poet of Tamil Nadu and has given to the world Thirukkural. The memorial statue of Thiruvalluvar is in Kanyakumari. The pedestal of the statue is of 38 feet height and the statue over it is 95 feet tall with a grand total of 133 feet for the entire sculpture. The 3 tier pedestal known as Atharapeedam is surrounded by an artistic Mandapa known as Alankara Mandapam with 38 feet height. Surrounding the Alankara Mandapa stand 10 elephant statues signifying 8 directions with earth and space down. The father of Sri. Rama, the hero of Ramayana was called Dasaratha as he was able to charioteer in ten directions. To help the tourists to worship the holy feet of Thiruvalluvar 140 steps are constructed inside the Mandapa. The pedestal with a height of 38 feet represents the 38 chapters in the Book of Aram in Thirukural and the statue of 95 feet on the pedestal represents the total chapters in Porul (70 chapters) and Inbam (25 Chapters). Thus the statue symbolically, and artistically signifies that the theme of Porul and Inbam are based on Aram.

KK/Oth/3:

MATHUR HANGING TROUGH BRIDGE: This is the tallest as well as the longest trough bridge in Asia, having a height of 115 feet and a length of one kilometre. Constructed in 1966, this bridge has become a place of tourist importance and hundreds of tourists visit this place. This is situated in Mathur, hamlet of Aruvikkarai revenue village in Thiruvattar Panchayat Union. The bridge has been constructed at Mathur across the river Parazhiyar at a cost of Rs. 12.90/- lakhs and the trough canal (Pattanamkal canal) on the bridge carries water for irrigation from one side of a hill to the other side of a hill. The trough has a height of seven feet with a width of seven feet six inches. The canal is being shouldered by 28 huge pillars. By the unrelented efforts of late Thiru. K. Kamaraj, the former Chief Minister of Tamil Nadu, this canal was constructed as a drought relief measure and for the development of agriculture in Vilavancode and Kalkulam Taluks. The District Administration has recently put up a staircase from top to the bottom of the bridge and also built a children's park and bathing platforms over here.



KK/Oth/4:

PECHIPARAI: About 43 km. from Nagercoil this dam has been constructed. This dam in Kalkulam Taluk, was built during the days of the Maharaja Sri Moolam Thirunal across the river Kodayar. The construction of the dam was designed on the pattern of the Periyar dam in the Madurai district. The length of the dam is 425.1 mts. It has a catchment area of 204.8 sq.km. There is a camp shed provided at the dam side for the visitors. The weather is very pleasant and hence attracts a large number of tourists. The reservoir is surrounded by dense forests which are famous for their valuable trees and rich wildlife such as tiger, elephants, deer etc. A hill tribe, small in number known as Kanikars dwell in the dense forests around the lake.

Season: Winter months are best suited for bird watching since a good number of migratory birds come for breeding in this place.



Possibilities of Ecotourism:

- This place is already having a little tourist infra structure with few pedal boats and rest houses along the dam. This could be made used by involving the local communities in operating this.

KK/Oth/5:

MUKKADAL: This is a natural dam constructed by T.Chitirai Maharaja. It supplies water to Nagercoil Municipality and it is also proposed to get water from here for Suchindrum and Kanyakumari. It is very picturesque spot and ideal for picnics by groups.

Accessibility: Pechiparai is situated at a distance of 43km from Nagercoil.

Airport: Trivandrum is the nearest airport.

Rail head: Nearest railway station is Nagercoil.

Bus Station: Busses come from Nagercoil and Trivandrum very frequently.

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
7	Interpretation, education, eco-tourism and visitors management											
	Establishment of State of the Art Marine Conservation Interpretation cum Education Center (MARCONI) with all necessary facilities mentioned in the Management Plan	400	10	10	20	20	25	25	30	30	35	605
	Establishment of five information centers	100	5	5	5	5	5	7	7	7	7	153
	Establishment of World Class State of Art Aquarium in the Rameswaram Island perhaps in Pamban	5000 (through BOT mode)										
	Necessary infrastructure development to facilitate and enhance the eco-tourism (10 Glass bottom boats, 3 jetties, snorkeling gear, diving gear, tourist rest huts, etc)	310	20	20	30	30	35	35	40	40	45	605
	Human resources and capacity building and guide training	25	25					15				65

5.5. Sustainable Eco-development Plan for Community Involved Livelihood Generation

The term "eco-development" seeks to reflect the interdependency between environmental problems and those connected with economic growth, demography and poverty. This leads to the principle of a trade-off between development and ecology or "eco-swap", according to which the project undertakes to support activities meeting the community's immediate needs in exchange for the latter's commitment to environmental restoration or conservation activities, in the spirit of a "social contract for long term concerted development" (Michel & Lazarev, 1997). The notion of participation brings the human development dimension into the eco-development concept, by introducing the idea of local control over decision-making (Michel & Lazarev, 1997).

With the setting up of Gulf of Mannar Marine National Park in Tamil Nadu, under the provisions of Wildlife (Protection) Act 1972, covering the 21 offshore islands along the Ramanathapuram and Tuticorin Districts, fisherfolks have lost livelihood access to the common property resources from the coral reef-based fisheries operations. However, to eek out a subsistence of livelihood option, they still resort to some level of marine resource harvesting from the protected area. By setting up the Gulf of Mannar Biosphere, a large buffer zone of seascape surrounding the Marine National Park as well as a coastal terrestrial landscape have been earmark as a multiple-user area where a diversity of alternate livelihood options are to be facilitated by the Gulf of Mannar Biosphere Reserve management agencies in an attempt to wean away the dependency of coastal communities from a multitude of marine resources. This major marine protected area management objective has been met with only to some extent by initiating some "eco-development measures" by the GOMBRT in the year 2002 following the India Eco-development Program (IEP) model. In this present plan, it is proposed to enhance the eco-developmental activity in a planned manner within the GOMBR limits following the guidelines setforth by Wildlife Institute of India (WII, 2004). This is proposed to be achieved by a proper assessment of the socio-economic dependency levels of dependent communities on coastal and marine biodiversity, identifying aternate livelihood options, enhancing community empowerment and setting in place proper intersectoral institutional mechanisms for the sustainability of such eco-developmental initiatives. The plan therefore examines the cultural, socio-economic and the sicio-political situation to suggest an implementatble eco-development plan.

5.5.1. Cultural and social Consideration in the Gulf of Mannar Biosphere Reserve Region

In Thavukadu locals believe the Gulf of Mannar to be a male sea, due to the nature of its rough waves, which hit against the reef belt and subside in force by the time they arrive at the shore. In contrast, Palk Bay is believed to be a female sea, where like a woman the waters are calmer most of the time, but once they awake due to wind or storms the damage is heavy, for there is no reef belt to control the action of the waves. (Rengasamy *et al.*, 2003).

Among the coastal communities of the Gulf of Mannar, India, locals believe that Appa Island is the home of an island God (*Santhanamariamman*) and by pleasing this God they will be protected from evil spirits when they stay on the island. It is also believed that another god (*Muniyasamy*) resides in a coral mound just near the island and close to an area known for dangerous currents and an underwater cave. Fisherfolks are warned that in order to escape from the wrath of deities they should not approach this area (Rengasamy *et al.*, 2003).

In the cultural and historical background of India, the Gulf of Mannar occupies a prominent place. The famous pilgrim centre of Rameswaram is situated in the Gulf, on the island of Pamban. It is connected with the religious hindu epic the Ramayana. It is said that Rama worshipped Shiva here, after his victory over Ravana, on his way to Ayodhya. The places mentioned in connection with Ramayana are situated in the environs of Rameswaram, and draw thousands of pilgrims daily from all over India (some of the other places are Dhanushkodi, Kandamadhana Parvatham, Navabashanam, villundal etc.). In fact the mainland and coastline of Ramnad 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, Devipattinam, Darbasaynam). Rameswaram is known as Sethu. The adage “from the Himalayas to Sethu” speaks of the oneness of India since prehistoric times.

The Raja of Ramnad from the mediaeval times (with the title “Sethupathi”) ruled over Rameswaram and the islands in the region of the Gulf of Mannar also came to be in his possession. It is said that the later parted away some of the islands either as gifts for use in trade to the businessman. Thus, some of the islands like Muyal tivu and Nallathanni Tivu were either fully or partly owned by individuals. Some of the islands like Krusadai were parted to the British long ago.

5.5.2. Livelihood-based scio-economic considerations in the Gulf of Mannar Biospher Reserve region

India is one of the lower ranking Medium Human Development countries. Coastal areas of India are heavily populated. Reef fisheries in India have been estimated to contribute to 5–10% of the total marine landings (Pet-Soede *et al.*, 2000), and contribute significantly to the subsistence and income of coastal fishing communities of Gulf of Mannar regions. Estimates of the numbers of small-scale fishers, amount to 21 000 in the Gulf of Mannar (Rengasamy *et al.*, 2003).

In the Gulf of Mannar, coral reefs fringe a chain of 21 coralline islands, sheltering mangroves, lagoons and a shallow ‘trapped sea’ with extensive seagrass beds. This mosaic of coastal ecosystems forms the basis for sea-based livelihoods among the coastal communities, including the extraction of seaweed, shells, lobsters, sea cucumbers and reef fish from the reef flats and lagoons; and the harvest of crabs, squid, fish and shells from the seagrass beds and ‘trapped sea’ between the islands and the mainland coast. For the coastal people of the Gulf of Mannar coral reefs are perceived as part and parcel of the ocean, as expressed below:

- ‘It is the reef from where everything sprouts and spreads throughout the entire sea’
- ‘The reef is a natural nursery’

- ‘It is because reefs are there and its fertility, we get different varieties of fish to catch and we have to keep different nets’ (Rengasamy *et al.*, 2003)

Socio-economic activities for livelihood generation in the Gulf of Mannar region

Exploitation of fishery resources in the inshore waters had been the sole occupation of several thousand fishermen families living along the Gulf of Mannar coast for centuries. They have been in such close intimacy with the sea that their life-style, culture, community and social life all centres around the sea.

Fisheries is the predominant industry in the coastal belt of the Gulf of Mannar. In Tamil Nadu marine fisheries account for 82% of all active fishermen, who are responsible for 76% of the total fish production in the state and 8% of the total marine catch for India. Tamil Nadu’s fishing fleet numbers 64 126 vessels of which 84% are traditional crafts (known locally as *Vallams* and *Vathai*) contributing 47% of the total fish landings. There are an estimated 3,16,422 people earning their livelihoods from marine fishing in the state, distributed among 591 fishing villages.

According to a Tamil Nadu marine fisherfolk census undertaken during 2000, 98 of these villages are located along the Gulf of Mannar coast with an estimated population of 72,766, of whom it is estimated 21,000 are active fishermen. Of the two coastal districts bordering the gulf, Ramanathapuram contributed 23% to the overall marine fish production in the state during 1998–1999, the largest production of any district in Tamil Nadu, while Toothukkudi contributed 13%. Traditional crafts were responsible for 39 and 38% of the overall production for Ramanathapuram and Toothukkudi districts, respectively.

Traditional or small-scale fishing is carried out predominantly in the ‘trapped sea’ between the islands and the mainland coast and in the shallow waters and reef areas surrounding the islands. Fishing takes place throughout the year, but changes in nature according to local availabilities of different species. Wind patterns generally restrict the use of small-scale crafts between the months of August and October, and during this period many fishermen simply switch to labouring on larger mechanized boats.

In addition to fisheries-related occupations along the coast, there are opportunities for employment in salt extraction, particularly in the western side of the Gulf near Tuticorin, and also in Palmyrah (toddy) tapping and agricultural labour. Skilled work is also undertaken, with mat weaving common in Ramanathapuram district. Moving inland from the coast toddy tapping and agriculture are the predominant occupations with small business-related opportunities prevalent near Rameswaram in connection with the tourism in this area (SSFRD, 1998).

Fishery based livelihood in Gulf of Mannar Biosphere Reserve region:

Marine Fisheries:

The livelihoods of people in the coastal buffer zone of the Gulf of Mannar Biosphere Reserve region largely depend on coastal and marine resources. However, agriculture and allied activities also plays a significant role in providing livelihoods for the poor. The activities of coastal-based people largely include fishing, salt making and

seaweed collection while other marine-based activities are also gaining importance. Ninety percent of the fisherfolk in the GOMBR region are artisanal (using wind or small engine powered craft) and only 10% use mechanized trawlers.

There are about 47 fishing villages along the Gulf of Mannar Marine National Park coast, of which 38 are in Ramnad District and 9 villages are in Tuticorin District. 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 which more than 12,000 are active fishermen.. The fisher-women are engaged in allied activities such as marketing, dry fish and net mending. The Department of Fisheries had in the recent years taken steps to formulate and implement special schemes to benefits fisherwomen in the hope that the fishing community will to gain economically and socially.

The GOMBR coastal belt has a very large proportion of country crafts, about 87%, against the mechanised boats, about 13%, in the total crafts. Thus a very large segment of traditional fishermen population has to work closer to the shoreline in shallow waters where the resources are poor and thereby their income is also poor. There are increasing number of instances where, due to poor catches and diminishing economic returns, the owners are selling the mechanized boats.

The fishermen employ traditional crafts such as catamarans, vallams, masula boats and dug-out canoes for their fishing operations (Table 5.5.2). The mechanized 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 mechanized under the Modernization Programmes introduced by the Department during the last few years. Despite the mechanization 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.

Table 5.5.2. Types of fishing crafts operating in the Gulf of Mannar Biosphere Reserve region.

Crafts	Length	Mode of Operation	Machinery		Fish Workers
			Cylinder	Horse Power (HP)	
Catamaran	6 to 25 Mulam	Sail/ Out Board Engine	1	8	1 to 4
Fibre Boat	25 Mulam	Out Board Engine	1	8 to 10	1 to 4
Vathai	7 to 15 Mulam	Sail/ Out Board Engine	1 to 2	8 to 14	1 to 4
Vallam	10 to 23 Mulam	In Board Engine	1 to 4	10 to 40	3 to 7
Thoni	> 15 Mulam	Sail/ Out Board Engine	1	8 to 10	20 to 40
Valivalai Boat	> 38 Feet	In Board Engine	6	80 to 120	5
Iruvalai Boat	35 to 52 Feet	In Board Engine	6	80 to 120	4 to 7

Note: 1 Mulam = 1.5 Feet

The various types of fishing gears used by the fishermen for fish capture are trawl nets, gill nets, shore seines, drift nets, olaivalai, karavalai, kalamakatti valai, long-lines, traps and others (Table 5.5.2). Of these, drift nets, long-lines, bottom-set gill nets, olavalai, karavalai and kalakkatti valai are mainly operated in and around these islands. Nylon and polypropylene had replaced the earlier cotton nets which were popularized by the Department by providing subsidy and loans.

Table 5.5.2. Types of fishing gears using in the Gulf of Mannar Biosphere Reserve region.

Name of the Net	Position Laid	Gear Composition	Thread Size (Diameter)	Mesh Size	Net/ Mesh Row's Depth	Casting Place	Species Caught
Nandu Valai		Synthetic Nylon	23, 28, 32 mm	90 to 130 mm	13 Mesh	Clay	Crabs
Chanku Valai		Plastic	0.5 mm	90 to 130 mm	13 Mesh	Sandy	Chanku
Singi Valai		Plastic	0.5, 0.75 mm	110 to 130 mm	13 Mesh	Rocky	Singiraal
		Synthetic Nylon	32, 40, 45 mm	110 mm	13 Mesh	Rocky	Singiraal
Disco Valai	Centre Position	Nylon	0.25, 0.5 mm	38 mm	65 Mesh	Clay/ Sandy	Iraal
	Outer Position	Nylon	3 mm	7 Inch	9 Mesh	Clay/ Sandy	Iraal
Thirkai Valai		Plastic/ Nylon	1.5 mm	1 Feet	13 Mesh	Rocky/ Clay	Thirukai Meen
Mandal Valai		Synthetic Nylon	45 mm	110 to 120 mm	20 to 35 Mesh	Rocky	Parai Meen
Maya Valai		Synthetic Nylon	23 mm	55 to 60 mm	30 Mesh	Rocky	
Kelunga Valai		Synthetic Nylon	20 mm	34 mm	50 Mesh	Rocky	Kelungaan
Velameen Valai		Synthetic Nylon	23 mm	48 mm	25, 35 Mesh	Rocky	Vela Meen
2 No. Valai		Synthetic Nylon	2 mm	60 mm	170 Mesh	Watery	Kumla, Sheela, Vaalai, Paarai, Vela Meen
Kola Valai (Chala, Chuda Valai)		Synthetic Nylon	0.5 mm	26, 27, 29 mm	350 to 400 Mesh	Watery	Chala, Chuda, Keeri Meen
Meen Valai		Synthetic Nylon	23 mm	55, 60 mm	100 Mesh	Watery	Mixed
Mural Valai		Synthetic Nylon/ Nylon	20/ 0.5 mm	38 mm	50 Mesh	Watery	Mural Meen
Kumla Valai		Synthetic Nylon / Nylon	2 mm	60 mm	100 Mesh	Watery	Kumla, Sheela, Vaalai Meen
Vali Valai (Paru Valai)		Nylon	4, 6, 8, 10 mm	95 to 120 mm	100 to 130 Mesh	Watery	Nei Meen, Keluthi, Ooli, Parai, Katta, Kaarai

The mechanisation of fishery has displaced women from their traditional roles in processing, marketing and making of nets; forcing them to take up alternative livelihoods. As women play a major role in supporting the sector, they would be the primary beneficiaries. Existing livelihoods related programmes in the buffer zone area do not provide adequate economic alternatives and in particular do not adequately address the needs of women fisher-folk. As a result, people's only alternative livelihood option has been harvesting of wild seaweed or coral, which they have been over harvesting.

As a result of the complexity of the types and efficiency of fishing craft and gear and the fluctuations in the available fishery resources, there are wide variations in the catch and income of fishermen. More than 70% of the active fishermen work as labourers in the boats owned by others on share-basis or for wages. The fishermen working in the country crafts such as catamarans, vathai, thoni and vallam (not motorized) earn a daily income in the range of Rs.20-30, except on a few days during the peak fishing season.

Average annual fish landings from the Marine park area during the last five years 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 1988-1989, prawns constitute 2300 tonnes 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 1980s although the industry is ancient and reported to have been established about hundred years ago. The two commercial important species that are collected by fishermen are *Holothuria scabra* and *Holothurai spinifer* which are processed and exported to Singapore and Hong Kong. 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 kind of fishing. Annually 60 tons of Holothurians valued at Rs. 90 lakhs were collected from Ramanathapuram district of which 50% are estimated from the Gulf of Mannar area. Due to the over exploitation of the holothurians their population have drastically declined, therefore, the Government of India banned Holothurians fishing, henceforth also in the Gulf of Mannar Biosphere Reserve.

Sea-weed collection

The species that are commercially valuable are *Sargassum* spp., *Turbinaria* spp., *Gelidiella* spp., *Gracillaria* spp., which are in demand for the production of agar, cellulose and algin used for food processing and pharmaceutical industries. 5000-7000 tons (dry weight) are harvested annually 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 on Rs. 20/- to 30/- per fisherman. The fishermen and women collect seaweeds near the islands and at times stay in the islands and collect them. The islands where significant quantities of seaweeds are harvested are Anaiparai, Pallimunai, Nallathanni, Challi island, Puthur theevu, Pamban island, Appa tivu, Anaipar, Manoli island, Putti island and hare island.

Coral collections

Coral reefs play a complex but a significant role in the marine eco-system. Coral reefs are said to be one of the most productive areas in the sea. Corals which were indiscriminately mined and harvested a few years ago from the Gulf of Mannar have been banned since 1982. Although this may help halt further degradation and facilities the recovery of the depleted areas, improved protection would be necessary to halt some level of illegal coral collection practiced now and suitable restoration and management to maintain a possible sustainable utilization of reef resources.

Chank, Pearl and Oyster fishing

Diving for pearl oysters and chanks had been another important occupation of fishermen for more than 2000 years. Collection of chanks and oysters by diving is still a major vocation for several hundred fishermen in Gulf of Mannar region. Pearl fishery which was 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 into this region. The last pearl fishery in Gulf of

Mannar was conducted in 1961 and since then due to various reasons, the population of pearl oysters had not been adequate enough to organize such fishery.

Chank fisheries is also a Government controlled activity and continues to be fished on an annual basis, which is of considerable commercial importance to government. The Department of Fisheries registers divers for fishing from November to May; takes over the chanks collected and pay the Divers at a predetermined rate depending on the size and quality of chanks fished. The Tuticorin *jadi* varieties of chanks are in demand in West Bengal for making ornaments and for manufacturing artifacts. Chanks below the size of 60 mm. diameter considered juvenile when caught are released to sea and no payment is paid for such collections. Chank 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 fetch a revenue of Rs. 48 lakhs.

Other non marine based livelihood activities:

In addition to fishing many are involved in various supplementary activities for their livelihoods viz., charcoal making, salt making, mat weaving, coir making and agriculture and allied activities. Availability of timely and adequate credit from the formal system and lack of support systems for marketing are the two main problems faced by the people.

The fisherwomen are more burdened and try to supplement the family income through fishery related trades such as dry fish preparation and marketing, seaweed collection and net-making and mending, and non-fishery activities such as working as labour in salt pans, and beedi making. These activities are seasonal and possible only in certain areas and do not add much to the family income.

Drift wood and dry twigs are collected from the islands mostly by fisherwoman as firewood and sold. Though this is not a major occupations, this is taken up by fisherwomen for supplementing the family income.

5.5.3. The status of Eco-development Programme practiced in the Gulf of Mannar Biosphere Reserve region

The Gulf of Mannar Biosphere Reserve Trust (GOMBRT) which was set up by Tamil Nadu Government in December 2000 have been responsible for initiating several eco-developmental activities in the Gulf of Mannar Biosphere Reserve area after the GEF-Supported UNDP Project for Strengthening the Management of the Gulf of Mannar Biosphere Reserve was initiated in the year 2002.

The project addresses a major challenge, namely the conservation of coastal biodiversity of the highest ecological value in a large area subject to considerable pressure from poor populations upon the sole resources that appear to be at their disposal. To meet this challenge, the project follows the only framework which can succeed, namely to combine the necessary protection of the threatened ecosystem and ecological processes while facilitating other economic and social benefits which will meet the essential need of local people, through providing appropriate institutional, financial and managerial arrangements.

In order to integrate the concerns of livelihood security of the people in the vicinity of the BR with Conservation, GOMBRT in collaboration with several Non-Governmental Organization has divided the entire Marine National Park coastal area into core zones and in a 10 kilometer terrestrial area from the coast has identified a total of 306 villages (Table 5.5.3) which are considered to have been located within the area of influence and impact the coastal and marine resource. Of these, 222 coastal villages have been prioritized to be covered under the UNDP-GEF project based on their marine resource dependency (Table 5.5.4). Of these, 139 villages have organized democratic institutional structures in the form of municipalities and panchayats (Table 5.5.5). Eco-development committees have been established in 73 villages till the first week of October 2006 out of the 222 prioritised in Ramnad and Thoothukudi Districts. An institutional mechanism for each of these EDCs have been set in place through a governing body consisting of 8 members representing different castes among villagers with one member being from the Forest Department (Forest Guard) representing the GOMBRT for implementing the eco-development programs in each of these villages. Various eco-developmental programmes (alternate livelihood options) have been initiated by the Trust in these 73 villages based on detailed micro-plans developed by collaborating NGOs (Table 5.5.6) through Participatory Rural Appraisal (PRA). After a review of the existing eco-development programs implemented by the GOMBRT under the supervision of the Eco-Development Officer (EDO), the present eco-development plan proposes the need to continue and enhance the eco-developmental activities with certain modifications as suggested in this management plan in all the identified villages during the 10 year plan period.

This Plan has also identified the villages along the Gulf of Mannar Biosphere Reserve in the two other districts such as Tirunelveli and Kanyakumari, where the process of microplan and VMC development needs to be taken up gradually during this 10 year Plan period.

Table 5.5.3 Identified marine resource dependent villages in the Gulf of Mannar Biosphere Reserve 10 km terrestrial buffer zone

SL. NO.	NAME OF THE VILLAGE	TOTAL NUMBER OF HOUSEHOLDS	DISTANCE FROM THE SEA SHORE IN KILOMETERS	FISHING DEPENDENCE			ILLEGAL ACTIVITIES
				COMPLETE DEPENDENCE	PARTIAL DEPENDENCE	NO DEPENDENCE	
MANDAPAM ZONE							
DANUSKODI SUB - ZONE							
001	Ramakrishnapuram	230	02	ü			
002	Natrajapuram	287	02	ü			
003	Rajagobal Nagar, Nethaji Nagar, Muthuramalingam Nagar	300	03		ü		
004	Verkodu	250	04	ü			
005	Maruthupandiyar Nagar	137	04	ü			
006	Karaiyur	174	04	ü			
007	Serankottai	296	04	ü			
008	Sethupathi Nagar	72	04	ü			
009	Mariyamman Kovil South Karaiyur	223	3.5	ü			
010	Muthuraiyar Nagar	250	04	ü			
011	Manthoppu	100	04	ü			
012	Sallimalai	200	06		ü		
013	Kentharma Parvatham, Irattai pillaiyar Kovil	250	06		ü		
014	Vadakadu	220	06	ü			
015	Sudukattanpatti	300	06		ü		
016	Erakadu	200	06		ü		
017	Theetchadhar Kollai	200	06		ü		
018	Ramar Theertham	300	04		ü		
019	Sambai, Bathirakaliyamman Kovil Street	320	04		ü		
020	Olaikuda	180	07	ü			
021	Gandhi Nagar, Railway Colony	320	05		ü		
022	Santhiya Nahar, M.S.K. Nagar	180	04		ü		

023	Semma Madam	100	04	Ü		
024	Kudiruppu	190	04	Ü		
025	Narikuli, Keelakadu	92	04	Ü		
026	Mangadu	100	04	Ü		
THANGACHIMADAM SUB – ZONE						
027	Thangachimadam	360	03	Ü		
028	Panathoppu	300	04	Ü		
029	Nalu Panai	80	04	Ü		
030	Anthonyarpuram	100	05	Ü		
031	Susaiappar Pattinam	580	05	Ü		
032	Victoriya Nagar	350	05	Ü		
033	Manthoppu	250	05	Ü		
034	Thaneertru	120	06	Ü		
035	Ariyankundu	125	06	Ü		
036	Meyyampuli	165	06	Ü		
037	Pekkarumpu	110	05	Ü		
038	Notchivadi	50	05	Ü		
039	Thenkuda Verkadu Pudur	76	04	Ü		
040	Raja Nagar	320	03		Ü	
041	Ayanthoppu	45	03	Ü		
042	MGR Nagar	140	03	Ü		
043	Savariyar Nagar	60	03	Ü		
044	Valasai Theru	180	03	Ü		
045	Pallivasal Theru	240	03		Ü	
046	Budaiyal Nagar	85	03		Ü	
047	V.O.C. Street, North Street	135	04		Ü	
048	Nadu Theru South Street	90	03		Ü	
049	Gandhi Nagar, Indira Nagar, Arul Nagar, Balan Nagar, Grace Nagar	94	03	Ü		
050	Francis Nagar	230	01	Ü		
051	Light House	265	1	Ü		
052	Akkal Madam Colony	300	2	Ü		

053	Kamarajar Nagar	180a	2		Ü		
054	Thravai Thoppu	100	2		Ü		
PAMBAN SUB – ZONE							
055	Kundugal	145	1		Ü		
056	Chinnapalam	200	1		Ü		
057	Thoppukadu	120	1		Ü		
058	Therkuvadi (Nadutheru Mundalmunai)	428	1		Ü		
059	Pamban	550	1		Ü		
060	Thonithurai (Thoppukadu, Kalangiyam Nagar, Fishermen Colony Old and New)	289	1		Ü		
061	Koviladi Gandhi Nagar	300	0.5		Ü		
062	A.K.S.Thoppu, Munaikadu, Ummaiyalpuram	255	1			Ü	
063	Rawoother Appa Tharga 1 to 8 street, Mykundu	261	1			Ü	
064	T. Nagar, Kanakku Appusamy Street 1 to 3	300	1			Ü	
065	Sethu Nagar St. 1 to 4, Sethu Nagar Main Road	182	1			Ü	
066	Sethu Nagar St.5 to 7, Main Road 1 st street	180	1			Ü	
067	Sethurastha Main Road, East st, West st, North st, Nalla Rawoother street	162	1			Ü	
068	Pallukadichan Street, Sethurastha Main Road East, Sammatiyar Street	211	1			Ü	
069	Thandal Street, Thandiyar street, Maniyakarar street	210	1			Ü	
070	Kadai Theru 1 to 3, Nadutheru, Maraikayar Street, Ambalagarar Street, Tharagam Street	419	1			Ü	
071	East street 1, 2, Railway Peetar Street, Valaiyar street, North sea shore	350	1			Ü	
072	I.N.P. Colony, Olaihoppu st. 1,2, Koviladi, Railway Colony(100)	188	1			Ü	
073	Jamine Sathru Street	215	1			Ü	
074	South sea shore, Idaiyar Street, Jamine sathru Street	253	1			Ü	
075	Maravar street, East st.1,2, West st.1-3	256	1			Ü	
076	Adidravidar Colony, Sigara Thoppu st.1	174	1		Ü		
077	Singara Thoppu st.2, Anna Kudierupu, Ayyanar Kovil Kudieruppu, Chikri Kudieruppu, Mandapm Camp	156	1			Ü	
078	Maraikayar Pattinam	150	0.5			Ü	
079	Samathuvapuram	101	0.5			Ü	

080	Valaiyarvadi	254	2	Ü		
081	Idaiyar valasai	150	2		Ü	
082	Nadumunai Kadu	50	2		Ü	
083	Vedalai South Sea shore, Aruppukadu, Muslim St. East, South, North	565	0.5		Ü	
084	Kunjar valasai	225	0.5		Ü	
085	Seeniyappa Therga	140	0.5		Ü	
UCHIPPULI SUB – ZONE						
086	Suntharamudaiyan	134	1		Ü	
087	Pillaimadam	136	2		Ü	
088	Sathakon Valasai	62	5		Ü	
089	Ariyaman	43	5		Ü	
090	Thillai Natchiyamman Kovil Kudieruppu	73	5		Ü	
091	Palkulam	32	5		Ü	
092	Alaikathavalasai	75	4		Ü	
093	Irumani	80	5		Ü	
094	Manthoppu	100	5		Ü	
095	Salavalasai	100	5		Ü	
096	Kupanivalasai	60	5		Ü	
097	Maravetti valasai	70	5		Ü	
098	Pirappan Valasai	100	5		Ü	
099	Kadukai Kiramam	150	5		Ü	
100	Enmanamkondan	190	5		Ü	
101	Therga Valasai	220	5		Ü	
102	Pudunagaram	650	5		Ü	
103	Utchippuli, Sethunagar	220	5		Ü	
104	Kettuvalasai	50	5.5		Ü	
105	Thoothivalasai	425	5.5		Ü	
106	Poomalai Valasai	92	5		Ü	
107	Utchippuli Sathiya Nagar	250	5		Ü	
108	Notchiurani	66	2		Ü	

109	Managudi	15	2		Ü	
110	Kadukai Valasai	100	3		Ü	
111	Keela Kadukai valasai	60	3		Ü	
112	Melakadukai Valasai	100	3		Ü	
113	Surankattu valasai	85	3		Ü	
114	Chinnudaiyar Valasai	50	3		Ü	
115	Kilakku Naraiyurani	70	3		Ü	
116	Ammapatnam	60	3		Ü	
117	Agasthiyar Kootam	58	3		Ü	
118	Naraiyurani East & West	100	3		Ü	
119	Kuduwathi	100	2		Ü	
120	Pudhumadam	270	1		Ü	
121	Chinna Irattaiyurani	100	2		Ü	
122	M.K.Valasai	70	3		Ü	
123	Vaniyankulam	60	2		Ü	
124	Vairamperumal Valasai	70	2		Ü	
125	Iruttuyurani	40	2		Ü	
126	Moopan Valasai	80	2		Ü	
127	Poovalli	60	2		Ü	
128	Thamaraiikulam	150	2		Ü	
129	Valngapuri	75	1	Ü		
130	Keelamangundu, Meelamangundu	65	2		Ü	
131	Karan	108	2		Ü	
132	Thalai Thoppu	150	0.5	Ü		
133	Sembadaiyar Kulam	150	8		Ü	
134	Perunkulam	200	8		Ü	
135	Kumbaram	100	7		Ü	
136	Servaiagarayurani	50	7		Ü	
137	Vattan Valasai	100	7		Ü	
138	Enthal	120	7		Ü	
139	Otaichar Valasai	62	7		Ü	

140	Valanthuravai	100	8		Ü		
141	Valudur	100	8		Ü		
142	Vani	70	8		Ü		
KEELAKARAI ZONE							
PERIYAPATTINAM SUB – ZONE							
143	Salaithottam	35	8		Ü		
144	Kollanthoppu	22	8		Ü		
145	Sethu Nagar	60	5		Ü		
146	Vadaku Pudukudiyiruppu	65	5.5	Ü			
147	Muthuarayar Nagar	59	5.5	Ü			
148	Muthupettai	210	4.5	Ü			
149	Indra Nagar	65	0.5	Ü			
150	Therku pudukudiyiruppu (Muthu Nagar)	45	0.5	Ü			
151	Periyapattinam	800	3.5	Ü			Sea Cucumber Collection
THINAIKULAM SUB – ZONE							
152	Pannakarai	10	3.0		Ü		
153	Karichankundu	50	3.0		Ü		
154	Krishnapuram	52	2.5		Ü		
155	Thoppuvalasai	80	0.5	Ü			
156	Kalkadu	25	1.0	Ü			
157	Anjaneyapuram	42	1.0	Ü			
158	Velayudhapuram	63	0.5	Ü			
159	Kalimankundu	95	0.5	Ü			
160	Kattayan Valasai	102	1.5	Ü			
161	Kuppa Valasai	35	2.5	Ü			
162	Vellayan Valasai	39	3.5		Ü		
163	Mottayan Valasai	38	4		Ü		
164	Chittan Kadu	48	4		Ü		
165	Kuthukal Valasai	65	3.5		Ü		
166	Kuppachivalasai	60	3.5	Ü			

167	Marivalasai	66	3.5	Ü			
168	Shanmugavel Pattinam	60	0.5	Ü			
169	Kattaiyan Peran Valaivu	56	3.5	Ü			
170	Thinaikulam	52	3.5		Ü		
171	Silayappan Valasai	44	4.0		Ü		
172	Vethakkran Valasai	48	4.5		Ü		
KEELAKARAI SUB – ZONE							
173	Sethukarai	55	0.5	Ü			
174	Kizhakku Mutharayar Nagar	35	0.5	Ü			
175	Pakkiriyappa Pallivasal	98	0.5	Ü			
176	Idinthakal Pudur	35	0.5	Ü			
177	Sivagamipuram	68	2.5	Ü			
178	Keelaku Pudhu Nagar	48	0.5	Ü			
179	Meenavar Kuppam	85	0.5	Ü			
180	Keelakarai	700	1	Ü			Sea Cucumber and Chank Collection
181	Pannattar Theru	75	1	Ü			
ERWADI ZONE							
ERWADI SUB – ZONE							
182	Bharathi Nagar	139	3	Ü			
183	Vivaganantha Puram	67	2	Ü			
184	Mayakulam	28	5		Ü		
185	Mangaleswari Nagar	230	2	Ü			
186	Mutharaiyar Nagar	66	0.1	Ü			
187	Chinna Erwadi	240	2	Ü			
188	Sadamuniyan Valasai	180	1.5		Ü		
189	Pitchimupan Valasai	41	1.5		Ü		
190	Meyyan Valasai	26	1		Ü		
191	Mottikilavan Valasai	31	1		Ü		
192	Kalpar	62	2		Ü		
193	Adhamcheri	60	2		Ü		

MARIYUR SUB – ZONE							
194	Valinokkam	700	0.5	Ü			
195	Keelamunthal	700	0.5	Ü			
196	Meelamunthal	150	1	Ü			
197	T.Mariyur	500	3	Ü			
198	S.Mariyu	1000	2		Ü		
199	Anna Nagar	5	3		Ü		
200	Muthuregunatha Pattinam	50	3		Ü		
201	Gandhi Nagar	150	1		Ü		
202	Pandiyan Nagar	11	3		Ü		
203	M. Krishnapuram	150	3			Ü	
204	Oppilan	500	3		Ü		
205	Periyakulam	400	5			Ü	
206	Matathokulam	150	6			Ü	
207	Kaduku santhai Sathiram	500	7			Ü	
208	Pasumponnar Nagar	6	7			Ü	
209	Poopandiyar Puram	400	5		Ü		
210	Sanmugakumarapuram	80	4		Ü		
211	Elanthaikulam	45	3		Ü		
212	M. Kuthiraimoli	50	0.5		Ü		
213	Kanigapuri	100	0.5		Ü		
214	Therku Mookaiyur	200	0.5	Ü			
215	Vadaku Mookaiyur	100	1.5		Ü		
216	Uraikinaru	200	6		Ü		
217	Vadaku Naripaiyur	600	1.5		Ü		
218	South Naripaiyur	600	0.5	Ü			
KAMARAJA PURAM SUB – ZONE							
219	Ponnagaram	100	1		Ü		
220	Vettukadu	150	1		Ü		

221	Kadal Katti kudiruppu	60	0.5	ü			
222	Amman Kulam	30	1		ü		
223	Theraviya Puram	70	1		ü		
224	Velayutha Puram	80	1		ü		
225	Palammal Kudiruppu	40	0.5		ü		
226	Puthu Kiramam	20	1		ü		
227	Vellapatti	250	0.5		ü		
228	Vepamarathu Panai	250	0.5	ü			
229	Kamaraja Puram	100	0.5		ü		
230	Periyamayagi puram	100	1		ü		
231	Rayappar Puram	30	1.5		ü		
232	Manikam Nagar	120	2		ü		
233	Kanniraja Puram	1000	1.5		ü		
234	Pilaiporuthamman Kudiruppu	100	2		ü		
235	Rochma Nagar	300	0.1	ü			
236	Rayappan Nadar Kudiruppu	25	1		ü		
237	Poosari Theru	20	1		ü		
THOOTHUKUDI ZONE VEMBAR SUB – ZONE							
238	Vembar South	280	0.1	ü			Sea Cucumber and Chunks
239	Vembar North	225	0.1	ü			Sea Cucumber and Chank Collection
240	Vembar Subramaniya Puram	125	0.1	ü			
241	Pachaiyapuram	55	3		ü		
242	Kunchaiyapuram	40	3			ü	
243	Periyasampuram	180	0.1	ü			
244	Ethanapatti	80	8			ü	
245	Kalaikoodam	135	2			ü	
246	Vaipar	140	3			ü	
247	Keelavaipar	350	0.1	ü			Chank Collection
248	Sippikulam	225	0.1	ü			Chank Collection

249	Kundaperumal Puram	75	5			Ü	
250	Panaiyoor	80	6			Ü	
251	Vepalodai	85	10			Ü	
252	Kulathoor	400	8			Ü	
253	Therku Kalmedu	90	10			Ü	
254	Pattinamaruthur	105	0.1	Ü			
255	Tharuvaikulam	1150	0.1	Ü			Coral Collection
256	Ananthamadam Patcheri	225	7		Ü		Coral Collection
257	Vellapatty	310	0.1	Ü			Coral and Chank Collection
258	Keelaarsadi	120	5			Ü	
259	Siluvaipatti	150	0.1	Ü			Coral Collection
260	Thalamuthu Nagar	360	2	Ü			Coral Collection
261	Rajapalayam	210	2	Ü			Coral Collection
262	Arokyapuram	320	3		Ü		Coral Collection
263	T.Saveriyar Puram	250	4	Ü			Coral Collection
264	Poopandiyar Puram	125	5	Ü			Coral Collection
265	Lourdhammal Puram	180	1.5	Ü			
266	Keelalangerathattu	120	1.5	Ü			
267	Melalangerathattu	70	1.5			Ü	
268	Mettupatty	280	0.5	Ü			
269	Sangukuli Colony	350	0.5	Ü			Purse Seine Net Operation
270	Mappilaiyoorani	225	4			Ü	
271	Poopalraya Puram	550	0.1			Ü	Hunting Sea Turtles
272	Thesapuram	2475	0.1	Ü			
273	Fathima Nagar	550	1	Ü			
RATCHANYAPURAM SUB – ZONE							
274	Inigo Nagar	180	0.1	Ü			
275	New Harbour	185	0.1	Ü			
276	Muthiyapuram	1225	4			Ü	

277	Mullakkadu	325	4			Ü	
278	M. Xavieyar Puram	125	4			Ü	
279	Pullaveli	120	0.1			Ü	
280	Ratchenya Puram	280	1.5	Ü			
281	Palaya Kayal	385	1.5		Ü		
282	Manjalneer Kayal	120	3			Ü	
283	Korkai	110	5			Ü	
284	Vallavalaan	110	6			Ü	
285	Aathoor	720	6			Ü	
286	Punna Kayal	1850	0.1	Ü			Hunting Sea Turtles
287	Eral	715	7			Ü	
288	Keeranoor	125	3			Ü	
289	Arumbuganeri	1100	6			Ü	
290	Kayal Pattinam	1700	1.5			Ü	
291	Kombuthurai	180	0.1	Ü			Hunting Shark and Rays
292	Singithurai	285	0.1	Ü			Chank Collection
293	Odaikarai	120	3			Ü	
294	Veerapandiyan Pattinam	1150	0.1	Ü			Chank Collection
295	Mela Shanmuga Puram	275	2			Ü	
296	Thiruchendur	2400	0.1			Ü	
297	Jeeva Nagar	65	0.1	Ü			Chank Collection
298	Amalin Nagar	420	0.1	Ü			
299	Aalanthalai	650	0.1	Ü			
300	Paraman Kuruchi	850	6			Ü	
301	Thandu Pattu	250	8			Ü	
302	Udangudi	1425	7			Ü	
303	Kulasekarakal Pattinam	180	0.1	Ü			Chank Collection
304	Manappadu	1575	0.1	Ü			Hunting Sea Turtles and Operation of Purse Seine Nets
305	Padukkapattu	225	3			Ü	
306	Periya Thalai	1450	0.1	Ü			Hunting Sea Turtles and Operation of Purse Seine

							Nets
TOTAL	71183						

Table 5.5.4 Details of EDC project villages and their fisheries related dependency activities (12 EDC villages could not be covered)

No	PROJECT VILLAGES (DISTANCE FROM SHORE)	TOTAL NO OF HOUSE HOLD (ACTIVE FISHERMEN HOUSE HOLD)	FISHING CRAFT	FISHING GEAR	NEAREST ISLAND	NEAREST LANDING CENTRE	FURTHEST FISHING GROUND	COMPETITION/CONFLICT WITH OTHER AREA FISHERMEN
	MANDAPAM ZONE							
	DANUSKODI SUB – ZONE							
1	Ramakrishnapuram (0.3 k.m)	230 (200)	Vallam (48) Vathai (25)	Shore seine , Drag nets, Lobster nets, Prawn nets, crab nets etc	Single island	Danuskodi (20 K.m)	Near srilanka Areas	Naribayur, Pamban, Muthal, Thankachimadam, Serankottai, Kalimankundu, Thinaikulam, Thoothukudi, Vembar, Kannyakumari, etc
2	Nataraja puram (0.6 km)	400 (350)	Vallam(100), Vathai(30)	Shore seine , Drag nets, Lobster nets, Per seine	Single island	Danuskodi (22k.m)	Near srilanka islands	Naribayur, Pamban, Muthal, Thankachimadam, Serankottai, Kalimankundu, Thinaikulam, Thoothukudi, Vembar, Kannyakumari, etc
3	Netaji nagar & Rajagopal nagar (0.4 k.m)	1700 (400)	(Labors only)	–		Verkodu coast (0.4 m)	–	–
4	Muthuramalinga nagar (0.5 k.m)		(labors only)	–		Verkodu coast (0.5 k.m)	–	–
5	Verkodu (0.2 k.m)	500 (450)	Mechanised boat (160) Vallam(5)	Drag net, per seine Trawl net, pair trawl net, crab net ,lobster trap, prawn net (Bottom lined Trawl nets)		Verkodu (0.2 k.m)	Near Srilanka island (Kacha)	Mudukulathur, Earwadi, mundal, Sethu karayoor,mardhupandia Nagar, Sethupathy Nagar Seran kotati Kamuthi, kadal
6	Maruthupandiyan nagar (0.3 km)	160 (130)	Vallam(5) Vathai(25) Mechanized boat(10)	Drag net, per seine Trawl net, pair trawl net, crab net ,lobster trap, prawn net (Bottom lined Trawl nets)		Karaiyur coast (0.5 k.m)	Near Srilanka islands (Kacha)	–
7	Karaiyur (0.3 k.m)	600 (500)	Vallam(20) Vathai(1000) Mec . Boat (4)	Crab nets, Disco nets, Shore nets, Lobster nets, Drag		Karaiyur coast	Near Srilanka islands (Kacha)	Mudukulathur, Erwadi, mundal, Sethu karayoor,mardhupandia Nagar, Sethupathy Nagar

				nets, Trawl net, Prawn net (Bottom line trawl ets)		(0.3 k.m)		Seran kotati Kamuthi, kadal
8	Serankottai (0.2 k.m)	250 (230)	Vallam(25) Vathai(50)	Crab nets, Cuttlefish net, Shore seine, Drag nets,		Karaiyur coast (0.6 k.m)	-	-
9	Sethupathinagar (0.3 k.m)	70 (20)	Vallam - 2	-		Karaiyur coast (0.8 k.m)	-	-
10	Mariyamman kovil south Karaiyur (0.2 k.m)	160 (130)	Vallam (52) Mechanized Boat(25)	Crab nets, Cuttlefish net, Shore seine, Drag nets, Trawl nets, Prawn (Bottom line Trawl nets)		Karaiyur coast (0.4 k.m)	-	-
								-
	PAMBAN SUB - ZONE							
11	Tharuvai thoppu & Kundugal (0.4 km)	350 (250)	Vallam - 27 Vathai - 12	Crab net, Lobster net,	Single islands, Kurusadai islands	Kundukal	Srilanka islands	-
12	Chinnapaalam (0.2 km)	230 (210)	Vallam 32 Vathai 113	Crab net Lobster trap Ray net Prawn net Fish net Mural fish net	Kurusadai islands,	China paalam	Srilanka island	-
13	Thoppukadu (0.5 km)	300 (80)	Vallam – 60 Catamaran – 30	Crab nets, Cuttlefish net, , Drag nets, Trawl nets, Prawn (Bottom line Trawl nets)	Kurusadai islands, Manoli islands.	Pamban coast	Srilanka's island	Munthal, Erwadi, Vembar, Thoothukudi, Kunjarvalasai, Notchiyurani, Kadukaivalasai, Chinnudaiyarvalasai, Surankattu valasai, Keezhakarai, Rameswaram, Kanyakumari, uvari, Puthumadam, Uchipulli, Tharuvaikaulam
14	Therkuvadi (0.5 k.m)	400 (220)	Mechanized boat – 80 Vallam -30 Fiber boat -20	Drag nets, Lobster nets, Trawl nets, Prawn Nets (Bottom line trawling)	Kurusadai , Single, Manoli islands	Pamban coast	Srilanka's island	
15	Thonithurai (0.8 k.m)	540 (230)	Mechanized boat -10 Vallam – 20	Gill nets ,Drag nets, Lobster nets, Trawl nets, Prawn Nets (Bottom line trawling)	Kurusadai, Manoli, Mulli islands.	Thonithurai	Srilanka's island	Madapam, Valyarvadi, Vedalai, Nadumunai kadu, Aruppukadu, Sodavalai kuchi, singivalaikuchi.

16	Valaiyarvadi (0.4 k.m)	260 (200)	Vallam (42) Vathai (60) Catamaran(17)	Gill nets, Drag nets, Shore seine, Long line, Crab trap, Prawn nets (Bottom line), Lobster nets etc	Manoli, Kurusadai .islands	Valayarvadi	-	-
17	Nadumunaikadu , Seeniyapa dharga, Mutharaiyarnagar (0.4 km)	300 (200)	Vallam (15) Vathai (12) Catamaran (6)	Gill nets, Drag nets, Shore seine, Logline, others (crap trap, Prawn nets (Bottom line), Lobster nets etc)	Kurusadai, Manoli Islands	Seeniyapa dharga	-	-
18	Vedalai thenkadarkari - singivalai kuchi , soodavalaikuchi, Arupukadu (0.4 K.m)	350 (260)	Mechanized boat - 9 Vallam - 16	Lobster/crab net, Shore Seine, Gill nets, Trawl nets, Shore seine, Long line, Crab trap, Prawn nets (Bottom line), Lobster nets etc	Kurusadai, Manoli , Musal islands	Vedalai	Srilanka's island	-
19	Kunjarvalasai (0.3km)	200 (100)	Labors	-	Kurusadai, Manoli, Musal islands.	Vedalai and mandapam	-	-
	UCHIPULI SUB - ZONE							
20	Pudhunagaram (5k.m)	350 (50)	Vallam - 20 Vathai -50	Crab net, Lobster net, Prawn net , Shore seine, Gill nets (Bottom set, Drift net)	Musal, Valai, Mulli islands.	Thankachimadam & pudhumadam	-	-
21	Notchiurani (1 k.m)	230 (60)	Labors	-		Pudhumadam	-	-
22	Kunduthi , (2.5 k.m) Maanaankudi (2 k.m)	100 (80)	Catamaran - 6	Crab nets, Prawn net, Disco thoondil, Chunk collection	Musal, valai islands	Maanaankudi	-	Pamban , Erwadi, Keezhkarai
23	Kadukai valasai, East, west (3 k.m)	800 (180)	Labors	-		Maaanankudi	-	-
24	Surankatuvalasai (3 k.m)	300 (25)	Labors	-		Maanakudi	-	-
25	Chinnudaiyarvlasai (2.5 k.m)	500 (50)	Labors	-		Pudhumadam	-	-
26	Ammapattinam (2 k.m)	400 (40)	Labors	-		Pudhumadam	-	-

27	Agastiyarkootam (0.5 k.m)	117 (70)	Labors	-		Puthumadam	-	-
28	Naraiyurani East (1.5 k.m)	106 (20)	Labors	-		Puthumadam	-	-
29	Naraiyurani west (1.5 k.m)	164 (30)	Labors	-		Puthumadam	-	-
30	Pudhumadam (0.2 m)	< 2000	Vallam - 10 Vathai – 5 Catamaran -5	Drag nets, Preseine, Disco thondil, Prawn nets, Crab nets, lobster nets, Chanks collection, Maya valai	Musal, Valai, Mulli islands	Puthumadam	-	Kanyakumari, Keelakarai, Thoothukudi, Sayalkudi
31	Chinna irattaiyurani (4 k.m)	107 (40)	Labors	-		Puthumadam	-	-
32	Vaniyankulam (2 k.m)	300 (220)	Labors	-		Puthumadam	-	-
33	M.P.K.Valasai , Irruttoorani, Moopan valasai (2 k.m)	500 (100)	Labors	-		Puthumadam	-	-
34	Irrataiyurani (3 k.m)	325 (75)	Labors	-		Valankapuri	-	-
35	Thamaraiikulam (3 k.m)	291 (27)	Labors	-		Valankapuri	-	-
36	Valangapuri (0.5 k.m)	300 (35)	Vallam -4 Catamaran – 3	Crab net, Prawn net, lobster net, Disco thoondil.,Chooda valai,,	Musal, Valai, Mulli islands	Valangapuri	-	Puthumadam, Kanyakumari, Keezhakarai
37	Arul ozhi ngar (0.4 k.m)	65 (20)	Vallam – 17 Catamaran - 2	Shoreseine, Nadu valai, Mural valai,		Valangapuri	-	Kanyakumari, Keelakarai, Thoothukudi
38	Keelamankundu , Melamankundu (1 k.m)	200 (85)	Labors	-		Karan	-	-
39	Karan (0.3m)	275 (60)	Vathai -5	Lobster nets, Paru valai, Crab net	Musal, Valai, Mulli islands	Karan	-	Kanyakumari, Keelakarai, Thoothukudi
40	Thalai thoppu (0.5 k.m)	114 (72)	Vallam 6	Lobster nets, Paru valai, Crab net	Musal, Valai, Mulli islands	Thalai thoppu, karan	-	Kanyakumari, Keelakarai, Thoothukudi, vambar
41	Sembadaiyarkulam (3 km)	112 (23)	Labors	-		Thalai thoppu	-	-
42	Perunkulam	200 (65)	Labors	-		Thalai thoppu	-	-

	(5 k.m)							
43	Kumbaram (3 km)	300 (40)	Labors	-		karan	-	-
44	Servaiagarayurani (4 km)	30 (46)	Labors	-		karan	-	-
45	Vattan valasai (3 k.m)	275 (40)	Labors	-		karan	-	-
46	Enthal (5 k.m)	350 (30)	Labors	-		karan	-	-
47	Otaicharvalasai (4 k.m)	160 (20)	Labors	-		karan	-	-
	KEEZHAKKARAI ZONE							
	PERIYAPATTINAM SUB - ZONE							
48	Salaitthottam (1 k.m)	30 (10)	(Labors)	-		Indira nagar	-	-
49	Kollanthoppu (0.8 k.m)	210 (75)	(Labors)	-		Pudhukidiruppu	-	-
50	Sethunagar (0.6 km)	75 (40)	(Labors)	-		Indira nagar	-	-
51	Pudhukudirupu North (0.5 km)	170 (120)	(Labors)	-		Indira nagar	-	-
52	Mutharaiyar nagar (1 k.m)	150 (110)	Vallam – 5 Vathai - 16	Crab nets, Prawn nets Lobster net, Gill nets, Shore seine etc.	Thaiyari Appa Islands	Indira nagar	Kanyakumari, Palk bay, Dhota	Keelakarai, Pannakarai, Erwadi
53	Muthupettai (1k.m)	500 (200)	Vallam – 30	Crab nets, Prawn nets Lobster net, Gill nets, Shore seine etc.	Thaiyari Appa Islands	Indira nagar	Dhanuskodi, Pamban,	-
54	Indranagar (0.5 km)	300 (170)	Vallam – 15, Vathai – 25	Crab nets, Prawn nets Lobster net, Gill nets, Shore seine etc.	Thaiyari Appa Islands	Indira nagar	Dhanuskodi, Pamban , Rameswaram, Kanyakumari	Keelakarai, Pannakarai, Erwadi, Pamban
55	Pudhukudiruppu South (0.6 km)	120 (70)	Vallam – 45 Vathai - 10	Disco thoondil, Gill nets, Lobster nets, Prawn nets, Crab nets	Thaiyari Appa Islands	Pudhukudiruppu South	Rameswaram, Danuskodi, Pamban	Keelakarai, Pannakarai, Erwadi
56	Periyapattinam (1 km)	2000 (500)	Mechanized boat - 50 Vallam -20	Per seine, Drag nets, Drift gillnets, Lobster nets etc	Thaiyari Appa Islands	Indiranagar	-	Danus Kodi, Srilankas island, Pamban

	THINAIKULAM SUB – ZONE							
57	Pannakarai (3 k.m)	30 (10)	(labors)	-	Thaiyari Appa Islands	Indiranagar	-	-
58	Maraikayar nagar (3k.m)	70 (30)	(labors)	-	Thaiyari Appa Islands	Indiranagar	-	-
59	Karichankundu (4 k.m)	100 (60)	(Labors)	-	Thaiyari Appa Islands	Thoppu valasai, Indira nagar	-	-
60	Krishnapuram (4 k.m)	120 (30)	(Labors)	-	Thaiyari Appa Islands	Thoppu valasai, Indira nagar	-	-
61	Thoppuvalasai (0.2 k.m,)	150 (125)	Vathai – 32 Vallam - 11	Disco thoondil, Gill nets, Lobster nets, Prawn nets, Crab nets	Thaiyari Appa islands	Thoppu valasai	Erwadi, Pamban, Vembar, Keelakarai	Pannakarai, Maraikayar, Karichanundu, Krishnapuram
62	Kalkadu (0.6)	25 (20)	Labors	-	Appa islands	Kaliman kundu	-	-
63	Anjaneyapuram (o.6 k.m)	120 (100)	Vathai – 18 Vallam – 4 (without engine)	Drag net, sooda valai, Crab net, Disco hoodle, Prawn nets, Ray island	Appa, Mulli islands	Kaliman kundu	-	Pamban, Kanyakumari, Thoothukudi, Danuskodi
64	Velayudhapuram (0.3 k.m)	80 (60)	Vallam – 30	Drag net, sooda valai, Crab net, Disco hoodle, Prawn nets, Ray island	Appa, Mulli islands	Kaliman kundu	-	Danuskodi, Kanyakumari, Thoothukudi
65	Kaliman kundu (0.5 m)	1250 (220)	Vallam – 102 Mec . boat -5	Mural nets, Sooda valai, Disco Thoodlle, Drag nets,	Valai,Appa, Mulli islands	Kaliman kudu	Thoppu valasai, Kalkadu	Danuskodi, Kanyakumari, Thoothukudi
66	Kattaiyan valasai (1 k.m)	120 (80)	Vallam – 4 Vathai - 12	Mural nets, Nandu valai, Singi valai, Sooda valai, Disco Thoodlle, Drag nets,	, Valai Appa, Mulli islands	Kaliman kudu	Thoppu valasai, Kalkadu	Danuskodi, Kanyakumari, Thoothukudi
67	Kuppa valasai (2 k.m)	125 (10)	Labors	-		Kaliman kundu	-	-
68	Vellayan valasai (5 k.m)	75 (25)	Labors	-		Kaliman kundu	-	-
69	Mottaiyan valasai (5k.m)	61 (30)	Labors	-		Kaliman kundu	-	-

70	Chittan kadu (4 k.m)	70 (50)	Vallam – 1 Vathai - 4	Sheela valai, Kumla valai, mural valai, Prawn nets, Crab nets	Appa, Valai islands	Kaliman kundu	–	–
71	Kunthukal valasai (2 k.m)	75 (40)	Labors (only)	–		Kaliman kundu	–	–
72	Kuppachivalasai (1.5 k.m)	80 (30)	Labors	–		Kaliman kundu	–	–
73	Marivalasai (0.8 m)	250 (40)	Labors	–		Kaliman kundu	–	–
74	Shanmugavel pattinam (0.2 m)	80 (75)	Vallam – 10 Vathai – 2	Sooda valai, Nandu valai, Disco Thoodle Kumula valai,	Appa , Valai, Musal	Shanmugavel pattinam	Kaliman kundu, Sethukarai, Keelakarai, Periyapattinam	Rameswaram, Erwadi, Vembar, Thoothukudi
75	Kattiyar peran valaivu (1 k.m)	70 (20)	Labors	–	Appa , Valai, Musal	Shanmugavel pattinam	–	–
77	Thinaikulam (3 km)	450 (40)	Labors	–	Appa , Valai, Musal	Shanmugavel pattinam	–	–
78	Silyappan valasai (5 km)	130 (45)	Labors	–	Appa , Valai, Musal	Shanmugavel pattinam	–	–
79	Vethakaran valasai (6 km)	66 (10)	(labors only)	–		Shanmugavel pattinam	–	–
	KEEZHAKARAI SUB – ZONE							
80	Sethukarai (0.3 k.m)	280 (75)	Vallam – 25	Soda valai, nandu valai, Disco thoondle, Kumla valai, ean valai	Appa islands	Sethu karai	Shanmugavel pattinam, Keelakarai, kaliman kundu	Keezhkarai, Erwadi
81	Mutharaiyar nagar East (0.5 k.m)	44 (40)	Vallam - 3 Vathai -8	Soda valai, nandu valai, Disco thoondle, Kumla valai, ean valai hoodle,	Appa islands	Pakriyappa palivasal coast	Kalimankundu, Keelakarai, Erwadi, Thoothukudi, Kanyakumari	–
82	Pakkiriyappa pallivasal (0.8 k.m)	30 (20)	Vallam 6 Vallam with engine 1 Vathai 23.	valai, Disco thoondle, Kumla valai, mean valai, Sooda valai, nandu	Appa islands	Pakriyappa palivasal	Kalimankundu, Keelakarai, Erwadi, Thoothukudi, Kanyakumari	Erwadi, Keezhkarai, Vembar, Vaipar.
83	Idinthakalpudur (0.8 km)	200 (150)	Vallam 1 Vathai 4 Vathai with	Drag nets, Nandu valai, Cumla valai, Singi valai,	Appa islands	Keelakarai	Kaliman kundu, Erwadi, Vembar, Thoothukudi,	–

			engine 5	Velameen valai, Vali valai			Kanyakumari	
84	Sivakamipuram (0.5 km)	120 (40)	Vathai – 10	Nandu valai, Disco valai, Mean valai, Cumla valai.		Keelakarai		
85	Pudhu nagar East (0.8 k.m)	82 (60)	Vathai 12 Engine vathai 9	Velameen valai, Maya valai, Disco valai, Nadu valai, singi valai		Keelakarai	-	-
86	Meenavar kuppam (0. 5)	60 (40)	Vallam 28 Vatahi 4	Disco thoondle, singi valai, Nadu valai, Thirukai valai, mural valai, Siru valai, Paru valai,		Keelakarai	-	-
87	Keelakarai (0.3 k.m)	10000 (350)	Mechanized boat – 30	Paru valai, siru valai, Disco	Appa , Poomarichanpatti	Keelakarai	Erwadi, Vembar, Thoothukudi,	Dhanuskodi, Periyapattinam, Kanyakumari
88	Pannatar theru (0.5 K.m)	120 (70)	Vallam – 70 Vathai – 100 Catamaran - 40	thoontle, Drag net, Per seine, Trawl net, Lobster net, Prawn net (Bottom-line)	Pullivinichalli islands,		Kaya kumari	
	ERWADI ZONE							
	ERWADI SUB - ZONE							
89	Bharathi nagar (0.5 km)	300 (250)	Labors	-	-	China Erwadi, Keelakarai	-	-
90	Vivekananthapuram & Muthurajapuram	110 (80)	Labors	-	-	China Erwadi, Keelakrai	-	-
91	Mayakulam	120 (100)	Labors	-		China Erwadi	-	-
92	Mangaleswarinagar (0.8 km)	300 (180)	Vallam (engine)– 10 -15 Vathai – 30 -40	Crab trap, mural net, vilai mean valai,		China erwadi	Keezhakarai, Pamban, Danuskodi	Thoothukudi, Kanyakumari, Periyapattinam, Tharuvaikulam, Chinna erwadi
93	Mutharaiyar nagar (0.5 km)	70 (40)	Labor	-		China Erwadi	-	-
94	Chinna Erwadi (0.8 km)	120 (100)	Vallam 50-60 Vathai 4-5 Mechanized boat 2,	shore seine, trawl net , lobster trap, moral net,	Appa , Poomarichanpatti Pullivinichalli islands,	China erwadi	Danuskodi, Rameswaram, Pamban, Munthal, Keezhakarai	Kanyakumari, Thoothukudi, Mannapadu, Periyathalai, Tharuvaikulam
95	Sadaimuniyan valasai (0.5 km)	300 (290)	Vathai – 200 Vallam -5	Lobster net, Crab nets, Chunk	Appa , Poomarichanpatti	Sadaimuniyan valasai	Keezla karai, Vembar,	Chinna Erwadi, Mangaleswari nagar, Tharuvaikulam,

				collection, Mural nets , Shore seine	Pullivinichalli islands,		Danuskodi	Thoothukudi,
96	Mariyamman nagar (1 k.m)	70 (30)	Labors	-		-	-	-
97	Pitchimooan valasai (1 km)	200 (75)	Labors	-		-	-	-
98	Meyyan valasai (1 km)	175 (20)	Labors	-		-	-	-
99	Mottaikilavan valasai (1 km)	130 (45)	Labors	-		-	-	-
100	Kalpar (1 km)	57 (20)	small Vathai 4	Crab, disco and fish net	Appa , Poomarichanpatti Pullivinichalli islands,	Sadaimuniyan valasai	Keezhakarai, Danuskodi, Rameswari, Vaipar	Thoothukudi, Tharuvaikulam, Manappadu, Vaipar, Pamban
101	Adamcheri (1 km)	98 (60)	Vallam 1 Vathai 14	Crab net fish net, ray net, lobster trap, prawn net, disco net	Appa , Poomarichanpatti Pullivinichalli islands,	Sadaimuniyan valasai		
102	Adenchery (1Km)	40 / -	-	-		-	-	-
	MARIYUR SUB- ZONE							
103	Vaalinokkam (0.5 km)	1200 (700)	Vallam – 40 Vathai – 20 Catamaran – 10 Mechanized boat – 10	Drag net, Per seine, Crab net, Lobster net, Disco net, Mean vaslai	Poomarichanpatti , Pullivini islands	Valinokam	Danuskodi, Rameswaram, Vaipar	China Erwadi, Keezhkarai, Mariyur, etc
104	Mela munthal (0.5 km)	800 (600)	Vallam – 20 Vathai – 45 Catamaran -40	Shoreseine, Crab net, Drag net, Lobster nets, Mean valai, Nandu valai, Sooda valai	Poomarichanpatti , Pullivini islands	Muthal	Danukodi, Rameshwaram, Kanyakumari	China Erwadi, Munthal, Mariyur, Keezhkarai, Tharuvaikulam, Thoothukudi
105	Keelamunthal (0.6 km)							
106	T. Mariyur (0.4 km)	1200 (800)	Vallam – 60 Catamaran – 20	Drag net, Lobster nets, Mean valai, Nan	Poomarichanpatti , Pullivini islands	Mariyur	Danukodi, Rameshwaram	Munthal, Vaipar, Ervadi, Thoothukudi
107	S. Mariyur (0.5 km)							
108	Muthu requnatha pattinam (1 k.m)	150 (70)	Labors	-		Mariyur , Muthal	-	-
109	Ganthinagar, Annanagar, & Pandiyan nagar (1 k.m)	300 / 120)	Labors	-		-	-	-
110	M. Krishnapuram	75 / 20	Labors	-		-	-	-

	(1 k.m)							
111	Oppilian (0.5 k.m)	1000 / 250	Vallam -30 Vathai -20	Shore seine, crab nets, Prawn net, Lobster net , Sooda mean valai, Mural mean valai, chunk valai	Pullivini islands	Oppilan	Munthal, keezhkarai, Dhanuskodi, Dhoti,	Thoothukudi, Kanyakumari, Mannapadu, Vaipar, vempar,
112	Periyakulam\ (2 km)	450 / 50	Vallam -4	Shore seine		Muthal, Mookaiyur		
113	Madathokulam (3 k.m)	96 / 20	Labors	-		-	-	-
114	Kaduku santhai (4 km)	180 / 40	Labors	-		Mookaiyur, Muthal	-	-
115	Sathiram (4 km)	335 / 30	Labors	-		-	-	-
116	Pasumponnar nagar & Poopndiyar nagar (0.5 m)	160 (40)	Labors	-		Mookaiyur coast	-	-
117	Sanmugakumarapuram (0. 6 km)	80 (20)	Labors	-		Mookaiyur, Munthal	-	-
118	Elanthaikulam (1 km)	250 (60)	Labors	-		Mookaiyuir, Munthal	-	-
119	M. Kuthiraimozhi (1 km)							
120	Kanigapuri (0.6 km)	250 (120)	Vallam -4	Shore seine		Mookaiyur coast Mookaiyur coast	Danus Kodi, Rameswaram, Keezhakarai, Vembar	Thoothukudi, Kanyakumari, Cheval patti,
121	Mookaiyur North (0.5 km)	200 / 50	Vallam -7	Lobster net, Prawn nets, Shore seine, Per seine, Disco nets, Crab nets, Mean val;ai				
122	Mookaiyur South (0.5 km)	1000 / 500	Vallam – 60					
123	Uraikinaru (0.6 km)	200 / 40	Labors	-		Naripaiyur coast	-	-

124	Naripaiyur North (0.5 km)	1400 / -	-	-		-	-	-
125	Naripaiyur south (0.5 km)	700 / 300	Vallam – 20 Vathai – 30 Catamaran -5	Shore seine, Disco nets, Lobster nets, crab nets, vila mean valai, Sheela valai etc		Naripaiyur coast	Vembar , Keezhakarai, Rameswaram , Danuskodi,	Thoothukudi, Kanyakumari, Tharuvaikulam, Vaipar, Vembar
	KAMARAJAPURAM SUB – ZONE							
126	Ponnagaram (0.5 k.m)	135 / 60	Labors	-	Upputhanni	-	-	-
127	Vettukadu (0.5km)							
128	Kadal katti kudirupu (0.7 k)	70 / 40	Labors	-		-	-	-
129	Amman puram (0.6 km)	65 / 30	Vathai -6	Shore seine, Crab nets, :Lobster nets		Naripaiyur coast	-	-
130	Theraviya puram (0.4 km)	70 / 20	labors	-		-	-	-
131	Velayuthapuram (0.5 km)	150 / 60	Labors	-	-	-	-	-
132	Palammal kudirupu (0.5 k.m)	120 / 40	Labors	-	-	-	-	-
133	Pudhukiramam (0.5 km)	30 / 15	Labors	-	-	Naripaiyur coast	-	-
134	Vellapatty (0.5km)	80 / 40	Labors	-		Naripaiyur coast	-	-
135	Vepamarathupanai	80 / 60	Vallam – 13 Shore seine Boat – 10	Shore seine, Lobster nets, Disco net etc	Upputhanni, Nalahanni, Karaichalli islands	Naripaoyur coast	Vembar, Keelakarai	Vembar, Erwadi, Keelakarai, Tharuvaikulam, Thoothukudi, Thiruchendur
136	Kamarajapuram (1. k.m)	121 / 20	Labors	-	-	Naripaiyur coast	-	-
137	Periyanayagi puram (1 k.m)	70 / 40	Labors	-	-	Naripaiyur coast	-	-
138	Rayyapar puram	50 / 10	labors	-	-	Naripaiyur coast	-	-
139	Manikam nagar (0.8 k.m)	121 / 20	Labors	-	-	Naripaiyur coast	-	-
140	Kannirajapuram (0.8 km)	350 / 100	Labors	-		Naripaiyur coast	-	-
141	Pilaiporuthamman kudirupu	35 / 18	Labors	-	-		-	-

	(0.3 km)							
142	Rochma nagar (0.6 km)	270 / 40	_ Vallam – 57 Mechanized Boat – 18 (Erwadi)	_ Drag net, Trawl nets, ,Lobster net , Prawn net, etc.,	_	Vembar	_	_
143	Ramya nadar kudiruppu (0.6 km)	34 / 12	Labors	_	_	Vembar		
144	Poosari theru (0.6 km)	21 / 17	Labors	_	Nallathani, Upputhani islands	Vembar		
	THOOTHUKUDI ZONE							
	MEMBAR SUB – ZONE							
145	Vembar south (0.5 k.m)	2000 / 900	Vallam – 30 Vathai – 6 Mechanized boat – 28	Trawl nets, Shore seine, Drag nets Nandu valai, soda valai, Singi valai, Disco thoondle etc.	Nallathani, Upputhani islands	Vembar	Danus Kodi, Rameswaram, Pamban, Keelakarai, Kanyakumari	Naripaiyur, Vaipar, Tharuvaikulam, Thoothukudi, Uvari, Veerapandiyan pattinam, Mannapdu.
146	Vembar north (0.7 km)	150 / 60	Shore seine Boat – 6					
147	Vembar valasamuthiram (1km)	300 / 50						
148	Pachaiyapuram (0.5 km)	187 / 50	Vallam – 3 Catamaran -5	Drag nets, Lobster net, Prawn net, Disco net, others	Karaichalli, Uppu thani, nalla thani islands	Pachaiyapuram	Vaipar, Erwai	Vembar, vaipar, Periyasamy puram, Pattinamaruthur
149	Kunchaiyapuram (0.4 km)	43 / 20	Vallam – 2 Catamaran -3	Sooda valai, mural valai, Prawn nets, Disco thoondle	Karaichalli, Uppu thani, nalla thani islands	Periyasamy puram	Vaipar, Erwadi	Vembar, Vaipar, Tharuvaikulam, Thoothukudi, Erwadi
150	Periyasamy puram (0.2 km)	260 / 150	Vallam -10 Catamaran -5	Drag nets, Fishing nets	Karaichalli, Uppu thani, nalla thani islands			
151	Kalaikoodam (3 k.m)	70 / -	Labors	_	Karaichalli, kasuwar islands	_	_	_
152	Vaipar- kalloorani (4 k.m)	245 / -	Labors	_	Karaichalli, kasuwar islands	_	_	_
153	Keelavaipar (1 k.m)	648 / 300	Vallam – 110 Vathai – 6 Catamaran -24	Crab net, prawn net Salai valai, parrh valai, tirka valai , Drag nets	Karaichalli, kasuwar islands Kaswar	Keela vaipar Chippikulam	Vembar, Chippikulam, Tharuvaikulam, Thrku kalmedu, Thoothukudi	Vembar, Erwadi, Keelakarai, Dhanuskodi , Rameswaram, Kanyakumari
154	Chippikulam (0.8 km)	500 / 350	Fibre boat -25					
155	Veppalodai (3 km)	700 / 30	Labors	-	Kaswar	_	_	_
156	Therku kalmedu (5 k.m)	125 / 10	Labors	_	Kaswar	_	_	_
157	Pattinamaruthur (0.5 km)	250 / 100	Vallam 15 Vathai 10	Salai, Valai, Sheela, Surai, ,	Kaswar	Pattinamaruthur	Vembar, Thiruchenthur	Thoothukudi, Vembar, vaipar, tharuvaikulam, vellapatty etc

				Lobster, Disco net, Sudai				
158	Tharuvaikulam (0.5 km)	1610 / 800	Vallam – 40 Vathai – 10 Mechanized boat -45 (thoothukudi fishing Harbor)	Drag net, Crab trap, Trawl, Prawn, Lobster net, Perseine,	Kaswar, van islands	Tharuvaikulam	Kanyakumari, Vembar, Keezhakarai, Erwadi, Dhanukodi, Rameswaram	Manapadu, Kulasekara pattinam, Periyathalai, Thersapuram, Vembar, Keezhakarai,
159	Ananthamadam patcheri (5 k.m)	290 / 40	Labors	–	Kaswar, van islands	Tharuvaikulam, Vellapatty,	–	–
160	Vellapatty (0.8 km)	800 / 500	Vallam-65 Vathai-4	Shore seine Drag net Crab net	Kaswar, van islands	Vellapatty	Vembar, Keelakarai, Danuskodi, Rames waram, Kanyakumari	Manapadu, Kulasekara pattinam, Periyathalai, Thersapuram, Vembar, Keezhakarai,
161	Keela arasaradi and thupaspatti (3 k.m)	207 / 20	Labors	–	Kaswar, van islands	Vellapatty	–	–
	THOOTHUKUDI SUB – ZONE							
162	Siluvaipatti (1.5km)	201 / 170	Vallam – 25	Drag net, disco net, Soo da valai , Mural Valai , nandu valai, Singi valai	Kaswar, van islands	Siluvaipatti	Om sakthi nagar, Thai nagar, Durarai singh nagar, sahersain nagar, Ganapanthi nagar, Alagu muthu nagar	Vembar, Ratchenyapuram
163	Thalamuthunagar (1 km)	368 / 250	Vallam- 5	Drag nets, Disco net, Singi valai, Nandu vali, Mural valai, Kla valai	Kaswar, van islands	Therasa puram	–	–
164	Rajapalayam (1 km)	325 / 170	Valam- 30	Drag net, Thirukai valai , Disco thoondle, Mural valai, Vali valai Disco net,	Kaswar, van islands	Rajapalayam	Vaipar, Vembar, Tharuvaikulam, Kayakumari	–
165	Samir rose nagar (1 km)	220 / 140	Vallam – 25	Drag net, Disco net	Kaswar, van islands	Therasapuram	Kanyakum,ari, Mannapadu,	–

166	Arokyapuram (1 km)	320 / 100	Vallam - 5		Kaswar, van islands	Thersa puram	Vembar, Vaipar, Keelakarai, Erwadi, Rameswaram, Dhanuskodi	-
167	T.Saveriyar puram (2 km)	242 / 155	Vallam – 14 Mechanized Boat -	Shoeshine, Prawn nes, Mural nets	Kaswar, van islands	Therasa puram		-
168	Poopandiyar puram (3 km)	150 / 80	-	Shore seine	Kaswar, van islands	Thersapuram		-
169	Loorthammal puram (0.5 km)	300 / 150	Vallam -20	Shore seine, Dragnet	Kaswar, van islands	Therasa puram		-
170	Keela alankarathattu (0.6 km)	120 / 85	Labors	-	Kaswar, van islands	Therasa puram		-
171	Mela alankarathattu (0.7 km)	300 / 75	Labors	-	Kaswar, van islands	Therasapuram		-
172	Cruzpuram (0.5 km)	800 / 400	Labors	-	Kaswar, van islands	Therasapuram		-
173	Thersapuram North (0.2 km)	1100 / 600	Vallam – 1000 Ply wood Boat- 20 – 25 Catamaran - 20 Mechanized boat – 50 (in Thoothukudi Fishing Harbor)	Drag net, Illuvalai , Pureseine	van islands	Therasapuram		Kanyakumari, Mannapdu, Uvari, Veerapandiyan pattinam, New harbour, Rajapalayam
174	Thersapuram South (0.2 km)							
175	Therasapuram west (0.6 km)							
176	Santherayapar kovil Street (0.3 k.m)	200 / 100	Mechanized boat – 30 Vallam -20	Drag net, disco net, vilai mean valai, venganei, Deep sea fishing	van islands	Fishing harbour, Thersa puram	-	
177	Pudhu theru (0.4 km)	450 / 150	Vallam – 10 Catumaram-2 Mechanized Boat- 100	Crab net, Lobster net, Prawn net, Chunk net, Disco net. Trawling net , Pair Trawler, Pure seine net	van islands	Fishing harbors, Thersa puram	-	
178	Sangukuli colony (0.5 k.m)	325 / 300	Vallam – 10 Vathai - 7	Sooda valai, Mural vlai, Crab net, Singi valai	van islands	Thersa puram	-	
179	Mutharayar nagar	170 / 60	Labors	-	van islands	Thersapuram	-	
180	Mettupatti (0.5 km)	300 / 50	Labors	-	van islands	Thersapuram	-	
181	Poopalarayarpuram	2000 / 600	Vallam – 10,	Drag nets, trawl	van islands			

	(2 k.m)		Mechanized boat – 10 (Fishing harbor)	nets, Pureseine, Lobster net, Nandu valai, Mural valai, Mean valai.		Thersa puram	–	–
182	New harbour (1 k.m)	70 / 60	Vallam – 45 Vathai – 20 Catamaran 60	Drag net, Mural net, nandu valai, Mean Valai.	van islands	New harbour	Palyakayal, Thoothukudi, Vaipar, Vembar, Erwadi	Thoothukudi, Palyakayal, Thersapuram
183	Inigo nagar (0.6 km)	240 / 200	Vallam - 25 Fiber glass boat – 100 Catamaran – 50	Crab net, Fish net, disco net, Lobster net, Drag nets	van islands	Inigo nagar	Kanyakumari, Danuskodi, Rameswaram	Fathima nagar, Limestone, Tharuvaikulam, New harbour, Thersapuram, Vaipar , Veerapandiyan pattinam
184	Fathima nagar south (1 km)	1100 / 600	Vallam – 4 Catamaran - 20	Crab net , Maya valai, Lobster net, Kuthu valai, Sala valai, Mani valai	van islands	Inigo nagar	–	–
185	Fathima nagar North (1 km)							
186	Limestone (0.8 km)	250 / 75	Labors	–	van islands	Inigo nagar, theresa puram , Fishing Harbour	–	–
187	Annai theresa nagar (0.6 km)	120 / 45	(labors)		van islands	Inigo nagar, Thersa puram, New harbor	–	–
188	Sahayapuram (1 km)	70 / 60	–	–	van islands	Thoothukudi Fishing harbor, Thersa puram	–	–
189	Vivekanatha nagar (0.8 Km)	80 / 45	–	–	van islands	Thoothukudi Fishing harbor	–	–
	RATCHENYAPURAM SUB – ZONE							
190	Ratchenyapuram & Palaya kayal (3 k.m)	900 / 550	Vallam – 45 Vathai -20 Catamaran – 55	Drag nets, Disco net, Singi valai, Nandu vali, Mural valai, Kla valai	-	Ratchenyapuram & Palaya kayal	Kanyakumari, Keelakarai, Vaipar	Thoothukudi, Tharuvaikulam, Uvary, Veerapandiyan pattinam, Mannapdu, Jeeva nagar
191	Korkai (1 km)	130 / 35	Labors	–	-	Palayakayal	–	–
192	Maramangalam (0.5k.m)	300 / 80	Labors	–	–	Ratchenyapuram & Palaya kayal	–	–
193	Mukkani (1 k.m)	400 / 50	Labors	–	-	Ratchenyapuram & Palaya kayal (3 k.m)	–	–

194	Punna kayal North (0.3k.m)	1500 / 900	Vallam – 300 Vathai – 200 Catamaran – 20	Kanyakumari, Thoothukudi, manappadu, Periyathalai, Thoothukudi, Vaipar	-	Punna kayal	Kanyakumari, Danuskodi, Rameswaram	Thoothukudi, Kanyakumari, Palayakal, Mannapadu, Uvari
195	Punnakayal South (0.3km)							
196	Senthamangalam (0.5km)	400 / 150	-	-	-	Punnakayal		
197	Singithurai (0.2 km)	350 / 170	Vallam – 40 Catamaran - 10	Drag nets, trawl nets, , Lobster net, Nandu valai, Mural valai, Mean valai	-	Singithurai	Kanyakumari, Thoothukudi, manappadu, Periyathalai, Thoothukudi, Vaipar	Uvari, Kanyakumari, Veerapandiyn pattinam, Thoothukudi
198	Kombuthurai (0.2 km)	250 / 150	Vallam -70 Catamaran -40	Crab net , Maya valai, Lobster net, Kuthu valai, Sala valai, Mani	-	Kombuthurai	Thoothukudi, Kanyakumari, Periya thalai, Mannappadu	
199	Veerapandiyan pattinam North (0.5 km)	1500 / 600	Mechanised boat – 55 Vathai – 18 Vallam -5 Catamaran -40	Trawl net – Prawn , Lobster (Bottom line trawl nets), Drag nets, Salai valai, Mean valai	-	Veerapandiyan pattinam	Kanyakumari, Vembar, Keezhakarai, Erwadi, Thoothukudi, Dhanuskodi	Kombuthurai, Singithurai, Thoothukudi, Alanthalai, Kayakumari, Uvari
200	Veerapandiyan pattinam South (0.5 km)							
201	Jeeva nagar (0.2 km)	200 / 150	Vallam – 13 Vallam with engine – 18	Dragnets, Salai valai, Tirukai valai, Crab nets,	-	Thiruchenthur coast	Thoothukudi, vembar	Alanthalai, Periya thalai, Thoothukudi, Kombuthurai, singithurai, Uvari,
202	Alanthalai North (0.3 k.m)	232 / 200	Vallam -5 Vathai 12 Catamaran - 200	Drag nets, Per seine, Crab nets, lobster nets, Chanku valai	-	Alanthalai	Thoothukudi, Kanyakumari	Jeeva nagar, Thoothukudi, Kombuthurai, Singithurai, Uvari
203	Alanthalai South (0.3 km)							
204	Amali nagar (0.4 k.m)	600 / 520	Vallam -5 Catamaran – 70	Drag nets, Salaivalai Crab trap Tirkai valai Chunku valai	-	Amalin nagar	Erwadi, Keelakarai, kanyakumari	Uvari,Periyathalai Kulasekara pattinamAlanthalai, Punakayal, Mannapadu
205	Manappadu North (0.4 km)	1155/ 800	Vallam – 7 Vathai 100 Fibre boat – 101 Catamaram - 10	Drag nets, Salaivalai Crab trap Tirkai valai Chunku valai	-	Manapadu	Danuskodi, Rameswaram, Erwadi, Keelakarai, kanyakumari	Uvari,Periyathalai Kulasekara pattinamAlanthalai, Punakayal
206	Manappadu South (0.2 km)							

207	Periya Thalai North (0.3 km)	1500 / 200	Vallam – 10 Catamaran - 100	Drag nets, Per seine, Crab nets, lobster nets, Chunk valai	– -	Periya thalai	Danuskodi, Rameswaram Kanyakumari, Keelakarai,	Uvari, Mannapadu, Kulasekara pattinam, Alanthalai, Punakayal
208	Periya thalai South (0.3 k.m)							
209	Pathovai nagar (0.6 k.m)	155 / 60	Catamaran -10	Mean valai, disco thoondle	-	Kulasekarapattinam	–	–
210	Kulasekara pattinam (0.2 k.m)	2000 / 300	Vallam -10 Vathai – 40 Catamaran -60	Drag nets, Gill nets, Prawn nets, Lobster nets, Crab nets (Bottom line), mural nets etc	–	Kulasekara pattinam	Danuskodi, Rameswaram Kanyakumari, Keelakarai	Uvari, Mannapadu, Periyathalai, Alanthalai, Punakayal

Table 5.5.5 List of Eco-Development project villages with existing democratic institutional structures (panchayats, panchayat unions, special panchayats, and municipalities

S/N	Name of the Zone	Name of the Sub-Zone	Name of the Project Village	Name of the Panchayat	Name of the Panchayat Union/ Special Panchayat/ Municipality
001	Mandapam	Dhanushkodi	Serankottai		Rameswaram Municipality
002	Mandapam	Dhanushkodi	Sethupathi Nagar		Rameswaram Municipality
003	Mandapam	Dhanushkodi	Ramakrishna Puram		Rameswaram Municipality
004	Mandapam	Dhanushkodi	Natraja Puram		Rameswaram Municipality
005	Mandapam	Dhanushkodi	Verkodu		Rameswaram Municipality
006	Mandapam	Dhanushkodi	Karayur Mariaman Koil St.		Rameswaram Municipality
007	Mandapam	Dhanushkodi	Maruthupandiyar Nagar		Rameswaram Municipality
008	Mandapam	Dhanushkodi	Karaiyur South		Rameswaram Municipality
009	Mandapam	Dhanushkodi	Dhanushkodi		Rameswaram Municipality
010	Mandapam	Dhanushkodi	Mukundarayar Sathiram		Rameswaram Municipality
011	Mandapam	Dhanushkodi	Naduthurai		Rameswaram Municipality
012	Mandapam	Dhanushkodi	Rameswaram		Rameswaram Municipality
013	Mandapam	Dhanushkodi	Orakkadu		Rameswaram Municipality
014	Mandapam	Dhanushkodi	Kudiyiruppu		Rameswaram Municipality
015	Mandapam	Thangachimadam	Ariyangundu	Tangachimadam Panchayat	Mandapam Panchayat Union
016	Mandapam	Thangachimadam	Vallathaadi	Tangachimadam Panchayat	Mandapam Panchayat Union
017	Mandapam	Thangachimadam	Anthonyar Puram	Tangachimadam Panchayat	Mandapam Panchayat Union
018	Mandapam	Thangachimadam	Susaiyappar Pattinam	Tangachimadam Panchayat	Mandapam Panchayat Union
019	Mandapam	Thangachimadam	Thangachimadam	Tangachimadam Panchayat	Mandapam Panchayat Union
020	Mandapam	Thangachimadam	Villundi	Tangachimadam Panchayat	Mandapam Panchayat Union
021	Mandapam	Thangachimadam	Saveriyar Nagar	Tangachimadam Panchayat	Mandapam Panchayat Union
022	Mandapam	Thangachimadam	Victoria Nagar	Tangachimadam Panchayat	Mandapam Panchayat Union
023	Mandapam	Thangachimadam	Francis Nagar	Pamban Panchayat	Mandapam Panchayat Union
024	Mandapam	Thangachimadam	Akkalmadam	Pamban Panchayat	Mandapam Panchayat Union
025	Mandapam	Pamban	Kunthukal	Pamban Panchayat	Mandapam Panchayat Union
026	Mandapam	Pamban	Thoopukkadu	Pamban Panchayat	Mandapam Panchayat Union
027	Mandapam	Pamban	Pamban	Pamban Panchayat	Mandapam Panchayat Union
028	Mandapam	Pamban	Chinnapalam	Pamban Panchayat	Mandapam Panchayat Union
029	Mandapam	Pamban	Therkuvadi	Pamban Panchayat	Mandapam Panchayat Union
030	Mandapam	Pamban	Thonithurai	Pamban Panchayat	Mandapam Panchayat Union
031	Mandapam	Pamban	Mandapam		Mandapam Special Panchayat
032	Mandapam	Pamban	Kalanjiyam Nagar		Mandapam Special Panchayat
033	Mandapam	Pamban	Marakayarpattinam	Marakayarpattinam Panchayat	Mandapam Panchayat Union
034	Mandapam	Pamban	Samathuvapuram	Vedaalai Panchayat	Mandapam Panchayat Union
035	Mandapam	Pamban	Vedaalai	Vedaalai Panchayat	Mandapam Panchayat Union
036	Mandapam	Pamban	Valaiyerwadi	Vedaalai Panchayat	Mandapam Panchayat Union
037	Mandapam	Pamban	Seeniyappa Dhargha	Sathakonvalasai Panchayat	Mandapam Panchayat Union
038	Mandapam	Uchipulli	Thuthivalasai	Enmanamkondan Panchayat	Mandapam Panchayat Union
039	Mandapam	Uchipulli	Manthoppu	Enmanamkondan Panchayat	Mandapam Panchayat Union
040	Mandapam	Uchipulli	Saalaivalasai	Irumani Panchayat	Mandapam Panchayat Union
041	Mandapam	Uchipulli	Soorangaatuvalasai	Manangudi Panchayat	Mandapam Panchayat Union
042	Mandapam	Uchipulli	Agasthiyar Koodam	Pudumadam Panchayat	Mandapam Panchayat Union
043	Mandapam	Uchipulli	Nedumangundu	Pudumadam Panchayat	Mandapam Panchayat Union
044	Mandapam	Uchipulli	Paal Kulam	Sathakonvalasai Panchayat	Mandapam Panchayat Union
045	Mandapam	Uchipulli	Maanangudi	Manangudi Panchayat	Mandapam Panchayat Union
046	Mandapam	Uchipulli	Nochiyoorani	Nochiyoorani Panchayat	Mandapam Panchayat Union
047	Mandapam	Uchipulli	Naaraiyoorani	Pudumadam Panchayat	Mandapam Panchayat Union
048	Mandapam	Uchipulli	Pudumadam	Pudumadam Panchayat	Mandapam Panchayat Union
049	Mandapam	Uchipulli	Karan	Karan Panchayat	Mandapam Panchayat Union
050	Mandapam	Uchipulli	Thalaithopu	Karan Panchayat	Mandapam Panchayat Union
051	Mandapam	Uchipulli	Valangaveri	Thamaraikulam Panchayat	Mandapam Panchayat Union

052	Keelakarai	Periyapattinam	Sethu Nagar	Karan Panchayat	Thiruppulani Panchayat Union
053	Keelakarai	Periyapattinam	Muthupettai	Muthupettai Panchayat	Thiruppulani Panchayat Union
054	Keelakarai	Periyapattinam	Periyapattinam	Periyapattinam Panchayat	Thiruppulani Panchayat Union
055	Keelakarai	Periyapattinam	North Kudiyiruppu	Periyapattinam Panchayat	Thiruppulani Panchayat Union
056	Keelakarai	Periyapattinam	Saalaihottam	Karan Panchayat	Thiruppulani Panchayat Union
057	Keelakarai	Periyapattinam	Kollanthopu	Neyanaar Maraikan Panchayat	Thiruppulani Panchayat Union
058	Keelakarai	Periyapattinam	Mutharayar Nagar	Periyapattinam Panchayat	Thiruppulani Panchayat Union
059	Keelakarai	Periyapattinam	Indira Nagar	Periyapattinam Panchayat	Thiruppulani Panchayat Union
060	Keelakarai	Thinai Kulam	Thinai Kulam	Thinaikulam Panchayat	Thiruppulani Panchayat Union
061	Keelakarai	Thinai Kulam	Thopuvalasai	Thinaikulam Panchayat	Thiruppulani Panchayat Union
062	Keelakarai	Thinai Kulam	Kalkaadu	Thinaikulam Panchayat	Thiruppulani Panchayat Union
063	Keelakarai	Thinai Kulam	Kattaiyanperan Valaivu	Thinaikulam Panchayat	Thiruppulani Panchayat Union
064	Keelakarai	Thinai Kulam	Velayudapuram	Kalimangundu Panchayat	Thiruppulani Panchayat Union
065	Keelakarai	Thinai Kulam	Marivalasai	Kalimangundu Panchayat	Thiruppulani Panchayat Union
066	Keelakarai	Thinai Kulam	Kuppachivalasai	Kalimangundu Panchayat	Thiruppulani Panchayat Union
067	Keelakarai	Thinai Kulam	Kuppavalasai	Kalimangundu Panchayat	Thiruppulani Panchayat Union
068	Keelakarai	Thinai Kulam	Kuthukkalvalasai	Kalimangundu Panchayat	Thiruppulani Panchayat Union
069	Keelakarai	Thinai Kulam	Vellaiyanvalasai	Kalimangundu Panchayat	Thiruppulani Panchayat Union
070	Keelakarai	Thinai Kulam	Mottaiyanvalasai	Kalimangundu Panchayat	Thiruppulani Panchayat Union
071	Keelakarai	Thinai Kulam	Kalimangundu	Kalimangundu Panchayat	Thiruppulani Panchayat Union
072	Keelakarai	Thinai Kulam	Krishnapuram	Vannangundu Panchayat	Thiruppulani Panchayat Union
073	Keelakarai	Thinai Kulam	Karisalgundu	Vannangundu Panchayat	Thiruppulani Panchayat Union
074	Keelakarai	Thinai Kulam	Pannakkarai	Vannangundu Panchayat	Thiruppulani Panchayat Union
075	Keelakarai	Keelakarai	Shanmugavelpattinam	Kalimangundu Panchayat	Thiruppulani Panchayat Union
076	Keelakarai	Keelakarai	Anjineyarpuram	Kalimangundu Panchayat	Thiruppulani Panchayat Union
077	Keelakarai	Keelakarai	Sivagamipuram	Kangirangudi Panchayat	Thiruppulani Panchayat Union
078	Keelakarai	Keelakarai	Pakkiriappavalasai	Kangirangudi Panchayat	Thiruppulani Panchayat Union
079	Keelakarai	Keelakarai	Kilaku Pudunagar	Kangirangudi Panchayat	Thiruppulani Panchayat Union
080	Keelakarai	Keelakarai	Meenavar Kuppam	Kangirangudi Panchayat	Thiruppulani Panchayat Union
081	Keelakarai	Keelakarai	Mutharayar Nagar	Kangirangudi Panchayat	Thiruppulani Panchayat Union
082	Keelakarai	Keelakarai	Sethukarai	Sethukarai Panchayat	Thiruppulani Panchayat Union
083	Keelakarai	Keelakarai	Keelakarai		Keelakarai Municipality
084	Keelakarai	Keelakarai	Pannattar street		Keelakarai Municipality
085	Keelakarai	Keelakarai	Mayakulam	Mayakulam Panchayat	Thiruppulani Panchayat Union
086	Erwadi	Erwadi	Mangaleswari Nagar	Mayakulam Panchayat	Kadalady Panchayat Union
087	Erwadi	Erwadi	Bharathi Nagar	Mayakulam Panchayat	Kadalady Panchayat Union
088	Erwadi	Erwadi	Chinna Erwadi	Erwadi Panchayat	Kadalady Panchayat Union
089	Erwadi	Erwadi	Sadaimuniyan Valasai	Erwadi Panchayat	Kadalady Panchayat Union
090	Erwadi	Erwadi	Kalpar	Erwadi Panchayat	Kadalady Panchayat Union
091	Erwadi	Erwadi	Mottaikilavan Valasai	Erwadi Panchayat	Kadalady Panchayat Union
092	Erwadi	Erwadi	Pichchaimoopen Valasai	Erwadi Panchayat	Kadalady Panchayat Union
093	Erwadi	Erwadi	Meiyan Valasai	Erwadi Panchayat	Kadalady Panchayat Union
094	Erwadi	Erwadi	Adamcheri	Erwadi Panchayat	Kadalady Panchayat Union
095	Erwadi	Mariyur	Valinokam	Valinokam Panchayat	Kadalady Panchayat Union
096	Erwadi	Mariyur	Keela Mundal	Valinokam Panchayat	Kadalady Panchayat Union
097	Erwadi	Mariyur	Mundalkal	Valinokam Panchayat	Kadalady Panchayat Union
098	Erwadi	Mariyur	Mela Mundal	T.Mariyur Panchayat	Kadalady Panchayat Union
099	Erwadi	Mariyur	Mariyur	T.Mariyur Panchayat	Kadalady Panchayat Union
100	Erwadi	Mariyur	Oppilan	Oppilan Panchayat	Kadalady Panchayat Union
101	Erwadi	Mariyur	Mookaiyur	Mookaiyur Panchayat	Kadalady Panchayat Union
102	Erwadi	Mariyur	Ilanjipanai	Naripaiyur Panchayat	Kadalady Panchayat Union
103	Erwadi	Mariyur	Naripaiyur North	Naripaiyur Panchayat	Kadalady Panchayat Union
104	Erwadi	Mariyur	Naripaiyur South	Naripaiyur Panchayat	Kadalady Panchayat Union
105	Erwadi	Kamarajapuram	Kamarajapuram	Naripaiyur Panchayat	Kadalady Panchayat Union
106	Erwadi	Kamarajapuram	Periyanayagipuram	Naripaiyur Panchayat	Kadalady Panchayat Union
107	Erwadi	Kamarajapuram	Veppamarathupanai	Naripaiyur Panchayat	Kadalady Panchayat Union
108	Erwadi	Kamarajapuram	Vellapatti	Naripaiyur Panchayat	Kadalady Panchayat Union

109	Erwadi	Kamarajapuram	Manikanagar	Naripaiyur Panchayat	Kadalady Panchayat Union
110	Erwadi	Kamarajapuram	Pudukudiyiruppu	Naripaiyur Panchayat	Kadalady Panchayat Union
111	Erwadi	Kamarajapuram	Rochmanagar	Kannirajapuram Panchayat	Kadalady Panchayat Union
112	Thoothukudi	Vembar	Vembar South	Vembar South Panchayat	Villathukulam Panchayat Union
113	Thoothukudi	Vembar	Vamber North	Vembar North Panchayat	Villathukulam Panchayat Union
114	Thoothukudi	Vembar	Periyasampuram	Periyasampuram Panchayat	Villathukulam Panchayat Union
115	Thoothukudi	Vembar	Keelavaipar	Keelavaipar Panchayat	Villathukulam Panchayat Union
116	Thoothukudi	Vembar	Chippikulam	Keelavaipar Panchayat	Villathukulam Panchayat Union
117	Thoothukudi	Vembar	Pattinamaruthur	Pattinamaruthur Panchayat	Ottapidaram Panchayat Union
118	Thoothukudi	Vembar	Tharuvai Kulam	Tharuvai Kulam Panchayat	Ottapidaram Panchayat Union
119	Thoothukudi	Vembar	Vellapatti	Mela Arasaradi Panchayat	Ottapidaram Panchayat Union
120	Thoothukudi	Vembar	Lourdhamalpuram	Thoothukudi Rural Panchayat	Thoothukudi Municipality
121	Thoothukudi	Vembar	Sangukuli Colony	Thoothukudi Rural Panchayat	Thoothukudi Municipality
122	Thoothukudi	Vembar	T.Saveriyar Puram	Mappilaiyoorani Panchayat	Thoothukudi Municipality
123	Thoothukudi	Vembar	Siluvaiatti	Mappilaiyoorani Panchayat	Thoothukudi Municipality
124	Thoothukudi	Vembar	Thalamuthu Nagar	Mappilaiyoorani Panchayat	Thoothukudi Municipality
125	Thoothukudi	Ratchanyapuram	Threspuram		Thoothukudi Municipality
126	Thoothukudi	Ratchanyapuram	Inigo Nagar & Fathimanagar		Thoothukudi Municipality
127	Thoothukudi	Ratchanyapuram	Pudhiyathuraimugam	Muthaiyapuram Panchayat	Thoothukudi Municipality
128	Thoothukudi	Ratchanyapuram	Ratchanyapuram	Palaya Kayal Panchayat	Meenavakundam Panchayat Union
129	Thoothukudi	Ratchanyapuram	Palaya Kayal	Palaya Kayal Panchayat	Meenavakundam Panchayat Union
130	Thoothukudi	Ratchanyapuram	Punna Kayal	Punna Kayal Panchayat	Alwar Thirunagari Panchayat Union
131	Thoothukudi	Ratchanyapuram	Kombuthurai		Kayalpattinam Municipality
132	Thoothukudi	Ratchanyapuram	Singithurai		Kayalpattinam Municipality
133	Thoothukudi	Ratchanyapuram	Veerapandiyapattinam	Veerapandiyapattinam Panchayat	Thiruchendur Municipality
134	Thoothukudi	Ratchanyapuram	Jeeva Nagar		Thiruchendur Special Panchayat
135	Thoothukudi	Ratchanyapuram	Amalinagar		Thiruchendur Special Panchayat
136	Thoothukudi	Ratchanyapuram	Aalandhalai		Thiruchendur Special Panchayat
137	Thoothukudi	Ratchanyapuram	Kulasekarapattinam	Kulasekarapattinam Panchayat	Udangudi Panchayat Union
138	Thoothukudi	Ratchanyapuram	Manappadu	Manappadu Panchayat	Udangudi Panchayat Union
139	Thoothukudi	Ratchanyapuram	Periyathaalai	Periyathaalai Panchayat	Sathan Kulam Panchayat Union
Total	4 - Zones	12 - Sub-Zones	139 - Project Villages	44 - Panchayats	9 – Panchayat Unions/ 2 – Special Panchayat/ 4 - Municipalities

Total number of Zones	- 004 (Four Zones)
Total number of Sub-Zones	- 012 (Twelve Sub-Zones)
Total number of Project Villages	- 139 (Hundred and thirty nine Project Villages)
Total number of Panchayats	- 044 (Forty four Panchayats)
Total number of Panchayat Unions	- 009 (Nine Panchayat Unions)
Total number of Special Panchayats	- 002 (Two Special Panchayats)
Total number of Municipalities	- 004 (Four Municipalities)
Total number of Households	

Table 5.5.6. List of identified collaborating NGOs with GOMBRT for implementation of Eco-development activities.

Sl N	NAME OF THE NGO	ADDRESS (ES)
01	Tamilnadu Rural Reconstruction and Management (TRRM)	2/1911/12 2 nd Floor, Om Shakthi Nagar, 4 th main road, Ramanathapuram, Tamil Nadu, Pin code – 623 503.
02	SHAWDO	Mohammed Sathak Polytechnic, Kilkarai, Ramnad, Tamil Nadu.
03	DHAN Foundation	1/372, Nehru nagar, First Street, Bharathi Nagar, Ramanathapuram. 18 – Pillaiyar Kovil Street, S.S.Colony, Madurai – 625 010.
04	Small Industries Product Promotion Organisation (SIPPO)	Nodal Office, No.52, First floor, T.B.Road, Madurai – 625 016.
05	Arumbugal Trust	C-92, 2 nd Cross Street, Maharaja Nagar, Tirunelveli, Pincod – 627 011.
06	People’s Action for Development (PAD)	Field Off: 1/104, Thevar Street, Vembar Post, Villathikulam, Thoothukudi District, Pincod – 628 906.
07	De Rose Society (Chavaliar Roche Society)	Nehru Nagar, Old SBJ Colony, Thoothukudi District, Tamil Nadu.
08	Tuticorin Multipurpose Social Service Society (TMSSS)	Bishop’s Harge, Thoothukudi District, Tamil Nadu, Pincod – 628 001.
09	M.S.Swaminathan Research Foundation (MSSRF)	3/231, kanakku Appusamy Street, Mandapam, Ramnad, Pincod – 623 518. Village Resource Centre, 3/1943 Main Road, Thankachimadam, Ramnad.

Objectives of the (2007-2016) eco-development plan

The dependent fisherfolks, during stakeholders meeting organized by the WII-GOMBRT authorities express their willingness for proper guidance and training in additional income generating vocations that will improve their socio-economic condition and decrease their dependency on coastal and marine biodiversity. Without the support and understanding of the lifestyle of these people who are affected by setting up of the National Park and Biosphere Reserve, no strategies for any kind of management is likely to be sustainable in the long run. This plan, thus is proposed with these following objectives.

The objective of the eco-development plan is to *combine guaranteed ecological balance with economic and socio-political dynamism* at local level. More specifically, the Eco-development plan of the Gulf of Mannar Biosphere Reserve aims:

1. To ameliorate the hardships faced by the fishing villagers living in Biosphere Reserve, due to the curtailment of their access to fishing in the National Park, with a view to reducing their dependence on the protected area
2. Planning for resource substitution
3. Socio-economic upliftment of the target population
4. Involving local communities in conservation by adopting a "Community participatory" system of management, so as to elicit public support for conservation
5. Creating organised community institutions at the village level, and assuring benefits and rights to usufruct by developing viable partnerships with the village communities, subject to successful protection and conditions laid by the park management
6. Developing micro-institutional and technical functions in the community management organisations, so as to make them self-sustaining in the long run with minimum dependence on the Park Management
7. Formulation of utilisation rules and their enforcement, so that the contemplated welfare actions are not nipped in their infancy

The planned activities of eco-development program forms an integral part of the Buffer Zone (Biosphere Reserve) Management objectives, for it is this Zone that is expected to absorb the biotic pressures and insulate the Core Zone (Marine National Park) from such pressures. Community involved activities of "Social buffering" is expected to support "Extension buffering" that involves providing a habitat for the spillover population of fish and other marine resources for sustainable use. The eco-development activities area not restricted only to the presently prioritized 222 Buffer villages of the Gulf of Mannar Biosphere Reserve region but are expected to be carried out in other coastal villages in Tirunelveli and Kanyakumari districts during the plan period of 2007-2016.

2. Suggested guidelines for establishment and implementation of the Eco-development plan

- a. Establish and empower community based institutions
- b. All eco-development initiatives in the Gulf of Mannar Biosphere region should be socio-culturally compatible with the target communities, without changing their original ways of life.
- c. Enable the legal and policy framework for eco-development programme for the State in general and for the Gulf of Mannar Biosphere Reserve in particular.
- d. Care should be taken to identify such policies that might change in future and affect the eco-development initiatives and beneficiaries negatively.
- e. More importance should be given for enhancing renewable resource production under eco-development initiatives.

- f. Funds have to be made available as per micro plans. There should not any disturbances in the fund flow.
- g. Regulated community based aquaculture and mariculture programmes need to be encouraged; however, these programmes should not affect the environment especially to the ground water system.
- h. Without the minimum level of literacy, conservation programmes may be difficult to implement. Hence, proper education should be imparted to the target community.
- i. Eco-development initiatives should be directed at generating employment opportunity in large numbers in other than fisheries sector.
- j. The inflow of fund should be regular and un-fluctuating to achieve the initiatives as per prioritisation.
- k. Community development works should always be undertaken for the continuation of dialogues with the target community.
- l. Wildlife crime cases should be quickly disposed of to emphasize the government's commitment to wildlife conservation.
- m. An eco-development tax should be levied on all types of charges relating to tourism in the Biosphere. This can be used to support eco-development initiatives.
- n. Under sectoral integration, efforts should be made to acquire funds from various quarters, giving an effective thrust to eco-development programme.
- o. EDCs should be rewarded every year for their excellent performance.
- p. Hoteliers and other businessmen, the sole beneficiaries of eco-tourism in the Biosphere Reserve, should contribute for eco-development from their incomes.
- q. Training like driving, cycle repairing, TV repairing, scuba diving, nature guides, aquaculture, mariculture, cultivation and poultry etc. should also be imparted and some incentives should be given to help the villagers start their enterprises.

3. The suggested framework for the implementation of Eco-development plan in the Gulf of Mannar Biosphere Reserve region

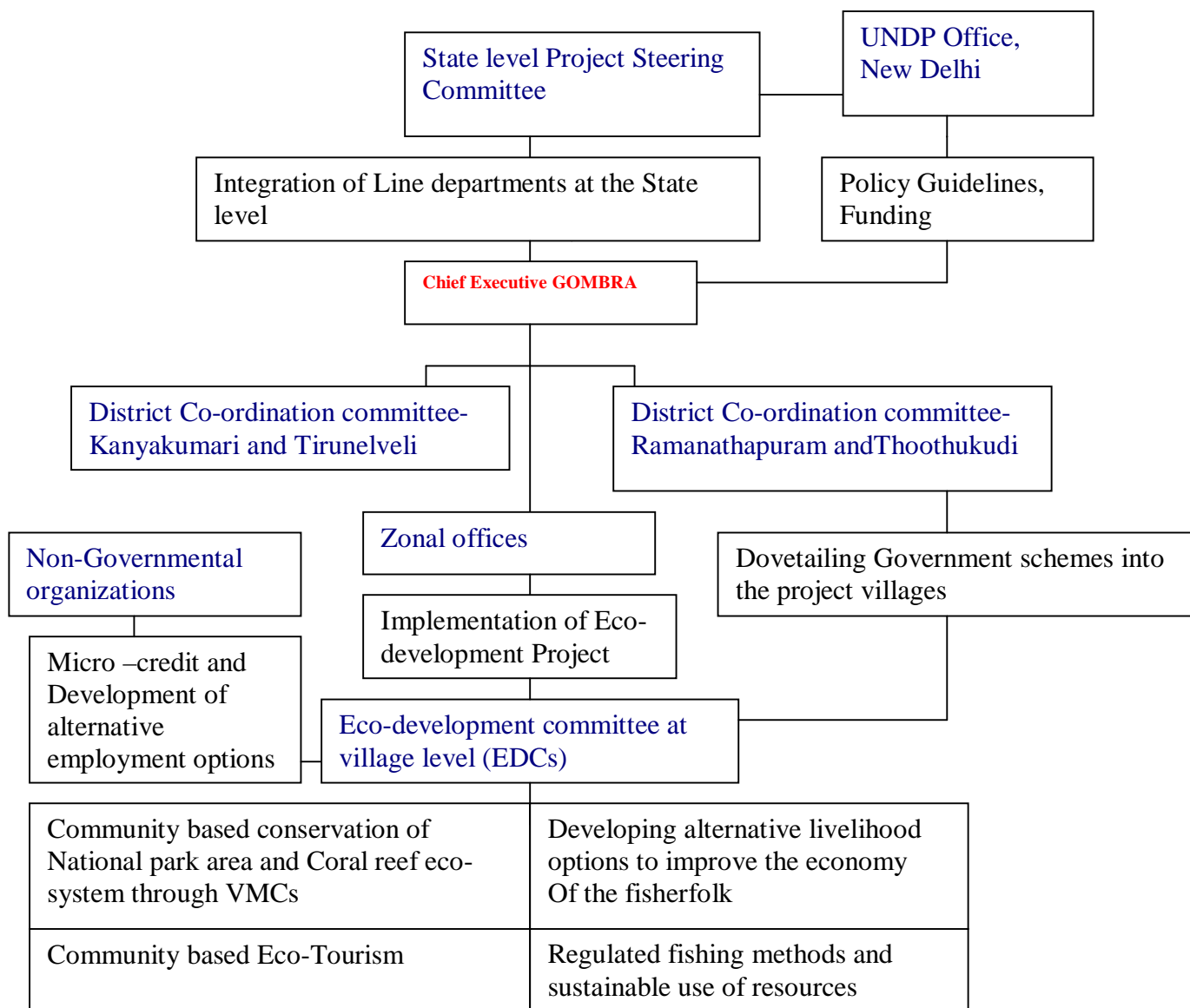


Figure 5.5.1 The suggested frame work for implementation of Eco-development plan in the Gulf of Mannar Biosphere Reserve region

While the broad framework for the implementation of the Eco-development plan in the Gulf of Mannar Biosphere Reserve region through the UNDP-GEF project is in place (see Figure 5.5.1) an appropriate revised framework needs to be developed for implementation of the eco-development plan in the post UNDP-GEF project scenario by the proposed GOMBRA.

The EDC villages are to be grouped into zones and subzones for administrative convenience. Each zone are to be co-lead by one Range Officer and One Inspector of Fisheries to look after the zonal administration. Under each zone, there will be 2 to 5

subzones headed by either Forester or Sub-Inspector of Fisheries who will liaise with the fisher folk and local NGOs for implementation of the eco-development activities. At each EDC village level, the Eco-development committee will decide the activities to be taken up in the village. Each eco-development committee will consist of one executive council with 6 executive committee members and one president. In the executive council there will be 4 women candidates to ensure gender equity. All the decisions taken by the Eco-development committee will be routed through the executive committee in the form of resolutions.

The following activities are to be taken up by the eco-development committee.

- v Disbursal of soft loans to the EDC members for undertaking alternative employment options.
- v Vocational Training to the fisher folk especially women.
- v Capacity building of EDC members.
- v Undertaking infrastructure development works in the project village either as entry point activity or through the funds diverted to the project villages by the District co-ordination committee.
- v Awareness creation about the importance of conservation of Gulf of Mannar Biosphere Reserve, protected animals under wildlife protection act 1972, harmful netting practices, social issues affecting their quality of life, etc.
- v Formation of community based conservation zones to regulate the activities in their respective zones and to promote sustainable harvest of marine resources.
- v Coordinated efforts with the local NGOs and local bodies for the overall improvement of the socio-economic conditions of the fisher folk.

4. Establishment of eco-developmental zones based on area of influence and impact

Coastal resource dependent communities within 10 km from the sea shore between Pamban and Kanyakumari are considered to be the direct dependents on the Gulf of Mannar Biosphere Reserve resources. **Presently, however, the coastal communities between Pamban and Tuticorin are considered to have a higher stake on the Biosphere Reserve and the Marine National Park and hence have been prioritised to be covered under the Eco-development Phase I in Ramnathapuram and Tuticorin districts (Zone I) in the first five years. Communities from this zone highly influence both buffer and core zones of the Biosphere Reserve. The coastal area between Tuticorin and Kanyakumari comparatively has less influence and impact on the buffer zone of the Biosphere Reserve and hence it is proposed to cover them under the Eco-development Phase II in Tirunelveli and Kanyakumari districts (Zone II) in the second five years.** In the present management plan it is proposed to focus more attention and activities of eco-development in Zone I while initiating the process of creation of identification of villages, formation of EDCs in Zone II as well for which the geographic scope and identification of villages have been carried out.

5. Improved strategy for formation of eco-developmental committees

Out of the 306 identified villages along the buffer zone of the Gulf of Mannar Biosphere reserve, a total of 222 villages were prioritised as project villages 210

EDCs have been formed as on January 2007. The EDCs, containing a minimum of 8 members each, have atleast 4 female members, which is mandatory. However, **the selection of the Presidents for each of the EDCs should be based on the individuals association or involvement with marine resources. The members of the Eco Development Comitees should atleast be aware of the the Gulf of Mannar Biosphere Reserve's significance and willing to help coserve its biodiversity.**

6. Demarcation and Profiling of marine resources exploitation zone by EDC villages

Of the 210 Eco development Comitees formed (as on 31-01-07), 47 are in Mandapam group, 41 in Keelakkarai, 56 in Earwadi and the remaining 41 are in Tuticorin group. The villagers from Mandapam zone venture as far as into the Sri Lankan waters. The areas most frequented by this group of fisher men are of Mandapam group of islands, though occasionally they also venture into Anaipar and Appa islands in the Keelakkarai group. The villagers from Keelakkarai group are however confined to the Keelakkarai group of islands, Appa and Thalayari islands are the most frequented ones. Earwadi group of fisherfolks have an added advantage of the three island group, as they are very close to the shore when compared to others. These people also fish in the waters around Poomarichan and Pullivasal islands very often. Tuticorin group of people exploit in waters which are as far as Rameswaram and some times also venture till Danushkodi on north and Kanyakumari in the south. With fishing in the National Park area having been prohibited, all these fishermen not only legally prosecuted by Forest Department but also face resistance from the fishing communities of the villages which are close to those respective islands. This causes much damage to their gears when some people gets hold of the intruders gear and either keep it for themselves or damage their nets. **To avoid such infringement and damage of their assets, a strict demarcation of Marine National Park boundaries is required for facilitating the EDC village fisherfolks to be made aware of the exploitation and non-exploitation zones.**

7. Effective and Village Marine Conservation Microplan development through PRA and prioritizing Eco-development activities

Once the dependent villages on the buffer zone have been indentified and EDCs formed, microplans for Eco-development activities needs to be developed through Participatory Rural Appraisal facilitated by Trust building exercises carried out with the involvement of local NGOs. The Strength, Weakness, Opportunities and Threats of implementing identified eco-development activities analysed before they are prioritized for implementation. Three model VMC and the process that needs to be followed are appended in the Plan.

8. Range of livelihood option practices and their impact analysis:

There are a variety of factors that affect or control (externally) the livelihood opportunities of the fisherfolk in the Gulf of Mannar region.

- i.) Natural Resources: this happens to be a primary factor affecting the livelihoods of people anywhere in the world. Availability of resources is determined largely by resource status, which in the Gulf of Mannar is observed to be degrading since several decades.

- ii.) Cultural Aspects: Attitudes such as responsibility towards sustainable utilization of resources is strongly influenced by cultural aspects of any community. Since the coastal communities have the practice of marine fishing as a livelihood for many generations, it has to be well understood that a great deal of time and commitment should be spent on providing them with proper incentives for altering their livelihood options.
- iii.) Market System: with the existing marketing system, a major role being played by the middle-men and few financiers in who lend loans to the fisher folk and in return, the fisherfolks have no other options other than to sell their catch to these financiers. In the Gulf of Mannar region, the relationship between market traders and the fishers is known as *Sattambi*, which guarantees trade for the small harvests of the traditional and small scale fishermen (Whittingham, E., J. Campbell and P. Townsley, 2003).

The livelihoods of people in the Gulf of Mannar Biosphere Reserve (buffer zone) are partly on coastal and marine resources. Apart from fishing, the main activities of the coastal fisherfolk include salt making, sea weed collection, fish drying etc., with the mechanization of fishery sector, fisherwomen had been displaced from their traditional roles in processing, marketing, making of nets, fish drying etc. The financial condition of most of the fishing families has led women to deviate into illegal collection of wild seaweed stocks from the Marine National Park area or working as labour in salt pans, beedi making etc. This seldom helps them in supporting their families, triggering their involvement in illegal activities like coral mining, fishing around islands, collection of few protected shells etc.

Agriculture and allied activities, even though marginal, still play a major role in providing livelihoods for the people. Major part of the agriculture in the rain deficient Gulf of Mannar Biosphere Reserve region thrives on the existing 71 tanks irrigating 3,750 Ha (MSSRF, 1997). This constitutes 21% of the tank-fed area near the reserve. Tanks irrigate around 80% of the land under cultivation at present as there is no other kind of agriculture existing in this region. As this is mostly seasonal, the farmers, during the non-agricultural season, shift into the fishery sector by working as labourers in trawl boats or even venturing into illegal marine resource harvesting. This trend seems to be increasing in the recent years as seasonal agriculture itself has become erratic.

However, there seems to be an ample demand for the nature based products like palm leaf mats, baskets etc., and artifacts made out of legally permissible exploitation and use of sea shells. Poor marketing options existing in the region coupled with the interference of middle men appears to be the main problem requiring immediate attention to deal with. Apart from this, a survey done by MSSRF during 1999 has summarized the profitability and marketing options of few of the alternative livelihood options available (Table: 5.5.7).

Table: 5.5.7 Profitability and marketing options of selected alternate livelihood options (MSSRF, 1999)

Activity	Profitability (CBR)	Employment	Market	Institution
Charcoal production (Prosopis &)	1:1.15		Urban centers upto Mumbai	

Cashew)				
Dairy farming	1:2	300 man days per 6 units	Local	
Pearl culture	1:1.25	5100 mandays per unit	External	CMFRI
Oyster farming	1:1.13	1800 man days per unit	Cochin	CMFRI
Seaweed culture	1:1.12	1200 man days per unit	Local	CMFRI
Agar production	1:1.53	1200 man days per anum	Local	CSMCRI, MPEDA
Fish pickle unit	1:1.18	1800 man days per unit	Local	MPEDA

CBR: Cost Benefit Ratio

Apart from these, there are a few more alternate livelihood options that could be taken up as the impact they have on the environment is mostly non-detrimental.

- Promotion of charcoal making using invasive *Prosopis juliflora*; already villagers have started this activities in Ramanathapuram and Tuticorin district. Removal of these invasive species also enables native vegetation to flourish and improve the local ecology.
- Onshore native seaweed species cultivation can help in reducing the excess nutrients added to the system through eutrophication at some places and also helps in supporting a wide range of fish species as they are good feeding and breeding grounds for many.
- Halophyte plantation in saline infested areas will provide extra income from production of natural vegetation salt (used in ayurvedic medicines) but also helps in delainating the saline infested soil.

There are a few alternate income generation options such as onshore aquaculture practices which may result in eutrophication, salination of soil etc., Nevertheless, these can be avoided if proper precautions are taken.

9. Alternate livelihood options feasible in the Gulf of Mannar Biosphere region

To wean away a large section of fishermen from illegal marine resource exploitation from protected islands and use of destructive fishing gears etc. a range of feasible alternative livelihood options have been described. An assessment of 207 EDC villages was carried out to examine their present dependency on livelihood options and their expected and feasible alternate livelihood options (Table 5.5.8) These activities can be taken up not only to generate income for the fisherfolk that also leading to specialized skill development of the local people.

Table 5.5.8 Analysis of feasible alternate livelihood options in selected EDC villages.

Zone (No. of Villages)	Fishing			Agriculture			Others			Alternative livelihood options expected	Feasible/ Recommended alternatives
	C	P	N	C	P	N	C	P	N		
MANDAPAM (47)	19	24	0						2	<ul style="list-style-type: none"> • Small scale hotels, • Grocery shops, • Dried fish, • Horticulture, • Animal husbandry, • Candle making, • Palm based Handicrafts, • STD booths, • Boat mechanics, • Aqua culture, • Phenyl/ Detergent soap manufacturing, 	<ul style="list-style-type: none"> • Fish drying/pickling • Horticulture • Animal husbandry • Palm based handicrafts • Candle making • Aquaculture • Boat mechanics • Phenyl/Detergent soap manufacturing
KEELAKKARAI (40)	19	16			12				2	<ul style="list-style-type: none"> • Mushroom culture, • Fish drying, • Animal husbandry 	<ul style="list-style-type: none"> • Mushroom culture • Fish drying/pickling • Animal husbandry
VEMBAR/EARWADI (55)	15	35	6						3	<ul style="list-style-type: none"> • Char coal making, • Animal husbandry, • Fish drying, • Aqua culture, • Palm based handicrafts, • Vermiculture 	<ul style="list-style-type: none"> • Charcoal making • Animal husbandry • Fish drying/pickling • Aquaculture • Handicrafts • Vermiculture
TUTICORIN (65)	38	12	10						16	<ul style="list-style-type: none"> • Charcoal making, • Palm based handicrafts, • Aqua culture, • Cosmetic making, • Automobile workshops, • Small scale hotels, • Textile business, • Grocery shops, • Cycle workshops, • Sea weed culture, • Auto rickshaws, • Cold storages, 	<ul style="list-style-type: none"> • Charcoal making, • Palm based handicrafts, • Aqua culture, • Cosmetic making, • Automobile workshops, • Textile business, • Cycle workshops, • Sea weed culture, • Auto rickshaws, • Cold storages (community based) • Small scale industrial like fish pickling units etc., • Candle making,

											<ul style="list-style-type: none"> · Small scale industries like fish pickling units etc., · Candle making, · Beedi making, 	
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a. Community based seaweed culture using native species

Presently, a large number of marginalized fisherfolk along the Gulf of Mannar Biosphere Reserve region are engaged in the collection of seaweed from the wild either from the Core or the Buffer Zone. Most damaging part of this wild collection is the use of a metal scraper to harvest the weed which leads to the damage of other non-target species. There are no efforts done till date to develop native species seaweed culture in the Gulf of Mannar. This is practiced in the Palk Bay side of Mandapam. This is required to be promoted along the Biosphere Reserve. Culture through rafts has been observed to give good results in this area. However, culture of non-native species should be strongly discouraged. Subsidised loans are required to be given to the EDC members seeking to take up this as an alternative income generation source. This should be given to the EDC group as a whole but not to any single person. There should also be a limit on the number of people to be involved in such activity as an increase in number of such onshore seaweed culture may also have negative impact on marine biodiversity. Training on the culture aspects could be sought from specialized research institutes like CMFRI.

b. Community based fish product industries

To enhance the income generation options of marginal unorganized sector fisherfolks, value addition to the exploited fisheries resource can be done through converting them as pickle, canned-food etc. The MSSRF and other NGOs have already initiated such model industries. Since such value addition facilities may require significant volume of raw material, this can be taken up by farming cooperatives or through village communities. Such effort however, requires extension and technical training through a slightly educated group and hence requires to be targeted at somewhat educated youth. Such community-based fish product industry also requires safe disposal of waste and a proper marketing network to make them economically viable and sustainable.

c. Involvement in eco-tourism activities as a guide, scuba driver, boatman etc.

Members of the Eco-development committees could also be made involved in various eco-tourism operations after empowering them through proper training. This would include Dive Guides, Boatmen in tourist boats, nature guides, guides at various tourist places etc. They can also be supported and encouraged to set-up smallscale souvenirs stalls, eateries etc. in main tourist places along the Biosphere Reserve.

d. Charcoal making

Charcoal making using *Prosopis juliflora* can be encouraged among the EDC villages. This can be promoted along the Gulf of Mannar Biosphere Reserve terrestrial buffer zone as though the Marine National Park islands are also infested with *Prosopis* such activities may be difficult to take up in a National Park. However, if the National Park as a habitat improvement measure removes the invasive *Prosopis*, the EDC members may be provided with the remove material for charcoal making. Other Government *poramboke* lands along the Reserve may also be leased-out to the EDC members to harvest the *Prosopis* for charcoal making and after complete removal of *Prosopis*, they can be further contracted to plant the area with suitable local vegetation for restoring terrestrial vegetation.

e. Handicrafts using palm trees and permitted shells

The Gulf of Mannar Biosphere Reserve coastline has an abundance of Palmyra palm (*Borassus flabellifer*) the State tree of Tamil Nadu. Though almost 100% of this tree is utilized traditionally by people in some way or other, production of value added handicrafts made out of palm leaves can bring in an option of alternate livelihood. Though this is in practice in some coastal villages, efforts need to be done to bring this into a more organized sector. EDC members who have some know how of making mats and baskets and other artifacts using bamboo or palm leaves need to be provided with additional skill upgradation, marketing opportunities and exposure to similar products being developed in other regions through organized and supported exposure visits. Community owned selling centers in tourist places where the local people could be made to sit and sell their own products may also help. The smallscale industries department and other related agencies may be required to be brought in to develop this sector along the Gulf of Mannar Biosphere Reserve region. This should be made into an organized cottage industry with links to other places of the country where there is demand.

f. Halophyte plantation (salt plant) on saline land

In recent years in the west coast of India vegetation based natural salt are being produced from coast-based halophytes like *Salicornia brachiata* and *Salicornia brachiata*. Such natural vegetation origin salt are in high demand in the ayurvedic pharmaceutical industries. Such halophyte plantations also helps in desalinating the hypersaline soils. Such activities can be encouraged by allocating degraded saline patches to village EDCs. Such plantations can also be cultivated along the banks of salt pans or in the salt marshes. In addition natural vegetation salt, pickles can also be prepared from these plants. These products can be sold in the community owned stalls at the main tourist centers or link to other user and marketing agencies. The GOMBRT may organize exposure visit for identified EDC members to the west coast to enable them understand the prospect of such alternate income generation option.

g. Community based dairy farming

The Gulf of Mannar Biosphere Reserve region is rain and pasture land deficient area, livestock and animal husbandry related activities have not been a major income generation option. However coastal villagers have been involved in cattle and livestock rearing for emergency supplementary income. With increasing changes in the demographic profile and urbanization there is the prospect of additional income out of intensive diary and micro-livestock farming. The GOMBRT may liase with the Animal Husbandry Department of Tamil Nadu for catalysing such activities.

h. Community based Aqua culture

With the traditional involvement of coastal communities in fisheries sector the EDCs may be at ease to adopt aquaculture involving select marine species. Since export of prawn, lobster, brackish water fishes, and marine ornamental fishes gaining importance day-by-day, prawn/shrimp and other marketable aquaculture may be promoted as alternate livelihood with the EDC members. Suitable villages with brackish water provision located near the coast needs to be identified for this purpose. Training and extension through involvement of professional institutions from the Tamil Nadu fisheries Department, CMFRI Mandapam and Tuticorin Fisheries College may be involved in providing training and promoting such activities. Aqua culture practices shall also include culture of edible oyster, pearl oyster etc. Facilities like cold storage and processing plants may also be required at a later stage if a larger number of EDCs become involved in such alternate income generation options.

10. Capacity building of EDCs

Capacity building is an important aspect when it comes to empowering communities for adopting alternate livelihood options. In Eco-development programmes such as this is very essential to empower community not only in the choice of livelihood options but also on various aspect of coastal and marine biodiversity conservation and habitat monitoring. It may be essential to identify suitable EDC members based on their educational qualification, aptitude and willingness to receive professional training to become trainers and also to assist the GOMBRT authorities to monitor sensitive ecosystems like seagrass beds, corals, mangrove habitats etc. Periodic training workshops to refresh the knowledge of these selected people by the GOMBRT will create a local human resource base for long-term involvement and input to the Biosphere Reserve management. Such capacity building exercises can be initiated in partnership with local NGOs and/or Research Institutes who have expertise in the respective fields. For example, training on monitoring coral reefs and sea grass beds can be done in association with PAD/SDMRI; restoration of water tanks with the DHAN Foudation; Sea weed culture and other aqua culture aspects with CMFRI/Tuticorin Fisheries College and Research center etc.

11. Development of Village Marine Conservation Plans:

The concept of conservation, when people have a major stake over the resources, especially in the places like the Gulf of Mannar, would yield better results when

people are made to be involved at the time of planning of any conservation efforts. A recent example of this would be that of Fiji, where a group of land owners from the Nacula Tikina in the Yasawa group of islands, in partnership with Partners in Community Development Fiji (PCDF) and local tourist resorts, have created their own marine resource management plans in 2006 (ICSF, 2006). Similar efforts could be made in the Gulf of Mannar region by making the EDCs participate in developing their own Village Marine Conservation plans.

Initially, four villages, one from each group of the Biosphere reserve should be selected and Village Marine Conservation (VMC) plans prepared and the alternative livelihood options may be tested in these 'Model villages' first and upon getting successful results, the similar VMC plans be developed for other villages along the Gulf of Mannar Biosphere Reserve. Three model Village Marine Conservation plans have been developed by the Wildlife Institute of India in a consultative participatory process (see Appendix). These VMCs may be tested during the first two years of the management plan for replicating similar VMCs in all identified EDC villages.

12. Institutional mechanism for evaluation of eco-development program and activities

While the institutional structure for implementing the Eco Development plans is proposed to be with Gulf of Mannar Biosphere Reserve Trust in a participatory mode with the identified EDCs, collaborating Non-governmental organization, other Government line Departments and professional institutions, the progress and effectiveness of the Eco-development plan with respect to the objectives needs to be monitored by a inter-sectoral high powered committee. The Gulf of Mannar Biosphere Reserve authorities chief executive being the member secretary should have identified members of all involved agencies in this committee. The district collectors of all the four districts as well as nominated members from professional NGOs and scientific institutions may also be included in this high power committee to meet atleast once a year to review the implementation of the Eco-development plan and suggest corrective measures.

13. Evaluation and review

The future of the National Park depends largely on the effectiveness and successful implementation of this plan in the Gulf of Mannar Biosphere Reserve. While the progress of the implementation of the activities of eco-development plan are to be reviewed by the High powered steering committee suggested in the earlier section, the actual effectiveness of eco-development measures on the enhancement of ecology of the Marine National Park needs to be monitored by identifying indicators, since the assumption of eco-development measures is to decrease the dependency of people on marine resources and their degradation. In such an assumption, if a bench mark status of the indicators is maintained the future monitoring of those indicators must show improvement to conform the eco-developmental activities are providing the anticipated improved ecological status of the indicators. Hence, periodic evaluation and necessary review of implemented works and their expected outputs (Table 5.5.9) needs to be carried out both by in-house agencies as well as independent specialized agencies or a group or individuals. This can be done at regular intervals atleast, not

less than once a year. This not only helps to know if the plans are successful or not and also to make necessary changes. The evaluation may also include socio-economic monitoring of the dependant communities. A model collaborative monitoring system example is given in Table 5.5.10. giving detail of indicators, means of verification, who can do this and what is to be done.

Table 5.5.9 Major activities of Eco-development program and expected outputs

(Source: The stakeholders planning workshop for Gulf of Mannar Biosphere Reserve)

Purpose: Local communities practice sustainable fishing.	Output 1: Number of non-fishers in fishing activities is controlled	Activity Cluster 1.1 - Develop livelihood strategies for non-fishers	Activities: - Assess and analyse the immigration patterns to coast - Assess feasibility/viability of livelihood options - Coordinate with other line departments for improved livelihoods - Capacity building on selected livelihood options	Assumptions, Pre-conditions & Risks: · No new project or programme is implemented by any agency promoting immigration of for away communities · Few enterprising families are encouraged to establish alternate livelihood as models · Proper systems of marketing are developed for promoting the products produced by traditional communities
	Output 2: Enhanced internal/ community pressure against destructive fishing practices	Activity Cluster 2.1: Undertaking awareness programmes for local communities about destructive fishing practices	Activities: - Compile information on destructive fishing practices - Implement campaign with NGOs - Media outreach	· Intensive steps for social capital building are taken for communities · Traditional institutions are identified and revived
	Output 3: Improved in clarity of tenure over resources	Activity Cluster 3.1: Strengthen community management systems	Activities: - Trust building within community through EDCs/SHGs - Community institution building	Information about traditional management systems is gathered and community confidence and pride in these systems is regenerated

<p>Output 4: Increased incomes from sustainable fishing practices</p>	<p>Activity Cluster 4.1: Work with Fisheries Department on developing appropriate measures for reducing operational costs</p> <p>Activity Cluster 4.2: Work with key agencies towards enhancing the value of catch</p> <p>Activity Cluster 4.3: Work with FSD to improve access to infrastructure needed for fishing</p>	<p>Activities:</p> <ul style="list-style-type: none"> - Assess information on factors determining operational costs - Training on engine and craft maintenance - Establish information system for increasing fishing efficiency - Take steps for strengthening of local groups/ organizations - Take steps for reducing the control of middle men - Take measures to build strong storage, post harvest and marketing systems 	<ul style="list-style-type: none"> · Fisheries department is taken actively involved · Capacity building of fisheries department is in place · Village level institutions are strengthened
<p>Output 5: Diverse off season livelihoods for local fishermen in place</p>	<p>Activity Cluster 5.1:</p>	<p>Activities:</p> <ul style="list-style-type: none"> - Assess feasibility/viability of livelihood options - Coordinate with other line departments for improved livelihoods - Capacity building on selected livelihood options 	<ul style="list-style-type: none"> · Livelihood activities help to reduce migration along coast and between inland and coast · Other agencies are part of co ordination mechanism
<p>Output 6: System of effective enforcement of existing laws in place</p>	<p>Activity Cluster 6.1: Promoting better coordination between enforcement agencies 6.2: Building capacity of enforcement agencies 6.3 Enhancing capacity of communities for internal enforcement</p>	<p>Activities:</p> <ul style="list-style-type: none"> - Setting up coordination committee 	<ul style="list-style-type: none"> · There are proper GOs for the co ordination committee · Proper institutional arrangements and areas for capacity building identified · New capacities are used
<p>Output 7: Appropriate and participatory policy frame work in place</p>	<p>Activity Cluster Facilitating participatory review of existing policy to generate refined policy</p>		<ul style="list-style-type: none"> · Modified policies are accepted by the government and required orders are given

Sustainable fishing practices adopted by mechanized fishing boats	Output 1: Generation of optimum catches from trawl efforts	Activity Cluster Enhancing the non fishery (land based) returns of livelihoods to reduce migration of inland farmers	Activities - Assess feasibility/viability of livelihood options - Coordinate with other line departments for improved livelihoods - Capacity building on selected livelihood options	<ul style="list-style-type: none"> · Number of people employed by trawlers can be limited · New capacities are actually used
	Output 2: Generation of adequate returns from mechanised fishing	Activity Cluster Working with Fisheries Department for promoting diversified and sustainable fishing practices	Activities Explore and demonstrate alternative/non-destructive methods of trawl fishing	<ul style="list-style-type: none"> · Required models are built and put in place
	Output 3: System of efficient enforcement of existing laws and policies in place	Activity Cluster Supporting effective enforcement and monitoring through coordination with relevant agencies	Activities Develop an effective monitoring system Building of local organizations and enforcement agencies	Monitoring systems are actually used and proper management actions are taken as a follow up
	Output 4: Regulatory frameworks for managed trawl operations in place	Activity Cluster Undertake studies for generating data base and information to build refined regulatory framework	Activity - Assist FSD with implementation in critical sites	The findings are shared with others and these actually flow in management actions

<p>Purpose: Conservation of the non-fish natural resources in the GoMBR.</p>	<p>Output 1: Regulated mining of rare earth minerals with minimal environmental impacts.</p>	<p>Activity Cluster 1.1: Reducing the influence of the mining industry.</p>	<p>Activities: *Identify all the major organizations and departments involved in mining *Establish a working relationship with all the identified stakeholders *Sensitize the stakeholders about BD values of GoMBR and negative impacts of unregulated mining and environmental laws *Seek their cooperation for conservation.</p>	<ul style="list-style-type: none"> · Other agencies are part of co ordination mechanism · There is a system of frequent interaction with the stakeholders
		<p>Activity Cluster 1.2: Enhance capacity and motivation of Panchayats/local communities to enable more effective monitoring of the mining activities.</p>	<p>Activities: *Compile existing guidelines and disseminate in appropriate form *Assess the reasons for the low-levels of motivation amongst the panchayats/local communities * Based on the results of the assessment develop and implement a capacity development strategy to build the capacities of the panchayats/local communities to effectively monitor the environmental impacts of the mining</p>	<ul style="list-style-type: none"> · Other agencies are part of co ordination mechanism
		<p>Activity Cluster 1.3: Promoting an environmentally sensitive policy framework and legislation for coastal mining</p>	<p>Activities: *Analysis of existing policies and laws *Suggest amendments and revisions to the policy and legal framework</p>	<p>The amendments suggested in the existing policies and legal framework are formally recognized and approved by the Govt. and concern Department.</p>

		Activity Cluster 1.4: Promoting coordination among departments for effective enforcement of regulations	Activities *Identify and establish groups of agencies/ departments dealing with the regulation of mining *Hold regular meetings for info sharing and to sensitize them to environmental concerns and to ensure better coordination and enforcement	
Output 2: Controlling coral mining.		Activity Cluster 2.1: Promoting coordination and assisting departments for effective enforcement of regulations	Activities *Enhancing the capacity of the WLW (Infrastructure & equipment and manpower) *Identify and establish a group of agencies/ departments dealing with the control of coral mining *Hold regular meetings for info sharing and to sensitize them to the importance of coral conservation and to overall environmental concerns and to ensure better coordination and enforcement	Agencies are involved in decision making and programme implementation
		Activity Cluster 2.2: Enhancing the viable livelihood options for the local communities involved in mining	Activities: *Establishment of EDC/VMCs *Development of microplans *Feasibility study of alternative livelihoods and pilots *Implementation of microplans	<ul style="list-style-type: none"> · New people do not start coral mining · New industrial use for coral does not emerge · Alternative livelihoods are incorporated and implemented in the microplans

		Activity Cluster 2.3: Advocating stopping the use of coral as a raw material by the lime industry.	Activities: *Identify all the lime industries involved in mining *Establish a working relationship with all the identified industries *Sensitize the industries about BD values of GoMBR and negative impacts of coral mining and environmental laws *Seek their cooperation for conservation.	Agencies are involved in decision making and programme implementation
Output 3: Illegal collection of protected and rare species reduced	Activity Cluster 3.1: Support relevant agencies in enforcing the existing regulatory laws and policies	Activities: *Enhancing the capacity of all the relevant agencies especially the WLW (Infrastructure & equipment and manpower) and the Customs department, the relevant port officials and the Coast Guard *Establish a group of agencies/departments dealing with the protection of these species and control of the illegal trade *Hold regular meetings for information sharing and to sensitize them to the importance of the protection and conservation of these species and the larger environmental concerns, and to ensure better coordination and enforcement	Agencies are involved in decision making and programme implementation	
	Activity Cluster 3.2: Reducing the market demand for the protected and rare species	Activities: *Work with relevant agencies to curb the market links and reduce the market demand for rare/endangered species		

		Activity Cluster 3.3: Enhancing the viable livelihood options for the local communities dependent on collection of these species	Activities: *Understand dependency patterns of the local communities on these species *Establishment of EDC/VMCs *Development of microplans *Feasibility study of alternative livelihoods and pilots *Implementation of microplans	
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Purpose: Effective safeguards and regulations against negative impacts of infrastructure projects in GoMBR on biodiversity and livelihoods	Output 1: Conservation priorities are mainstreamed into infrastructure and development planning	Activity Cluster 1.1: Ensuring that the ecological and economic values of GoMBR are recognized by decision-makers and politicians	Activities: - Develop and applying a methodology for valuation of biodiversity and ecological services of GoMBR - Effectively communicate these values to decision-makers and politicians	Assumptions, Pre-conditions & Risks:
Output 2: Strong environmental clearance procedures are in place	Activity Cluster 2.1: Promoting the development of an effective framework, systems and capacities for decision-making	Activities: - Analysis of gaps in existing framework in context of GoM	- Adequate political will exists - Process is not influenced by vested interests	The clearing procedures are made transparent to public at large

		Activity Cluster 2.2: Facilitating effective public participation in the process	Activities: -Create village based awareness programmes -System of public hearings (public view should be considered) - Strengthening of local/ peer pressure groups - Creation of institutional mechanism for wider dissemination of information	
		Activity Cluster 2.3: Ensuring that EIAs are conducted by professional/independent agencies	Activities: - Enhance role of trust in EIA process** - Enhance capacity for carrying out EIAs (through core expert group) - Collate social/ ecological baseline data needed for EIAs	The data generated are actually used for generating the modified clearing procedures with due approvals of the Government.

Table 5.5.10. A model collaborative monitoring system

Identified indicator	Means of verification	Who does it	What is to be done	At what interval
Increased and catch of resident fishers increased	Monitor fish catches for catch per gear per fisher, income earned	Users, Village Management Committee, fisheries officers	Deliver catches/record data Compile and analyse data Feed back information to fishers and District	Daily Monthly Six months
Increased stocks on all reefs within management area	Simple stock assessment of key species from catch statistics which recorded type and number of gears, area fished, species caught, number of fish per size class, weight of catch. Underwater census of key species	Users, VMC, FOs Same as above	Record data Analyse data Feedback information to fishers and District Same as above	Daily Six months Six months Every Six months
Reduced number of incidences of illegal fishing e.g., dynamite, seine nets and sticks, poison, spears and spearguns	Patrol logs which recorded number and type of complains/reports of illegal fishing and action taken	VMC, FOs, Village Militia	Record complaints, incidences, responses and results Evaluate effectiveness and report to District FO and Village Government	Daily Monthly
All vessels and fishers of incidences of legal but destructive fishing	District Fisheries Licensing records	District FO	Compile licensing records	Yearly
Reduced number of incidences of legal but destructive fishing	Patrol logs recording instances of extractive use and action taken	Users, VMC, FOs	Record data Analyse data Feedback information to fishers and District	Daily Six months
Management controls in place	Bylaws, regulations	VMC, Village Government, District Government	Formulate bylaws/regulations Approve bylaws/regulations	As required
No extractive use of closed reef	Patrol logs recording number of reported instances and what action taken. Legal gazette of reef closure specifying restrictions and penalties	Users, VMC, FOs	Record data Analyse data Feedback information to fishers and District	Daily Six months Six months
Catch information recorded	Catch statistics recording fishing effort and catch from each device	Users, VMC, FOs	Deliver catches/record data Compile and analyse data, feed back information to fishers and District	Daily Six months Six months
Reduced number of visiting vessels	Catch statistics recording fishing effort of residents and visitors	Users, VMC, FOs	Deliver catches/record data Compile and analyse data, feed back information to fishers and District	Daily Six months Six months

(Adopted from Horrill and van Ingen, 1997)

Table 5.5.11: Eco – Development Program villages along the Coastline in the Gulf of Mannar Biosphere Reserve in the District Of Ramanathapuram and Thoothukudi

DISTRICT	ZONAL H.Q	SUB –ZONAL H.Q	ECO DEVELOPMENT COMMITTEE	VILLAGES IN SUB – ZONES	NAMES OF THE EDC VILLAGES
RAMANATHAPURAM	Pamban	Danuskodi	10	11	Ramakrishnapuram, Natarajapuram, Netajinagar & Rajagopal nagar, Verkodu, Maruthupandiyannagar, Karaiyur, Serankottai, Sethupathinagar, Mariyamman kovil street Southkaraiyur)
		Pamban	9	15	Tharuvai thoppu, Kunthukal, Chinnapalam, Thoppukadu, Therkuvadi, Thonithurai, valaiyurvadi, Nadumunaikadu, & (Seeniyapa dharga, Mutharaiyar naga), Vedalai thenkadarkarai, & (Singivalai kuchi, Soodavalai kuchi, Arupukadu), Kunjarvalasai)
		Uchipulli	28	31	Pudhunagaram, Notchiurani, Kuduthi, & Maanaankudi, Kadukai valasai (East & west), Surankatu valasai, Chinnudaiyar valasai, Amman pattinam, Agastiyarkootam, Naraiyurani East, Naraiyurani West, Pudhumadam, Chinna irattaiyurani, Vaniyankulam, M.P.K.valasai, & (Irruttoorani, Moopan valasai), Irrattaiyurani, Thamaraikulam, Valangapuri, Arulozhi nagar, Keelamankundu, & Melamankundu, Karan, Thalaithoppu, sembadaiyarkulam, Perunkulam, Kram, servaigarayurani, Vattan valasai, Enthal, Oumbattaicharvalasai
	Keezhakarai	Periyapattinam	9	9	Salaithottam, Kollanthoppu, Sethunagar, Pudhukudirupu north, Mutharaiyar nagar, Muthupettai, Indranagar, Pudhukudiruppu south, periyapattinam
		Thinaikulam	22	22	Pannakarai, Maraikayar nagar, Karichankundu, Krishnapuram, Thoppuvalasai, kalkadu, Anjaneyapuram, Vlayuthapuram, Kalimankundu, Kattaiyanvalasai, Kuppavalasai, Vellyan valasai, Mottaiyan valasai, Chittan kadu, Kunthukal valasai, Kuppachi valasai, Marivalasai, Shanmugavel pattinam, Kattaiyan peran valaivu, Silyappan valasai, Vethakaran valasai
		Keezhakarai	9	8	Sethukarai, Mutharaiyar nagar (East), Pakkiriappa pallivasal, Idinthakalpudhur, Sivakamipuram, Pudhu nagar (East), Meenavar kuppam, Keezhakarai, Pannatar street
		Erwadi	14	15	Bharathi nagar, Vivekanathapuram, & Muthurajapuram, Mayakulam, Mangaleswari nagar, Mutharaiyar nagar, Chinna Erwadi, Saaimuniyan valasai,

					Mariyamman nagar, Pitchimooan valasai, Meyyan valasai, Mottaikilavan valasai, Kalpar, Adamcheri, Adencheri
	Erwadi	Mariyur	23	22	Vaalinokkam, Keelamunthal, Melamunthal, T. Mariyur, S. Mariyur, Muthu regunatha pattinam, Ganthi nagar, & (Anna nagar, Pandiyan naga)r, M. Krishnapuram, Oppilian, Periyakulam, Madathakulam, Kaduku santhai, sathiram, Pasumponnar nagar &, Poopandiyar nagar, sanmugakumarapuram, Elanthaikulam, M.kuthiraimozhi, Kanigapuri, Mookaiyur North, Mookaiyur south, Uraikinaru, Naripaiyur North, Naripaiyur south
		Kamarajapuram	19	19	Ponnagaram, Vettukadu, Kadalkattikudiruppu, Amman pattinam, Theraviyapuram, Velayuthapuram, Palammal kudiruppu, Pudhukiramam, Vellapatty, Vepamarathupanai, Kamarajapuarum, Periyanyakipuram, Rayyapar puram, Manikam nagar, Kanniraja puaram Pilaiporuthamman kudirupu, Rochma nagar, Ramyanadar kudiruppu, Poosari theru
THOOTHUKUDI	Thoothukudi	Vembar	17	17	Vembar south, Vembar north, Vembar valasamuthiram, Pachaiyapuram, Kunchayapuram, periyaswamy puram, Kalaikoodam, Vaipar- Kallloorani Chippikulam, Veppalodai, Therku kalmaedu, Pattinamaruthur, Ananthamadam patcheri, Vellapatty, keela arasaradi, & Thoopasupatti
		Thoothukudi	28	25	Siluvaipatti, Thalamuthunagar, Rajapalayam, Samir rose nagar, Arokyapuram, T. Saveriyar puram, Poopandiyarpuram, Loorthammal puram, Keela alakarathattu, Mela alankarathattu, Cruzpuram, Thersapuram north, Thersapuram south, Thersapuram west, Santherayapar kovil street, Pudhutheru, sangukuli colony, Mutharayar nagar, Mettupatti, Poopalrayar puram, new harbour, Inigonagar, Fathima nagar south, Fathima nagar North, Lime stone, Annai theresa nagar, Sahayapuram, Vivekanathapuram
		Ratchenyapuram	21	17	Ratchenyapuram & Palaya kayal, Korkai, Maramangalam, Mukkani, Punnakayal North, Punnakayal south, Senthamangalam, Singithurai, Kombuthurai, Veerapandiyar pattinam North, Veerapandiyar pattinam south, Jeeva nagar, Alanthalai North, Alanthalai South, Amalin nagar, Manappadu north, Mannapadu south, Periyathalai North, Periyathalai South, Pathovai nagar, Kulasekarapattinam

No	District	Total no of EDC	Total no of villages
1	Ramanathapuram	143	152
2	Thoothukudi	66	59
	Total	210	211

Table 5.5.12. Alternative livelihoods option expressed by people and proposed alternative livelihoods to each village

No	Project villages	EDC Formed	Expected alternatives	Suggested alternatives based on skills / require further counseling
	Mandapam zone			
	Danuskodi sub – zone			
1	Ramakrishnapuram	2006	Small scale hotels, Grocery shop, Dried fish, Plantation for flowers , vegetables, Dairy farm	Horticulture, floriculture and small scale fisheries related activities
2	Nataraja puram	2005	Dried fish, Animal Husbandry etc,	Aquaculture and animal husbandry
3	Netaji nagar & Rajagopal nagar	No EDC formed	–	Require severe counseling
4	Muthuramalinga nagar			
5	Verkodu			
6	Maruthupandiyan nagar	2005	*	Aquaculture, and fisheries related activities
7	Karaiyur	2004	Fish sale, dried fish sale, grocery shop, small scale hotels	New job opportunities including mechanized deep water fisheries activities
8	Serankottai	2004	Candle making, Handicraft (Palm trees & Plastic), Hotel (small scale),, STD booth (For handicraft)	Handicraft and small time avocation
9	Sethupathinagar	2005	-	Require counseling
10	Mariyamman kovil south karaiyur	2005	Boat mechanic, Aqua culture Marine based alternatives	Small scale industries related to fisheries
	Pamban sub – zone			
11	Tharuvai thoppu & Kundugal	2005	*	Require counseling
12	Chinnapaalam	2004	Fishing related alternatives	Reef restroation, aquaculture
13	Thoppukadu	2005	*	Require counseling
14	Therkuvadi	2005	Dried fish, Animal husbandry	Fishery related activities
15	Thonithurai	2006	*	Require counseling
16	Valaiyarvadi	2006	*	Require counseling
17	Nadumunaikadu , Seeniyapa dharga, Mutharaiyarnagar	2006		Require counseling
18	Vedalai thenkadarkari - singivalai kuchi , soodavalaikuchi, Arupukadu	2006	*	Aquaculture related and fishery related industries

19	Kunjarvalasai	2006	*	Require counseling
	Uchipuli sub – zone			
20	Pudhunagaram	June 2006		Require counseling
21	Notchiurani	Oct 2006	Aqua culture, Palm based alternatives or Recommended alternatives.	Aquaculture and handicraft
22	Kunduthi , Maanaankudi	2006	Any types of alternatives.	Require counseling
23	Kadukai valasai, East, west	Sep 2006	*	Require counseling
24	Surankatuvalasai	Sep 2006	*	Require counseling
25	Chinnudaiyarvalasai	Oct 2006	*	Require counseling
26	Ammappattinam	Nov 2006	Palm based , Candle making, Soap, Phenyl preparation	Handicraft and other small scale industries with proper training
27	Agastiyarkootam	2006	*	do
28	Naraiyurani East	Dec 2006	*	do
29	Naraiyurani west	Dec 2006	*	do
30	Pudhumadam	No formed	-	-
31	Chinna irattaiyurani	Dec 2006	*	do
32	Vaniyankulam	No formed	-	-
33	M.P.K.Valasai , Irruttoorani, Moopan valasai	Nov 2006	*	do
34	Irrataiyurani	Dec 2006	*	do
35	Thamaraikulam	No formed	-	-
36	Valangapuri	No formed	-	-
37	Arul ozhi ngar	Dec 2006	*	Require counseling
38	Keelamankundu , Melamankundu	Nov 2006	*	Require counseling
39	Karan	2005	Palm based alternatives, Seaweed culture	Handicraft industries
40	Thalaitoppu	2005	*	Handicraft industries
41	Sembadaiyarkulam	Oct 2006	*	Handicraft industries
42	Perunkulam	Dec 2006	*	Handicraft industries
43	Kumbaram	No formed	-	-
44	Servaigarayurani	No formed	-	-
45	Vattan valasai	No formed	-	-
46	Enthal	No formed	-	-

47	Otaicharvalasai	No formed	-	--
				--
	Keezhakkarai zone			--
	Periyapattinam sub – zone			--
48	Salaithottam	2004	*	Require counselling
49	Kollanthoppu	2004	*	Require counselling
50	Sethunagar	2005	*	Sea weed culture
51	Pudhukudirupu North	2005	*	Any type of small scale industries
52	Mutharaiyar nagar	2005	*	Fishery related industries
53	Muthupettai	2005	Flori culture, Mushroom culture etc	Agriculture based industries
54	Indranagar	2004	*	Require counseling
55	Pudhukudiruppu South	2005	*	Require counseling
56	Periyapattinam	Dec 2006	*	Require counseling
	Thinaikulam sub – zone			
57	Pannakarai	Jan 2007	*	Require counseling
58	Maraikayar nagar	Dec 2006	*	Require counseling
59	Karichankundu	Dec 2006	*	Require counseling
60	Krishnapuram	Dec 2006	*	Require counseling
61	Thoppuvalasai	Dec 2006	*	Require counseling
62	Kalkadu	2006	*	Require counseling
63	Anjaneyapuram	2006	*	Require counseling
64	Vlayudhapuram	2006	*	Require counseling
65	Kalimankundu	2005	*	Require counseling
66	Kattaiyan valasai	2006	*	Require counseling
67	Kuppa valasai	Dec 2006	*	Require counseling
68	Vellayan valasai	Nov 2006	*	Require counseling
69	Mottaiyan valasai	Nov 2006	*	Require counseling
70	Chittan kadu	May 2006	*	Require counseling
71	Kunthukal valasai	Oct – 2006	*	Require counseling
72	Kuppachivalasai	Nov 2006	*	Require counseling
73	Marivalasai	2005	*	Require counseling
74	Shanmugavel pattinam	2004	*	Require counseling
75	Kattiyar peran valaivu	2005	*	Require counseling
76	Thinaikulam	2006	*	Require counseling
77	Silyappan valasai	2006	*	Require counseling
78	Vethakkarai valasai	2006	*	Require counseling
	Keezhakarai sub - zone		*	Require counseling
79	Sethukarai	2004	*	Require counseling
80	Mutharaiyar nagar East	2004	*	Require counseling
81	Pakkiriappa pallivasal	2004	Boat mechanism, Dried fish	Small scale industries

82	Idinthakalpudur	2005	*	Require counseling
83	Sivakamipuram	2006	*	Require counseling
84	Pudhu nagar East	2005	*	Require counseling
85	Meenavar kuppam	2005	Animal husbandry, Dried fish,	Fishery related and livestock
86	Keelakarai	2006	*	Require counseling
87	Pannatar theru	2005	*	Require counseling
	Erwadi zone			
88	Bharathi nagar	2006	*	Require counseling
89	Vivekananthapuram & Muthurajapuram	2006	*	Require counseling
90	Mayakulam	2006	*	Require counseling
91	Mangaleswarinagar	2006	*	Require counseling
92	Mutharaiyar nagar	2006	*	Require counseling
93	Chinna Erwadi	2005	Aquaculture	Aquaculture
94	Sadaimuniyan valasai	March 2006	Marine related alternatives, Charcoal business	Aquaculture and agriculture related
95	Mariyamman nagar	2006	*	Require counseling
96	Pitchimooan valasai		*	Require counseling
97	Meyyan valasai	2006	*	Require counseling
98	Mottaikilavan valasai	2005	*	Require counseling
99	Kalpar	2005	* *	Require counseling
100	Adamcheri	2005	*	Require counseling
101	Adenchery	2006	Palm based , Charcoals, Animal husbandry	Handicrafts, agricultural based and animal husbandary
	Mariyur sub- zone			
102	Vaalinokkam	Dec 2006	Aqua culture	aquaculture
103	Keelamunthal	2005	*	Require counseling
104	Melamunthal	2005	*	Require counseling
105	T. Mariyur	2004	*	Require counseling
106	S. Mariyur	2004	*	Require counseling
107	Muthu requantha pattinam	Nov 2006	*	Require counseling
108	Ganthinagar, Annanagar, & Pandiyan nagar	Dec 2006	*	Require counseling
109	M. Krishnapuram	2006	*	Require counseling
110	Oppilian	2006	*	Require counseling
111	Periyakulam	December – 2006	Animal husbandry (Goat, Cattle) , Vermi culture, Handicraft (Palm trees & Plastic wire), Charcoal	Animal husbandary, hadicrafts, and small scale industries
112	Madathokulam	Oct 2006	*	Require counseling
113	Kaduku santhai	Oct – 2006	*	Require counseling
114	Sathiram	Nov – 2006	*	Require counseling

115	Pasumponnar nagar & Poopndiyar nagar	Oct 2006	*	Require counseling
116	Sanmugakumarapuram	Dec 2006	*	Require counseling
117	Elanthaikulam	Dec 2006	*	Require counseling
118	M. Kuthiraimozhi		*	Require counseling
119	Kanigapuri	Jan – 2007	*	Require counseling
120	Mookaiyur North	2006	*	Require counseling
121	Mookaiyur South	2004	*	Require counseling
122	Uraikinaru	2006	*	Require counseling
123	Naripaiyur North	2006	*	Require counseling
124	Naripaiyur south	2004	*	Require counseling
	Kamarajapuram sub – zone			
125	Ponnagaram	2006	*	Require counseling
126	Vettukadu	2006	*	Require counseling
127	Kadal katti kudirupu	2006	*	Require counseling
128	Amman puram	2006	*	Require counseling
129	Theraviya puram	2006	*	Require counseling
130	Velayuthapuram	2006	*	Require counseling
131	Palammal kudirupu	2006	*	Require counseling
132	Pudhukiramam	Oct – 2006	*	Require counseling
133	Vellapatty	2005	*	Require counseling
134	Vepamarathupanai	2004	Need a Factories (small scale industries) and support to Marketing	Small scale industries
135	Kamarajapuram	2005	*	Require counseling
136	Periyamayagi puram	2004	*	Require counseling
137	Rayyapar puram	2006	*	Require counseling
138	Manikam nagar	2004	*	Require counseling
139	Kannirajapuram	Oct – 2006	*	Require counseling
140	Pilaiporuthamman kudirupu	Dec 2006	*	Require counseling
141	Rochma nagar	Oct – 2006	We don't have any idea of alternatives.	Require counseling
142	Ramaya nadar kudiruppu	Oct – 2006	We don't have any idea of alternatives.	Require counseling
143	Poosari theru	June – 2006	We expect some valuable alternatives	Require counseling
				- -
	Thoothukudi zone			
	Vembar sub – zone			
144	Vembar south	Dec – 2006	*	Require counseling
145	Vembar north	Dec 2006	*	Require counseling
146	Vembar valasamuthiram	Oct – 2006	*	Require counseling
147	Pachaiyapuram	No formed	*	-

148	Kunchaiyapuram	Nov – 2006	*	Require counseling
149	Periyasamy puram	Nov - 2006	Any Factories and Recommended alternatives	Small scale industries
150	Kalaikoodam	Dec 2006	Charcoal , Palm based	Agricultural based industries
151	Vaipar- kalloorani	sept2006	*	Require counseling
152	Keelavaipar	2004	*	Require counseling
153	Chippikulam	2005	*	Require counseling
154	Veppalodai	Dec 2006	*	Require counseling
155	Therku kalmedu	Nov 2006	*	Require counseling
156	Pattinamaruthur	2005	*	Require counseling
157	Tharuvaikulam	2004	*	Fisheries related industries
158	Ananthamadam patcheri	Dec – 2006	*	Require counseling
159	Vellapatty	2004	*	Require counseling
160	Keela arasaradi and thupaspatti	Dec 2006	*	Require counseling
	Thoothukudi sub – zone			
161	Siluvaipatti	2005	Aquaculture	Aquaculture
162	Thalamuthunagar	2004	Any types of Cosmetics making	Fishery related
163	Rajapalayam	Nov 2006	*	Require counseling
164	Samir rose nagar	November – 2006	*	Require counseling
165	Arokyapuram		Aquaculture	Aquaculture
166	T.Saveriyar puram	2005	*	Require counseling
167	Poopandiyar puram	Oct - 2006	*	Require counseling
168	Loorthammal puram	2004	*	Require counseling
169	Keela alankarathattu	2005	*	Require counseling
170	Mela alankarathattu	2006	*	Require counseling
171	Kruzpuram	No formed	*	-
172	Thersapuram North	April 2006	Lath and auto work shop, Small Hotels, Textiles Business, Cycle work shop, Grocery shop	Industries and mechanical skills related
173	Thersapuram South	Nov 2006	*	Require counseling
174	Therasapuram west	Nov – 2006	Lath and auto work shop, Small Hotels, Textiles Business, Cycle work shop, Grocery shop	Small scale industries
175	Santherayapar kovil theru	Oct 2006	*	Eco-tourism.
176	Pudhu theru	May ,2006	Aquaculture	Fisheries related
177	Sangukuli colony	2006	*	Require counseling

178	Mutharayar nagar	2006	*	Require counseling
179	Mettupatti	2006	*	Require counseling
180	Poopalarayarpuram	Dec -2006	*	Require counseling
181	New harbour	2006	Seaweeds culture or any other aquacultures	Aquaculture
182	Inigo nagar	2004	Share auto, Cold storage rooms (we need cold storage rooms. Because its reduce the fishing activity.(means if available , fishermen's going to fishing alternative days, or some days in a week) .	Small scale industries
183	Fathima nagar south	2006	(We need Factories or companies (esp. Bouquet shop(Florist companies). Small scale industries (like Fish pickle etc.) , Textiles business) or Should be given Fiber boat to each fishermen's (if given , we survive)	Agriculture, floriculture and small scale industries
184	Fathima nagar North	Oct – 2006		
185	Limestone	2006	*	Require counseling
186	Annai therasa nagar	Nov 2006	*	Require counseling
187	Sahayapuram	2006	*	Require counseling
188	Vivekanatha nagar	Nov 2006	*	Require counseling
	Ratchenyapuram sub – zone			
189	Ratchenyapuram & Palaya kayal	2004	Aqua culture	Aquaculture
190	Korkai	Oct 2006	*	Require counseling
191	Maramangalam	Oct 2006	Beedi making, candle making etc	Small scale industries
192	Mukkani	2006	Beedi making, any other small scale business, Seaweed culture	Small scale industries
193	Punna kayal North	2006	*	Require counseling
194	Punnakayal South	2006	*	Require counseling
195	Senthamangalam	Nov - 2006	*	Require counseling
196	Singithurai	2006	*	Require counseling
197	Kombuthurai	2006	*	Require counseling
198	Veerapandiyan pattinam North	September – 2006	Government jobs	Require counseling
199	Veerapandiyan pattinam South	No formed	*	- -

200	Jeeva nagar	2004	*	Require counseling
201	Alanthalai North	No formed	*	--
202	Alanthalai South	Nov 2006	*	Require counseling
203	Amali nagar	2006		Require counseling
204	Manappadu North	No formed	.	-
205	Manappadu South			
206	Periya Thalai North		-	--
207	Periya thalai South		-	--
208	Pathovai nagar		-	--
209	Kulasekara pattinam		Palm based materials (Handicrafts)	

12. Socio-economic profile of coastal villages of Thoothukudi coast to Kanyakumari coast

A total of 99 villages were identified and surveyed along the coasts of Tuticorin (from Tuticorin town, south wards), Tirunelveli and Kanyakumari (east coast) districts to study their socio-economic condition, so that, a better eco-development programme would be initiated in these vilalges. Villages which fall within a distance of 10 KM from the shore line (Biosphere Reserve) were chosen as these areas falls inside the buffer zone of the Biosphere Reserve. Of the 99 villages surveyed, 22 are coastal villages and the remaining 77 are inland village which fall under the Biosphere Reserve. In Tuticorin, there are 12 coastal villages and 34 inland villages. In Tirunelveli district, there are 7 coastal and 39 inland villages. In Kanyakumari district, there are 3 coastal and 4 inland villages. From Tuticorin district, people from all the 46 villages in the Biosphere Reserve are dependent on marine resources up to some degree, such as sea weed harvesting or sea shell collection or as laborers in fishing vessels either throughout the year or during a particular season. In contrary, the dependency of people on marine resources is only limited to that of coastal villages, and the people of inland villages are not at all dependent on the marine resources in Tirunelveli and Kanyakumari districts. In Tuticorin district, there are 165 divers who collect molluskan sea shells and 7 families are involved in sea weed culture. In Kanyakumari district, though there are 200 people who were trained to culture sea weeds, there are only 7 people who harvest sea weed from wild. This difference in dependency on the resources may be attributed to a lack of resources such as sea weeds and molluskan sea shells in the off-shore areas of Tirunelveli and Kanyakumari districts and also to the rougher sea condition.

**LIST OF FISHING VILLAGES AND THEIR STATISTICS
ALONG THE COAST OF THOOTHUKUDI, TIRUNELVELI AND
KANYAKUMARI DISTRICTS**

Table. 5.5.13. Population Status

S.No	District	Village	Fishermen Population			
			♂	♀	☺	Total
1.	THOOTHUKUDI	RATCHANYAPURAM	219	203	208	630
2.		PAZHAYAKAYAL	287	291	265	843
3.		PUNNAKAYAL	2254	2017	2772	7043
4.		KOMBUTHURAI	167	166	270	603
5.		SINGHITHURAI	404	193	444	1041
6.		VEERAPANDIYAN PATTINAM	939	932	790	2661
7.		JEEVANAGAR	64	62	79	205
8.		AMALINAGAR	536	481	652	1669
9.		ALANTHALAI	788	790	981	2559
10.		KULASEKHARAPATTINAM	133	154	184	471
11.		MANAPADU	1544	1493	1577	4614
12.		PERIYATHAZHAI	1535	1397	1681	4613
TOTAL			8870	8179	9903	26952
13.	TIRUNELVELI	KOODUTHALAI				
14.		KOOTAPANAI				
15.		OVARI				
16.		KOOTHANKULI				
17.		IDINTHAKARAI				
18.		PERUMANAL				
19.		KOOTAPULY				
TOTAL						
20.	KANYAKUMARI	AROCKIYAPURAM	768	689	842	2299
21.		CHINNAMUTTOM	634	569	741	1944
22.		KANNIYAKUMARI	2922	2953	1354	7229
TOTAL			4324	4211	2937	11472
GRAND TOTAL						

♂ - Male

♀ - Female

☺ - Children (below 17 years of age)

Table 5.5.14. Employment Status (Men)

S.No	District	Village	Fishing	Fresh Fish trade	Dried fish trade	Net making	Diving	Allied activities	Employed in			Total
									Govt.	Private	others	
1.	THOOTHUKUDI	RATCHANYAPURAM	181	0	2	0	0	0	4	6	6	199
2.		PAZHAYAKAYAL	180	0	2	0	0	4	6	51	4	247
3.		PUNNAKAYAL	1706	129	0	9	1	32	29	50	206	2162
4.		KOMBUTHURAI	159	0	0	0	0	0	0	0	0	159
5.		SINGHITHURAI	299	0	6	1	0	0	0	2	2	310
6.		VEERAPANDIYAN PATTINAM	341	10	3	0	0	26	46	192	182	800
7.		JEEVANAGAR	63	0	0	0	0	0	0	0	0	63
8.		AMALINAGAR	449	7	3	0	0	0	2	21	21	503
9.		ALANTHALAI	718	30	15	0	0	0	15	10	0	788
10.		KULASEKHARAPATTINAM	132	1	0	0	0	0	0	0	0	133
11.		MANAPADU	1126	34	0	8	0	82	10	100	20	1380
12.		PERIYATHAZHAI	1289	7	0	0	0	76	4	7	23	1406
TOTAL			6643	218	31	18	1	220	116	439	464	8150
13.	TIRUNELVELI	KOODUTHALAI	172	0	0	0	0	3	0	2	0	177
14.		KOOTAPANAI	212	1	0	0	0	0	1	0	8	222
15.		OVARI	1097	9	0	0	0	0	6	82	103	1297
16.		KOOTHANKULI	843	4	0	0	0	5	10	10	67	939
17.		IDINTHAKARAI	1120	12	0	0	0	0	14	71	100	1317
18.		PERUMANAL	318	8	3	0	0	0	0	0	5	334
19.		KOOTAPULY	818	21	0	1	0	0	30	72	111	1053
TOTAL			4580	55	3	1	0	8	61	237	394	5339
20.	KANYAKUMARI	AROCKIYAPURAM	650	12	0	0	0	0	0	0	47	709
21.		CHINNAMUTTOM	503	9	0	0	0	0	0	0	48	560
22.		KANNIYAKUMARI	2726	17	0	14	26	0	56	34	12	2885
TOTAL			3879	38	0	14	26	0	56	34	107	4154
GRAND TOTAL			15102	311	34	33	27	228	233	710	965	17643

Table 5.5.15. Employment Status (Women)

S.No	District	Village	Fishing	Fresh Fish trade	Dried fish trade	Net making	Diving	Allied activities	Employed in			Total
									Govt.	Private	others	
1.	THOOTHUKUDI	RATCHANYAPURAM	0	0	12	0	0	0	2	8	4	26
2.		PAZHAYAKAYAL	0	0	7	0	0	0	2	36	1	46
3.		PUNNAKAYAL	0	20	30	0	0	0	3	8	40	101
4.		KOMBUTHURAI	0	0	0	0	0	0	0	0	2	2
5.		SINGHITHURAI	0	3	5	0	0	0	0	0	0	8
6.		VEERAPANDIYAN PATTINAM	0	1	3	0	0	3	25	25	6	53
7.		JEEVANAGAR	0	0	0	0	0	0	0	0	0	0
8.		AMALINAGAR	0	3	0	0	0	0	4	3	1	11
9.		ALANTHALAI	0	208	0	0	0	0	0	0	0	208
10.		KULASEKHARAPATTINAM	0	60	0	0	0	0	0	0	0	60
11.		MANAPADU	0	10	0	0	0	0	8	0	0	18
12.		PERIYATHAZHAI	0	0	5	0	0	3	17	7	6	3
TOTAL			0	305	62	0	0	6	61	87	60	536
13.	TIRUNELVELI	KOODUTHALAI	0	0	0	0	0	5	0	0	2	7
14.		KOOTAPANAI	7	0	0	0	0	0	0	0	0	7
15.		OVARI	0	0	24	0	0	0	11	28	66	129
16.		KOOTHANKULI	0	10	0	0	0	9	15	13	69	116
17.		IDINTHAKARAI	0	28	0	0	0	0	18	38	239	323
18.		PERUMANAL	0	14	3	1	0	0	1	0	1	20
19.		KOOTAPULY	0	104	0	1	0	0	25	21	62	213
TOTAL			7	156	27	2	0	14	70	100	439	815
20.	KANYAKUMARI	AROCKIYAPURAM	0	13	0	0	0	0	0	0	7	20
21.		CHINNAMUTTOM	0	9	0	0	0	0	0	0	9	18
22.		KANNIYAKUMARI	0	72	112	0	0	0	24	97	44	349
TOTAL			0	94	112	0	0	0	24	97	60	387
GRAND TOTAL			7	555	201	2	0	20	155	284	559	1783

Table 5.5.16. Fishing crafts

Village	Mechanised						Non Mechanised								IBE	OBM
	Make		Type				Make			Type						
	Wooden	FRP	Trawl	Gill netter	Liner	Total	Wooden	FRP	Ply-wood	Masula	Vallam	Dugout canoe	Catamaran	Total		
RATCHANYAPURAM	0	0	0	0	0	0	31	0	0	0	5	0	26	31	5	0
PAZHAYAKAYAL	0	0	0	0	0	0	25	0	0	0	2	0	23	25	2	0
PUNNAKAYAL	0	0	0	0	0	0	264	20	4	0	259	0	29	288	236	23
KOMBUTHURAI	0	0	0	0	0	0	5	14	26	0	40	0	5	45	0	45
SINGHITHURAI	0	0	0	0	0	0	39	1	0	0	35	0	5	40	35	1
VEERAPANDIYAN PATTINAM	1	32	1	29	3	33	66	0	0	0	0	0	66	66	0	57
JEEVANAGAR	0	0	0	0	0	0	8	0	0	0	8	0	0	8	8	0
AMALINAGAR	0	0	0	0	0	0	162	1	0	0	1	0	162	163	1	155
ALANTHALAI	0	0	0	0	0	0	196	0	0	0	0	0	196	196	0	191
KULASEKHARAPATTINAM	0	0	0	0	0	0	28	0	0	0	24	0	4	28	23	1
MANAPADU	0	0	0	0	0	0	158	22	27	0	26	0	181	207	26	181
PERIYATHAZHAI	0	0	0	0	0	0	479	1	0	0	0	0	480	480	0	389
TOTAL	1	32	1	29	3	33	1461	59	23	0	400	0	1177	1577	336	1043
KOODUTHALAI	0	0	0	0	0	0	97	0	0	0	0	0	97	97	0	97
KOOTAPANAI	0	0	0	0	0	0	95	0	0	0	0	0	95	95	0	95
OVARI	0	0	0	0	0	0	420	0	0	0	0	0	420	420	0	420
KOOTHANKULI	0	0	0	0	0	0	301	19	0	0	19	0	301	320	0	216
IDINTHAKARAI	0	0	0	0	0	0	273	0	15	0	15	0	273	288	0	251
PERUMANAL	0	0	0	0	0	0	50	0	0	0	0	0	50	50	0	4
KOOTAPULY	0	0	0	0	0	0	122	0	3	0	3	0	122	125	0	105
TOTAL	0	0	0	0	0	0	1358	19	18	0	37	0	1358	1395	0	1188
AROCKIYAPURAM	4	0	2	2	0	4	284	48	17	0	65	0	284	349	0	72
CHINNAMUTTOM	39	0	32	7	0	39	174	9	6	0	15	0	174	189	0	24
KANNIYAKUMARI	134	0	78	56	0	134	688	17	20	0	37	0	688	725	0	98
TOTAL	177	0	112	65	0	177	1146	74	43	0	117	0	1146	1263	0	194
GRAND TOTAL	178	32	113	94	3	210	3965	152	84	0	554	0	3681	4235	336	2425

Table 55.17. Fishing gears

Village	Gillnet	Trawl-net	Shore seine	Boat seine	Long line	Trap	Others	Total
RATCHANYAPURAM	384	0	0	0	0	0	0	384
PAZHAYAKAYAL	328	0	0	0	0	0	0	328
PUNNAKAYAL	3108	0	0	0	7200	0	0	10308
KOMBUTHURAI	203	0	0	0	1366	0	0	1569
SINGHITHURAI	1398	0	0	0	450	0	0	1848
VEERAPANDIYAN PATTINAM	1745	6	0	0	98	0	307	2156
JEEVANAGAR	0	0	0	0	0	0	89	89
AMALINAGAR	2430	0	0	0	0	0	8	2438
ALANTHALAI	2955	0	0	0	0	0	224	3179
KULASEKHARAPATTINAM	0	0	0	0	0	0	74	74
MANAPADU	2715	0	2	0	0	0	390	3107
PERIYATHAZHAI	3853	0	0	0	0	0	420	4273
TOTAL	19119	6	2	0	9114	0	1512	29753
KOODUTHALAI	1453	0	0	0	0	0	1191	2644
KOOTAPANAI	1523	0	0	0	0	0	0	1523
OVARI	6398	0	0	276	0	0	197	6871
KOOTHANKULI	4615	0	0	0	17	0	0	4632
IDINTHAKARAI	4193	0	0	0	5910	0	0	10103
PERUMANAL	952	0	0	0	0	0	0	952
KOOTAPULY	1928	0	0	0	0	0	0	1928
TOTAL	21062	0	0	276	5927	0	1388	28653
AROCKIYAPURAM	320	6	0	0	70	0	0	396
CHINNAMUTTOM	190	45	0	0	65	0	90	390
KANNIYAKUMARI	1150	210	0	0	500	60	170	2090
TOTAL	1660	261	0	0	635	60	260	2876
GRAND TOTAL	41841	267	2	276	15676	60	3160	61282

ANNEXURE 5.1

MODEL VILLAGE MARINE CONSERVATION PLAN (VMCP) OF SEENIYAPADHARGA, PERIYAPATTINAM, AND THARUVAIKULAM VILLAGES IN GULF OF MANNAR MARINE BIOSPHERE RESERVE (GOMBR).

INTRODUCTION :

The coastal geographic region of the Gulf of Mannar Biosphere Reserve in Tamil Nadu stretches from Cape Comorin in South, all along the Bay of Bengal of the four coastal districts of Kanyakumari, Tirunelveli, Thoothukkudi and a part of Ramanathapuram to the eastern most end of Danushkodi island. Most of the coastal villages up to 3-5km from coast line almost entirely and up to 10km from the coast are partially dependent on the coastal and marine renewable resources for their livelihoods. Following the declaration of the Gulf of Mannar Marine National Park in 1986 encompassing the 21 off-shore islands and surrounding coral reefs, access to the common property marine resources within the Marine National Park area to the villagers are being denied. The inclusions of the seascape into the Biosphere Reserve surrounding the Marine National Park is an attempt to bring-in some enabling regulatory mechanisms to enhance the marine resource base and its use by the dependent coastal villages. There are over 300 coastal villages in this region, whose dependency on the coastal and marine resources for their livelihood are being impacted. The GOMBR management authorities are making a serious attempt to create and provide alternative livelihood options in these coastal villages through development and implementation of a participatory Eco-development plan under the activities of the GEF-UNDP funded project.

BACKGROUND:

The Wildlife Institute of India, who jointly with the Tamil Nadu Forest Department and GOMBRT are developing the Management Plan for the Gulf of Mannar Biosphere Reserve Conservation Area have been asked to develop a 'Model Village Marine Conservation Plan' using some acceptable alternative livelihood option frameworks for adoption, and based on its success for replication in other coastal villages in this region. A Model Village Marine Conservation (VMC) Plan has been prepared by the Wildlife Institute of India (WII), as a part of the Eco Development Plan activities suggested in the Management Plan for the Gulf of Mannar Marine Biosphere Reserve. The plan examines the existing resource base in these three villages and the prospects of marine conservation and sustainable utilization of the reserve's resources through the active participation of the fishing communities along the Gulf of Mannar Biosphere Reserve (GOMBR).

It is observed that fishing is an ancient tradition and its practice in various modified forms can be encountered everywhere along the coast of Gulf of Mannar. Traditionally, much of the fishing was carried-out from land and from the adjoining lagoons with small nets and traps and only a minor portion of the fishing operation was carried-out offshore. Over time, with the growth of human population and market demands along the Gulf of Mannar (GOM) coast has led to a drastic expansion of the offshore fishing and gradual depletion of many of the marine resources. The type of small vessels, the fishing gears and labor, an intensive character of the operation, had

changed from generation to generation. However, some fishing practices benefited greatly from the advent of new technology, such as those that replaced sails by diesel-powered engines and efficient gear handling techniques. These kinds of developments added to growing market demand from the growth of population and in turn led to over fishing of most of the vulnerable species in the Gulf of Mannar coast. Therefore, a range of destructive human activities like poaching of endangered species and certain destructive fishing practices like trawling over coral reefs etc., have been observed to have increased in the GOM. These types of resource-damaging activities are fairly common in and around the Gulf of Mannar Marine National Park and Biosphere Reserve.

Marine fisheries in the GOM region is currently being governed by the Tamilnadu Fisheries Act. Ever since the area was declared as a Marine National Park in 1986 and Biosphere Reserve in the year 1989, like any other Protected Area in the world, it has been almost impossible to implement any regulatory management strategies or enforcing any laws without the support and active participation of the local communities/resource users. Development of Model Village Marine Conservation (VMC) Plan, is therefore, an exercise to examine how such plans of Eco-development approach of conservation and sustainable use of marine and coastal resources with the active participation of the local communities can be implemented, and whether this may have the prospect of replication in other coastal villages in the GOMBR region. The VMC plan development is based on the premise of setting in place a mechanism for

- Active Participation of local communities in protection and sustainable use of biological resources in the GOMBR
- Elimination of further deterioration or alteration of natural habitats for the benefit of resource generation.
- Protection of endangered and threatened animal and plants species inclusive of their habitats and
- Sustainable use and careful Management of commercially important species and their habitats for the economic benefit of user communities.

AIM OF THE EXERCISE:

To assess the current practice of marine resource utilization in selected fishing villages and through their participation develop an appropriate VMC Plan of Alternative Livelihood Options (ALO) to improve their livelihoods in partnership with other stakeholders to effectively conserve, manage and utilize the marine biodiversity in the GOMBR.

THE PROCESS AND METHODOLOGY OF VMC DEVELOPMENT:

The WII along with the GOMBRT followed a process for developing the Village Marine Conservation Plan (VMCP) in the three identified villages which are as under :

Step I:

- Identification of villages for developing VMCP based on the criteria of their livelihood dependency on coastal Marine resources, the proximity to the coast, their impact on the resources base, the overall

condition of the resource base and the capability of the villages to adopt alternative livelihoods option.

Step II:

- Following the identification of the villages, collection of secondary data on the environmental status of the village adjoining resources, assets, existing livelihood practices and the general awareness and understanding of the villagers on the concept of Marine National Park & Biosphere reserve.

Step III:

- Organizing stakeholders meeting and Participatory Rural Appraisal (PRA) for Trust building and actual assessment / conformation of information gathered through secondary sources.

Step IV:

- Identifying the self governance structures and the need for enabling policy environment and reforms.

Step V:

- Conducting a SWOT analysis of the villages for adopting sustainable Alternative Livelihood Option.

Step VI:

- Identify Traditional, Enhances, Diversified and Additional Livelihood Options and review them against stage IV & V to shortlist implementable Alternative Livelihoods Options and Examine their Feasibility.

Step VII:

- Identify Vulnerability context of the identified options to decrease off-set - Mechanisms

Step VIII:

- Identify capacity building, Trust building and extension need for Alternative Livelihood option. (ALO's)

Step IX:

- Analyze potential viability and sustainability (Social, economic, environmental and Institutional) of the identified ALO's.

Step X:

- Prepare the VMC plan along with the village community.

1. THE IDENTIFIED VILLAGES AND THEIR PROFILES:

This Model Village Marine Conservation plan was attempted in three selected fishing villages which are completely dependent on marine resources, with a high degree of unsustainable resource use by certain unhealthy fishing practices. The villages so selected are: Seeniyapadharga, Periyapattinam in the Ramanathapuram district and Tharuvaikulam in the Thoothukudi district.

1.A. SEENIYAPADHARGA

LOCATION:

This fishing village is located in the Pamban sub-zone of the Mandapam Eco-development Programme zone in the Ramanathapuram district. It is located at a distance of 500m from the coast. Hare and Manoli Island is located on the eastern side of the village at a distance of about 12km and 7 km, and Mulli on the South eastern side of this village at a distance of 12 and 16km respectively. People of this village are involved in **destructive** activities like collection of sea weeds and chanks from the National Park area.

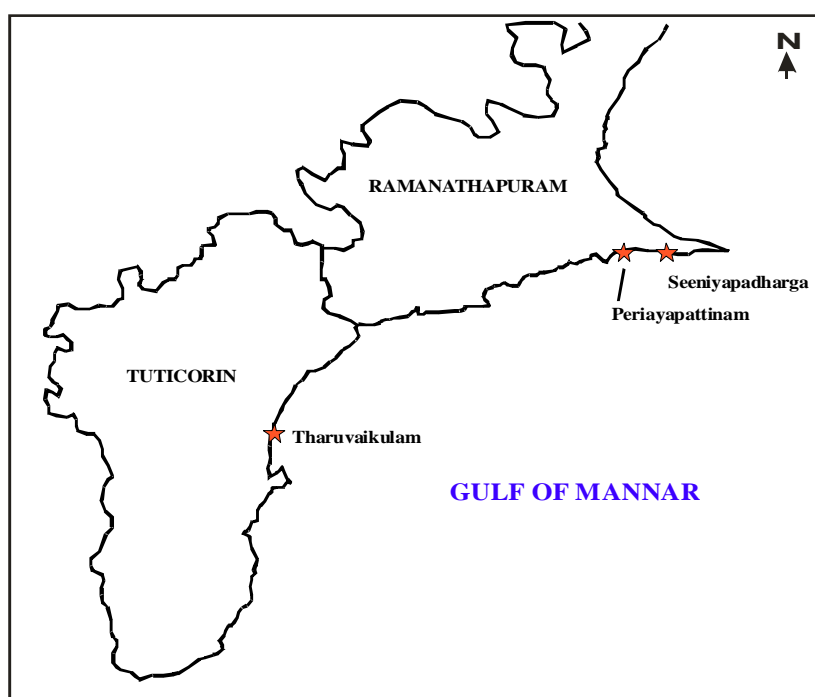


Fig. 1. Location of Model Villages of Marine Conservation (VMC) plan

Demographic profile of village:

POPULATION:

This village has a total population of Four hundred and sixty two (462) with 232 males and 230 females. Nearly 70% of the populations are fishermen, comprising of both Hindus and Muslims.

RELIGION:

Out of the total population, nearly 60% are Hindus and the remaining 40% are Muslims.

LITERACY:

Almost 60% of the population is literate with 80% of them being men and the remaining 20% are women. Out of the total literates, nearly 80% have acquired education up to 10th standard, 15% up to Higher Secondary level and 5% having graduated from colleges.

B . PERIYAPATTINAM:

LOCATION:

Periyapattinam was one of the oldest ports in Ramanathapuram district. During the ancient periods, this village was named as Fakkthan or Pathhan by Marco polo and Ibin padukkoo. During the 10 th century A.D., this village was called as Parakkirama pattinam by the King Pandian and then in the 12 century A.D as Pavithra manikka Pattinam. Since ancient period, this village is one of the Coastal village (600 m distance) as well as important pearl and Chank collection centre in Tamilnadu. Now, this village is one of the Major Chank collection centre in Ramanathapuram district. Apart from these, fishers in the village collect seaweeds and sea cucumber also. The Southeastern side of Periyapattinam has a group of three islands .i.e., Mulli, Valai and Appa islands. Of these Three, the Valai island is further subdivided into three regions i.e., the eastern side has Murukuthalai, the western side has a thalaiyari island. Valai Island or Needuntheevu is located in between these two islands.

Population:

The total population of Periyapattinam fishing village is one thousand three hundred and twenty eight (1328). Of these, Male population consists of seven hundred and eight (708), individuals, and female population comprises six hundred and twenty (620) individuals. In the total population, forty percent (40%) of them are belonging to fishermen category. The fishers of this village belong to Islam and Hindu religion. Periyapattinam is predominately inhabited by Muslims and they constitute seventy percent (70%). The remaining thirty percent (30%) belong to Hinduism.

Religions:

Out of the total population, nearly 70% are Muslims and the remaining 30% are Hindus and Christians.

Literacy:

The literacy level of this village is approximately fifty two percent (52%). Among the literates, seventy percent (70%) of them are Male and Thirty percent (30%) of them are female. Among the literates, majority of people have acquired primary school of education and a few of them have acquired middle school level of education. In this village, 10% of them have acquired college level education especially in Professional colleges. Boys are engaged in fishing at the age of 10 and girls are engaged in household activities at the age of 12 – 14. The literacy level is higher for women among Hindu families. This is because of low income through fishing. Another important reason is that the assistance of boys is needed for their fishing activities. If the laborers are engaged, the fishers have to lose their income. This is the reason why boys and girls drop out and they do not even complete their middle school education.

C. THARUVAIKULAM:

LOCATION:

Tharuvaikulam is one of the fishing villages of Gulf of Mannar which belongs to Vembar sub-zone of Thoothukudi Eco-development Programme Zone in the Thoothukudi district, Tamilnadu, which is located at a distance of 10km from Thoothukudi. It is a village formed by the people immigrated from various other

places in south part of Tamilnadu during 18th Century. The fishers of this village live closer to the seashore (within 300m distance from the shore). Two hundred years ago their important occupations comprised of Palm based and Agriculture based activities. But after that, they have slowly shifted to marine based activities. Since last fifty years, almost eighty percent of the people are involved in fishing and its allied activities. Three existing islands of the Tuticorin group (Van on the southeastern side and Kasuwar and Karaichalli on the eastern side of the village) lie close to this village. The traditional coral miners and trainers of coral mining for other area people in the Gulf of Mannar belong to this Village.

POPULATION:

According to a Participatory Rural Appraisal (PRA) report prepared by GOMBRT and the WII team, the total population of this village is six thousand. Of these, male constitutes three thousand two hundred and female population is two thousand and eight hundred. Of these, the children constitute nine hundred. Now, seventy percent of them belongs to fishermen category and the remaining thirty percent are framers (palm based works), labors (salt pan, construction, business and others). Fishers of this village are mostly Christian, while only a few of them are Hindus and Muslims.

RELIGION:

Out of the total population, nearly 60% are Christians and the remaining 40% are Hindus and Muslims.

LITERACY:

The literacy level of this village is approximately sixty eight percent (68%). Among the literates, fifty five (55%) of them are male and forty five percent (45%) of them are women. Among the literates, majority of people have acquired primary school level education and a few of them have acquired middle school level education. Boys are engaged in fishing at an age of 10 and girls are engaged in household activities at an age of 12-14. This is because of low income through fishing. Another important reason is that the assistance of boys is needed for their fishing activities. If the laborers are engaged, the fishers have to lose their income. This is the reason that boys and girls drop out and they do not even complete their middle school education.

1. DEMOGRAPHIC PROFILES OF IDENTIFIED VILLAGES:

A. POPULATION:

DETAILS OF THE POPULATION IN THE VILLAGES				
		SEENIYAPADRAGA	PERIYAPATTINAM	THARUVAIKULAM
1	Total no of House hold	96	700	1610
2	Total no of Families	96	775	1700
3	Total no of population	462	1328	6000
4	Total no of Male Population	232	708	3200
5	Total no of Female Population	230	620	2800
6	Active Fishermen Family	64	500	1020
7	Percentage of Active Fishermen	66%	40%	60%

B. LITERACY:

DETAILS OF LITERACY LEVEL				
		SEENIYAPADRAGA	PERIYAPATTINAM	THARUVAIKULAM
1	Male	47%	36%	36%
2	Female	12%	16%	32%
	Total	59%	52%	68%

2. Evaluation of Asset Capital of the VMC villages and SWOT Analysis.

The existing livelihood practices in the VMC planning villages are dependant on the natural, physical, human, social and financial capital assets and their availability to them. Though most of these assets tend to fluctuate, depending of various political, institutional and socio-cultural factors, there are some assets which are central to their choice and practices of livelihood option. An analysis of the asset capital for the three villages show a limitation of financial and physical assets. Even though the natural capital assets in the form of Marine resources are available, the changing legal provisions of the GOMMNP make it inaccessible to them and therefore became limiting (Table 2a).

2. ASSET CAPITAL OF THE IDENTIFIED VILLAGES:

	SEENIYAPADRAGA	PERIYAPATTINAM	THARUVAIKULAM
NATURAL ASSETS			
Agriculture land	ü	ü	
Forest land	ü		ü
Rivers, ponds, water tanks and wells	ü	ü	ü
Marine resources	ü ü ü	ü ü ü	ü ü ü
HUMAN ASSETS			
Knowledge & Skill	ü	ü	ü ü
Health & Ability to work	ü ü ü	ü ü ü	ü ü ü
Literacy	ü	ü	ü ü
Schools	ü	ü ü	ü ü

FINANCIAL ASSETS			
Livestock	ü ü	ü	ü ü
Jewellery	ü	ü	ü ü
Grain			
Savings	ü	ü	ü ü
PHYSICAL ASSETS			
Road access	ü	ü ü	ü ü ü
Hospitals		ü ü	ü
Communication	ü	ü ü	ü ü
Local market			ü
Access to other market	ü	ü ü	ü ü

Low - ü

Medium - ü ü

High - ü ü ü

SWOT ANALYSIS

However, the present scenario of externalities to which the villages are subjected to, it was necessary to conduct a SWOT analysis to examine how the villages can cope up and adopt to modified, diverse and alien livelihood options. The SWOT analysis based on the asset capital and PRA exhibits the villages to have the ability to adopt to new livelihood options provided, the policy reforms, governance mechanism and facilitating process are in place (Table 2b).

Table 2b. SWOT Analysis Of The Experimental VMC Villages:

	STRENGTH	Seeniyapadharga	Periyapattinam	Tharuvaikulam
1	Strong Back ground community	ü	ü	ü ü ü
2	Conservation awareness	ü	ü	ü ü
3	Education	ü	ü	ü ü
4	Marketing facilities		ü	ü ü
5	NGO's support	ü ü ü	ü ü ü	ü ü ü
	WEAKNESS			
6	Lake of Scientific knowledge	ü ü	ü ü	ü ü
7	Lack of Sufficient support from Government	ü	ü	ü ü
8	Poverty	ü ü	ü	ü
9	Lack of Investment on alternative livelihood options	ü	ü	ü
10	Lack of Marketing Facilities	ü ü ü	ü ü	ü
11	Lack of Economic Security			
12	Lack of education	ü ü	ü ü	ü
13	Regulation of Wild life (Protection) Act			ü
	OPPORTUNITY			
14	Training for alternative livelihoods during Rough & off season Times	ü ü ü	ü ü ü	ü ü ü
15	Willingness to take up the alternative livelihoods options	ü ü ü	ü ü ü	ü ü ü
	THREAT			
17	Conflicting Political climate		ü	ü ü ü
18	Fisheries Mechanization	ü	ü	ü ü ü
19	Influx of fishermen from other villages	ü ü ü	ü ü	ü
20	Money lenders problems	ü ü ü	ü ü ü	ü ü ü

3. EXISTING LIVELIHOOD PRACTICES:

A. SEENIYAPADHARGA:

Majority of the people from this village are involved in fishing and allied activities, with few canoe operators fishing as far as 20km off-shore. A few of the younger people have emigrated to foreign countries for employment.

The main livelihood activities of this adjoining fishing village are:

- (i) Fishing,
- (ii) Seaweed collection,
- (iii) Chank collection,
- (iv) Agriculture,
- (v) Floriculture,
- (vi) Own business like Tea shop, Grocery shop etc.,
- (vii) Handicraft (Palm trees) and
- (viii) Working as construction laborers and others

B. PERIYAPATINAM:

The main occupation of this village is fishing and chank collection. All of them are fishing only in the lagoon areas. In this, majority of the fishermen are engaged in fishing and allied activities (Seaweed, Sea cucumber collection). Hundred and twenty five (125) families are involved in agriculture practices, nearly Five hundred (500) families are involved Chank collection, Seaweed collection and Sea cucumber collection. Remaining villagers are practicing other activities (Grocery, labors – others etc.,)

- (i) Fishing
- (ii) Chank collection
- (iii) Sea cucumber collection
- (iv) Seaweed collection
- (v) Agriculture
- (vi) Own Business (like Micro livestock, Petty trading, etc.,)
- (vii) Labors (Building construction, agriculture, Fencing etc.,)

C. THARUVAIKULAM:

Fishing is the main occupation of this village. Majority of the people are fishing only in the lagoon areas i.e., region between main land and islands in the Gulf of Mannar. However, majority of country boat fishers are fishing 20 kilometers away and mechanized boat fishers are fishing above 100 km towards Dhanuskodi. In this village, seventy percent of the fisherman are engaged in fishing and allied activities. Around 30% are practicing the non-fishing activities; Young fishermen have migrated to foreign countries for employment. . The main livelihood activities of these fishing villages are

- (i) Fishing,
- (ii) Coral mining
- (iii) Fresh and dried fish traders

- (iv) Chank collection (Diving)
- (v) Workers of saltpans
- (vi) Own business (Like Tea shop, Grocery shop etc.,) and
- (vii) Labors (like building construction, and others)

Table 3a. Essential livelihood options being practiced in identified villages

NO.	LIVELIHOODS	SEENIYAPADHARGA * (FAMILY)	PERIYAPATTINAM * (FAMILY)	THARUVAIKULAM * (FAMILY)
1	Fishing – Own	24	40	500
2	Fishing – labors	40	268	570
3	Business(Salt pans, Livestock rearing, Agriculture, Petty trading	9	135	158
4	Foreign	7	63	10
5	Labors (Saltpans, Boat repairers, Building construction, Agriculture, Fencing, Handicraft etc)	11	223	417
6	Govt. Employees	1	3	5
7	Private Employees	4	18	40

- * - Seeniyapadharga – 96 families (Total number of families)
- * - Periyapattinam - 775 families (Total number of families)
- * - Tharuvaikulam - 1700 families (Total number families)

Table 3b. Seasonal livelihood options practiced in model villages

A. seeniyapadharga

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fishing	ü	ü							ü	ü	ü	ü
Chank collection	ü									ü	ü	ü
Seaweed collection	ü								ü	ü	ü	ü
Floriculture & agriculture	ü	ü	ü	ü							ü	ü
Handicraft (Palm trees)	ü	ü							ü	ü	ü	ü
Labors – others		ü	ü	ü	ü	ü	ü	ü				

B. PERIYAPATTINAM

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fishing	ü	ü							ü	ü	ü	ü
Chank collection	ü	ü							ü	ü	ü	ü
Seaweed collection	ü	ü							ü	ü	ü	ü
Sea cucumber collection	ü	ü							ü	ü	ü	ü
Agriculture	ü	ü	ü	ü							ü	ü
Labors – others		ü	ü	ü	ü	ü	ü	ü				

C. THARUVAIKULAM

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fishing and Chank collection	ü	ü	ü					ü	ü	ü	ü	ü
Dried fish sale	ü	ü	ü	ü						ü	ü	ü
Net making	ü	ü	ü	ü	ü	ü	ü	ü	ü			
Salt pans			ü	ü	ü	ü	ü	ü	ü			
Coral mining	ü									ü	ü	ü
Labors- Other			ü	ü	ü	ü	ü	ü	ü			

4. FISHING CRAFTS AND GEARS USED IN VILLAGES:

4.A. Seeniyapadharga:

Fishers in Seeniyappa Dharga have only the restricted zone available for fishing, because fishers in this village do not have any mechanized boats. Majority of the people are fishing only in the lagoon areas i.e., region between main land and islands in the Gulf of Mannar. The non-mechanised boats used in the Seeniyappa Dharga village are plank-built boat (vathai) and Canoes (Vallam) .Canoes are fixed with 10HP in-board motors, while plank-built boats are operated by sail only. Seeniyappa Dharga village have Forty one (41) fishing vessels with 26 traditional plank-built boats and 15 canoes. Most of these vessels are exclusively used for fishing, chank collections and seaweed collection. Every day after fishing, the family members help in mending their nets.

In this village, fisherman use different types of fishing gears (Valai) depending upon the type of species of fish to be caught. These are crab nets, lobster nets, disco hooks and drift gill nets. Apart from these nets, fishers of this village are known to use drag net. The coast line of this village is having a luxuriant sea grass and sea weed beds covered with shallow water. Hence, variety of fishes and other associated animals are found in this region. By virtue of these conducive environmental conditions and resource harvest practice, it has become a breeding ground for the protected major marine organisms

4.B. Periyapattinam:

Fishers in Periyapattinam have only non- mechanized boats like canoes, Plank built boat. The total number of fishing vessels is forty (40). Of these, vessels numbering twenty five (25) are canoes and fifteen (15) are Plank built boats. Canoes are fixed with inboard oil engine of 8 to 14 HP. Plank built boats are operated by sail only. Fishermen in this village use different types of gears depending upon the type or species of fish targeted. These are Nandu valai, singi valai, disco valai, veechna valai, and thoodil.

4.C. Tharuvaikulam:

Fishers of this village use both mechanized and non- mechanized (Motorized and Non – motorized) boats for fishing. The total numbers of fishing boats are five fifty. Of these, forty five(45) are mechanized (with out trawl nets), and non –mechanized comprises of four forty five (Canoes – 420; Plank-built boats – 35). Canoes are fixed with inboard oil engine of 8 to 14 HP. During fishing season, more number of mechanized boats goes to various parts of Gulf of Mannar especially towards Dhanuskodi. These Mechanized boats are fixed with inboard engine of 68 HP to 110 HP – level and 102 or 104 model with a length of 40 feet. In this village, mechanized boats doesn't comprise trawls. Instead, they use only passive gears like gill nets. There is a local agreement between the mechanized and traditional sectors, which prohibits bottom trawling under any circumstance. The agreement doesn't impose any restriction on the time schedule to be followed by both the sectors. The vessels leave to the sea at the best suitable time depending on the targeted fish... (Ragupathy venkatachalam , 2005)

Fishermen use a variety of nets depending upon the species of fish targeted. The nets are named after the fishes, which they are intended to catch. They are using *Paru Valai*, *Nandu Valai*, *Singi Valai*, *Thirukai Valai*, *Eral Valai*, *Mural Valai*, and *Thoondil* (hook and line). Depending upon the economic condition, fishers use all types of nets. Thirty percent of them have all types of nets even though they are living in economically poor conditions. They obtain money from money-lenders and fish traders for purchasing nets. According to fishers, the availability of several marine resources is seasonal and the method of fishing varies with the types of fish targeted to be caught.

Table 4a. Different kinds of fishing crafts in model villages for common marine resource harvest

NO.	NAME	VERNACULAR NAME	SEENIYAPADHARGA	PERIYAPATTINAM	THARUVAIKULAM
1	Plank built boat	Vathai	26	15	35
2	Canoes	Vallam (out board motor)	15	25	420
3	Mechanized boat	Launch			45 * (with out trawl net)
	Total		41	40	500

* - In post tsunami Tharuvaikulam Panchayat stopped trawl net use in marine areas

4b. Kinds of fishing gears in use in model villages

a. Seeniappadharga:

S.NO.	TYPES OF GEAR	GEAR COMPOSITION	MESH SIZE	CASTING PLACE	SPECIES CAUGHT
1	Nandu Valai (Bottom set Gillnet)	Synthetic nylon nets	90 – 130 mm	Clay	Crabs, Prawn
2	2nd no. valai (Drift gillnet)	Synthetic nylon nets	60 mm	Water	Vilai , Nagarai, Soodai, Parai, Valai, Vaval ,Kumula
3	Singi valai (Bottom set Gillnet)	Synthetic nylon nets	40 – 60 mm	Rocky	Lobster, Prawn

b. Periyapattinam:

S.NO	TYPE OF GEARS	GEAR COMPOSITION	MESH SIZE	CASTING PLACE	SPECIES CAUGHT
1	Nandu Valai (Bottom set gillnet)	Synthetic nylon nets	90-130 mm	Clay	Crabs
2	2 nd no Valai (Drift gill net)	Synthetic nylon nets	60 mm	Water	Vilai, Nagari, soodai, paarai, Valai , Vaval , Kumula
3	Singi Valai (Bottom set gill net)	Synthetic nylon nets	40- 60 mm	Rocky	Lobster
4	Mural Valai	Synthetic nylon nets	60mm	Water	Mural

c. Tharuvaikulam:

S.NO	TYPES OF GEARS	GEAR COMPOSITION	MESH SIZE	CASTING PLACE	SPECIES CAUGHT
1	Paru Valai (Drift gill nets)	Synthetic nylon nets	120-140 mm	Water	Big sized fishes like, Barracudas, Sharks etc.
2	Nandu Valai (Bottom set gill net) / Pots	Synthetic nylon nets	40 – 50 mm	Clay	Crabs, lobster, Sepia spp & chanks
3	Choodai Valai (Drift gill net)	Synthetic nylon twine	10 mm	Water	<i>Sardinella</i> spp., and other small sized fishes
4	Mural Valai	Synthetic nylon nets	38 mm	Water	<i>Albennes</i> spp, <i>Rhynchorhampus</i> spp., <i>Hemirtampus</i> spp.,
5	Irral Valai (Bottom set gill net)	Synthetic nylon twine	20 -30 & 100 - 130 mm	Clay	Prawns,
6	Maya Valai	Synthetic Nylon	50 – 60 mm	Rocky	<i>Lethrinus</i> spp., Sharks., <i>Sardinella</i> spp., etc.
7	Karaimadi Valai (Inshore drag net or shore seine)*	Nylon with coir	Bag length – 1 m; Net – 15 m; wing – 400 – 500 m.	Shallow water	All types of fishes – small to large size

* Are considered destructive fishing gears.

5. ECOLOGICAL DAMAGE SCENARIO:

5.A. SEENIYAPADHARGA:

1. Seaweed collections:

Sea weed collection by this village had started as early as 1950s. Sargassum is the main species collected by them mostly during Sept-Jan. Seaweeds are collected from the off-shore waters of Mulli, Moyal and Manouli Islands, on the sea ward side by operating motor boats consisting a five-men crew. A minimum of 1tonne (wet weight) can be collected this way. The dried sea weed is sold at a market price of Rs.2/- per KG (dry weight). It is estimated that an average of 5000-7000tonnes of sea weed is harvested annually by these people.

2. Chank collections:

Chank collection is one of the important occupations among the fishers living in this village. People collect chanks from the nearby islands from depth between 10-25Mt. nearly, 30% fishers are engaged in this task. The peak season for chank collection is four months in a year i.e., Oct-Jan They collect different types of Chanks for different decorative purposes. The collected chanks are normally sold at a price of Rs.10/- per piece, size ranging from 10-20Cm, and at a price of Rs.300/- per Kg of the smaller individuals. The operculums will normally go at a price of Rs.100-1500/- depending on the species. The chank fishers sell their catch to Keezhakarai and Rameswaram chank traders. Sometimes, chanks are directly exported to Ahemadabad. Some times they collect Prohibited chanks like Trochus, Lambis spp etc.

3. Island based Fishing:

Since most of the villagers have *vallams* and *vathai*, they are mostly confined to the lagoon area, often fishing around the islands.

4. Usage of nylon and plastic threaded nets:

These types of nets are made by synthetic nylon, locally referred to as '*Thanduci valai*'. The mesh sizes may vary depending upon the species being targeted.

5.B. PERIYAPATTINAM:

1. Chank Diving (Chank collection):

Traditionally, the chank divers have been residing only in Periapattinam and Keezhakarai fishing village. However, the fishers of nearby villages are engaged here as laborers during chank collection. Nowadays, others also have learnt chank diving and pursue their occupation as chank divers. Chank collection is also one of the important occupations among the fishers living in this village. They are exclusively chank divers. However, during offseason, they are doing seaweed and seacucumber collection. The chank divers are belonging to Muslim community. The peak season for collection is four months in a year i.e., November, December, January and February and the eight months are off- season. They collect different types of chanks such as Kuli chanku, oothu chaku, Yaanai muli, Ayarn muli, Kuthirai muli etc. The first two types of chanks are used for ornamental purposes. Kuthirai muli and Yaanai muli chanks are used for exquisite ornamental designs. The chank fishers sell their catch to Keezhakarai and Rameswaram chank traders;

2. Sea cucumber and seaweed collection:

Fisher folks here are also collecting Seaweed from the surrounding islands (Mulli , Appa, and valai islands). *Sargassum and Ulva* are the two species collected by the seaweed collectors. Its collection period is from September – January. Single boat is shared by a crew of five Members and can collect minimum of one ton (wet weight) per day, nearly five thousand (5000) to seven thousand (7000) tons (dry weight) seaweeds are harvested annually .The collected seaweeds are sold for Rs. 2 / kg (dry wt).

Sea cucumber collection is an another important occupation of this village. Fisher folks are collecting of sea cucumber mainly from the surrounding islands (Mulli, Valai, and Appa islands). Its collection period is October – April. Decrease of Sea cucumber may affect the food web in marine ecosystems. Because it's a detritus feeders. (local name is Marine earth worm)

According to the fisher folks knowledge the life span of *Seaweeds and Sea cucumber* is only for short periods. So, they don't find any mistake in collecting these seaweeds and sea cucumber as it will perish itself, otherwise.

5.C. THARUVAIKULAM:

1. Coral mining:

Tharuvaikulam peoples are one of the traditional coral miners in the Gulf of Mannar. Normally corals are mined for limestone and construction materials. Some times coral pieces are removed for use as bricks or road-fill. Sand and limestone from coral reefs are also made into cement for new buildings. Corals have been used as a source of calcium carbonate, so dead coral is harvested for calcium supplement. Coral species are used in the dried ornamental trade business, collected and traded for jewelry. Coral ornaments and jewelry are often sold to tourists and exporters. Some live corals are collected for the marine aquarium industry and Public aquaria and some corals are used for medicinal purposes. The development of lime based industries in and around Thoothukudi has accelerated the practice of coral mining.

2. Island fishing :

The fisherfolk of this village are also involved in reef related fishing activities near islands (Van, Kaswar, Karaichalli, Vilaguchalli, Nallathanni, Upputhani, Appa, Yannaipar, Musal, Kurusadai, islands) in Gulf of Mannar. Some times they are staying in the islands for up to two or three days. Especially van and Kaswar Island, this village people are practicing **Beach seine** (Shore seine) fishing.

Table5. Illegal Marine Resource Harvest Practices In Proposed Villages Following GOMNP Declaration Of IWP Act – 1972

		SEENIYAPADHARGA	PERIYAPATTINAM	THARUVAIKULAM
1	Coral Mining			ü
2	Sea cucumber collection		ü	
3	Seaweed collection (within the National Park)	ü ü	ü	
4	Chank collection (within the National Park)	ü	ü ü	ü
5	Island Based fishing	ü	ü	ü ü ü
6	Island Staying		ü	ü ü ü
7	Using of destructive nets			ü ü

Low - ü Medium - ü ü High - ü ü ü

6. THE EFFECT OF ECOLOGICAL DAMAGE:

6.A. SEENIYAPADHARGA:

Seaweed collection:

This is the most important money yielding as well as damaging activity observed in the National Park area of the Gulf of Mannar. Since corals cannot survive beyond a certain limit of nutrient richness, presence of sea weeds helps in the healthy propagation of corals as the sea weeds helps them by filtering the water with any excess nutrients found. Sea weeds also helps in absorbing the wave action exerted on the shores. So, the presence of sea weeds not only helps the shores from coastal erosion, but also helps in the healthy propagation of the corals.

Chank collection:

Shell collection which causes coral reef degradation to some extent. This activity increases the sedimentation in coastal water leading to the death of coral.

Island based fishing:

Non-motorized sail boats are used for fishing around the islands of the Tuticorin and Vembar group of islands. These boats often cause mechanical damage to the corals. Over exploitation of certain reef associated herbivorous fishes has resulted in the excess algal settlement on the corals.

Usage of Nylon and Plastic nets:

The entanglement of fishes in the nylon threaded nets often results in injuries which fetch them a lesser price in the market. Not only this, interviews with fishers revealed that these nylon nets cause some sonic disturbances under the water column resulting in a mass migration of fishes to new feeding grounds.

Trawling in Lagoon areas:

Mechanized boat owners of Pamban and Mandapam villages often trawl closer to this village causing a major damage to the resources. The majority of the coral reefs have been destroyed by fishing using modern fishing techniques like trawling netting and gill netting. These destructive methods cause direct damage to the eco- system and indirectly affect their growth by increasing turbidity and suspended sediments in the coastal waters and reducing the clarity of seawater and increasing sediment loads in feeding and breeding grounds.

6.B. PERIYAPATTINAM:

Seaweed collection:

Seaweed collection by this village is also causes the same ecological damages which have mentioned under Seeniyapadharga village..

Chank collection:

Shell collection which causes coral reef degradation to some extent. This activity increases the sedimentation in coastal water leading to the death of coral.

Island based fishing:

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Trawling in Lagoon areas:

Mechanized boat owners of Keezhakarai, Erwadi, Thoothukudi and Mandapam villages often trawl closer to this village causing a major damage to the resources. The majority of the coral reefs have been destroyed by fishing due to modern fishing techniques like trawling netting and gill netting. These destructive methods cause direct damage to the eco- system and indirectly affect their growth by increasing turbidity and suspended sediments in the coastal waters and reducing the clarity of seawater and increasing sediment loads in feeding and breeding grounds.

6.C. THARUVAIKULAM:**1. Coral mining:**

In pre-Tsunami period, these village people were involved in coral mining and dead coral collection from Karaichalli, Kaswar ,Nallathani, Velaguchalli, and Van islands. In thoothukudi and around villages, old houses (app.. before 1980's) constructed by corals. A greater extent of coral reefs were mined and used for construction instead bricks. These mined corals are transported by Lorry to another or required areas. Each lorry loads of is approximately Rs.500 and one tractor loads costs around Rs. 200 – 250/- .

The Ramco cement Factory had been engaged in these types of activities, because of their Raw materials requirements. After 1990, this has been gradually decreased. But, now some areas including Tharuvaikulam peoples are practicing these types of illegal activities.

Already two islands (Povarsan patti, vilanguchalli islands) are submerged which is suspected due to destruction of corals. Remaining islands levels are reducing. It these conditions will be continuing the entire islands would be destroyed.

2. Island Fishing:

These village people are doing beach seine fishing in Islands (esp ; Kaswar, van islands). This is totally destroying islands Ecosystems.

7. COMMUNITY VIEWS ON RESTRICTIONS:

7.A. SEENIYAPADHARGA:

1. **Seaweed collection:** According to the knowledge of fisher folk, the life span of *Sargassum* species is only six months. So, they don't find any reason behind imposing ban on collecting them as they will perish after six months naturally.
2. **Chank collection:** This is very important economic activity for fisher folk around this region. They are not very well informed about which species are prohibited for trade.
3. **Island based fishing:** as availability of fish species around the islands is more than any other area, people are attracted towards island based fishing.
4. **Usage of Nylon and Plastic nets:** Fisher folks of this village are very well aware of the damages caused by the nylon and plastic nets on the marine ecosystem. But, due to low catch by cotton thread nets when compared with the nylon nets, more people are attracted towards the use of these nets. Villagers are ready to use cotton thread nets, on a condition that no nylon nets be used by anyone in the adjacent villages.
5. **Trawling in Lagoon areas.** These fishing villages have a request to stop mechanized fishing near islands and it would be appreciable if the same decision can be taken near the mainland shore also, because traditional fisher folks are fishing in this area.

7.B. PERIYAPATTINAM:

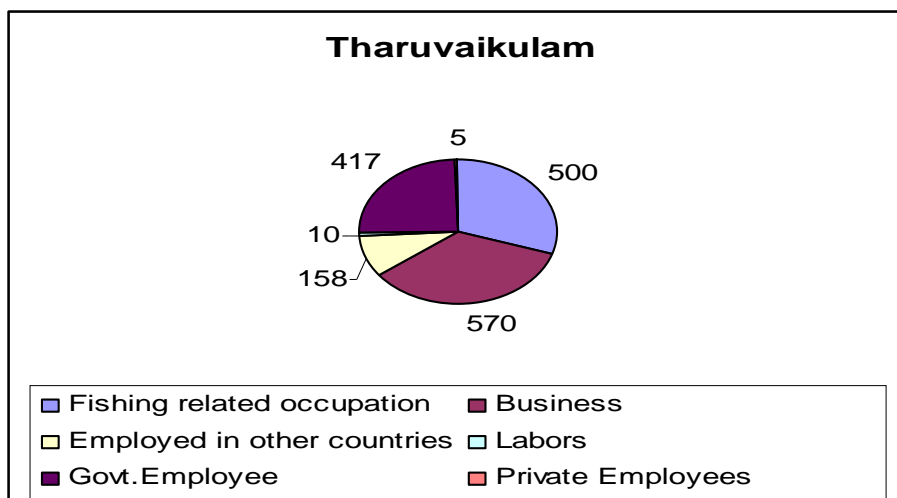
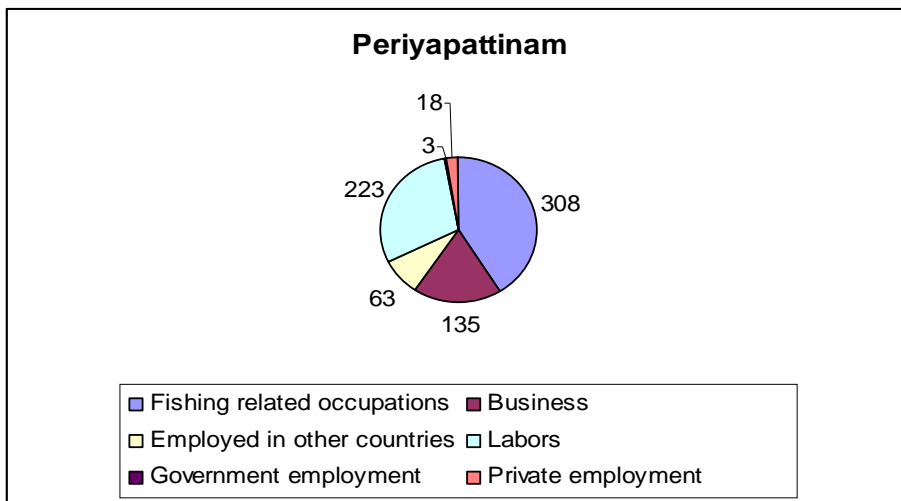
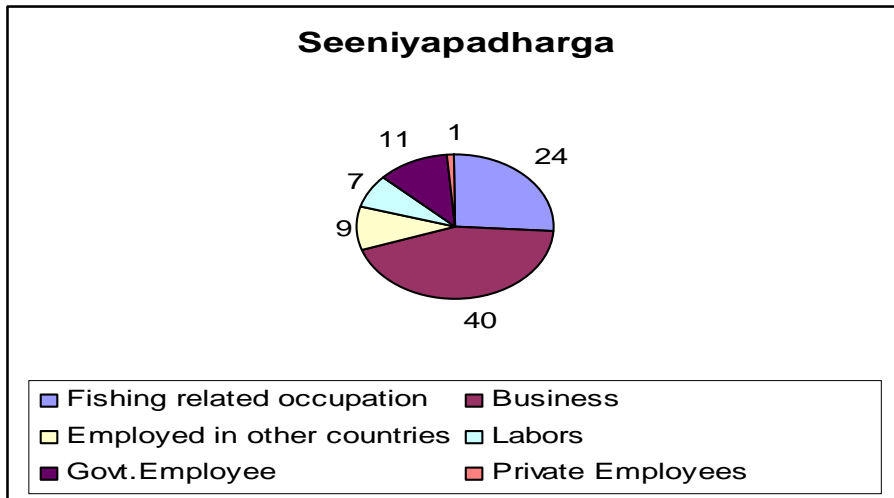
1. **Seaweed collection:** According to the knowledge of fisher folk, the life span of *Sargassum* species is only six months. So, they don't find any reason behind imposing ban on collecting them as they will perish after six months naturally.
2. **Chank collection & Sea cucumber collection:** They are divers only. So, they are not affecting any ecosystems. But Mechanized boat's fishers collect the chanks and sea cucumber through Nets. So, it complete affects the lagoon areas. This is very important economic activity for fisher folk around this region. They are not very well informed about which species are prohibited for trade
3. **Island based fishing:** People reveal, that they are doing fishing near islands. Here, fishes and chanks are more than the other areas. Island based fishing have the surety for regular income. As availability of fish species around the islands is more than any other area, people are attracted towards island based fishing.
4. **Usage of Nylon and Plastic nets:** Fisher folks of this village are very well aware of the damages caused by the nylon and plastic nets on the marine ecosystem. But, due to low catch by cotton thread nets when compared with the nylon nets, more people are attracted towards the use of these nets. Villagers are ready to use cotton thread nets, on a condition that no nylon nets be used by anyone in the adjacent villages.
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decision can be taken near the mainland shore also, because traditional fisher folks are fishing in this area.

7.C. THARUVAIKULAM:

- 1. Coral mining:** Usually Non- Traditional immigrant fishermen are involved in these activities. They have immigrated some two-three generations back from adjacent villages especially for coral mining. Whereas, people from Arokiyapuram , Poopalarayarpuram, Keelaarasaradi, Anathamadam patcheri work as labors in this. If Tharuvaikulam villagers are given emphasis towards the promotion of Alternative livelihoods, marine resources can be recouped from the damages occurred in the past.
- 2. Island fishing:** Traditional fishermen community have are posing a continuous threat by fishing within the National Park boundaries. Most of the time they used to stay temporarily in the islands (Kaswar, van islands.), fishing using Seine nets,. These islands need stringent regulations to reduce the pressure.

Chart 1. CONTRIBUTION OF VARIOUS EXISTING LIVELIHOOD OPTIONS TO VILLAGE ECONOMY



8. APPROACH TO REVERSE DAMAGES:

v Population pressure:

Increasing population through immigration along the coast of this village adds an additional pressure on inadequate and increasingly vulnerable coastal resources. Increase of the population in coastal areas through the migration from the near by non- coastal villages. Mostly farmers are migrating to the coastal areas should be stopped by encouraging other departments, to engage them to do their own livelihoods, like Agriculture, etc., in their original villages.

v Implementation of Participatory Management:

Nearby, the lagoon area of this village , trawl fishing are operated by Mechanized boat operators from Pamban and Mandapam areas. People opine that trawl fishing is the only depleting these resources rapidly. These people want to control these types of activities. They are not getting any support from Government side for this. If government concentrate on this type of activities (at least Govt – Fisheries and Forest department take steps for these village people’s complaints) surely village people will come forward for Biodiversity Management.

v Poverty:

The point of protecting and preserving the marine and coastal environment by promoting the unsustainable use to sustainable use. The studies show clearly that the problems facing the poor and their natural use of base. Because these poor peoples are forced to resort to illegal activities as labors. The Poverty can force people to use resource unsustainably. The alternate livelihoods in this situation are seen as a solution to combat poverty by income generating activities and means to promote them to sustainable utilization of resources.

9. ALTERNATIVE LIVELIHOOD OPTIONS IN VILLAGE MARINE CONSERVATION PLAN RECEIVE LUKEWARM RESPONSE:

Alternative livelihood program aimed at stake holder involved in destructive activities were ineffective from local communities in the present context. Introduction of alternative livelihoods in this context will not bring about the desired change from the unsustainable use to sustainable use of resources. But the development of alternative livelihood options is required to be promoted to reduce pressure on the marine resources. The first important point is to understand which activities are damaging to the ecosystem and second is to ensure the right stakeholders are targeted. Alternative livelihoods are very essential for both the development of coastal communities and for the conservation of marine and coastal biodiversity and ecosystems.

Implementing alternative livelihood options is quite different as well as difficult in marine protected areas when compared with any terrestrial areas owing to complexities involved with the ecosystem as well as its stake holders’ livelihood practices. A normal fishing net used by any poor fisherman would cost around few thousand rupees. More over, fishing is largely a seasonal activity, offering quite irregular income These kind of delicate issues needs to be addressed before implementing any alternative livelihood plans. First, right persons and feasible

options should be addressed. Completely new livelihoods activities whilst leaving their existing practices is a risky strategy, because their circumstances are often risk averse, it is also a strategy that is unlikely to result in the desired change. So, choice of the alternatives is very important point when it comes to identifying right persons and assigning them right tasks which can off them a near equal income when compared to that of fishing or any other allied activities.

Most of the alternative livelihood plans are not offering equal amount as that of fishing or any other allied activities (legal/illegal) both in terms of satisfaction and money returns. This situation could be over come by involving a family in more than one alternative livelihood options. This helps families in achieving desired income. When a single person is taken into consideration, he can only handle a single option but when a family is involved, assuming there are four members in that family, at least two members can handle a task and income generation could be enhanced this way (**Model given in Table below**).

Family Members	Prospect of Multiple Alternatives Livelihood option in one family		
	Aquaculture / Poultry farming ,/ Cattle farming / Floriculture	Handicraft / Pickle or food selling / Tailoring	Marketing,/Textiles business/Bicycle repairers
Head of the family	ü		
Spouse		ü	
Male child	ü		ü
Female child		ü	ü

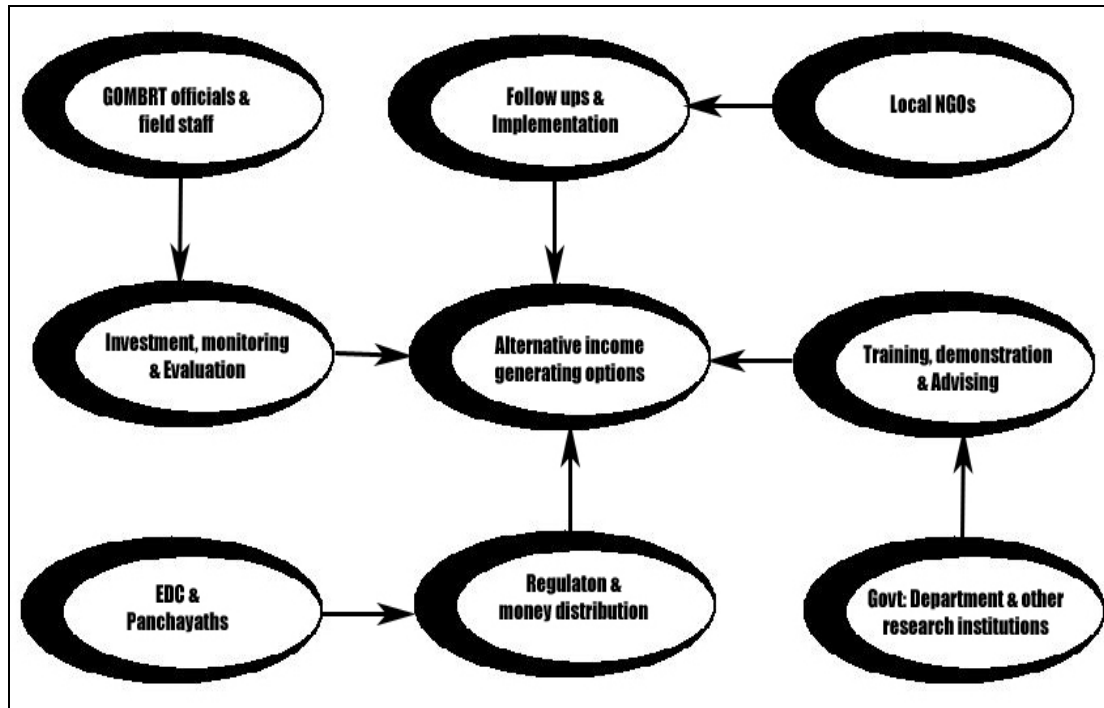
Table 9.. Matrix used to examine the sustainability of a suggested alternative livelihood option

	Environmental Natural Resources (ENR)								Non Environmental Natural Resources (NENR)					
	Aquaculture (seaweed culture crab and lobster culture fattening)	Agriculture (Floriculture, horticulture etc)	Micro livestock rearing	Palm & coconut by product(handicraft & jaggery)	Lac production(Gujarat model)	Food processing units	bee keeping	Halophyte based salt production (Gujarat model)	Tailoring & Textiles	Motor mechanics	Petty trades	Cycle repairing		
1 Does the alternative relate to the needs and aspirations of the poor?	ü ü ü	ü ü	ü ü ü	ü ü	?	ü ü ü	?	?	ü ü ü	ü ü ü	ü ü	ü		
2 Is the alternative viable & suitable (from an economic,environmental, institutional, social and culture perspective) ?	ü ü	ü ü	ü ü ü	ü ü	?	ü ü ü	?	?	ü ü ü	ü ü ü	ü ü ü	ü ü ü		
3 Can the alternative accommodate the no: of the people concerned in line with markets for the level of goods and services to be produced ?	ü ü ü	ü ü ü	ü ü	ü ü	?	ü ü ü	?	?	ü ü	ü ü	ü ü	ü		
4 Does the alternative have acceptable levels of risk to the poor whilst not increasing their vulnerability?	ü ü	ü ü	ü ü	ü ü	?	ü ü ü	?	?	ü	ü	ü	ü		
5 Does the alternative build on existing strength & assets (building blocks) of the poor?	ü	ü	ü ü	ü ü ü	?	ü ü	?	?	ü ü	ü ü	ü ü	ü ü		

6 Is the alternative in harmony with existing lively hood strategies and does it fully accommodate gender and socioeconomic differences?	ü ü ü	ü ü ü	ü ü	ü	?	ü ü	?	?		ü	ü ü	ü ü	ü		
7 Does the alternative compliment existing strategies of other people in the community?	?	?	?	?	?	?	?	?		?	?	?	?		
8 Does the alternative conform with national policies & legislations?	ü ü ü	ü ü ü	ü ü ü	ü ü ü	ü ü ü	ü ü ü	ü ü ü	ü ü ü		ü ü ü	ü ü ü	ü ü ü	ü ü ü		
9 Does the alternaive enhance the independence of the poor?	ü ü	ü ü	ü ü ü	ü ü	ü ü	ü ü ü	ü ü ü	ü ü ü		ü ü ü	ü ü ü	ü ü ü	ü ü ü		
10 Does the alternative ensure the right of the poor	ü	ü ü ü	ü ü ü	ü ü ü	ü ü ü	ü ü ü	ü ü ü	ü ü ü		ü ü ü	ü ü ü	ü ü ü	ü ü ü		
11 Can the alternate enhance the innovative capacity, vision and adaptability of the poor to cope with future changes to their lively hoods	ü ü ü	ü ü ü	ü ü	ü ü	ü ü	ü ü ü	ü ü ü	?		ü ü ü	ü ü ü	ü ü	ü		

ü Low ü ü Medium ü ü ü High

10. NETWORKING AND IMPLEMENTATION SUGGESTED RELATIONSHIP OF CROSS – SECTIONAL AGENCIES IN VILLAGE MARINE CONSERVATION PLAN THROUGH ALO DEVELOPMENT:



Implementation of Alternative Income Generation options has a higher chance of success if implemented through a network of local NGO's, Government Departments, interested research organizations/institutions. The present dissatisfaction of the local communities can also be attributed to the lack of support staff to execute the existing plans. This can be effectively managed when the tasks are out-sourced. Affinity of the local NGOs will be helpful in the successful implementation of the alternative livelihood plans with the active participation of the people.

Investing funds, timely monitoring and evaluation of the projects should be taken care of by the GOMBRT while NGOs would actually be implementing the plans. Technical support and advice on the logistic issues could be sought from the concerned Government departments and/or research organizations/institutions.

Table 10. Cross-sectoral involvement in implementation of alternative livelihood option in VMCP of model villages.

	Alternative livelihoods	Target Groups	Marketing through	Buyers and users	Training/Demonstration & Extention By	Investment, Monitoring & Evaluation	Implementation facilitators
1	Aquaculture	Fishermen	Educated youth of the community through co-operative	PEPSI (Seaweeds), Seafoods companies (Nila, Diamond, Deva, Kadalkanni etc)	CIBA,NIOT, CMFRI, CSMCRI, SDMRI	GOMBRT & NGOs	Local NGOs
2	Fish pickling units	Fisherwomen	Educated youth of the community co-operative	Tourist places and all Grocery shops.	SDMRI, PAD, Fisheries College and Research center, TTK	GOMBRT & NGOs	-do-
3	Floriculture	Men and women of the fishing community	Educated youth of the community	Madurai Flower Market	Dept., of Agriculture	GOMBRT & NGOs	-do-
4	Live stock rearing	Fishing community	House holds	High Market demand in all places	Dept., of Agriculture and Animal Husbandry	GOMBRT & Line Departments	-do-
5	Palm based handicrafts	Fisher women	Co-operative	Handicrafts development board, Kathicraft – Ramnad, Madurai, Thoothukudi	Local NGOs	GOMBRT & NGOs	-do-
6	Medicinal plant cultivation	Men & Women	-do-	Aurvethic & Pharamatutical companies	Dept of Agriculture	GOMBRT & Line Departments	-do-
7	Bicycle repairing & Mechanics	Fishermen	House holds	Local villagers	Mohamed sadak polytechnic – Keezhakarai	GOMBRT	-do-
8	Textiles Business(Like marketing)	Fisherwomen	-	Local villagers	-	GOMBRT	-do-
9	Grocery shop	Men & Women	House holds	Local villagers	-	GOMBRT	-do-

11. IDENTIFICATION OF TARGET GROUPS IN COMMUNITY:

It is very important to identify and assign right kind of livelihoods for right kind of people. Data is already available with the GOMBRT on the degree of dependency of various villages on the Reserve's resources. These villages shall be grouped based on their degree of dependence on the resources and livelihood options suggested herein shall be implemented considering the suitability of the situation. Selection of villages is possible since already 123 villages, out of 222 EDC villages, have been identified as completely marine resource dependant. Of this, 80 villages are located close to the national Park Boundary, of which 45 villages are completely dependant as well as causing medium level of damage. There are 17 villages which are causing high level of damage. As fishing within the Biosphere Reserve is not illegal, it is important to initially select villages that are causing serious damage and concentrate on suitable alternatives to minimize damage. After partially success, more to the next level and so on. In the present VMC, our first target is Tharuvaikulam followed by Periyapattinam and Seeniyapadharga.

12. FACILITATING THE ALTERNATIVE LIVELIHOOD OPTIONS (ALOs) IN THE VMCP:

1. Provide a range of ALO option base on the village asset and heterogeneity nature of livelihood option practiced
2. Enhance skill knowledge of the village community through training and extension for a adopting livelihood options,
3. Accept the willingness of the community to accept on ALO rather than thrusting an option on them
4. Prove that the suggestion and Adoption of ALO should bring in equal or better economic return to previous activator and bring supplementary income to their core activity
5. Create infrastructure and start-up- capital through micro credit facility needs to be created
6. Establish village institutions for self governance , regulations with infrastructure,
7. Analyze, Identified and extension linkages with markets for the products of ALOs
8. To monitor how the ALO adoption has decreased/eliminated the pressure from the eco-resources of the marine region
9. Develop a cost-scientific analyze of each ALO and AIG activity before promoting it establish
10. Natural recourse user technical rights particularly in the GOMBR region , seascape and landscape

13. CHOICE OF Alternative Livelihood Options (ALOs) IN MODEL VILLAGES:

Although some alternative livelihoods were suggested to the fishermen community, at the time of discussion, it was found that they have a preference for the following natural and non-natural resource based alternative livelihood options. The list is given below.

a. Natural Resources Based Livelihood Activities:

Agriculture, Floriculture, Mari culture (Crab and lobster fattening), Bed making, Bee keeping, Carpentry, Cooking and selling food, Harvesting and selling Palm and coconut tree by-products, Livestock rearing (Poultry farming, Cattle farming, Dairy farming), Plantation of medicinal crops, Vermiculture, Sericulture, Handicraft (Palm trees)

b. Non – Natural resource based livelihood activities:

Bicycle repairers, Tailoring, Hair-dressing, Mechanics, Petty trading, Grocery shops, Textiles business.

Table 13. Identified opportunities / prospects of adopting alternate livelihood options through vmc in model villages:

S. No.		SEENIYAPADHARGA	PERIYAPATTINAM	THARUVAIKULAM
1	Willingness to take up other livelihood options	ü	ü	ü
2	Aquaculture			ü
3	Agriculture	ü	ü	
4	Floriculture	ü	ü	
5	Livestock rearing	ü	ü	ü
6	Handicrafts	ü	ü	
7	Food processing units (pickles, jams etc)	ü	ü	ü
8	Cycle repairing		ü	
9	Tailoring & Textiles	ü	ü	ü
10	Motor mechanics		ü	ü
11	Petty trades	ü	ü	ü

14. SELF GOVERNANCE IN VMC VILLAGES:

A review of village community structures and discussion with village members reveals that, traditional taboos and restrictions on natural resource exploitation practices are not being implemented because of no clarity of tenural rights of coastal villages on resource on a spatio-temporal basis. Legal and illegal resource exploitation by migratory fisherfolk as well as neighboring villages on the traditional resources harvesting regions of particular villages, forces them also to follow similar invasion into prohibited areas and other regions. The mechanism for traditional tenural rights

villagers need to be established. The villagers are willing to form their own governance structures and prepare rules and regulations for members to follow. They do not want a hierarchal governance structure where the GOMBRT and GOMMNP staff take-up top level positions and direct and/or order institutions.

TRUST BUILDING VISIBILITY ACTIVITY BY GOMBRA:

Even though, through the EDCs, the GOMBRT has been trying to set-in the motion ALOs or AIG options, there are no visible trust-building activities in place in coastal villages. It is felt that since the sea-scape between the GOMMNP boundary and coastline is the buffer zone with rights of villagers for fishing and other permissible marine resource exploitation, GOMBRA may consider placement of Fish Aggregating Devices (FAD) with technical support from the NIOT. This will help fisher-folk to fish around the FADs and not to venture out in the GOMMNP territory since each FAD maintenance will be the responsibility of the coastal villages where they have been placed, the village will set-in place, exploitation rules and regulations. The success and visibility of FADs will be one of the best trust-building exercise for the GOMBRT authorities.

INVITING OTHER MARINE CONSERVATION ORGANISATIONS TO ADOPT VILLAGES OR CLUSTER OF VILLAGES TO DEVELOP, INVEST AND IMPLEMENT VILLAGE MARINE CONSRVATION PLANS:

The global and national conservation organizations such as IUCN, WWF, NCF, TNC etc., have their own AIG and ALO development framework and successful models, the GOMBR Authority and TamilNadu Government may consider inviting such organizations to be partners with the GOMBRT in adopting individual/village clusters and revise funds for developing VMCPs and implement models. This way, the GOMBR Authorities will have larger number of partners and models to work, with less man power deployment from their resources. Such an approach will also develop long-term sustainable models.

Table 14. Existing community governance structures in model villages for self - governance

S. NO.	COMMUNITY STRUCTURE	SEENIYAPADHARGA	PERIYAPATTINAM	THARUVAIKULAM
1	Active Panchayat	ü	ü	ü
2	Youth club	ü	ü	Nil
3	Active NGOs	TRRM	DHAN, SHDWO, TRRM	DHAN, TMSS, D-Rose
4	Self Help Group/Facilitators	3 (TRRM)	6 (DHAN)	8 (DHAN)
5	Temples, mosque, church	ü	ü	ü
6	Active Fishermen society	ü	ü	ü

15. MODELS OF ALTERNATIVE LIVELIHOOD OPTIONS (ALOS):

15.1. Alternative livelihood option of seaweed culture:

- Fishers of the village are faced with a declining trend in their revenue due to resources depletion of their traditional fishing grounds. Seaweed farming is seen by all villages as a revenue – generating, alternative activity that can bring additional income to the household. This seaweed culture is relatively simple to farm. Seaweed can be harvested regularly throughout the year providing a reliable source of income.
- If the culture of seaweed is of local indigenous varieties and undertaken on a small scale then this practice is likely to contribute significantly to the conservation of the coast. However if alien species are introduced the potential for a negative impacts on the environment is greatly increased as is the negative impact when large scale culture and harvesting takes place, to engaging this alternative, 10 % human pressure can be reduced from damaging of Marine National park areas.

SEAWEED CULTURE	WHO IS INVOLVED
Involved in livelihoods	Fishermen community (esp., Seaweed collectors) (both male & Female)
Marketing(sales of equipment & purchasing Raw materials)	Educated Fishermen (esp – Younster)
Buyer	PEPSI
Training & Demonstration	CSMCRI, CMFRI - Mandapam
Investment , Monitoring & Suggestion	GOMBRT – official & staff
Implement & Follow ups	Local NGO
Demand	High in forien (Japan, Australia, Singapur, Malasia etc)

Model plans of seaweed culture: (app)

(*Gracilaria edulis* – indigenous spp.,)

Raft culture:

- Total cost of one Raft (10 * 10 sq.ft) - Rs. 600
- Total raft per **individual** - 30
- Total investment (30 *600)/ **Individual** - Rs.18, 000
- Seaweed harvest with in 45 days - 300 kg

· Seed for next harvest	-	100 kg
· Balance seed weed	-	200 kg
· Dried seaweed (with in two days)	-	20 kg

Profit for one harvest

· The cost of dried seaweed per kg	-	Rs. 8
· 20 kg * 30*Rs.8 / harvest	-	Rs. 4800
· Interest per month	-	Rs. 400

Profit for 1st year

· Number of harvest per year	-	4
· Total income / 4 harvest / year (Only 5 Months)	-	Rs. 19200.
· Interest per year	-	RS. 4800
· Total profit / year	-	Rs. 14,400
· Balance amount of total credit in 1 st year (Rs.19200 – Rs 4800)	-	Rs. Rs. 14,400

Profit for 2nd Year

· Number of Harvest	-	6
· Total income / 6 harvest / year	-	Rs.28800
· Interest / Month in 2 nd year	-	Rs. 800
· Total interest of 2 nd year	-	Rs. 9600
· Total Profit / Year (within 9 months)	-	Rs. 19200
· Balance amount of Total credit In 2 nd year (Rs.14, 400 – Rs. 9600)	-	Rs. 4800

Profit for 3rd Year

· Number of Harvest	-	6
· Total income / 6 harvest / year	-	Rs.28800
· Interest / Month in 3 rd year	-	Rs. 800
· Balance amount of Total credit In 3 rd year	-	Rs. 4800
· Time taken refund of balanced Credit only	-	6 month
· Total profit in 3 rd year (Rs.28800 – Rs. 4800) (Within 9 Months)	-	Rs. 24000
· Time taken to refund of Total credit (app)	-	2 ½ years

15.2. Alternative livelihoods option II:

a. Floriculture: (Jasmine Plant culture).

- i. Floriculture is another important alternative and profitable income for this village's people. But only 5 % people are doing in this activity. Because the lack of income and lands. If to engage, this village fisher folks in the alternatives, 30 – 50 % pressure should be reduced from this village. Jasmine Plant can be harvested regularly throughout the year given by a proper training to SHG or individual, providing a reliable source of income.
- ii. But some risks inherent in this culture and as a result professionalization as a farming techniques has been difficult. But its low manpower work and high profitable alternatives.

FLORICULTURE	
Target groups	Fishermen community (esp., illegal activators)
Marketing (buying & selling)	Educated or younger fishermen people
Buyer	Business people – Madurai Flower Market or companies
Training & Demonstration	Department of Agriculture
Investment , Monitoring & Suggestion	GOMBRT
Implement & Follow ups	Local NGO's

B. Floriculture: (Jasmine culture – Cutting method)

· Cost of Made for One Shed (10 * 10 sq.ft)		
Including labor charges	-	Rs. 600
· Number of jasmine stems in One culture	-	4000
· Total cost of Jasmine stems (0.50 pa * 4000)	-	Rs. 2000
· Labor cost for farming	-	Rs. 300
· Cost of Fungicide (use once in 15 days)	-	Rs . 300
· Total investments	-	Rs.3200
· Cost of 1 Plant / harvest (within 60 days)-		Rs. 1.00
· Damaged plant (app)	-	500
· Total Income / Harvest (3500 * Rs1.00)	-	Rs.3500
· Total No of Harvest	-	6 times
· Total income / Year	-	Rs.21000
· Interest per Months	-	Rs.200
· Interest per year	-	Rs.2400
· Total Profit Per Year (Rs.21000 – Rs. 2400)-		Rs.18600
· Balanced amount for Total credit		
· (Rs.3200 – Rs. 2400)	-	Rs.800
· Time taken to refund of total credit	-	1 ½ years.

15.3. Alternative livelihood option: crab & lobster fattening

i) In these Gulf of Mannar , May to August, sea is very rough condition . if should not have required protection, to entir work would be spoiled. and the required some care full risk in the particular time ., during the time of disease. etc.,

ii) **Opportunity:**

Tank culture, Cage culture etc.,

A. MODEL PLAN:

Investment :

1. Flooting cages (each have 9 rooms) -	8	
2. Cost of one cage	-	Rs. 4500
3. Cost of 8 cages (4500 * 8)	-	Rs. 36000
4. Travel & formed etc	-	Rs. 2000
5. Total investment	-	Rs. 38000

A. Out going :

1. Required crabs	-	80
2. Wastage 10%	-	8
3. Availability	-	72
4. Cost of crabs (buying)		Rs.7,800
(0.75 kg / crab *Rs.130*8)		
5. Feeding cost (6kg*Rs.8*25 days)	-	Rs.1200
(less price fish)		
6. Extra charges	-	Rs.3000
7. Total out spending charges		Rs. 11,000

Total Investment (Intial invest +Outoing) - Rs.50000

B. Incomes:

1 Monthly harvest	-	one time
2 Wastage (20 %)	-	20
3. Available crabs	-	58
(72 – 20)		
4. Present one crab weight		
(After 25 days)	-	0.825 kg
5. Total weight		
(0.825 * 58)	-	48 Kg
6. Total cost		
(48 * Rs.300)		Rs.14,400
7. Fattening = 9 times / year	-	
Rs.(14,400 * 9)	-	Rs.1,29,600
8. Total investment (11,000*9)-		Rs.99000
9. Average annual income	-	Rs. 30,600
10. Income / Month	-	Rs. 3,400
11. Month Interest	-	Rs. 1000
12. Duration of return Credit	-	4 ½ years

Crab & Lobster Fattening or culture	
Target group	Fishermen community
Marketing (selling)	Fishermen - Youngster
Buyers	Sea foods – Nila , Diamond , etc
Training & Demonstration	NIOT, CMFRI, CIBA (Chennai),
Invesment , Monitoring & Suggestion	GOMBRT
Implement & Follows	Local NGO's

B. CRAB & LOBSTER FATTENING OR CULTURE

15.4. Alternative livelihood option: micro livestock:

a. Poultry farming:

Poultry farming	
Target group	Fishermen community
Marketing (selling of food , eggs & chicken meat)	Educated Fishermens (Youngster)
Chikhen stall	Fishermen community (youngster)
Buyer	
Training & Demonstration	Department of Agriculture & Animal Husbandry
Investment , monitoring & Suggestion	GOMBRT
Implement & Follow ups	Local NGO
Total reducing pressure in this village	

b. Cattle Rearing:

Cattle Rearing	
Target group	Fishermen community
Marketing (Selling of Fodder , Meat , wastage & Milks)	Fishermen - younster
Buyer	
Training & Demonstration	Department of Agriculture & Animal husbandry
Investment, Monitoring & Suggestion	GOMBRT
Implement & Follow ups	Local NGO's

15.5. Alternative livelihood option: Handicraft (Palm & Coconut by- products)

1. Handicraft is one of the main alternatives for women's of this village. They are making various items (like mat, pot, caps, ornamental things, etc.,) using by palm tree leaves. But they suffered by the proper Marketing facilities. Now, they are getting very low amount for their items. But in Markets, this item rate is double. So, Only the Middle man has to get the benefit.

- II. If to engage this alternative for women, they slowly reduced for their support of damaging activities. So, it should be able to reduce 10 % of pressure.

Handicraft	
Target group	Fishing womens
Marketing (sell by products to people & buy the products)	Fishermen - Youngster
Buyer	Tourist place Marketers.
Training & Demonstration	Handicraft development board & Kathicraft – Ramnad, Madurai.
Investment , Monitoring & Suggestion	GOMBRT
Implement & Follow ups	Local NGOs

15.6. Alternative livelihood option: Small scale Industries: (Sea foods & natural based products like pickle)

Small scale industries	
Target group	Fisherwomen
Marketing (Buying & Selling)	Fishermen - Younster
Buyer	
Training & Demonstration	SDMRI, PAD
Invesment , Monitoring & Suggestion	GOMBRT
Implement & Follow ups	Local NGO's
Total reducing the pressure from this livlihoods	

15.7. Alternative livelihood option: Bicycle repairers & Motor Mechanics:

Bicycle repaires	
Target group	Fishing community
Investment , Monitoring & Suggestion	GOMBRT
Training , Implement & Follow ups	Local NGO's

15.8. Alternative livelihood option: TAILORING:

Tailoring	
Target group	Fishing women
Investment , Monitoring & Suggestion	GOMBRT
Training , Implement & Follow ups	Local NGO's
Total reducing the pressure from this livlihoods	

15.9. Alternative livelihood option: GROCERY SHOPS:

Grocery shop	
Target group	Complete dependence fishermen community
Investment, Monitoring & Sugestion	GOMBRT
Training , Implementing & Follow ups	Local NGO's
Total reducing the pressure from this livlihoods	

15.10. Alternative livelihood option: TEXTILES BUSINESS:

Textiles business	
Target group	Fisherwomen
Invesment , Monitoring & Suggestion	GOMBRT
Training , Implementing & Follow ups	Local NGO's
Total reducing the pressure from this livlihoods	

15.11. Alternative livelihood option: TANK CULTURE OR ORNAMENTAL FISH:

Tank culture (Fresh & Sea water Fish)	
Target group	Fisher community
Investment , Monitoring & Suggestion	GOMBRT
Training & Demonstration	PAD, Thoothukudi Fisheries college
Training , Implementing & Follow ups	Local NGO's
Total reducing the pressure from this livelihoods	

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Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget (Rs in Lakhs)
8	Eco-development											
	Establishment of Eco-development zone in the Tirunelveli and Kanyakumari Districts (Two zones with 2 RFOs, 2 Forester, 2 Assistant and 2 care takers)	18	18	20	20	22	22	24	24	26	26	220
	Preparation of village marine conservation plans through PRA and utilizing local NGOs (Rs.10000/village for 300 villages)	30										30
	Promoting community based seaweed culture using native species (Target 60 units @1.5 lakhs/unit)	90 (through revolving fund credit)										90
	Promoting Alternative livelihoods as suggested in the Management Plan	500 (through revolving fund credit)										500
	Institutional mechanism for evaluation of eco-development program and activities at regular intervals including auditing	2	2	2	2	2	2	2	2	2	2	20

5.6. Disaster Management

5.6.1. Introduction

Indian subcontinent has always been vulnerable to natural disasters on account of its unique geo-climatic conditions and floods, droughts, cyclones, tsunami, earthquakes and landslides have been a recurrent phenomena. About 60% of the Indian landmass is prone to earthquakes of various intensities; over 40 million hectares of landmass and prone to floods; about 8% of the total area is prone to cyclones, 68% of the area is susceptible to drought and the entire coast of India prone to tsunami. In India, about 30 million people are affected by disasters every year. The loss in terms of private, community, public assets and wildlife has been astronomical. At the global level, there has been considerable concern over natural disasters. Even as substantial scientific and material progress is made, the loss of wildlife and its habitat due to disasters seems to not decrease. In fact, the human toll and economic losses have mounted but so far there has been no detail study on the impact of disasters on Indian wildlife. However, in recent years studies in the Nicobar islands have proved that there was a significant adverse impact on wildlife caused by the 2004 tsunami. It was in this background that the United Nations General Assembly, in 1989, declared the decade 1990-2000 as the International Decade for Natural Disaster Reduction with the objective to reduce loss of lives and property and restrict socio-economic damage through concerted international action, especially in developing countries. Planning the disaster management programme for wildlife habitats is much more difficult than the human habitation as it involves a lot more preparedness, especially in rescue of wildlife and its habitat from any natural disasters.

The Gulf of Mannar Marine National Park and Biosphere Reserve located at the southernmost tip of India along the Bay of Bengal in Tamil Nadu is a vulnerable Marine Protected Area from natural disasters, particularly originating from the marine environment such as cyclonic storms, tsunami and flood. Being in a low rain fall zone, the area is also subjected to recurrent droughts. The other disasters due to human errors in the coastal and marine environment expected in the region are fire, oil spillage, accidental capsizing of marine vessels with chemical hazards etc. In this background, the GOMBR management plan has included this Disaster Management plan for the period 2007 – 2016.

Objective

The objective of this plan is to

1. Identification of various possible disasters that may occur in this region
2. Establish a preparedness protocol for disasters management
3. Prescribed Disaster management actions

5.6.3. Possible Disasters expected for the Biosphere Reserve & National Park

1. Cyclone
2. Drought
3. Fire
4. Flood
5. Oil Spillage

6. Accidental capsizing of shipping vessel with hazardous chemicals
7. Tsunami
8. Earthquake

Disaster Management Prescriptions

Setting up of Disaster Management Cell: Mitigation, preparedness and response are multi-disciplinary functions, involving a number of Departments. Mitigation and preparedness measures go hand in hand for vulnerability reduction and rapid professional response to disasters. Institutional mechanisms which would facilitate this inter-disciplinary approach are required put in place. It is proposed to create a **Disaster Management Cell**, with representatives from the relevant Departments to bring about this coordinated and multi-disciplinary effort with experts covering a large number of branches. The cell could be headed by the Director of the BR Authority with representatives from Departments of Health, Water Resources, Agriculture, Defense, Chemicals, Science & Technology, Telecommunication, Urban Employment, Poverty alleviation, Rural Development, Indian Meteorological Department, police and fire service Members. Members of the cell should meet as often as possible to review the preparedness for any disaster management.

Cyclone Mitigation: The Government of India has constituted a National Core Group on Cyclone Monitoring & Mitigation. Experts from Indian Meteorological Department, National Centre for Medium Range Weather Forecasting, Central Water Commission, National Remote Sensing Agency and Indian Space Research Organisation have been made the Members of this Core Group, besides administrators from the relevant Ministries/Departments and State Governments vulnerable to cyclones. The Group has been assigned the responsibility of looking at warning protocols for cyclones; coordination mechanism between different Central and State Ministries/Departments/Organisations; mechanism for dissemination of warning to the local people and; cyclone mitigation measures required to be taken for the coastal States. The Group will also suggest short-term and long-term measures on technology up-gradation. The cyclone warning formats have been revised to Disaster Management in India. A project for Cyclone Mitigation (estimated cost Rs.1050 crore) has been drawn up in consultation with the cyclone prone States. This project envisages construction of cyclone shelters, coastal shelter belt plantation in areas which are prone to storm surges, strengthening of warning systems, training and education etc. This project has also been given in-principle clearance by the Planning Commission and is being taken up with World Bank assistance. The Authority's Disaster Management Cell has to prepare a cyclone mitigation plan for the Gulf of Mannar Biosphere Reserve with consultation of this National Core Group.

Handling of Hazardous Materials from ships accident / coast based industries: Traffic of cargo shipping vessels is expected to increase after the completion of the Sethusamudram canal. In the light of global and regional experience, there is a likely chance of accidents occurring to ships especially those carrying hazardous chemicals. Some of the industries located on the coastal region of the BR are also handling various chemicals which may be harmful for the biodiversity. Disaster Management Cell of the Biosphere Reserve Authority has to prepare a detailed disaster preparedness plan to cope with hazardous materials including oil spillage.

Oil Spill Related Disaster: With the existence of Tuticorin Port and establishment of Sethusamuthram Canal, the chances of chronic oilspill and possible acute oilspills in the region is very high. Also the recent oil exploration activities and possible strike of hydrocarbon in the offshore areas of Gulf of Mannar will increase chances of hydrocarbon related disasters. The Biosphere Reserve Management therefore, is to set in place a mechanism and protocol for facing such eventualities in consultation with the Indian Coast Guard (Nodal agency in India for Oilspill Management), Tuticorin Port Trust and the Sethusamuthram Canal Management Authority.

Tsunami preparedness and mitigation: Tsunami which occurred on 26 December 2004 originated from the Sumatra coastal earthquake and traveled to Tamil Nadu coast in about two hours which is the first time in the recent history of India. Although Tsunamis are predicted to occur every 15 years in the Pacific ocean, this interval may be larger in the Indian ocean. Compared to other parts of Tamil Nadu and the Andaman & Nicobar islands, the adverse impact of tsunami on the Biosphere Reserve was minimum due to the presence of the Sri Lankan island which actually acted as a Barrier. However, it would be better to prepare a 'Tsunami preparedness and mitigation protocol for the Gulf of Mannar Biosphere Reserve which hold unique biodiversity assemblages never seen anywhere else in the region. Since the adjoining districts have already had experiences and mitigated the impacts recent tsunami, the same model protocol may be reviewed and adopted for BR, if required, changes can be made in the existing tsunami preparedness and mitigation plan of the Tamil Nadu state for this unique region.

Flood Preparedness and response: In order to respond effectively to floods, Ministry of Home Affairs has initiated National Disaster Risk Management Programme in all the flood-prone States. Assistance is being provided to the States to draw up disaster management plans at the State, District, Block/Taluka and Village levels. Awareness generation campaigns to sensitize the all the stakeholders on the need for flood preparedness and mitigation measures. Elected representatives and officials are being trained in flood disaster management under the programme. BR Authority can consult this National Disaster Risk Management Programme for flood preparedness and response in the Gulf of Mannar Biosphere Reserve.

Earthquake Risk Mitigation: A comprehensive programme has been taken up for earthquake risk mitigation. The Bureau of Indian Standard (BIS) has laid down the standards for construction in the seismic zones, these should be followed in any infrastructure development in this region. Normally, the building construction in urban and suburban areas is regulated by the Town and Country Planning Acts and Building Regulations. In many cases, the Building regulations do not incorporate the BIS codes. Even where they do, the lack of knowledge regarding seismically safe construction among the architects and engineers as well as lack of awareness regarding their vulnerability among the population led to most of the construction in the urban/sub-urban areas being without reference to BIS standards. In the rural areas, the bulk of the housing is non-engineered construction. The mode of construction in the rural areas has also changed from mud and thatch to brick and concrete construction thereby increasing the vulnerability. The increasing population has led to

settlements in vulnerable areas close to the river bed areas which are prone to liquefaction. The Authority's Disaster Management Cell have to address these issues.

Strengthening of Fire Services: In order to further strengthen the capacity for response, the fire services are recommended to be developed into multi hazard response units in the all adjoining districts of the Biosphere Reserve. Fire service stations in this region should be well equipped with to meet fire hazards either on islands or on the mainland coastal region. In this connection, staff of these fire stations need a special training.

Setting up of Search and Rescue Teams in the Biosphere: The BR Authority are advised to set up their own Specialist Teams for responding to disasters. Members of this team need to be sent to the Training Centers for training in Search and Rescue in the States or at **CPMF** training institutions.

Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
9	Disaster Management											
	Setting up of Disaster Management Cell											
	Establishment of infrastructure, capacity building, training and preparedness as suggested in the Management Plan	50	50	50	50	50	50	50	50	50	50	500

Chapter 6

Policy, Administration, Evaluation and Review

6.1. Administration (Organizational structure)

To implement, administer and review the management activities of the Biosphere Reserves, the Government of India and the Tamil Nadu State Government have constituted a National level and a State level committee respectively. However, with the experience gained from the administrative mechanism in place it is proposed that a new model organizational structure for the administration of the Gulf of Mannar Biosphere Reserve be established. The suggestion is based on the rationale that unlike terrestrial protected areas which are under the administrative control of one agency i.e. forest department, the coastal and marine protected areas resources are common property resources and activities therein are controlled by a multitude of stakeholders agency.

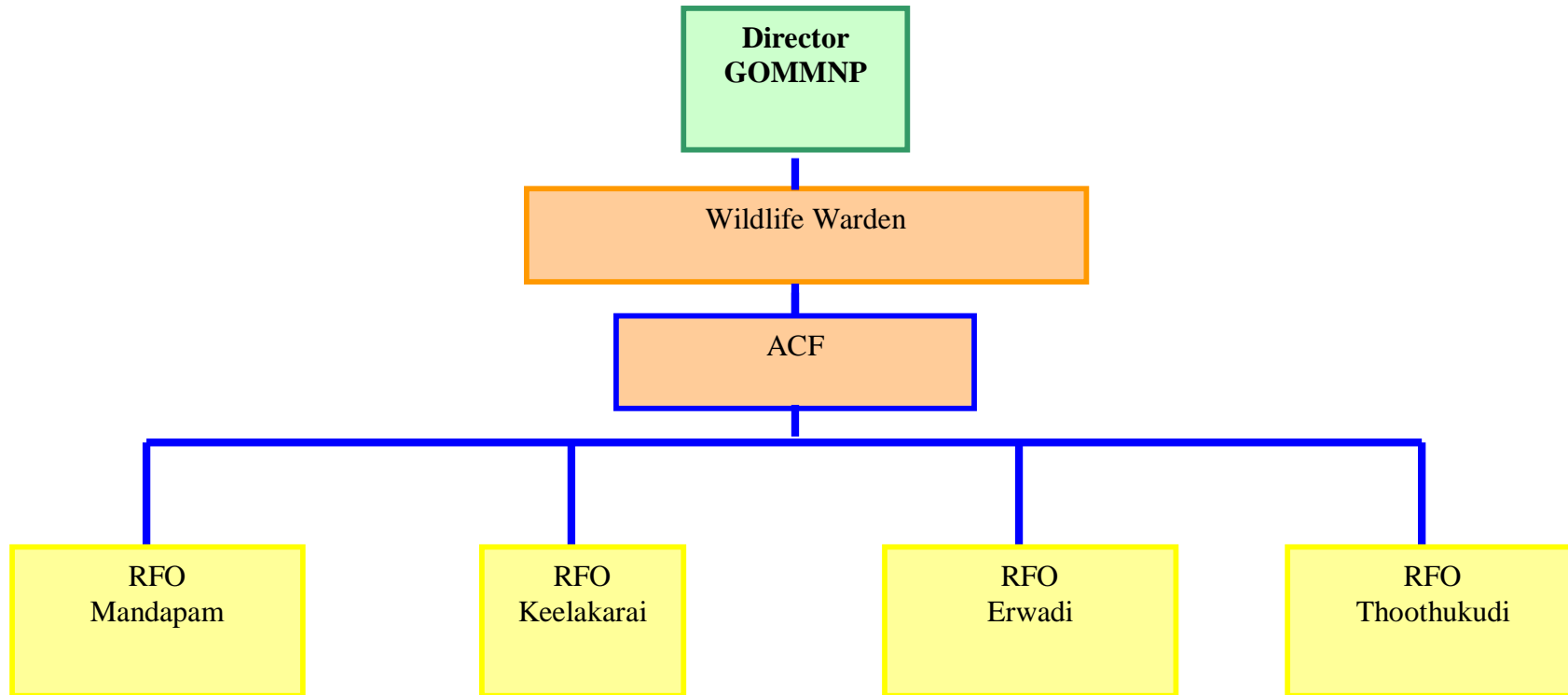
For the management of the Gulf of Mannar Biosphere Reserve, the Tamil Nadu Government has established the Gulf of Mannar Biosphere Reserve Trust, a special purpose vehicle to co-ordinate project implementation in order to effective inter-sectoral co-ordination and facilitate mainstreaming of biodiversity conservation issues into the productive sector and policy development. The Trust is registered under the Tamil Nadu Society Registration Act, 1975. However, the management and activities of the Gulf of Mannar Marine National Park is governed by the Conservator Forests, Virudhunagar Circle and implemented by the Wildlife Warden of the National Park. The Principal Chief Conservator of Forests and the Chief Wildlife Warden guides both the GOMBRT's Director as well as the GOMMNP's Director. And hence, in a way the Chief Wildlife Warden is the statutory head for the GOM Conservation Area, the GOMBRT has statutory authority to play a focal role in the implementation of the project providing the institutional framework and to work with Government to strengthen the overall policy framework and to enable other governmental agencies for better co-ordinate and collaborate in the enforcement of Coastal Zone Regulation and biodiversity conservation.

It is felt that the GOMBRT be made into **Gulf of Mannar Biosphere Reserve Management Authority** (GOMBRA) not only for unified control and management of all activities of the core area of the Biosphere Reserve i.e. the Marine National Park and the buffer and multiple use area i.e. Biosphere Reserve but also for better coordination and synergy with all other stakeholders agencies who will play an important role in the management of Reserve. The new Authority in such a situation will have better co-ordination between the management of the Marine National Park as well as the Biosphere Reserve through its own staff i.e. the Wildlife Warden, the Eco-development Officers and the suggested sociologist, biologist, fisheries and tourism officials to deal with human dimensions, research and monitoring unit, fisheries and eco-tourism aspects as well as eco-compatible and sustainable marine resource utilization activities. This kind of an authority structure is suggested since

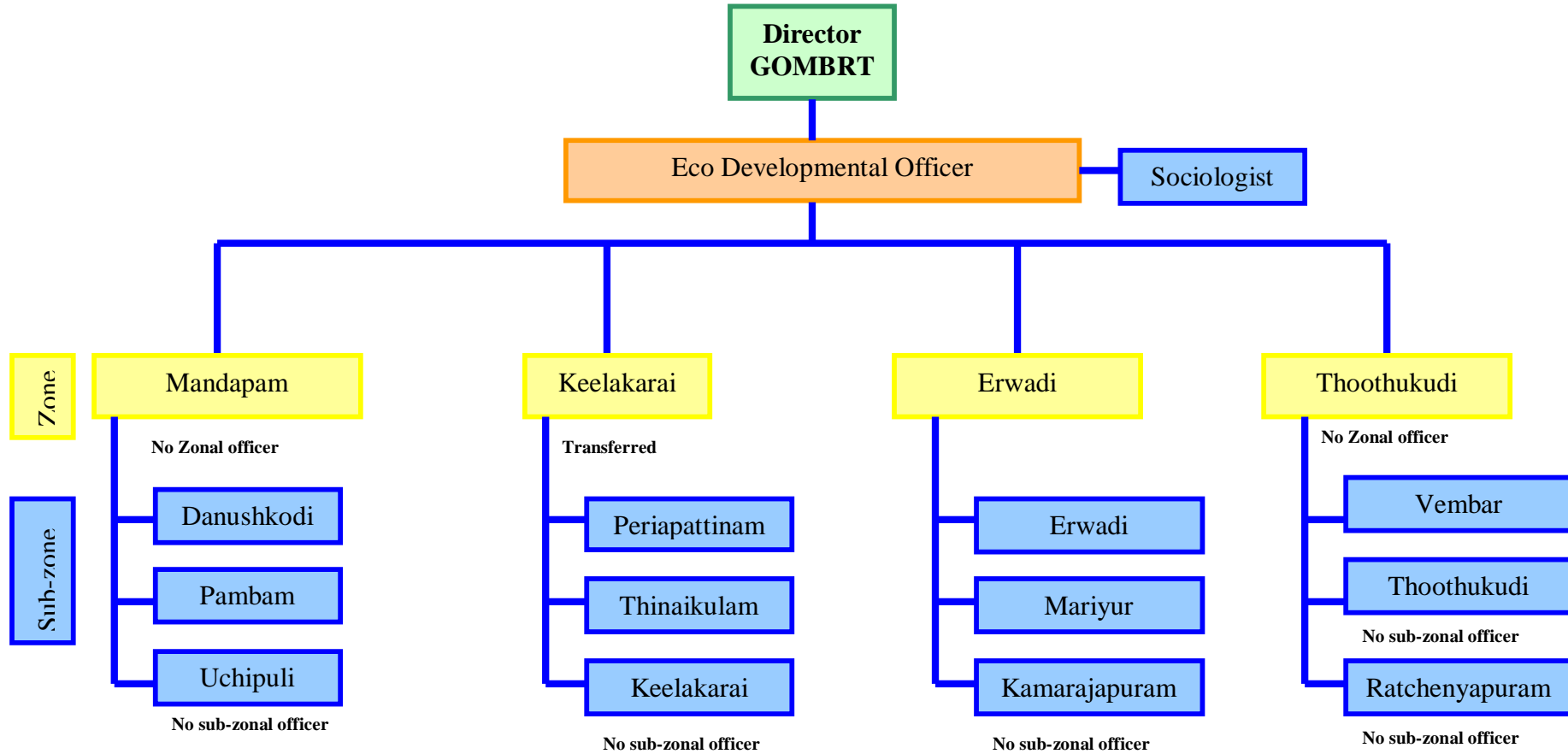
such models of common property resource harbouring protected areas are successfully being managed in India as well as outside e.g. Chilka Development Authority in Orissa and Loktak Development Authority in Manipur, both of which are RAMSAR wetland sites and the authorities are chaired by the respective Chief Ministers of the State. Similar international models for marine protected areas have been in existence and successfully working in the Great Barrier Reef Management Authority in Australia, St. Lucia Management Authority in South Africa. While it is suggested that the Chief Executive of the suggested GOMBRA will be a Chief Conservator of Forests, the Chairperson of its Governing Council be the Chief Minister/Chief Secretary of Tamil Nadu State. Appropriate level of peoples representative and other stakeholders agencies officials being members of the Governing Council. The Tamil Nadu Government may consider this and constitute an appropriate Governing Council for the proposed GOMBRA with statutory powers for over all governance of the country's first Marine Biosphere Reserve.

The Gulf of Mannar Biosphere Reserve in Tamil Nadu covering an area in excess of the 10000 sq. km spread over four districts, continental shelf, territorial waters and EEZ has the involvement of national agencies such as Indian Navy and Coast Guard, four district Collectors, a Port Trust etc. requires an equally higher level Authority with complementary specialized unit/wings to implement the strategy and action plans. Needless to say all these wings are required to be empowered with complementary staff and infrastructure befitting their status and planned activities.

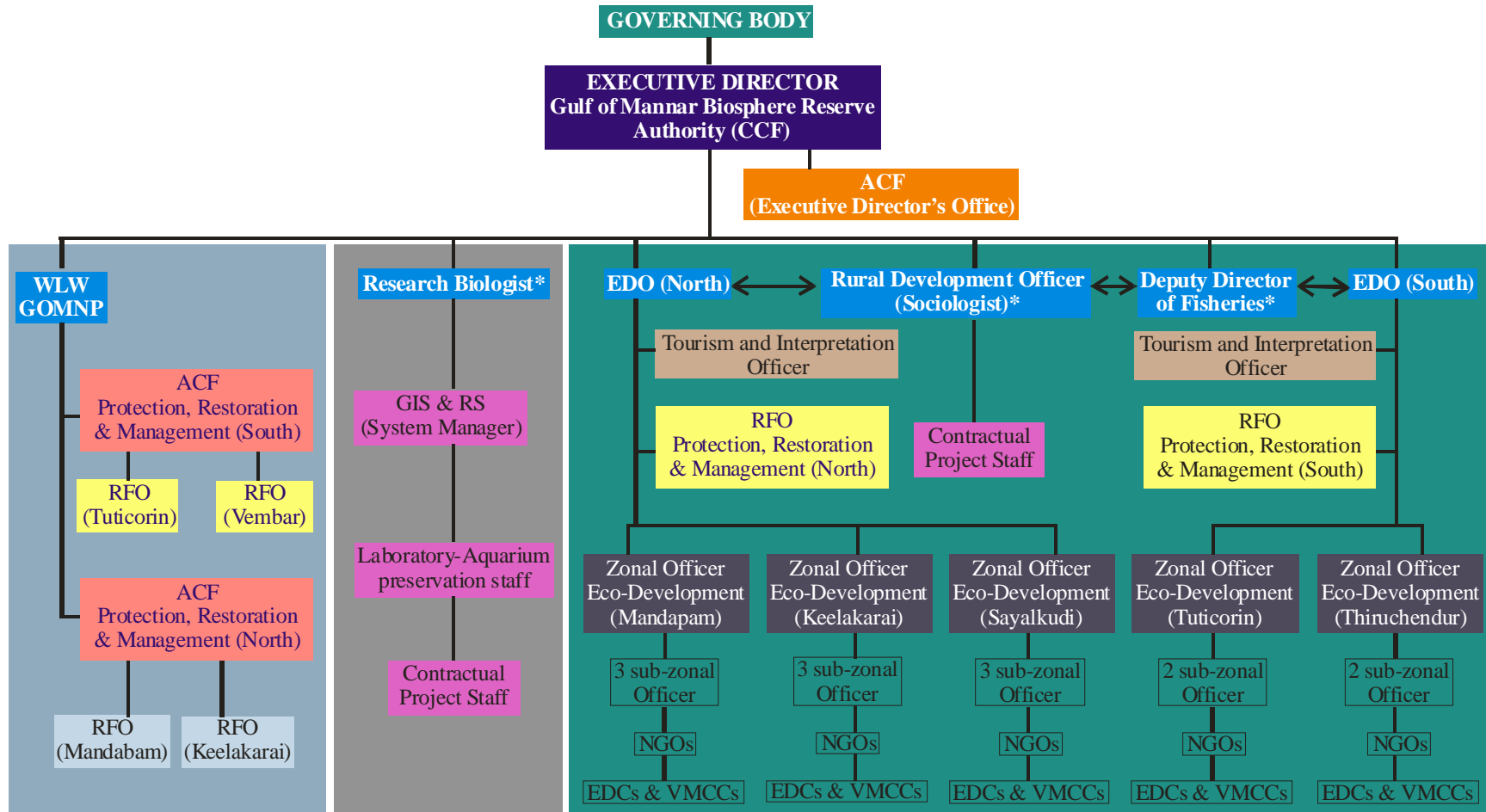
Current Administrative setup of Gulf of Mannar Marine National Park (up to RFO level)



Current Status of EDC Zone (Administrative setup) of Gulf of Mannar Biosphere Reserve



Proposed unified Administrative Setup of the Gulf of Mannar Biosphere Reserve Management Authority



* Officers will be appointed on deputation from other State Departments, University/Institutions, NGOs etc.

Activities and budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
II	BIOSPHERE RESERVE											
1	Administration, infrastructure and protection											
	Establishment of proposed GOMBR Authority											
	Delineation of Biosphere Reserve geographic area on land with hoardings (1 harding/village for 300 villages in the buffer zone)	30		15		15		15		15		90
	Recruitment of newly proposed staff (two Eco-Development Officers, one Fisheries Officer, one Social Welfare Officer, one Tourism Officer at Pay Band 3 level)	240										240
	Establishment of infrastructure for all newly appointed Group A service personnel such as Office, residency quarter, vehicle, driver, furniture etc.	100	10	10	12	12	14	14	16	16	18	222
	Establishment of Necessary infrastructure facilities at Madurai for Authority	100	20	20	20	25	25	25	30	30	30	325
	Implementation of Policy level reforms as suggested in the Management Plan											
	Establishment of Management Plan Implementation and review committee											

6.2. Required Policy Level Reforms

1. Gulf of Mannar Biosphere Reserve Trust and Gulf of Mannar Marine National Park to be under an unified control of a statutory authority '**Gulf of Mannar Biosphere Reserve Management Authority**' with multidisciplinary agencies/line departments participation, since Fisheries, Animal Husbandry, Rural Development and Agriculture have far greater grass-root level interface with community.
2. Fisheries: A review of Tamil Nadu Marine Fisheries Policy with special focus on
 - a. Bottom trawling should be banned inside the Biosphere Reserve
 - b. Review of using the destructive fishing gear and crafts in the Gulf of Mannar region and their control.
3. A decision to ban untreated industrial pollutants and sewage release into the Gulf of Mannar Biosphere Reserve which should taken up the State Pollution Control Board.
4. All industries including Ports in the Gulf of Mannar region should be addressed and facilitated to prepare, submit and implement an Environmental Management Plan (EMP).
5. Review of changes in the demographic profile of the coastal talukas and eliminating the causes of human migration into the coastal zone (e.g. Gradual disappearance of freshwater storing natural depression (*taruvai*) beyond the coastal sand dunes areas).
6. Examine the possibility of marine shell trade industry to be under the State Control as there are signs of over and indiscriminating harvesting of shells from sea.
7. Since the implementation and activities of sustainable utilization of coastal and marine resources in the multiple use area of the Biosphere Reserve is to take place through community participation and community based institutions, it is suggested to develop an appropriate mechanism to bring in the larger number of line departments officials at the middle and grass root level positions as per the recommendation made in the Management Plan.
8. The Gulf of Mannar Biosphere Authority and the Forest Department through the Government of Tamil Nadu may request the Government of India to initiate the process of co-ordination mechanisms with the Sri Lanka Government since the Gulf of Mannar Region and Biodiversity are Trans Boundary Issues.
9. Creation of a 'Anti-poaching Unit (initially proposed as 'Pilot Marine Patrolling and Policing Unit')' consisting of Ex-Indian Navy and Coast Guard Personals at the top and middle level and local fishermen at lower level be considered with the special focus for marine habitat and biodiversity protection. This will ensure presence of people with enough marine habitat experience in field.
10. Government of Tamil Nadu may be requested to involve the proposed Gulf of Mannar Biosphere Authority to review the regional developmental plans of the Gulf of Mannar Region and also to make the Authority a member in all future developmental projects so as to ensure a eco-compatible developmental plan for the region.

6.3. Management Plan Implementation and Review Committee

It is suggested the implementation and activities of the 10 Year Management Plan be reviewed at an interval of three years and corrective measures included for implementation for the next three years phase. With the third review setting tone for the next 10 year Management Plan to be developed during the 10th Year of the current Management Plan. A management plan implementation review committee has been suggested with following members:

Chief Wildlife Warden	- Chairman
Executive Director, Authority	- Member Secretary
Representative from MoEF, GOI	- Member
Director, Tamil Nadu Fisheries Department	- Member
Director, CMFRI	- Member
Director, WII	- Member
Director, ICMAM, As representative of DES (DOD)-	Member
Director, Environment, GoTN	- Member
Director, CMCS, MKU	- Member
Director, CASMB	- Member

6.4. Best Practised Case Studies

1. Fire Fly Sanctuary, Malayasia – For Community Involved Eco-tourism
2. Coastal lagoon in the North of Yucatan (Southeastern Mexico) – For restoration of seagrass beds.
3. Maldives - For Coral reef restoration
4. Lakshadweep – For Community involvement in the coral reef monitoring
5. Great Barrier reef – Zonation plan, planning for permissible and non-permissible activities in various zones
6. Management of Marine Park by the Fisheries Department, Malaysia – For involvement of other line departments
7. Chilika Development Authority, India – Community managed dolphin watch tourism
8. Gujarat, West Bengal and Tamil Nadu (Student sea turtle network) – For community based sea turtle hatcheries
9. Lesson from Sri Lanka – For Collaborative and community based management of coral reef resources
10. Madagascar first community run marine protected area in Andavadoaka – For partnerships in management actions

ANNEXURE

Data sheets

1. Prescribed proforma for maintenance of records of illegal hunting/poaching of wildlife in GOMMNP

Si No	Offence	Offenders	Date and place of occurrence	Type of action taken(compounded/booked in the court)	Status of the case	remark

3. Turtle nesting data sheet proforma in GOMMNP

Date	Time	Island/Beach	Species	Number	Nesting/non nesting	Remark

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ANNEXURE I

Marine Flora and Fauna of the Gulf of Mannar Biosphere Reserve

SEAWEED

Acanthopora spicifera
Caulerpa laetevirens
Caulerpa taxifolia
Centroceros sp.
Ceramium sp.
Champis sp.
Chondrus sp.
Clatratus sp.
Codium tomentosum
Cystoseira trinodis
Enteromorpha compressa
Euchemia sp.
Gelidiella acerosa
Gelidium sp.
Gigartina sp.
Gracilaria crassa
Gracilaria edulis
Gracilaria folifera
Herposiphonia spp.
Hormophyra triquetra
Hormophysa triquetra
Hydroclathrus clathratus
Hypnea musciformis
Hypnea valentiae
Kappaphycus alvarezii
Laminaris sp.
Laurencia papillosa
Monostroma sp.
Padina sp.
Polysiphonia sp.
Porphyra sp.
Pterocladia sp.
Sarconema furcellatom
Sargassum tenerrimum
Spyridia sp.
Stichospermum sp.
Tolypocladia sp.
Turbinaria conoides
Ulva latuca
Ulva reticulata
Undaria pinnatifida

SEA GRASSES

Hydrocharitaceae

Enhalus acroides
Thalassia hemprichii
Halophila ovata
Halopila ovalis ovalis
Halophila stipulacea
Halophila decipiens
Halophila beccarii

Potamogetonaceae

Halodule univervis
Halodule pinifolia
Halodule wrightii?
Cymodocea serrulata
Cymodocea rotundata
Syringodium isoetifolium

MANGROVES

Avicenniaceae

Avicennia alba
Avicennia officinalis
Avicennia marina

Combretaceae

Lumnitzera racemosa

Euphorbiaceae

Excoecaria agallocha

Lytheraceae

Pemphis acidula

Myrsinaceae

Aegiceras corniculatum

Rhizophoraceae

Bruguiera cylindrical
Bruguiera conjugata
Ceriops tagal
Ceriops decandra
Rhizophora conjugata
Rhizophora apiculata
Rhizophora mucronata
Bruguiera conjugata
Ceriops tagal
Ceriops decandra
Rhizophora conjugata
Rhizophora apiculata
Rhizophora mucronata

PORIFERA

1. Order: Agelasida

Agelasidae

Acanthostylotella cornuta

Agelas ceylonica

Agelas mauritiana

2. Order: Amphidiscosida

Hyalonematidae

Hyalonema lamella

3. Order: Astrophorida

Ancorinidae

Ancorina simplex

Asteropus simplex

Ecionemia acervus

Ecionemia laviniensis

Myriastria clavosa

Myriastria purpurea

Penares intermedia

Rhabdastrella globostellata

Rhabdastrella providentiae

Stelletta tethyopsis

Stelletta vestigium

Coppatiidae

Cryptotethya agglutinans

Jaspis bouilloni

Jaspis investigatrix

Jaspis penetrans

Jaspis reptans

Geodiidae

Erylus carteri Sollas

Geodia areolata

Geodia globostellifera

Geodia inconspicua

Geodia perermata

Geodia picteti

Geodia ramodigitata

Pachastrellidae

Halina extensa

Halina plicata

Pachamphilla dendyi

Pachastrella nana

Pachastrella parasitica

Poecillastra schulzei

Sphinctrella annulata

4. Order: Dendroceratida

Aplysinae

Aplysina lacunosa

Darwinellidae

Darwinella mulleri

Dendrilla cactus

Dendrilla membranosa

Dendrilla nigra

Hexadella purpurea

Druinellidae

Druinella purpurea

Dysideidae

Dysidia fragilies

Dysidia herbacea

Spongionella nigra

Spongionella tuburlosa

Grantiidae

Ute syconoides

5. Order: Dictyoceratida

Irciniidae

Ircinia aruensis

Ircinia cactiformis

Ircinia fusca

Ircinia ramodigitata

Ircinia ramosa

Ircinia tuberculata

Spongiidae

Hyatella cribriformis

Hyatella intestinalis

Phyllospongia papyracea

Phyllospongia papyracea

Spongia hispida

Spongia officinalis var. *ceylonensis*

Spongia officinalis var. *fenestrata*

Theorectidae

Cacopongia salaris

Cacospongia mollior

Fasciospongia anomala

Fasciospongia cavernosa

Hyrtilos erecta

6. Order: Hadromerida

Chondrillidae

Chondrilla australiensis

Chondrilla kilakaria

Chondrilla sacciformis

Chondrosia reniformis

Clionidae

Cliona anulifera

Cliona carpentari

Cliona celata

Cliona ensifera

Cliona lobata

Cliona mucronata

Cliona orientalis
Cliona quadrata
Cliona vastifica
Cliona viridis
Delectona higgini
Dotona pulchella
Thooce socialis
Thoosa (Cliothesa) investigatoris

Latrunculiidae

Latrunculia tenuinstella

Spirastrellidae

Spirastrella aurivilli
Spirastrella coccinaea
Spirastrella cuspidifera
Spirastrella inconstans
Spirastrella pachyspira
Spirastrella punctulata

Suberitidae

Aaptos aaptos
Aaptos unispiculus
Laxosuberites conulosus
Laxosuberites cruciatus
Laxosuberites lacustris
Laxosuberites proteus
Pseudosuberites andrewi
Subrites carnosus
Subrites tylobtusa
Terpios fugax

Tethyidae

Tethya diploderma
Tethya japonica
Tethya repens
Tethya robusta
Xenospongia patelliformis

Timeidae

Kotimea moorei
Timea capitatostellifera
Timea curvistellifera
Timea spinatostellifera
Timea stellata
Timea stelligera
Timea stellivarians

Placospongiidae

Placospongia corinata
Placospongia melobesioides

7. Order: Haplosclerida

Callyspongiidae

Callyspongia barodensis
Callyspongia ceylonica
Callyspongia clathrata

Callyspongia diffusa
Callyspongia fibrosa
Callyspongia fistularis
Callyspongia pambanensis
Callyspongia spinosissima

Chalinidae

Adocia carnosa
Adocia semifibrosa
Haliclona camerata
Haliclona implexa
Haliclona madrepora
Haliclona obstusispiculifera
Haliclona oculata
Haliclona pigmentifera
Haliclona tenuiramosa
Haliclona viridis
Reniera delicatula
Reniera tuberosa
Sigmadocia carnosa
Sigmadocia fibulata
Sigmadocia petrosiodes
Sigmadocia pumila
Taxodocia dendyi
Taxodocia ridleyi
Taxodocia toxius

Niphatidae

Aka diagonoxea
Aka minuta
Amphimedon multiformis
Gelliodes cellaria
Gelliodes fibrosa
Gelliodes incrustans

Petrosiidae

Petrosia nilgricens
Petrosia similis
Strongylophora durissima
Xerospongia exigua
Xerospongia testudinaria

Phoeodictyidae

Oceanapia arenosa
Oceanapia fistulosa
Oceanapia media
Oceanapia sagittaria
Oceanapia zoologica

8. Order: Hexactinosida

Aprocallystidae

Aphrocallistes bocagei

Farreidae

Farrea occa

9. Order: Homosclerophorida

Tetillidae

Cinachyra arabica
Cinachyra cavernosa
Cinachyra hirsuta
Paratetilla bacca
Samus anonyma

Plakinidae

Corticium acanthastrum
Corticium candelabrum
Plakina acantholopha
Plakina monolopha
Plakina trilopha
Plakinastrella ceylonica
Plakinastrella minor

10. Order: Lithistida**Corallistidae**

Corallistes aculeate
Corallistes elegantissima

Desmanthidae

Lophocanthus rhabdophorus

Theonellidae

Discodermia enigmatica
Discodermia interspersa
Discodermia laevidiscus
Discodermia papillata
Discodermia szeptrellifera
Discodermia sinuosa
Discodermia spinispirulifera

Theonella swinhoei

11. Order: Lyssacinosa**Euplectellidae**

Dictyaulus elegans
Regadrella decora

12. Order: Poecilosclerida**Anchinoidae**

Phorbas dubia

Axinellidae

Acanthella cavernosa
Auletta elongata
Auletta lyrata
Axinella agariciformis
Axinella barbarinoides
Axinella carteri
Axinella ceylonensis
Axinella conulosa
Axinella crassistylifera
Axinella donnani
Axinella durissima
Axinella halichondroides
Axinella labyrinthica

Axinella lamellata

Axinella manus

Axinella symmetrica

Axinella tenuidigitata

Bubaris vermiculata

Higginsia higgini

Higginsia mixta

Monocrepidium eruca

Myrmekioderma granulata

Phakettia ridleyi

Rhabdoploca cruvispiculifera

Coelosphaeridae

Coelosphaera encrustata

Coelosphaera navicelligera

Ectyodoryx lissostyla

Lissodendoryx balanophilus

Lissodendoryx similis

Lissodendoryx sinensis

Lissodendoryx ternatensis

Waldoschmittia schmidti

Crambidae

Psammochela fibrosa

Desmacellidae

Biemna fistulosa

Biemna fortis

Biemna tubulata

Dictyonellidae

Liosina paradoxa

Halichondriidae

Amorphinopsis excavans

Amorphinopsis foetida

Amorphinopsis oculata

Axinyssa flabelliformis

Ciocalypta penicillus

Collocalypta digitata

Epipolasis lapidiformis

Epipolasis topsenti

Halicondria glabrata

Halicondria panacea

Hymeniacidon petrosiodes

Petromica massalis

Spongosorites cavernosa

Spongosorites halichondrioides

Spongosorites solida

Topsentia nigrocutis

Hymedesmiidae

Hymedesmia dendyi

Hymedesmia mannarensis

Hymedesmia mertoni

Hymedesmia stylophora

Hymedesmia tenuissima

Lophomnidae

Acarnus souriei

Acarnus ternatus

Acarnus thielei

Cornulum vesiculatum

Damiria fistulatus

Damiria simplex

Zyzya papillata

Microcionidae

Antho annarensis

Artemisina indica

Clathria (Clathria) aeandrina

Clathria (Clathria) decumbens

Clathria (Clathria) indica

Clathria (Dendrocia) antyaja

Clathria (Microciona) aceratoobtusa

Clathria (Microciona) affinis

Clathria (Microciona) atrasanguinea

Clathria (Microciona) fascispiculifera

Clathria (Microciona) rhopalophora

Clathria (Thalysias) amiranteiensis

Clathria (Thalysias) longitoxa

Clathria (Thalysias) micropunctata

Clathria (Thalysias) vulpina

Clathria (Thalysias) lendenfeldi

Clathria (Thalysias) procera

Clathria (Thalysias) procera

var. *tessellata*

Echinoclathria rimosa

Holopsamma crassa

Mycalidae

Mycale (Aegagropila) contarenii

Mycale (Aegagropila) militaris

Mycale (Arenochalina) spongiosa

Mycale (Carmia) madraspatana

Mycale (Carmia) monanchorata

Mycale (Carmia) sulevoidae

Mycale (Mycale) crassissima

Mycale (Mycale) grandis

Mycale (Mycale) gravelyi

Mycale (Mycale) indica

Mycale (Mycale) mannarensis

Mycale (Mycale) mytilorum

Mycale (Mycale) tenuispiculata

Mycale (Mycale) trincomaliensis

Mycale (Paresperella) bidentata

Mycale (Paresperella) serratohamata

Mycale (Zygomycale) parishii

Myxillidae

Desmapsamma anchorata

Lotrochota baculifera

Myxilla (Myxilla) arenaria

Tedaniidae

Tedania (Tedania) anhelans

Raspailiidae

Aulospongus sessilis

Aulospongus tubulatus

Cyamon quadriradiata

Cyamon quinquerradiata

Echinadictyum clathratum

Echinadictyum gogonoides

Echinadictyum longistylum

Endectyon fruticosa

Endectyon lamellose

Endectyon thurstoni

Raspailia anastomosa

Raspailia fruticosa

Raspailia hornelli

Rhabderemiidae

Rhabderemia acanthostyla

Rhabderemia indica

Rhabderemia prolifera

Phoriospongiidae

Strongylacidon stelliderma

13. Order: Spirophorida

Scleritodermidae

Amphibleptula herdmani

Aciculites orientalis

CNIDARIA

1. Order: Scleractina

Acroporidae

Acropora cytherea
Acropora digitifera
Acropora echinata
Acropora humilis
Acropora hyacinthus
Acropora intermedia
Acropora microphthalma
Acropora millepora
Acropora muricata
Acropora rudis
Acropora secale
Acropora valenciennesi
Acropora valida
Astreopora myriophthalma
Montipora aequituberculata
Montipora digitata
Montipora edwardsi
Montipora explanata
Montipora exserta
Montipora foliosa
Montipora hispida
Montipora informis
Montipora jonesi
Montipora manauliensis
Montipora millepora
Montipora monasteriata
Montipora spumosa
Montipora tuberculosa
Montipora turgescens
Montipora venosa
Montipora verrucosa

Agaricidae

Pachyseris rugosa
Pavona cactus
Pavona clavus
Pavona decussata
Pavona varians

Asterocoeniidae

Madracis kirbyi

Dendrophylliidae

Turbinaria mesenterina
Turbinaria peltata

Faviidae

Cyphastrea microphthalma
Cyphastrea serialia
Echinopora lamellose
Favia fava
Favia pallida
Favia speciosa
Favia stelligera
Favites abdita
Favites bestae
Favites complanata
Favites halicora
Favites pentagona
Goniastrea pectinata
Goniastrea retiformis
Leptastrea purpurea
Leptastrea transversa
Leptoria phrygia
Montastrea valenciennesi
Platygyra daedalea
Platygyra sinensis

Fungiidae

Cycloseris cyclolites

Merulinidae

Hydnophora exesa
Hydnophora microconos

Mussidae

Symphyllia radians

Siderastreidae

Coscinaraea monile
Psammocora contigua
Pseudosiderastrea tayami

Oculinidae

Galaxea astreata
Galaxea fascicularis

Pectiniidae

Mycedium elephantotus

Pocilloporidae

Pocillopora damicornis
Pocillopora eydouxi
Pocillopora verrucosa

Poritidae

Goniopora planulata

Goniopora stokesi
Goniopora stutchburyi
Porites compressa
Porites exserta
Porites lichen
Porites lutea
Porites mannarensis
Porites minicoensis
Porites solida

Order: Alcyonacea

Alcyoniidae

Dendronephthya lanxifera var. *palkensis*
Dompia poecilliformes
Lobophytum compactum
Lobophytum crassum
Lobophytum latilobatum
Lobophytum pauciflorum
Lobophytum ransoni
Lobophytum sarcophytoides
Lobophytum variatum
Sarcophyton cherbonneri
Sarcophyton crassocaule
Sarcophyton elegans
Sarcophyton glaucum
Sarcophyton stellatum
Sarcophyton trocheliphorum
Sinularia brassica
Sinularia dissecta
Sinularia erecta
Sinularia grandilobata
Sinularia granosa
Sinularia hirta
Sinularia intacta
Sinularia leptoclados
Sinularia mannarensis
Sinularia ovispiculata
Sinularia polydactyla

Xeniidae

Xenia nana
Xenia ternate
Xenia umbellate

Nidaliidae

Siphonogorgia asperula
Siphonogorgia duriuscula

MOLLUSCA

1. Order: Mesogastropoda

Cassididae

Cassis cornuta

Cypraeidae

Cypraea talpa

Cypraea mappa

Cypraea lamacina

2. Order: Neogastropoda

Volutidae

Harpulina arausiaca

Conidae

Conus millne edwardsii

Faciolariidae

Pleuroploca trapezium

Order: Vetigastropoda

Trochidae

Trochus (Tectus) nilticus

Strombidae

Lambis (Harpago) chiragra chiragra

Lambis truncata sebae

Lambis chiragra arthritica

Anadara granosa

Anadara sp.

Crassostrea madrasensis

Donax sp.

Dosinia excise

Katelsia opima

Meretrix casta

Meretrix meretrix

Modiolus metcalfi

Ostrea forskali

Perna viridis

Bulla ampulla

Cerithedia cingulata

Cerithedia fluviatilis

Dosinia excisa

Dostia crepidularia

Litoria scabra

Littorina littorea

Melampus ceylonicus

Nassa sp.

Nassarius pullus

Nassarius sp.

Natica lineate

Lambis (Millepes) scorpius indomaris

Lambis crocea

Lambus scorpius scorpius

Lambus millipeda

Strombus plicatus sibbaldi

Turbo marmoratus

Placuna placenta

Charonia tritonis

Tudicla spirilus

Ovulidae

Cyprecassis rufa

Order: Veneroida

Tridacnidae

Tridacna maxima

Tridacna squamosa

Hippopus hippopus

Order: Nautilida

Nautilidae

Nautilus pompilius

BENTHIC FAUNA

Saccostrea cucullata

Solen lamarckii

Tellina nobilis

Tellina sp

Gastropods

Tellina sp.

Turitella attenuata

Turitella sp.

Umbonium vestiarium

Pythia plicata

Telescopium telescopium

ECHINODERMATA

1. Order: Apodida

Synaptidae

Protankyra innominata
Protankyra pseudodigitata
Protankyra tuticorenensis
Syaptula recta
Synaptula striata
Synaptula varians

2. Order: Aspidochirotida

Holothuridae

Actinopyga echinites
Actinopyga miliaris
Bohadschia marmorata
Bohadschia tenuisimma
Holothuria (Halodeima) atra
Holothuria (Halodeima) edulis
Holothuria (Lessonothuria) pardalis
Holothuria (Mertensiothuria) leuospilota
Holothuria (Metriatyla) scabra
Holothuria (Microthele) fuscogilva
Holothuria (Selenkothuria) moebii
Holothuria (Semperothria) cinerascens
Holothuria (Theelothuria) kurti
Holothuria (Theelothuria) spinifera
Holothuria (Thymiosycia) hilla
Holothuria (Thymiosycia) impatiens
Holothuria (Thymosycia) arenicola

Stichopodidae

Stichopus chloronotus
Stichopus hermanni
Stichopus naso
Stichopus variegatus
Stichopus vastus

Order: Dendrochirotida

Cucumariidae

Actinocucumis typicus
Colochirus quadrangularis
Cucumaria frauenfeldi
Cucumaria turbinata
Havelockia versicolor
Hemithyone semperi
Pseudocolochirus tricolor
Pseudocolochirus violaceus
Stolus buccalis
Stolus conjugens
Stolus rapax
Thyone papuensis
Trachythyone imbricata

Phyllophoridae

Actinocucumis typicus
Phyllophorus (Phyllophorella) spiculata
Phyllophorus (Urodemella) brocki

Psolidae

Psolus complanatus
Psolus mannrensis

Benthic fauna

Acartia sp.
Alpheus malabaricus
Ampithoe ramondi
Apseudes chilensis
Apseudes gymnophobia
Apseudes sp.
Atylus minikoi
Balanus amphitrite
Calanus sp.
Calappa sp.
Cheiriphotis megacheles
Clibanarius sp.
Cymadusa pathyi
Diogenes sp.
Erictiwnius brasiliensis
Eriopisa abhilashi
Eriopisa chilensis
Eriopisa sp.
Eriopisella sp.
Eurydice sp.
Gammaropsis esturinus
Gammaropsis sp.
Graniderrella gilesi
Hyale honoluluensis
Idunella chilensis
Isopod
Oithona rigida
Paracalliope indica
Parorchestia morini
Quadrivisio bengalensis
Talorchestia martensii
Tanaeus sp.
Urothoe sp.
Veliger larvae

Penaeid prawns

Solenocera crassicornis

CRUSTACEANS

S. hextii
S. indica
Metapenaeopsis stridulans
Metapenaeus affinis
M. brevicornis
M. dobsoni
Parapenaeopsis acclivirostris
P. hardwickii
P. maxillipedo
P. stylifera
P. Uncta
Penaeus canaliculatus
P. indicus
P. japonicus
P. latisulcatus
P. merguiensis
P. monodon
P. semisulcatus

Non-penaeid prawn

Acetes indicus

Lobsters

Panulirus homarus
P. ornatus
P. versicolor
or *Rama eral*
P. longipes
Puerulus sewelli
Thenus orientalis

Crabs

Calappa lophos
Scylla serrata
Portunus pelagicus
P. sanguinolentus
Chrybdis cruciata
C. edwardsi

Stomatopod

Oratosquilla nepa

POLYCHAETES

Ancistrosyllis constricta
Brado villosa
Ceratonereis sp.
Cirratulus cirratus
Cirratulus sp.
Cossura delta
Diopatra neapolitana
Disoma orissae
Euchlymene annandalei
Eunice sp.
Glycera alba
Heteromastus similis
Hydroides heteroceros
Hydroides norvegica
Laonome indica
Lumbriconereis latreilli
Lumbriconereis polydesma
Lumbriconereis simplex
Malacoceros indicus
Marphysa sp.
Mellinna sp.
Nephtys kauderin
Nephtys polybranchia
Nephtys sp.

Brittle stars
Cladocerans
Cyprids
Foraminiferans

Nereis costae
Nereis sp.
Onuphis eremite
Pectinaria crassa
Perenereis cavifrons
Perenereis cultrifera
Phyllodoce malmgrani
Polydora armata
Pomatoceros sp.
Potamila leptochaeta
Prionospia polybranchiata
Prionospio pinnata
Pulliella armata
Sabella sp.
Sabellaria sp.
Serpula sp.
Spirorbis sp.
Sternaspis scutata
Sternaspis sp.
Terebellides stroemi
Thalehasapia tenuis
Tharyx sp.
Tylonereis fauveli

Other Benthic fauna

Lucifer
Mysids
Nematode
Polyclad

FISHES

ELASMOBRANCHS

Sharks:

Chiloscyllium indicum
C. griseum
Rhiniodon typus
Stegostoma fasciatum
Carcharhinus brevipinna
C. dussumieri
C. limbatus
C. macroti
C. melanopterus
C. sorrah
Galeocerdo cuvieri
Laxodon macrorhinus
Rhizoprionodon acutus
Scoliodon laticaudus
Sphyrna blochii
S. zygaena
Centrophorus moluccensis

Skates:

Rhina ancylostoma
Rhinobatus granulatus
Rhynchobatus dijiddensis
Pristis microdon
P. pectinata
P. zijsron

Rays:

Dasyatis microps
D. zygei
D. kuhli
Gymnura micrura
G. poecilura
Himantura bleekeri
H. imbricata
H. uarnak
Hypolophus sephen
Urogynus africanus
Aetobatus flagellum
A. narinari
Aetomylaeus maculatus
A. nichrofii Nieuhof's
Rhinoptera adspersa
R. javanica
Manta briostis

Mobula diabolus

Narcine brunnea

N. timlei

TELEOSTS

Ten pounders:

Elops machnata

Tarpons:

Megalops cyprinoides

Bone fish:

Albula vulpes

Shads, Sprats & Sardines:

Anadontostoma chacunda

Dussumeieria acuta

Escualosa thoracata

Hilsa ilisha

H. keele

H. toli

Ilisha elongata

I. megaloptera

I. melanostoma

Nematolosa nasus

Opisthopterus tardoore

Pellona ditchela

Raconda russeliana

Sardinella albella

S. dayi

S. fimbriata

S. gibbosa

S. longiceps

S. sirm

S. clupeoides

Anchovies:

Coila dussemieri

Setipinna taty

Stolephorus bataviensis

S. commersonii

S. devisi

S. indicus

S. macrops

S. waitei

Thryssa dussumieri

T. malabarica

T. mystax

T. setirostris

OTHER CLUPEOIDS:**Wolf herrings:**

Chirocentrus dorab

C. nudus

Milk Fish:

Chanos chanos

Lizard fishes:

Saurida tumbil

Synodus indicus

Cat fishes:

Arius caelatus

A. dussumieri

A. maculatus

A. thalassinus

Cat fish eel:

Plotosus anguillaris

Eels, Morays & Congers:

Gymnothorax undulatus

Uroconger lepturus

Full beaks (Gar fishes):

Albennes hians

Strongylura crocodilus

S. leiura

Half beaks:

Hemirhamphus far

H. marginatus

Rhynchorhampus georgii

Flying fishes:

Cypselurus spilopterus

Exocoetus volitans

Unicorn cod:

Bregmaceros macclellandi

Flute mouths:

Fistularia villosa

Sea horse:

Hippocampus kuda Sea horse

Razor fish:

Centriscus scuttatus

Squirrel fishes:

Holocentrus rubrum

Myripristis murdjan

Barrcudas

Sphyaena barracuda

S. forsteri

S. jello

S. obtusata

Mulletts

Liza macrolepis

L. vaigiensis

Mugil cephalus

Thread fins

Eleutheronema tertradactylum

Polynemus heptadactylus

P. indicus

P. plebetus

P. Sexfilis

P. sextarius

Sea perches

Ambasis commersoni

A. gymnocephalus

Lates calcarifer

Psammoperca waigiensis

Sea basses & Reef cods

Cephalopholis boenack

Epinephelus quoyanus

E. areolatus

E. bleekeri

E. diacanthus

E. malabaricus

E. merra

E. morrhua

E. tauvina

E. undulosus

Tiger perches

Therapon jarbua

T. theraps

T. puta

Bull's eye

Priacanthus cruentatus

P. hamrur

Cardinal fish

Apogon leptacanthus

Whiting

Sillago sihama

White fish

Lactarius lactarius

Cobia

Rachycentron canadus

Carangids

Alectis ciliaris

A. indicus

Alepes djeddaba

A. mate
Atropus atropus
Carangoides armatus
C. chrysophrys
C. ferdau
C. malabaricus
Caranx carangus
C. ignobilis
C. melampygus
C. sexfaciatus
C. stellatus
Decapterus dayi
D. russelli
Elagatis bipinnulatus
Gnathanodon speciosus
Megalapsis cordyla
Scomberoides lysan
S. tala
Seriola nigrofasciata
Trachinotus bailloni
T. blochii
T. botla
Black pomfrets
Formio niger
Moon fish
Mene maculate
Dolphin fish
Coryphaena hippurus
Red baits
Dipterygnotus leucogrammicus
Jobfishes, Fusiliers & Snappers
Aprion pristipoma
Caesio caerulaureus
Lutjanus rivulatus
L. bohar
L. fulviflamma
L. lineolatus
L. malabaricus
L. russelli
L. sebae
L. vaigiensis
Threadfin breams
Nemipterus delagoae
N. japonicus
N. tolu
N. mesoprion

Scolopsis bimaculatus
S. vosmeni
Triple tails
Labotes surinamensis
Silverbells (Pony fishes)
Gazza minuta
Leiognathus berbis
L. bindus
L. brevirostris
L. daura
L. dussumieri
L. equulus
L. jonesi
L. lineolatus
L. splendens
Mojarras
Gerres abbreviatus
G. filamentosus
G. oyena
G. setifer
Pentaprion logimanus
Sweetlips & Grunters
Gaterin diagrammus
G. lineatus
Pomadasyus hasta
P. maculates
Johnieops aneus
J. sina *Sin croaker*
Johnius dussumieri
Kathala axillaries
Nibea maculata
Otolithus cuvieri
O. rubber
Pennahia macrophthalmus
Protonibea diacanthus
Emperor breams
Lethrinus miniatus
L. nebulosus
L. ornatus
L. ramak
Large-eyed breams
Monotaxis grandoculis
Gnathodentex aurolineatus
Gymnocranius griseus
Silver breams
Argyrops spinifer

Mylio latus

Goat fishes

Parupeneus indicus

Upeneus sulphureus

U. vittatus

Silver bat-fish

Monodactylus argenteus

Sweeper

Pempheris moluca

Sea chubb

Kyphosus cinerascens

Spade fishes

Tripterodon orbits

Platax orbicularis

P. teira

Sickle Fish

Drepane punctata

Butter fish

Scatophagus argus

Coral fishes & Angel fishes

Chaetodon auriga

C. collare

C. trifasciatus

C. vagabundus

C. zanthocephalus

Pomacanthodes annularis

P. semicirculatus

Etroplus suratensis

Demoiselles & Pullers

Abudefduf biocellatus

A. septemfasciatus

A. uniozellatus

Amphiprion sebae

Chromis caeruleus

Dascyllus aruanus

D. trimaculatus

Pomacentrus nigricans

P. tripunctatus

Parrot fishes

Callyodon bataviensis

C. ghobban

C. janthochir

C. dussumiere

C. fasciatus

Wrasses

Cheilinus chlorurus

C. diagramma

C. undulatus

Cheilio inermis

Coris gaimardi

Gomphosus coeruleus

Hemigymnus faciatus

Stethojulis axillaries

Thalassoma hardwicki

T. lunare

T. purpurea

Blenny

Entomacrodus striatus

Dragonet

Callionymus japonicus

C. sagita

Spine foots

Siganus oramin

S. javus

S. vermiculatus

Moorish idol

Zanclus cornutus

Surgeon fishes & Unicorn fishes

Acanthurus bleekeri

A. leucosternon

A. lineatus

A. matoides

Naso brevirostris

N. tuberosus

N. unicornis

Snake mackerels

Epinulla orientalis

Ribbon fishes (Hair tails)

Lepturacanthus savala

Trchiurus lepturus

Tunas, Mackerels & Seer fishes

Auxis rochei

A. thazard

Euthynnus affinis

Katsuwonus pelamis

Sarda orientalis

Thunnus albacares

T. tonggol

Rastrelliger kanagartha

Acanthocybium solandri

Scomberomorus commerson

S. guttatus

S. lineolatus

Sail fishes (Marlins)

Istiophorus platypterus

Makaira indica

M. nigricans

Sword fish

Xiphias gladius

Scorpaenopsis cirrhosa

Sebastapistes strongi

Sea robins

Peristedion adeni

Flat heads

Platycephalus indicus

P. scaber

P. triocellatus

Zebrias quagga

Cynoglossus lingua

Sucker fishes

Echeneis naucrates

Tripod fishes

Pseudotriacanthus strigilifer

Triacanthoides athiops

Triacanthus brevirostris

File fishes & Leather jackets

Abalistes stellatus

Canthidermis rotundatus

Balistapus undulatus

Rhinecanthus aculeatus

Paramonacanthus choirocephalus

Amanses sandwichiensis

Puffer fishes (Blow fishes)

Pomfrets

Pampus argenteus

P. chinensis

Hump heads

Kurtis indicus

Scorpion fishes (Sting fishes & Fire fishes)

P. tuberculatus

Flat fishes

Psettodes erumei

Bothus ovalis

Engyprosopon grandisquamis

Pseudorhombus arsius

Lagocephalus inermis

Tetradon hispidus

T. immaculatus

T. leopardus

T. nigropunctatus

T. stellatus

T. oblongus

Porcupine fishes

Diodon hystrix

D. maculifer

Frog fishes

Anternnarius leprosus

A. hispidus

Bat fishes

Halicutea stellata

Dragon fish

Pegasus draconis

REPTILES

Order: Testudines

Chelonidae

Caretta caretta

Chelonia mydas

Dermochelys coriacea

Eretmochelys imbricata

Lepidochelys olivacea

Sea Snakes

Sub family

Hydrophiinae

Hydrophis spiralis

H. cyanocinctus

H. ornatus

H. gracilis

H. caerulescens

H. fasciatus

H. lapemoides

Thalassophina viperina

Lapemis curtus

Pelamis platurus

Acrochordus granulatus

Cerberus rynchops

MAMMALS

Order: Cetacea

Delphinidae

Orcaella brevirostris

Physeteridae

Physeter macrocephalus

Ziphiidae

Mesoplodon ginkgodens

Order: Sirenia

Dugongidae

Dugong dugon

Other cetaceans occur in this region:

Steno bredanensis

Sousa chinensis

Grampus griseus

Tursiops truncatus

Stenella longirostris

Stenella coeruleoalba

Delphinus delphis

Lagenodelphis hoesi

Peponocephala electra

Feresa attenuate

Peudorca Crassidens

Orcinus orca

Globicephala macrorhyncha

Ziphius cavirostris

Mesoplodon densirostris

Mesoplodon ginkgodens

Physeter macrocephalus

Kogia breviceps

Kogia simus

Megaptera novangliae

Balanoptera musculus

Balanoptera physalus

Balanoptera edni

Balanoptera borealis

Balanoptera acutorostrata

Table: Summary of Management Plan prescribed activities schedules

Plan prescriptions	Activities	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Zonation	Zonation & boundary demarcation	√	√	√							
Protection Measures	Recruitment of vacant and proposed staff to enhance the protection measures	√	√	√							
	Establishment of necessary infrastructure facilities (building, vehicle etc)	√	√	√			√	√			
	Creation of Vembar Range with adequate infrastructure	√	√								
	Procurement of big sea going vessels and patrolling boats	√	√				√				
	Establishment of small patrolling huts in islands with patrolling boat and communication system	√	√	√			√	√			
	Creation of a Anti-poaching Unit consisting of Ex-Indian Navy and Coast Guard Personnel at the top and middle level and local fishermen at lower level	√	√	√			√	√			
	Continuation of Protection to Biodiversity and its environment	√	√	√	√	√	√	√	√	√	√
	Continuation of Protection to corals from identified threats	√	√	√	√	√	√	√	√	√	√
Restoration measures in the National Park (coral habitat)	Facilitate and monitor the natural recovery of corals	√	√	√	√	√	√	√	√	√	√
	Assisted recovery monitoring in identified places	√	√	√	√	√	√	√	√	√	√
	Marking permanent monitoring plots for in house monitoring	√	√				√	√			

			√	√	√	√	√	√	√	√	√
	Regular monitoring of permanent plots in all fringing reefs and patch reefs, preferably during Jan - March		√	√	√	√	√	√	√	√	√
	outsourcing – a professional and scientific assessment of coral reef status , distribution and abundance , monitor pollution and prepare detail maps once in 5 years (e.g. DOD-ICMAMPD resource information system)		√				√				√
	Co-ordinate and collate information into an open data database at the GOMBRA research and monitoring laboratory.	√	√	√	√	√	√	√	√	√	√
	Encourage and facilitate scientific research and monitoring of specific taxon, events and status by professional scientific agencies with their data being documented within the GOMBR database	√	√	√	√	√	√	√	√	√	√
	Restoration of corals using prescribed methodology in identified seascape		√	√	√		√	√			
Restoration measures in the National Park (seagrass habitat)	Mapping of sea grass beds with the information on status of each species.		√	√			√	√			
	Identification of permanent sampling plots for long term monitoring		√	√			√	√			
	Monitoring of seagrass status in the identified sampling points		√	√	√	√	√	√	√	√	√
	Extending the present sea grass distributional limit to the historical distributional limit (Restoration).		√	√	√			√	√		
Restoration measures in the National Park (mangrove)	Natural-cum-Assisted mangrove regeneration in the identified places	√	√	√	√	√	√	√	√	√	√
	Monitoring of mangroves in the National Parks		√	√	√	√	√	√	√	√	√
	Mangrove Restoration Effort Journal, on the	√	√	√	√	√	√	√	√	√	√

habitat)	lines of forestry plantation journal needs to be maintained											
Management of Invasive species in the National Park	Eradication of <i>Prosopis juliflora</i> from the National Park area		√	√		√	√			√	√	
	Diversity, distribution and possible impact of both aquatic and terrestrial invasive species needs to be monitored		√		√		√		√		√	
	Removal of all major invasive species from the sea turtle nesting beaches	√	√	√	√	√	√	√	√	√	√	√
	After initiating the eradication programme the Invasive Species Management Areas needs to monitored regularly and if required then the eradication programme needs to be continued		√	√	√	√	√	√	√	√	√	√
Species recovery and stock enhancement plan in the National Park	Species recovery/restoration programme to improve their endangered category – Sea horse & Pipe fishes	√	√	√	√	√	√	√	√	√	√	√
	Species recovery/restoration programme to improve their endangered category – Holothurians	√	√	√	√	√	√	√	√	√	√	√
	Species recovery/restoration programme to improve their endangered category – Balanoglossus	√	√	√			√	√				
	Stock enhancement of species that are important for subsistence and economic importance to dependent communities - Reef fishes		√		√		√		√		√	
	Stock enhancement of species that are important for subsistence and economic importance to dependent communities - Lobsters		√		√		√		√		√	
	Stock enhancement of species that are important for subsistence and economic importance to		√		√		√		√		√	

	dependent communities - Economically important Crabs										
Research, monitoring and training	Prioritization of research activities in the region. A total of 45 research programs have been identified in seven thrust areas such as landscapes level, habitat level, species level, technology related, multidisciplinary and management related, ecological restoration, socio-economic and policy related studies. Gulf of Mannar Biosphere Reserve Authority can facilitate these programs as per its priority.	√	√			√	√			√	√
	Establishment of a Research and Monitoring Centre (RMC) with staff and infrastructure as prescribed in the Plan	√	√	√							
	Long term research programmes prescribed in the Plan	√	√	√	√	√	√	√	√	√	√
	Short term research programmes prescribed in the Plan	√	√	√	√	√	√	√	√	√	√
	Coordination, documentation and data base of research information and posting in web page	√	√	√	√	√	√	√	√	√	√
	Maintenance of data base and web sites	√	√	√	√	√	√	√	√	√	√
	Capacity building for in-house research and monitoring	√	√	√	√	√	√	√	√	√	√
	Community involvement in research and monitoring	√	√	√	√	√	√	√	√	√	√
	Constitution of Research Advisory Committee	√	√				√				
	Annual research seminar and meetings of Research Advisory Committee		√	√	√	√	√	√	√	√	√
	Liaison and linkages with funding sources	√	√	√	√	√	√	√	√	√	√
Management of pollution in the Biosphere Reserve	A policy level decision to ban untreated industrial pollutants and sewage release into the Gulf of Mannar Biosphere Reserve	√	√								
	Review of Environment Management Plan of all	√	√	√				√	√		

	industries in the region by the State Pollution Control Board and the GOMBRA											
	Preparation of an 'ecological hotspots and fragile habitat map' along the coast of Gulf of Mannar Biosphere Reserve using the information provided in the Management Plan and to suggest a) no industry zone and b) permitted kind of industry zone	√	√	√				√	√			
	Hasten the development of regulations for discharge of industrial effluents into the coastal waters with the help of the State Pollution Control Board	√	√	√			√	√				
	Plantation around polluted saltpans for desalination: <i>Salicornia sp.</i> , <i>Avicenia sp.</i> may be considered for this purpose	√	√	√			√	√				√
	Monitoring of shell craft industries and aquaculture farms with respect to pollution	√	√	√	√	√	√	√	√	√	√	√
	Monitoring of pollution by RMC with TNPCB	√	√	√	√	√	√	√	√	√	√	√
	Development of Pollution Abatement Plan for this region	√	√	√			√	√				
Management of illegal trade on protected marine species	Regulation on fishing efforts to minimize or avoid the catch of protected marine shells and other species	√	√	√								
	Creation of awareness on the protected marine species through films, posters and other outreach programmes		√	√	√	√	√	√	√	√	√	√
	Issuance of Licenses for selling of seashells other than protected species	√	√				√	√				
	NGOs to discard promotion of protected seashell artifact making as a lively hood option	√	√				√	√				
	Monitoring the illegal trade on protected marine	√	√	√	√	√	√	√	√	√	√	√

	species in the region											
Restoration measures in BR (seagrass habitat)	Preparation of a detailed map of sea grass beds with the information on status of each species in the Biosphere Reserve using latest satellite imageries	√	√	√			√	√				
	Prevention of further decline of sea grass beds by eliminating the causes of decline such as pollution, indiscriminate fishing etc	√	√	√	√	√	√	√	√	√	√	√
	Prohibition of trawling fishing on the sea grass beds	√	√	√								
	Awareness programme in the catchment area regarding the excessive use of pesticide and other chemicals and its impact in coordination with the State Agriculture Department	√	√	√	√				√	√		
	Restoration of seagrass beds with the help of CSMCRI and technology adopted on a coastal lagoon in the North of Yucatan (Southeastern Mexico)	√	√	√	√	√						
Restoration measures in BR (mangrove habitat)	Mangrove afforestation efforts along the coast of Gulf of Mannar Biosphere Reserve – places have been identified in the Plan		√	√				√	√			
	Monitoring and maintenance of mangrove sites after restoration			√	√	√	√	√	√	√	√	√
Species of conservation significance and their recovery plan in the Biosphere Reserve	Recovery of sea turtles in the Gulf of Mannar Biosphere Reserve	√	√	√	√	√	√	√	√	√	√	√
	Recovery of Dugong in the Gulf of Mannar Biosphere Reserve	√	√	√	√	√	√	√	√	√	√	√
	Stock enhancement of economically important crabs in the Gulf of Mannar Biosphere Reserve		√	√				√	√			
	Monitoring and recovery of sea snakes in the Gulf of Mannar Biosphere Reserve	√	√	√	√	√	√	√	√	√	√	√

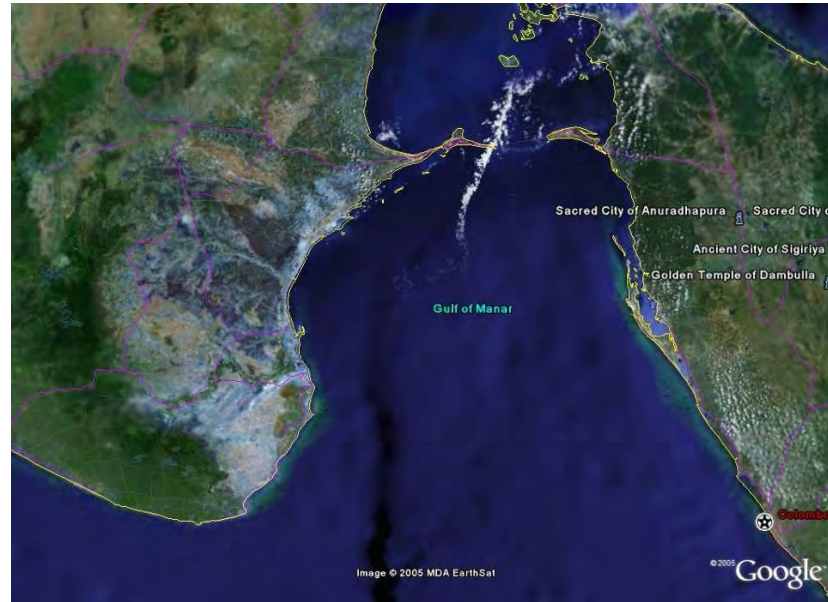
Interpretation, education, eco-tourism and visitors management	Establishment of Marine Conservation Interpretation cum Education Center (MARCONI)	√	√	√			√	√			
	Establishment of information centers in five places which have been identified in the Plan	√	√	√							
	Preparation of outreach materials as prescribed in the Plan	√	√			√		√		√	
	Establishment of necessary infrastructure for tourists in the identified tourism zone in coordination with the Tourism Department	√	√		√		√		√		
	Adaptation and follow up of Media message matrix for interpretation and conservation education as prescribed in the Plan	√	√	√	√	√	√	√	√	√	√
	Establishment of prescribed tourism in the identified tourism zone	√	√	√			√	√	√		
	Establishment of World Class State of Art Marine Aquarium	√	√	√	√						
	Human resource and capacity building for eco-tourism in the Biosphere Reserve		√	√			√	√		√	√
	Infrastructure development in the 'Value added tourism zone' identified in the Plan	√	√	√			√	√			
	Regulation and monitoring of visitors and tourism in the region as per the prescription of the Plan	√	√	√	√	√	√	√	√	√	√
Eco-development Plan for Community Involved Livelihood Generations	Complete identification of impacting villages in the area of influence and form EDCs in Ramnadapuram and Tuticorin Districts and develop VMCP & Microplan for each EDC village	√	√	√							
	Complete identification of impacting villages in the area of influence and form EDCs in Tirunelveli and Kanyakumari Districts and					√	√	√			

	develop VMCP & Microplan for each EDC village										
	Identify range of alternative livelihood options and facilitating expert organizations to assist in capacity building of EDCs		√	√	√			√	√		
	Set up high powered Eco-development Progress Monitoring Committee	√	√								
	Establish NGOs network	√	√								
	Establish indicators for monitoring of Eco-enhancement in Eco-Development Plan implemented Areas and initiate monitoring through professional institutions				√	√	√	√	√	√	√
	Monitor changes in human demographic profile in the Eco-development implementation zones	√	√	√			√	√			√
	Establish by-catch reduction and non-destructive methods of mechanized fishing in buffer zone	√	√	√							
	Conduct multi-stakeholders annual meetings to share eco-development plan implementation	√	√	√	√	√	√	√	√	√	√
Disaster Management	Creation of Inter-agencies Disaster Management Cell with coordination mechanism at GOMBRA		√	√							
	Develop a Disaster Management Protocol and Dril programme by a Disaster Management Professional Agency	√	√	√							
	Capacity building of in-house staff through training at Disaster Management Professional Institutions		√	√			√	√			√
	Train inter-agencies Disaster Management Cell personnel and GOMBRA personnel on emergency dealing with oil-spil, hazardous chemical spill in collaporation with Tuticorin Port Trust, Indian Coast Guard, Hydrocarbon		√	√	√					√	√

	Exploration Agencies and Sethusamuthuram Canal Authority												
	Setting up of Search and Rescue Teams in the Biosphere	√	√	√									
	Assess the efficacy of Gulf of Mannar Biosphere Reserve and Marine National Park infrastructure resistance ability to anticipated disasters by a professional agency	√	√	√				√	√				
Policy, Administration, evaluation and review	Establishment of 'Gulf of Mannar Biosphere Reserve Management Authority' (GOMBRA)	√	√	√									
	Formation of Governing Council of GOMBRA	√	√										
	Review and restructure the Governing Council of GOMBRA with statutory powers	√	√										
	Appointment of Officials and staff as prescribed in the Plan, for GOMBRA with necessary infrastructure facilities including support staff, buildings, vehicle, communication facilities etc	√	√	√									
	A review of Tamil Nadu Marine Fisheries Policy with special focus on a) Bottom trawling should be banned inside the Biosphere Reserve, and b) Review of using the destructive fishing gear and crafts in the Gulf of Mannar region and their control.	√	√										
	Expose a GOMBRA multi-tier personnel team to different Marine Protected Areas in India and outside		√		√		√		√			√	
	Policy decision to ban untreated industrial pollutants and sewage release into the Gulf of Mannar Biosphere Reserve which should taken up the State Pollution Control Board	√	√										
	Review of changes in the demographic profile of the coastal talukas and eliminating the causes of human migration into the coastal zone	√	√	√									

	Examine the possibility of marine shell trade industry to be under the State Control as there are signs of over and indiscriminating harvesting of shells from sea	√	√								
	Seek coordination from Sri Lanka to manage the Biosphere Reserve as a Trans Boundary Protected Areas	√	√	√							
	Policy decision on creation of Anti-poaching Unit as prescribed in the Plan	√	√								
	Formation and review of Management Plan implementation and review committee	√	√	√	√	√	√	√	√	√	√

ANNEXURE (BUDGET)
**Integrated Management Plan for the Gulf of Mannar Marine National Park
and Biosphere Reserve (2007-2016)**
BUDGET



2007



Activities and Budget (Rupees in Lakhs)

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
I	NATIONAL PARK											
1	Administration. Protection & Infrastructure development											
	Recruitment of proposed staff to enhance the protection measures (1 ACF, 4 Foresters, 6 Forest Guards)	30	30	30	33	33	33	36	36	36	39	336
	Establishment of new Range at Vembar for Vembar group of islands, recruitment of two newly proposed RFOs and recurring cost	30	11	12	13.5	14.5	16	17.5	20	21	22	177.5
	Establishment of necessary infrastructure such as office, staff quarter etc for ACFs	20	1	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.4	36.
	Delineation of boundary of NP		60	60	5	5	6	6	7	7	8	164
	Procurement two faster and bigger sea going vessels with communication systems, arms and first aid kits for patrolling as well as for rescue operation	200	20	20	25	25	30	30	40	40	40	470
	Replacement of old boats				10	35	5	5	5.5	5.5	6	72
	Procurement of patrolling vehicles as well as smaller vessels (speed boat) to each Range		50	10	10	11	11	12	12	13	13	142

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
	Creation of a Patrolling Hut at each island in first two years and then maintenance cost	50	50	5	5	6	6	7	7	8	8	152
	Field equipments at Patrolling Huts including a small motor boat, walkie talky, binocular, GPS, spot light, life jacket, camping gear etc		10	10	2	2	2.5	2.5	25 (New unit)	3	3.5	60.5
	Creation of a 'Anti-poaching Squad proposed as Pilot Marine Patrolling and Policing Unit' consisting of Ex-Indian Navy and Coast Guard Personnel on outsource basis, including maintenance of data base on offenders	4	5	5.5	6	6.5	7	7.5	8	8.5	9	67
	Restoration of Habitat											
2	Coral reefs											
	Vigilance, Protection and Monitoring of coral habitats through Anti-poaching Watchers from nearby villagers (40 persons)		15	15	16	16	17	17	18	18	19	151
	Assisted reef restoration and monitoring (Target 35 sq.km in 10 yrs)		20	20	45	45	75	75	80	80	85	525
	Monitoring of permanent plots every year, the GOMBRT and GOMMNP management requires to monitor plots in all fringing reefs and patch reefs around the islands through in-house		5	5	6	6	7	7	8	8	9	61

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
	monitoring (preferably during Jan – March).											
	Outsourcing – a professional and scientific assessment of coral reef status , distribution and abundance and prepare revised maps once in 5 years (e.g. DOD-ICMAMPD resource information system) Co-ordinate and collate information into an open data database at the GOMBR research and monitoring laboratory					50					75	125
3	Sea grasses Habitat											
	Mapping and monitoring of sea grasses habitat including pollution inside the NP		30		30		40		40		50	190
	Awareness programme in the catchment area regarding sewage & solid waste management, excessive use of pesticide and other chemicals and its impact on marine habitat		5	5	8	8	10	10	12	12	14	84
	Restoration of degraded sea grass habitat (target 20 sq.km)				20	20	60	50	70	60	40	320
4	Mangrove Habitat											
	Natural-cum-assisted restoration of mangrove habitat as prescribed in the Management Plan (Target plantation 100 ha @ 20 ha/year then onwards	6	7.5	8.5	9.5	11	2	2	2	2	2	52.5

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
	monitoring the plantation, @Rs.30000/ha)											
	Maintenance of mangrove plantation		1.5	2.5	3	3.5	4	4.5	5	5.5	6	35.5
5	Invasive species											
	Eradication of <i>P. juliflora</i>	6	7	8	9	10	2	2	2	2	2	50
	Eradication of <i>Kappaphycus alvarezii</i>	2	2	2	1	1	1	1	1	1	1	13
	Database on AIS for planning and executing programmes on management of invasives in islands	2			3			4				9
6	Species recovery programme											
	Recovery of sea horse and pipe fishes	1000										1000
	Stock enhancement of Holothurians	(All the recovery programs should be outsourced to professional institutions on the basis of their Species Recovery Plan Proposals after strict review process)										
	Recovery of balanoglossus											
	Recovery of reef fish resources											
	Stock enhancement of lobsters											
	Stock enhancement of economically important crabs											
	Recovery of sea turtle nesting habitat											
	Recovery of dugong											
	Monitoring and recovery of sea snakes											
7	Research and Monitoring											
	Formation of Research Advisory Committee of the GONBR											
	Establishment of a Research and Monitoring Centre (RMC) at	300	500	200	50	60	70	80	90	100	110	1560

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
	Keelakarai with all logistic facilities including laboratories, mini-aquarium, vehicle, boats, diving equipment etc											
	Coordination, documentation and data base of research information, and dissemination of information				10	10	10	10	10	10	10	70
	Establishment of library with books, scientific journals with necessary furniture	5	5	1	1	1	1	1	1	1	1	18
	Recruitment of RMC Research personnel on deputation or temporary basis	20	22	24	26	28	30	33	36	39	41	299
	Participatory capacity building including local community for in-house research and monitoring	10	11	12	13	14	15	16	17	18	19	145
	Annual research seminar	5	5	6	6	7	7	8	8	9	9	70
	Support to research activities	5	5	5	5	5	5	5	5	5	5	50
II	BIOSPHERE RESERVE											
1	Administration, infrastructure and protection											
	Establishment of proposed GOMBR Authority											
	Delineation of Biosphere Reserve geographic area on land with hoardings (1 harding/village for 300 villages in the buffer zone)	30		15		15		15		15		90

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
	Recruitment of newly proposed staff (two Eco-Development Officers, one Fisheries Officer, one Social Welfare Officer, one Tourism Officer at Pay Band 3 level)	240										240
	Establishment of infrastructure for all newly appointed Group A service personnel such as Office, residency quarter, vehicle, driver, furniture etc.	100	10	10	12	12	14	14	16	16	18	222
2	Management of Pollution											
	A policy level decision to ban untreated industrial pollutants and sewage release into the Gulf of Mannar Biosphere Reserve is proposed to be taken up with the State Pollution Control Board											
	All industries including Ports in the Gulf of Mannar region should be addressed and facilitated to prepare, submit and implement an Environmental Management Plan (EMP).											
	Identification of highly causative polluting industries in the region and necessary actions required for developing Environmental Management Plan for review and implementation. This needs to be	10					10					20

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
	taken up with the State Pollution Control Board – outsource to professional institution											
	Preparation of an ecological hotspots and fragile heritage maps along the coast of Gulf of Mannar Biosphere Reserve using the information provided in the Management Plan and to suggest a) no industry zone and b) permitted kind of industry zone – outsource to professional institution	20					20					40
	Enhance the green cover in the buffer zone especially on polluted salt pans with suitable plants (Target 3000 ha in 10 years time period @Rs.30000/ha)	900										900
3	Prevention of trade on protected species											
	A detailed stock assessment of seashells which are included in the WPA, should be carried out so as to know the present status (outsource to professional institutions)				10						10	20
	Awareness programme targeting Chank divers and seaweed collectors (outsource to NGOs)	10	10	10	10	10	10	10	10	10	10	100
	Creating market to traditional handicrafts and promoting natural products market all over the BR					15	15	15	15	20	20	100

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
	instead of seashell artifact promotion (30 villages/year through revolving fund credit)											
	Alternative source of livelihood such as, pearl culture, lobster and crab fattening, sea weed culture, Micro algae culture (with help of State Fisheries Department) and eco tourism (with help of State Tourism Department) initiatives to bring down the illegal trade	50	50	50	60	60	60	70	70	70	80	620
	Restoration of habitats											
4	Sea grasses habitat											
	Mapping of sea grass beds with the information on status of each species in the Biosphere Reserve is needs to be prepared using latest satellite imageries	This has already been initiated by the GOMBRT which needs to be followed up										
	Restoration and monitoring of sea grass habitats in the BR	Based on the findings of ongoing research on this subject supported by the GPMBRT				20	20	5	5	5	5	60
5	Mangrove Habitats											
	Natural-cum-assisted restoration of mangrove habitat as prescribed in the Management Plan (Target plantation 1000 ha @ 100 ha/year, @Rs.30000/ha)	300										300
	Monitoring and maintenance of	4	4	4	5	5	5	6	6	6	7	52

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
	mangrove sites after restoration											
6	Species Recovery Programme											
	Recovery of sea turtles in the Gulf of Mannar Biosphere Reserve	500 (Outsource to professional institutions and State Fisheries Department whenever required)										500
	Recovery of Dugong in the Gulf of Mannar											
	Recovery of Sea Snakes											
	Stock enhancement of economically important crabs and lobsters											
7	Interpretation, education, eco-tourism and visitors management											
	Establishment of State of the Art Marine Conservation Interpretation cum Education Center (MARCONI) with all necessary facilities mentioned in the Management Plan	400	10	10	20	20	25	25	30	30	35	605
	Establishment of five information centers	100	5	5	5	5	5	7	7	7	7	153
	Establishment of World Class State of Art Aquarium in the Rameswaram Island perhaps in Pamban	5000 (through BOT mode)										
	Necessary infrastructure development to facilitate and enhance the eco-tourism (10 Glass bottom boats, 3 jetties, snorkeling gear, diving gear, tourist rest huts, etc)	310	20	20	30	30	35	35	40	40	45	605
	Human resources and capacity	25	25					15				65

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
	building and guide training											
8	Eco-development											
	Establishment of Eco-development zone in the Tirunelveli and Kanyakumari Districts (Two zones with 2 RFOs, 2 Forester, 2 Assistant and 2 care takers)	18	18	20	20	22	22	24	24	26	26	220
	Preparation of village marine conservation plans through PRA and utilizing local NGOs (Rs.10000/village for 300 villages)	30										30
	Promoting community based seaweed culture using native species (Target 60 units @1.5 lakhs/unit)	90 (through revolving fund credit)										90
	Promoting Alternative livelihoods as suggested in the Management Plan	500 (through revolving fund credit)										500
	Institutional mechanism for evaluation of eco-development program and activities at regular intervals including auditing	2	2	2	2	2	2	2	2	2	2	20
9	Disaster Management											
	Setting up of Disaster Management Cell											
	Establishment of infrastructure, capacity building, training and preparedness as suggested in the Management Plan	50	50	50	50	50	50	50	50	50	50	500

Chapters/ section No.	Activity	Year I	Year II	Year III	Year IV	Year V	Year VI	Year VII	Year VIII	Year IX	Year X	Budget
10	Policy, Administration, evaluation and review											
	Establishment of Gulf of Mannar Biosphere Reserve Management Authority											
	Establishment of Necessary infrastructure facilities at Madurai for Authority	100	20	20	20	25	25	25	30	30	30	325
	Implementation of Policy level reforms as suggested in the Management Plan											
	Establishment of Management Plan Implementation and review committee											
	TOTAL (excluding 5000 lakhs for proposed Aquarium on BOT mode)	Rupees twelve thousand eight hundred and eighty two lakhs										12882