Integrated Management Plan of the Gulf of Mannar Marine National Park and Biosphere Reserve (2018-2027)

Tamil Nadu Forest Department

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Integrated Management Plan for the Gulf of Mannar Marine National Park and Biosphere Reserve

(2018-2027)

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Gulf of Mannar Marine National Park and Biosphere Reserve

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 $78^0$08'E to $79^0$30'E and along Latitudes from $8^0$35'N to $9^0$25'N with a total area of 10,500 Km^2. This marine Biosphere Reserve encompasses a chain of 21 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.

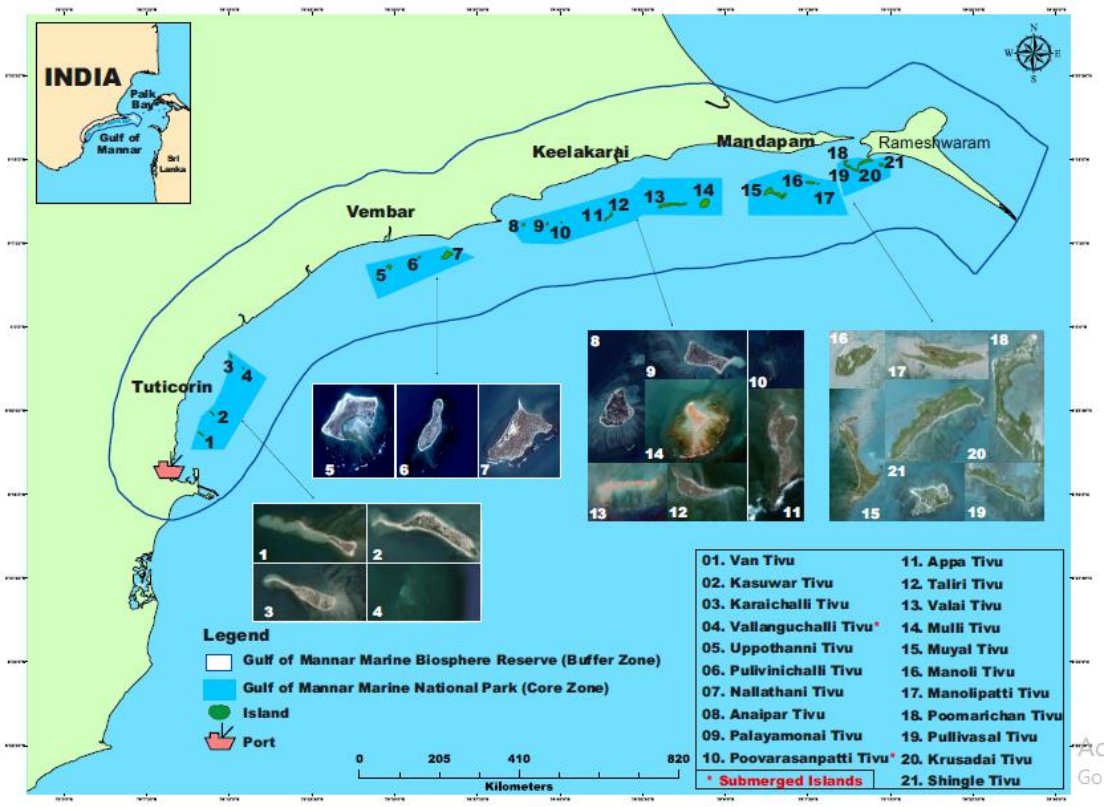
The importance of the Gulf of Mannar region dates back to the 2^{nd} Century AD because of its highly productive pearl banks and other religious significance. The Gulf of Mannar has drawn attention of conservationists even before the initiation of the Man and Biosphere (MAB) program by the UNESCO in 1971. With its rich biodiversity of 3600 species of various flora and fauna of the 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.

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.

At present there are two zones exist in BR such as Core Zone (National Park) that is surrounded by Buffer Zone (BR). In this Plan, we introduced one more Zone i.e. Tourism Zone inside the National Park and entire buffer zone can be declared as multipurpose use zone but in sustainable manner so that there is no harm to biological integrity of the region. Therefore, selective control of activities at different zones is proposed in the plan, including both strict protection and various levels of use.

Fishery resources in the inshore waters had been the sole occupations and livelihoods for several thousand families living along the coast of Gulf of Mannar for centuries. About 1,10,000 families from 268 fishing villages have been fishing in the BR. Of these, 55, 000 families live from Rameshwarm to Tuticorin. These fishermen 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.

Further, Gulf of Mannar National Park has been identified as the Important Bird Areas by BNHS-Birdlife International because of rich avian fauna consist of 187 species and the Gulf of Mannar Biosphere Reserve has recently been identified as an Important Marine Mammals Areas of the World by IUCN due to its dugong population and other marine mammals presence here.



VISION

"Ecologically functional 'Gulf of Mannar National Park and Biosphere Reserve' is an important marine biodiversity heritage site of India that should be conserved and managed as a 'Centre of Excellence for marine biodiversity conservation, livelihoods, recreation and nature education"

OBJECTIVES OF MANAGEMENT PLAN

- Appreciate and promote the importance of integrated and sustainable management of Gulf of Mannar Marine National Park and Biosphere Reserve.
- Promote participation of stakeholders in the management of Gulf of Mannar Marine National Park and Biosphere Reserve, and improve their livelihoods with eco-development programs.
- Mainstream biodiversity conservation into production sectors of the region especially fisheries, tourism, ports, industries and urban development.
- Effectively as well as scientifically protect, manage and monitor the biodiversity of Gulf of Mannar Marine National Park and Biosphere Reserve.
- Promote eco-friendly tourism that provides a rich experience for tourists, economic benefits to the local people and support to the Gulf of Mannar Marine National Park and Biosphere Reserve.
- Develop Gulf of Mannar Marine National Park and Biosphere Reserve as a world class coastal biodiversity site to promote eco-tourism and nature education.

EXISTING PROBLEMS

- Multi-stakeholders but lack of ownership and participation in conservation.
- Lack of inter-sectoral co-ordinations in planning and development that prevent the mainstreaming of biodiversity conservation into production sectors in the region.
- Poor socio-economic condition of people who live around the Biosphere Reserve.
- Limited alternative and additional livelihoods options are available in the region due to poor rainfall.
- Increasing anthropogenic pressure exerted by both local communities and industries inside and outside the National Park.

- Over exploitation of resources especially the fisheries resources inside the Biosphere Reserve.
- Industrial and sewage pollutions posing threat to wildlife as well as human health.
- Poor infrastructure and financial resources available with the Management Authority of Biosphere Reserve.
- Decline of fish diversity and fish catch and thereby poor socio-economy condition of fishing community.
- Lack of clarity on 'Scope of the Management Area of Gulf of Mannar Marine National Park and Biosphere Reserve'.
- Poor infrastructure to promote eco-tourism, eco-development and nature education, to strengthening protection and monitoring.
- Lack of knowledge to develop better climate change adaptation plan.

Management strategies

The strategies of Integrated Management Plan of the Gulf of Mannar National Park and Biosphere Reserve (2018-2027) is built on the pillars of International Conventions, National and Regional programmes of action, Partnerships, Self-reliance and Sustainability. Especially, the Management Plan is largely based on following recommendations of 3rd National Wildlife Action Plan of India (2017-2031);

1. Establish a 'Coastal and Marine Ecosystem Cell' to strengthen the conservation and management of coastal and marine biodiversity in all coastal States and UTs.

2. Strengthen the Coastal and Marine Protected Area (CMPA) network and its management in the country with active participations of stakeholders, both in governance and decision making.

3. Develop a common action plan for all coastal States and UTs integrating 'Climate Change Adaptation' (CCA) and 'Disaster Risk Reduction' (DRR) with shared responsibility into all sectors of governance and keeping the needs and aspirations of the local communities in focus.

4. Undertake 'Coastal and Marine Habitats Restoration Programme', especially for mangroves, coral reefs, seagrass beds, intertidal zone, sand dunes, lagoons, etc., so that livelihood opportunities of coastal communities are enhanced and they are also protected from impacts of various natural disasters and climate change.

5. Initiate programmes for long term studies and monitoring of threatened coastal and marine species, mitigation of human-marine species conflicts as well as rescue and rehabilitation of marine species.

6. Undertake cumulative and strategic impact assessments to harmonize development with conservation in the context of coastal and marine biodiversity.

7. Prepare guidelines for management of marine invasive species in India.

8. Establish a special centre for strengthening the knowledge management system of coastal and marine biodiversity and their conservation in India in coordination with a network of related organizations.

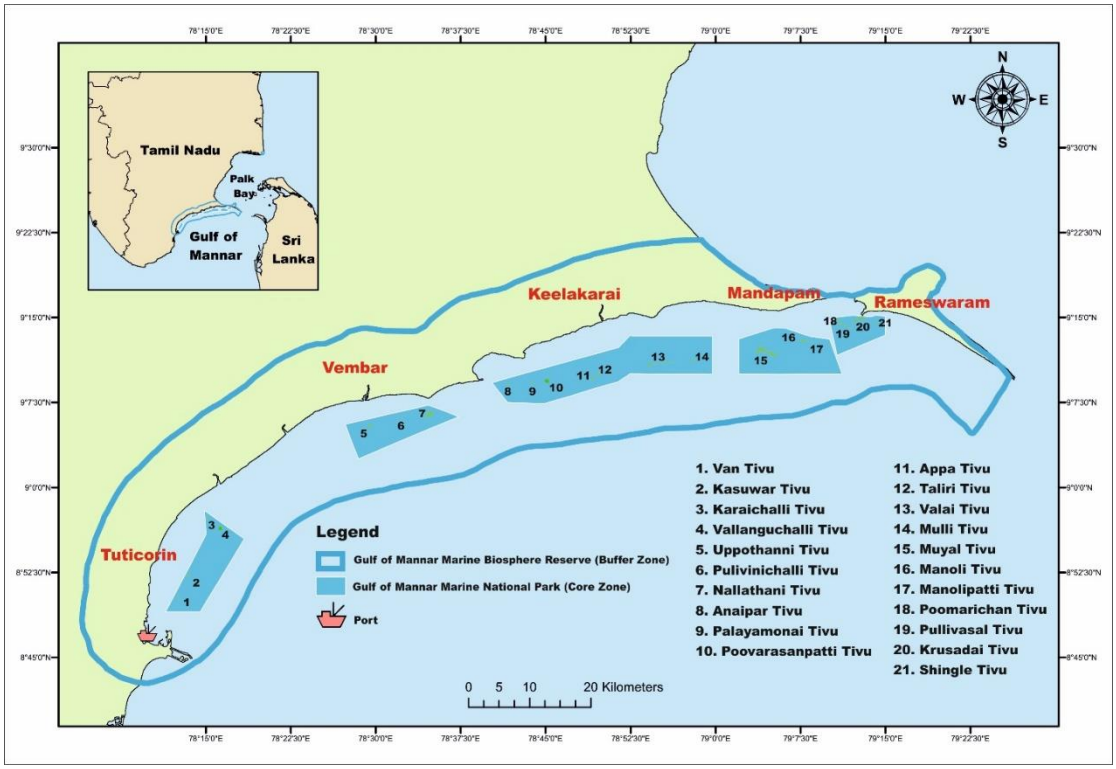
9. Ensure a 'clean coastal and marine environment in India' by preventing sea pollution including underwater noise.

10. Strengthen the field-based capacity to promote integrated and sustainable management of coastal and marine biodiversity. Training institutes should tailor their training curricula to meet needs of professionals of SFDs and all other Departments /Agencies at all levels of responsibilities to manage coastal and marine ecosystems.

Spatial Planning

Zonation

The Gulf of Mannar Marine Biosphere Reserve has been divided into two main zones. 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.



The Core zone (Gulf of Mannar Marine National Park)

Core conservation 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. Kurusadai Island with buffer of 1 km of its surroundings has been identified for tourism inside the National Park has been recommanded. Based on a study on impact of tourism on this zone would determine the further course of action related to opening up newer islands for tourism or completely closing tourism inside the National Park. This impact assessment study may be carried out after 5 years from now.

Further, it has been proposed in the Management Plan to identify and include 'Critical Wildlife Habitat' within the Biosphere Reserve and these CWH will then be protected as equivalent to core zones or CRZ 1. For example, critical dugong habitat, important sea turtle nesting beaches, oceanic bird flocking areas, etc.

The Buffer zone - Gulf of Mannar Biosphere Reserve (The Utilization/ Manipulation/Experimental zone)

This zone is proposed to be permitted for local people's use such as fishing and fisheries related activities, tourism and tourism 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

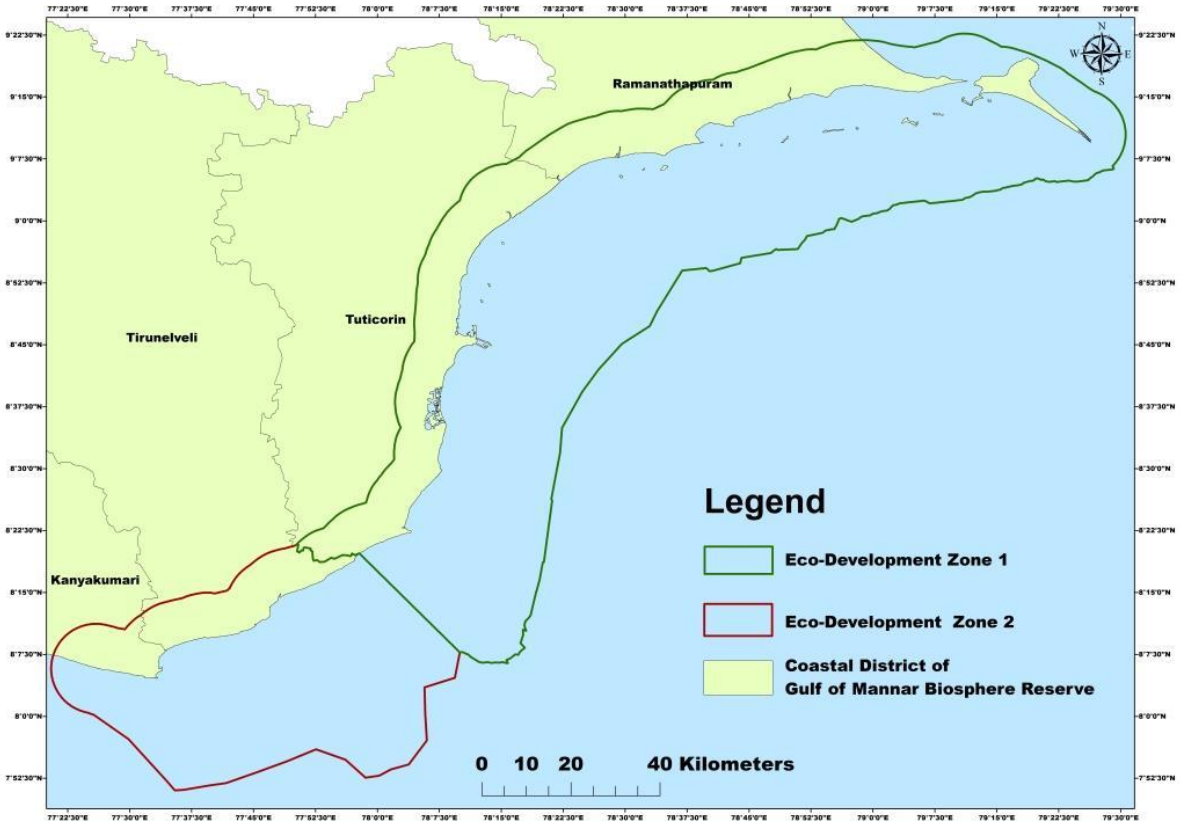
Notification of the Gulf of Mannar Biosphere Reserve the total area of the Reserve is reported to be 10500 sq. km which extend from Dhanuskodi Island to Cape Comorin.

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
10. Research and monitoring

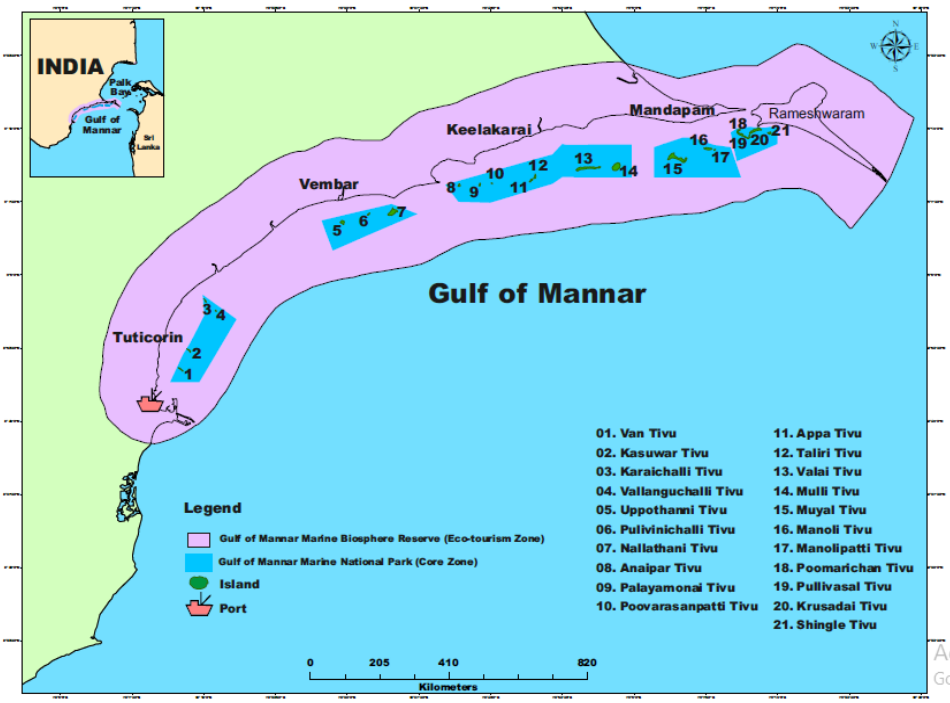
Eco-developmental Zone (Terrestrial)

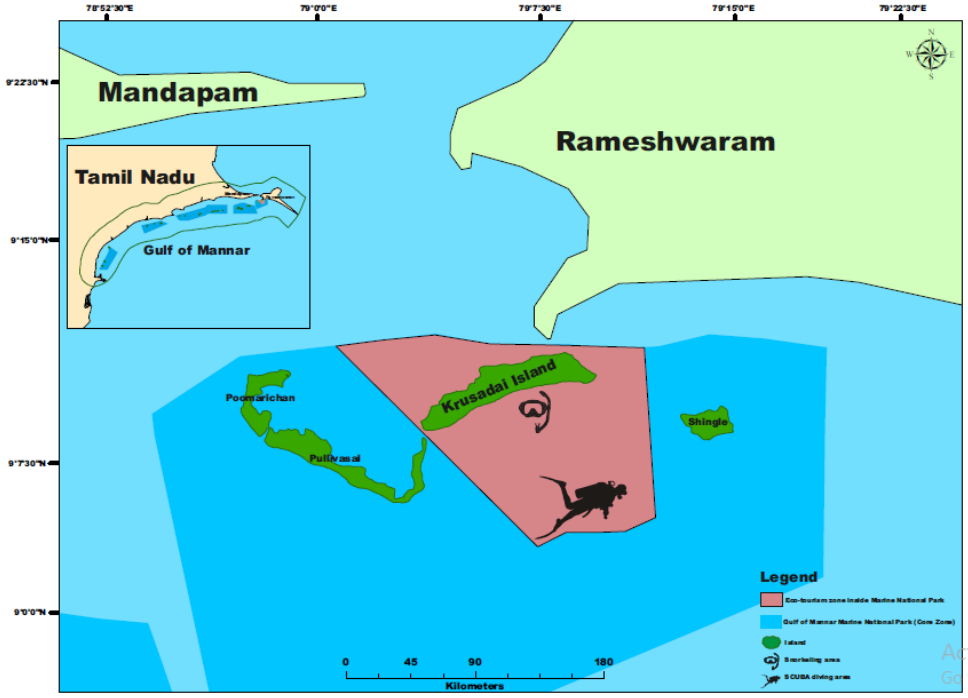
Ten kilometer stretch of coastal land starting from the sea shore all along the Biosphere Reserve are identified as the Eco-developmental (terrestrial) zone. This zone is also to be utilised for multiple use as like the Uilization zone. Drought resistant crops should be promoted in this zone so that extra pressure on marine resources would be minimised becuase of horti and agriculture activities.



Eco-Tourism zone

Eco-tourism zone is proposed to be used for various recreational activities (bird watching snorkeling, coral watching, aquatic sports, diving, sea walk, 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. Kurusadai Island and its surrounding areas has been identified for eco-tourism inside the National Park.





Demarcation of Boundaries

1. 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.

2. 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.

3. 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.

4. Further, demarcation of 'Tourism Zone inside the National Park i.e. Kurusadai Island' by colour buoys is required.

5. It has been proposed in the Management Plan to identify and include 'Critical Wildlife Habitat' within the Biosphere Reserve and these CWH will then be protected as equivalent to core zones or CRZ 1. For example, critical dugong habitat, important sea turtle nesting beaches, oceanic bird flocking areas, etc.

Administration and Protection Strategies

Administration

The coastal and marine protected areas resources are common property resources and activities therein are control by a multitude of stakeholders agency. Therefore, it is suggested to establish the 'Gulf of Mannar Biosphere Reserve Foundation (GOMBRF)' merging both the Gulf of Mannar Biosphere Reserve Authority and the Gulf of Mannar Biosphere Reserve Trust.

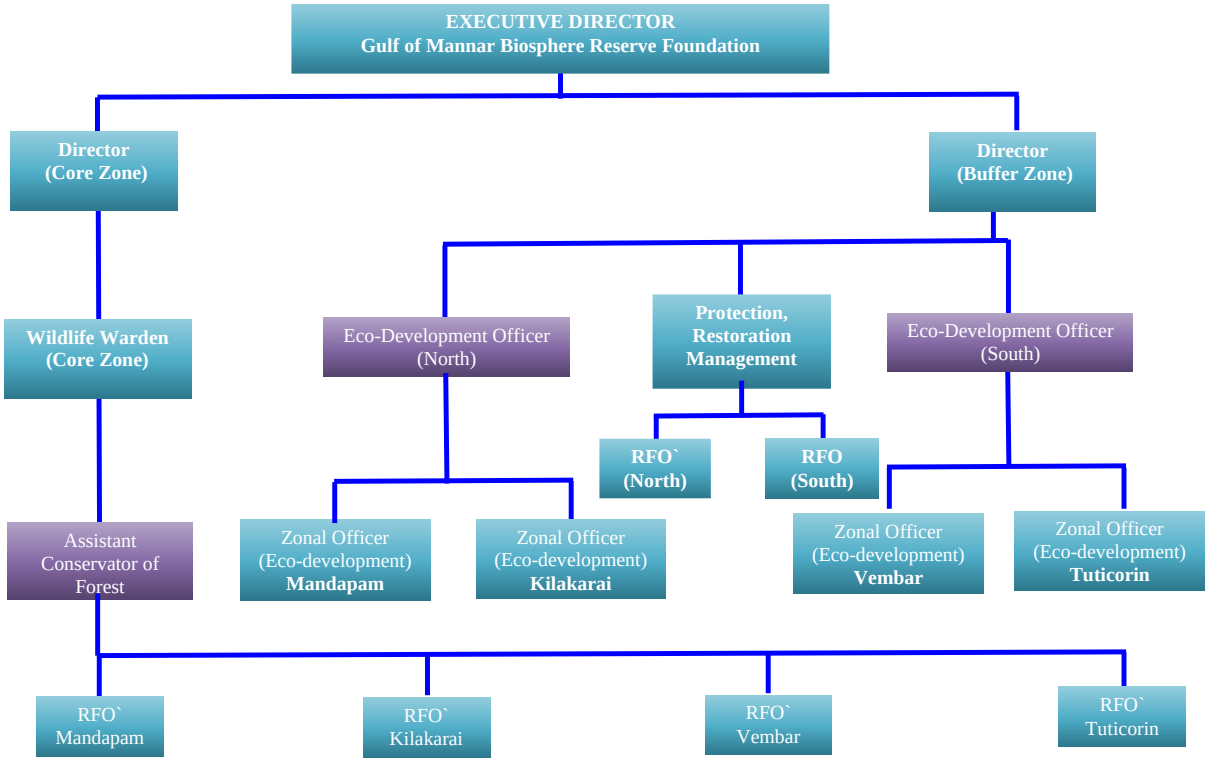
In addition to the funding support from the Government of Tamil Nadu and Government of India, all the developmental projects along coastal regions of entire Tamil Nadu should contribute certain percentage of fund (not less than 5% of the project cost if the project area falls inside CRZ 1 & 3, or Eco-sensitive zones or 1% of the project cost if the project areas in CRZ 2 or within 10 km from the high tide line) as compensation to the GOMBRF.

GOMBRF should also be given responsibility of coordinating the management of all coastal Protected Areas of the State including Dugong and Sea turtles recovery programs.

All industries in the Gulf of Mannar Biosphere Reserve region should contribute 10% of their CSR fund to the management of Biosphere Reserve.

This CSR grant should be used largely for Eco-development related activities that are beneficial for the livelihoods generation of the local communities.

Proposed unified Administrative Setup of the Gulf of Mannar Biosphere Reserve Management i.e. Gulf of Mannar Biosphere Reserve Foundaton.



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, GOMBRF	**- Member Secretary**
Representative from MoEFCC, GOI	**- Member**
Director, AIWC, TNFD	**- 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**
NGOs Representative (Two members)	**- Invited Member**

Protection Strategies

1. Except research, monitoring of biodiversity and restoration, no other activities is proposed to be permitted in the core zone (except Kurusadai Island where tourism allowed).
2. 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.
3. 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.
4. Minimum of two forest watchers should be posted in each of the island with a motorboat and communication systems.
5. People who are posted on the island needs to be given special incentives with free rations, and their stay on the islands should not harm the biodiversity at any level.
6. 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.
7. 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.
8. Creation of 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 Plan.
9. Creation of new posts with adequate logistics for operation, as per proposed under 'Gulf of Mannar Biosphere Reserve Foundation'.
10. In addition to the existing patrolling vehicle and vessels, 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.

11. In addition to the above, each of the Range must have a patrolling vehicle as well as smaller vessel (speed boat).

12. 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.

13. 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

14. Creation of a 'Anti-poaching squad 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 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.

15. Maintenance of data base on offenders

16. Special incentives should be provided for patrolling squad and those who stay in islands for patrolling and monitoring. Free rations should also be provided to those stay at the Patrolling camps at island.

17. Scuba training needs to be provided to frontline staff who are part of the patrolling and monitoring activities.

Management of Core Zone (Gulf of Mannar National Park)

Gulf of Mannarharbours a diverse of life forms. If not all, most creatures still experience severe threats from different faces such as over exploitation of resources, habitat degradation, invasion of exotic, illegal extraction, indiscriminate fishing and pollution. Dugongs, Dolphins, Whales, Turtles, Corals species, sea horses, sea cucumbers, and several other organisms are worthy of the need of significant conservation measures.

Species Recovery Programs

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.

1. **Dugong**
2. **Sea turtles**
3. **Holothurians**
4. **Lobsters**
5. **Sea horses and pipe fishes**
6. **Important Crabs**
7. **Sea snakes**
8. **Coastal birds**

Recovery of Dugongs

The Gulf of Mannar area is the last refuge of any significance off the Indian coast where the most endangered mammal, Dugong (*Dugong dugon*) occurs. Here, 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 which poses as destructive factors to seagrass beds. The Dugong feeds only on seagrasses and requires 30-40 kg of them every day. Seagrasses are also fed upon by various herbivorous animals including turtles, fishes, etc. Megaherbivores that depend on segrasses, control the community structure of the seagrass meadow by grazing. The meadows which are often grazed by Dugongs consists of fast growing species of seagrasses like Halophila and Halodule, which have relatively high nitrogen content to fibre content.

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.

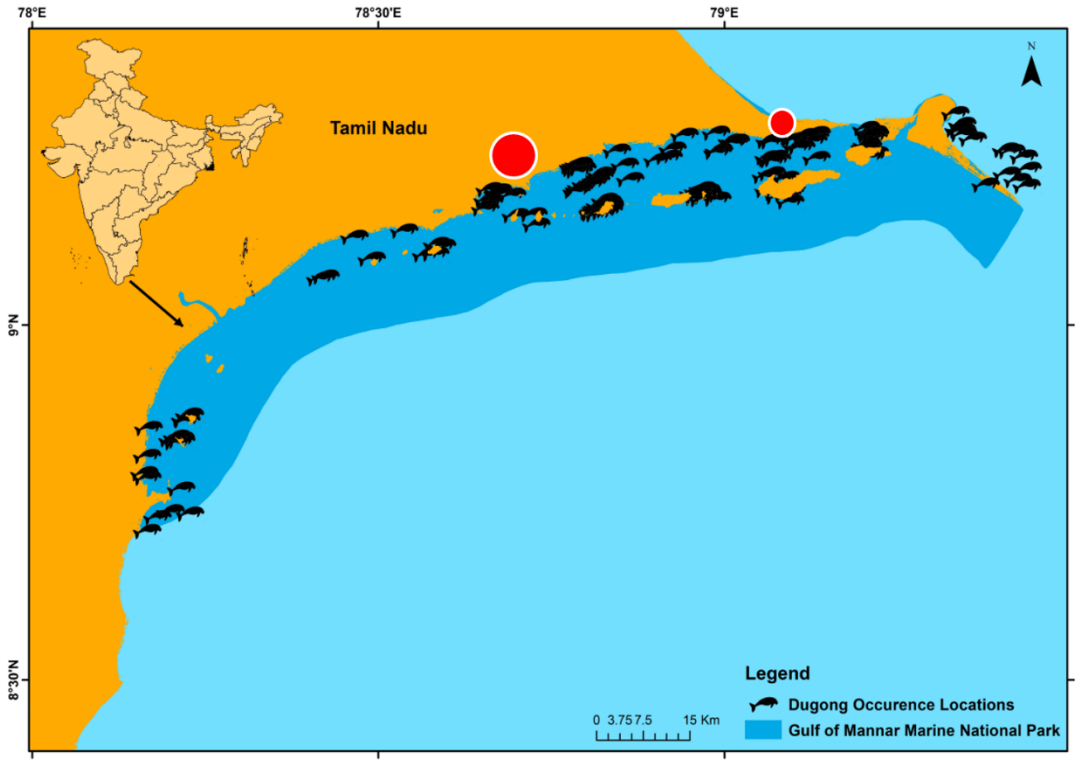


Figure 1 Critical dugong habitats of Biosphere Reserve

1. Recovering dugongs in Biosphere Reserve entails targeted, multidisciplinary research that flows into management actions and advocacy for policy changes. Therefore, dugong recovery program aims at: (a) assessing and monitoring Dugong population and habitat status; (b) implementing site specific management actions to recover populations and restore critical habitats; (c) incentivizing participatory conservation efforts involving local stakeholders; and (d) improving the capacity of enforcement and management agencies to promote integrated protection and management of Dugong and associated species.

2. At present, CAMPA-Dugong Programme of Wildlife Institute of India and Dugong Recovery of Programme of TBGP of Tamil Nadu Forest Department has been integrated and implemented in the region with help of various stakeholders that needs to be continued till end of this Management Plan.

3. Monitor the dugong populations with help of the Indian Coast Guard and the Indian Navy and also Marien Police.
4. Create a network of 'Friends of Dugong' with fishermen youths

5. Expand the 'Dugong Ambassador with Dugong Scholarship' scheme that has been implemented in the Palk Bay by CAMPA-Dugong Project to Biosphere Region.
6. Provide incentives (cost of damaged fishng nets and their two days wages) to fishermen who rescue and release back incidently caught dugong.
7. 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 and it should be monitored requlary.
8. Efforts are required to manage the Critical Dugong Habitats inside the buffer zone of Biosphere Reserve. WII has already identified these habitats that need to be monitoring.
9. Assess the populations of dugongs using various census techniques and establishment of marine mammals rescue and rehabilitation facilities in all three states.
10. Prevent the further decline of sea grass beds by eliminating the causes of decline such as pollution, indiscriminate fishing etc.
11. Extending the present sea grass distributional limit to the historical distributional limit.
12. Prohibition of trawling fishing on the sea grass beds.
13. Awareness programme in the catchment area regarding the excessive use of pesticide and other chemicals and its impact.

Recovery of 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 (Lepidochelysolivacea), green (Cheloniamydas), hawksbill (Eretmochelysimbricata) and leatherback (Dermochelyscoriacea. 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.Beach erosion due to both man made and natural phenomena, have reduced the nesting habitats and resulted in a drastic decrease of sea turtle nesting in the Biosphere Reserve. Moreover, beach armouring with exotic plantations, artificial illumination and tourism are few other threats to the nesting beaches and hatchlings. Hence, it is recommended:

1. Continuously monitor the nesting beaches and avoid exotic plantation within 500 m from the high tide line and also manage vegetations on the beaches. Further, it is recommended to protect the beaches and turtles with help of 'Network of Turtle Watchers'.

2. Protect the beaches and turtles with help of 'Network of Turtle Ambassadors' that can be created with help of senior school children and college students.

3. Take up beach management and hatchery programmes as per the manual has jointly been prepared by MoEF (GOI), UNDP, WII and MCBT on this subject can be used in the important turtle nesting areas.

4. All important turtle nesting areas of the Biosphere Reserve identified by WII in this Plan, that need to be protected and monitored.

Holothurians

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 *Apostichopusjaponicus. Holothuriascabra* or sandfish seem to be the ideal tropical holothurian most suited to restocking in the western Pacific and Southeast Asian waters (FAO).

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.

Lobsters

Stock enhancement and fattening of lobsters*Panulirushomarus*and *P. polyphagus* in this region is expected to improve the livelihood of the coastal fishermen who are fishing in the buffer zone of the Biosphere Reserve.

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.

Sea horse & pipe fishes

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.

Important Crabs

Of the 11 important commercial crabs in India, six crab species occur in BR. It is essential to enhance the stock of these 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.

Sea snakes

A total of 12 species of sea snakes have been reported in the Gulf of Mannar region. A public awareness programmefor fishermen in the Gulf of Mannar region is useful to prevent killings of these snakes that are incidently entangled in their fishignnets.

Coastal Birds

A total of 187 species of birds were reported from the Gulf of Mannar Marine National Park, of which 84 were aquatic species and the remaining are terestrial.

Long term monitoring of birds especially the coasta and oceanic birds and their flocking grounds on the islands needs to be initiated.

A bird watching centre, with some basic infra structure like a watchtower and an interpretation centre can be established in Danushkodi.

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	√	√	√		√	IUCN, IWPA, CITES	WII, MCB
2	Dugong	√	√	√		√	IUCN, IWPA, CITES	WII
3	Sea horses & pipe fishes	√	√	√	√		IWPA	CASMS, CMFRI
4	Lobsters				√			TFCRI, CMFRI, CFRI, CASMS
5	Holothurians	√	√	√	√		IWPA	CMFRI, TFCRI
6	Reef fishes	√		√	√			CMFRI, TFCRI
7	Balanoglossus	√	√	√				TFCRI, SDMRI
8	Sea snakes	√						WII
9	Commercially important crabs				√			CASMS, TFCRI, CMFRI

Habitat Recovery Programs in the National Park

All important habitats of National Park are required to be monitored and some areas need the restoration of habitats such corals etc. The assessment of biodiversity, (corals, mangroves, sea grass etc.,) socio economic value of the coastal region, biological connectivity and its status should also be monitored.

Recovery of Coral reef ecosystem

Corals and coral reefs of Gulf of MannarNational Park form an essential ecosystem, which supports a variety of ecologically and economically important marine life. Coral reefs in Gulf of Mannar occur mainly around the 21 uninhabited islands encompassing an area of about 683 ha. The islands in Gulf of Mannar Marine National Park are divided into three groups namely, Mandapam group (7 Islands), Keelakarai group (7 Islands) and Tuticorin group (7 Islands). The islands of Mandapam group are Shingle, Krusadai, Pullivasal, Poomarichan, Manoliputti, Manoli and Hare; those of Keelakarai group are Mulli, Valai, Thalaiyari, Appa, Poovarasanpatti, Valimumai and Anaipar; and those of Tuticorin group are Nallathanni, Puluvinichalli, Upputhanni, Kariyachalli, Vilanguchalli, Koswari and Vaan. Among these 21 islands, Vilanguchalli in Tuticorin group and Poovarasanpatti in Keelakarai group have already submerged under the water a few decades ago. Coral mining had been the chief reason for this loss.

1. A stricter Vigilance, Protection and Monitoring need to be enforced inside the National Park where corals are dominant.

2. 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.

3. Scaling up of coral rehabilitation activity in degraded reef areas in all islands. 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.

4. Regular maintenance and monitoring of rehabilitated coral sites are also equally important.

5. Development of artificial reef sites outside the Marine National Park Area for biodiversity enhancement particularly natural coral recruitment and fish production

6. Capacity building of officers and frontline staff towards marine biodiversity identification and monitoring with SCUBA diving and Snorkeling.
7. 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.
8. 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
9. 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)
10. Co-ordinate and collate information into an open data database at the GOMBR research and monitoring laboratory.
11. 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.

Seagrasses Habitat recovery

1. Long term monitoring 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 to seagrass beds.
3. Strict prohibition of fishing on the sea grass beds that 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 inititated with help of nearby professional organizations.

5. Awareness programme in the catchment area regarding the excesive use of pesticide and other chemicals and its impact
6. 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 of Mangroves

In general, Gulf of Mannar islands possess some unique type of mangrove vegetation. In this study, a total of10 true mangrove species were identified belonging to 6 families of 6 order. The mangrove species *Avicennia marina* is recorded in 14 islands and *Pemphisacidula*is from 13 islands. *Pemphisacidula*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 *Agicerascorniculatum*is found only in Krusadai and similarly *Bruguieragymnorrhiza* is recorded only in Manoli. However these two species are found in these two islands in very low abundance. *Bruguieracylindrica* and *Excoecariaagallocha* are shrubby and found mixed within the spaces of *Avicennia marina mangroves* in Mandapam group of islands.

1. It is important to undertake long-term research and monitoring studies of the mangrove ecosystems of GOMMNP with reference to the critical EBSA parameters like uniqueness or rarity, the vulnerability and fragility of the system, importance for threatened, endangered or declining species and/or habitats; and the biological diversity and productivity of the system.

2. Integration of traditional knowledge, innovations and practices of the local fishermen community can contribute significantly in the description and management of the mangrove ecosystems of the island and the shore. Documentation of such knowledge and practices would help the department of effectively engage the local community in the forest management.

3. Activities that aim to accelerate natural regeneration of desirable mangrove species need to be promoted by taking into consideration of the ecological and biological characteristics of each of the island of the National Park and other key locations of the Reserve.

4. The Forest department may be in association with the national institutions like NIOT and INCOIS can effectively use the tide and sea level data and climate change predictions to design and implement

the necessary activities that directly benefit to mitigating, and adapting with climate vulnerabilities.

5. Mapping of the degraded locations across the National Park and the Reserve has to be immediately undertaken with reference to both natural and man-made barriers and threats to ecosystem like salinity intrusion, soil degradation, grazing, and over harvesting. This has to be done by combining both remote sensing techniques and on the ground monitoring studies.

6. Planting in the intertidal mudflats (if mangroves historically occurred there) with most suitable mangrove species of the region has to be taken up in partnership with local community. Involve the trained local youth in planning, implementing and monitoring the mangrove plantations;

7. The need for meaningful partnership building with the Forest Department, Forest Research Organizations and NGOs working for the sustainable forest management appears urgent. Such a partnership and coordinated efforts will help to generate more funds on a regular basis from appropriate funding institutions in India and abroad.

8. 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.

9. Minor topographical alterations at mudflats (only those mudflats that had mangroves earlier) existing near the mangrove, opening of already dug-out trenches will facilitates the distribution of propaguleupto 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.

10. 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 was well as documented monitoring process.

Management of Buffer Zone of the Biosphere Reserve

Buffer Zone of the Gulf of Mannar Biosphere Reserve 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 10500 sq. km, which extend from Dhanuskodi Island to Cape Comorin.

Management of Pollution

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. The management actions have been prescribed to abete pollution in the region;

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. 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).
2. 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. The coastal region should be announced as protected area and the pollution creating activities should be monitored and got rid of.
4. 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.

5. 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

6. River Tamirabarani itself carries household wastes, garbage, industrial wastes and corporation debris. Creating activities regarding minimizing the pollution in river Tamirabarani also creates effective results in GOM region. Activities of industries in and around Tirunelveli and Tuticorin district should monitored.

7. It is proposed to initiate plantation around polluted saltpans for desalination: *Salicornia* sp.,/*Avicenia* sp. may be considered for this purpose.

8. 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.

9. 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.

10. 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.

11. Establish and empower community based coastal management committees, councils, agencies and enhance the community to identify a variety of issues and problems. Within the pollution hotspot areas an integrated EIA is very much essential to control the coastal pollution.

12. The raising of public awareness of importance of coastal region and threats to entire gulf. For this, the production and publication of awareness material especially using electronic media, broachersm AV CD's and other media is essential.

13. Sometimes ships also create pollution to coastal region such as i) ship or boat collision, grounding in coastal lane, ii) discharge of seawage from ship, iii) boat/ship solid waste, iii) oil spills iv) illegal disposal of toxic wastes.

13. Study regarding the pollution and risk assessment, EIA, Species distribution and other monitoring studies shall be given to universities, colleges and to other agencies. Some of the key studies to consider

- Biodiversity
- Environment & ecosystem properties
- Monitoring of flora and fauna
- Environmental impacts of (natural and man maid)
- Fisheries
- Economic valuation of GOM region

Species Recovery Programs in Buffer Zone

Dugong

1. Recovering dugongs in Biosphere Reserve entails targeted, multidisciplinary research that flows into management actions and advocacy for policy changes. Therefore, dugong recovery program aims at: (a) assessing and monitoring Dugong population and habitat status; (b) implementing site specific management actions to recover populations and restore critical habitats; (c) incentivizing participatory conservation efforts involving local stakeholders; and (d) improving the capacity of enforcement and management agencies to promote integrated protection and management of Dugong and associated species.
2. At present, CAMPA-Dugong Programme of Wildlife Institute of India and Dugong Recovery of Programme of TBGP of Tamil Nadu Forest Department has been integrated and implemented in the region with help of various stakeholders that needs to be continued till end of this Management Plan. GoMBRF may continue the implementation of all conservation actions initiated by CAMPA-Dugong Project after 2020.
3. Monitor the dugong populations with help of the Indian Coast Guard and the Indian Navy and also Marien Police.
4. Create a network of 'Friends of Dugong' with fishermen youths
5. Expand the 'Dugong Ambassador with Dugong Scholarship' scheme that has been implemented in the Palk Bay by CAMPA-Dugong Project to Biosphere Region.
6. Provide incentives (cost of damaged fishng nets and their two days wages) to fishermen who rescue and release back incidently caught dugong.
7. 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 and it should be monitored requlary.
8. Efforts are required to manage the Critical Dugong Habitats inside the buffer zone of Biosphere Reserve. WII has already identified these habitats that need to be monitoring.
9. Assess the populations of dugongs using various census techniques and establishment of marine mammals rescue and rehabilitation facilities in all three states.

10. Prevent the further decline of sea grass beds by eliminating the causes of decline such as pollution, indiscriminate fishing etc.
11. Extending the present sea grass distributional limit to the historical distributional limit.
12. Prohibition of trawling fishing on the sea grass beds.
13. Awareness programme in the catchment area regarding the excessive use of pesticide and other chemicals and its impact.

Sea turtles:

Continuously monitor the nesting beaches and avoid exotic plantation within 500 m from the high tide line and also manage vegetations on the beaches.

Protect the beaches and turtles with help of 'Network of Turtle Ambassadors' that can be created with help of senior school children and college students.

Take up beach management and hatchery programmesas per the manual has jointly been prepared by MoEF (GOI), UNDP, WII and MCBT on this subject can be used in the important turtle nesting areas.

All important turtle nesting areas of the Biosphere Reserve identified by WII in this Plan, that need to be protected and monitored.

Community based Turtle Conservation cum - Tourism may also be tried (e.g. Malvan coast, India; and Sri Lanka).

Stock enhancement of commercially important species

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.

Conservation of protected sharks in Gulf of Mannar National Park and Biosphere Reserve

The relevance of the Gulf of Mannar ecosystem to shark species and diversity cannot be overstressed. The pristine coral reef habitats in the Gulf of Mannar ecosystem provide the perfect aggregation grounds for breeding and feeding populations of several fish groups, including sharks. The park includes estuaries, mudflats, beaches and forests of the near shore environment. It also includes marine components such as coral reefs, seaweed communities, sea grasses, salt marshes and mangroves, all of which are critical and key habitats that promote such aggregations. There are several records of the earliest sightings, strandings and landings of different species of sharks along this coast. Raje et al. (2007) has noted that the Gulf of Mannar is rich in elasmobranch diversity and sharks were being regularly exploited in this region. Although consumption and grade were on a low scale in early years, increase in market demand in recent years have promoted while body utilisation of sharks, including trade for shark oil. Over exploitation of sharks in the region diminished its populations, therefore, the following recommandations have been suggested to sustainably manage their populations in GoMBR;

1. Immediate documentation of current fishing grounds on a spatio-temporal basis with respect to shark resources – this can be done on a participatory approach.
2. Data sharing between fishers and government research/implementation agencies can be made mandatory through educating the fishers about the biological vulnerability of shark resources. Such data can be used to identify seasons and grounds of shark aggregations for feeding and breeding and can be more effective in determining closed seasons, closed grounds and gear restrictions.
3. Occurrences (sightings and incidental catches) of protected species, particularly the whale shark, pondicherry shark, all sawfishes, giant guitarfish and porcupine ray, and the CITES listed species – hammerhead sharks, oceanic white-tip shark, manta rays, thresher sharks, silky shark and devil rays, must be mandatorily reported to the monitoring agencies. Wherever possible details regarding grounds, gear, weight of catch, numbers caught etc. must be recorded and shared.
4. While the GoM MNP is under strict regulation, seafaring activities like shark ecotourism can be encouraged in the GoM BR, to reduce shark fishing and offer alternate livelihood means for the fishers. Spotting and swimming with the whale shark can be promoted along the lines followed in countries like Australia and South Africa.
5. The impact of habitat degradation in the GoM BR due to anthropogenic and natural factors can be mitigated by

deploying coral embedded artificial reefs to increase the coral reef spread.

6. There should be a widespread awareness campaign in the region and fishers and locals should be educated about vulnerable shark resources ad the need for conservation and management. Posters, pamphlets and handouts can be distributed for generating awareness. Research agencies like CMFRI and NGOs can play a major role in these campaigns.
7. Continuous monitoring of shark occurrences and landings must be done to establish a strong database that will easily reflect changes in fishing and landing patterns as well as trade and utilisation, following the implementation of regular action plans which can be altered according to the status of the resource.
8. Strong linkage must be made mandatory between different agencies including research bodies, legislative and management implementing authorities, monitoring agencies, NGOs, fishermen associations, trader associations etc. with all the agencies working towards a common goal which protect the habitat, he resource and the interests of the primary stakeholders without affecting their livelihood.

Management of Molluscan Diversity in Biosphere Reserve

Molluscans are important for maintaining the integrity of marine ecosystem and its functioning. Gastropods are either grazers, predators of invertebrates or scavengers. They control the excessive algal growth by grazing the rock surfaces and check the outbreaks of nuisance invertebrates. The gastropod, giant triton (*Charoniatritonis*) is one of the species that feeds on the crown-of-thorns starfish (*Acanthasterplanci*), which can cause massive destruction to the coral reefs. Even though *C. tritonis* is a potential *A. planci* predator, its effect of predation on populations of *A. planci* has been questioned. However, their populations and their habitats have been over exploited. The following conservation action could recover the molluscans and their habitats in GoMBR;

1. Inventorization of molluscan diversity of the Gulf of Mannar Biosphere Reserve with reference to pollution and economic importance.

2. Mapping and monitoring of all critical mollucan beds of the Biosphere Reserve

3. Legally protected molluscans are exploited in and illegally traded as curios across coastal tourist and pilgrim centers of Tamil Nadu. High market demand coupled with lack of awareness and inadequate enforcement is the major driving force for illegal marine curio trade. Therefore, adequate awareness programs need to be conducted.

4. Patrolling on critical molluscan beds on regular basis

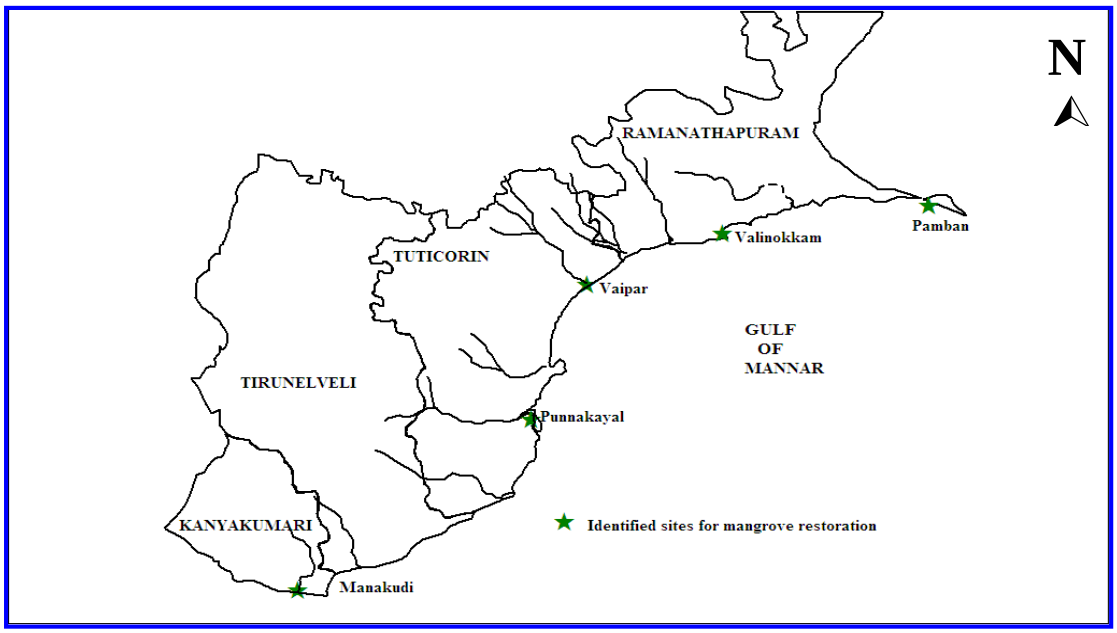
5. Necessary laws should be enforced by the wildlife/forest officials, along with educational and awareness programs and also promoting alternate resource of livelihood for seashell/coral collectors can curb the illegal marine curio trade

Habitat Recovery Programs in buffer zone of Biosphere Reserve

Seagrass Habitats

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. Extending the present sea grass distributional limit to the historical distributional limit. Habitat restoration of the sea grass beds needs to be inititated with help of nearby professional organizations.
4. Awareness programme in the catchment area regarding the excesive use of pesticide and other chemicals and its impact
5. 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.

Identified areas for mangrove restoration along the coast in the Gulf of Mannar Biosphere Reserve



Map not to scale

Suitable species for mangrove restoration:

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.

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).

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.

Integrated and Sustainable Management of fisheries in Gulf of Mannar Biosphere Reserve

Gulf of Mannar, located in the southeast coast of India, is a distinctive marine ecosystem bestowed with rich biodiversity. During 19th century, the fisheries was the only source of sustenance for a segment of the population living in the coastal region. Fishing in general was a profession carried on from generation to generation with almost all the members of the family taking part in it to varying degree. The socioeconomic condition of fishermen was very poor. The fishermen belonged to the lowest stratum of society and fishing was generally regarded as one of the meanest of all trades and profession. The following necessary resource management and conservation initiatives are needed to arrest the decline of marine natural resources;

1. Necessary resource management and conservation initiatives are needed to arrest the decline of marine natural resources. Marine fisheries is basically harnessing a natural resource and therefore its management must be anchored on knowledge- based interventions generated through close monitoring of their distribution, abundance, exploitation, population dynamics and fluctuations of fish stocks in relation to natural factors and anthropogenic interventions.

2. Communication gap between primary stakeholders (fishers) and Biosphere Reserve Authority should be minimized.
3. An inter-institutional collaborative management programme i.e. between Department of Forest and Department of Fisheries, Government of Tamil Nadu and other institutions can strengthen the conservation objectives into reality.
4. The critical fish breeding distribution area in the Biosphere Reserve needs to be mapped and informed to fishermen accordingly for sustainable fishing over there.
5. Documentation of the catch and fishing operations should be made mandatory.
6. Awareness programs should be organized for minimizing catch of juveniles and other bycatch using slightly increased mesh size.
7. Strict enforcement of State and Indian Fisheries acts that promote the sustainable fisheries in the region.
8. With help of CIFT, Kochi, an appropriate gear and craft need to be developed for Biosphere Reserve region to minimize the bycatch and damage to corals, seagrass and oyster beds. These gears may be offered to fishermen at the discounted rate by the BR authority.
9. Enforcement of closed season on important breeding grounds can ensure the long term sustainability of fishery resources. Appropriate compensation required to be provided to fishermen during the closed season.

10. Ranching of suitable candidate species needed for stock enhancement inside the National Park (core zone). Spill over populations of these species in the Biosphere Reserve (buffer zone) may be harvested by the fishermen.
11. The alternative livelihood opportunities such as crab fattening, mussel culture, seaweed farming, fish rearing in floating cages and existing near shore natural ponds can be provided. Only native fishes and weeds need to be used in this programme.
12. Encourage the fishermen youths to participate in the proposed ecotourism activities which can generate the extra income for their livelihood.
13. The research should be promoted on the environmental and social impacts of fishing nets and their impacts on biodiversity and Biosphere Reserve fishing communities.

Rescue and Rehabilitation of Marine Animals

Stranding of marine animals such as whales, dolphins, dugongs, turtles, etc have been observed frequently in the Gulf of Mannar Biosphere Reserve. Mostly, due to lack of adequate facilities and capacity, those stranded animals either let die or released back without any first aid but with injuries. However, stranded marine mammals have long attracted public attention. Those that wash up dead are, for all their value to science, seldom seen by the public as more than curiosities. Animals that are sick, injured, orphaned or abandoned ignite a different response. Generally, public sentiment supports any effort to rescue, treat and return them to sea.

1. A Marine Animal Rescue and Rehabilitation Facility (MMRRF) has been suggested to establish at Mandapam in collaboration with CMFRI with all required logistics including a 'Rapid Rescue Action Force'..
2. All marine animals stranded alive may be treated here and released back safely to the sea.
3. It is not advisable to bring all stranded alive animals to the rehabilitation centre. Only injured animals required to be transported to MMRRF and after treatment they should be released back.
4. All marine mammals and sea turtles can be treated here.
5. Other marine animals are treated here if require.
6. This centre need trained veterinarians and a rescue team with adequate training and logistics.

Management of Invasive Species in the Biosphere Reserve

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 *Prosopisjuliflora, Acacia spp., Parthenieum (which occurs on almost all islands) and Kappaphycusalvarezii.*

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 *Kappaphycusalvarezii***:** 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

MannarBiosphere Reserve whenever required and implement those actions.

4. 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.
5. 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.
6. Preventing the introduction of alien invasive species is the cheapest, most effective and most preferred option and warrants the highest priority.
7. 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.
8. 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.

9. **Management of other invasive species:**

    a. Both the Ministry of Environment, Forest and Climate Change (GoI) and Tamil Nadu Forest Department supported SDMRI to carry out studies on Kappaphycus ecology and its management in islands. However, a long term monitoring study on Kappaphycus is essential to monitor its spread, so that it can be controlled better.

    b. Regular manual removal and monitoring by the National Park Authority has helped to control the invasion of *K. alvarezii* at Krusadai Island, while in Mulli Island most corals have not so far been affected. The removal of the seaweed has also helped to control a further invasion at Shingle Island. In addition, the cessation of *K. alvarezii* cultivation for over 18 months, due to the occurrence of 'ice-ice disease' on the alga, has also helped in controlling the invasion. However, the rapid regrowth of the alga after removal poses a big challenge to conservation managers in protecting the corals in the GoM from the invasion of *K. alvarezii*, because regular removal and monitoring uses a considerable proportion of yearly budgets. But, fund constraint should not be an excuse for allowing this species to spread in Biosphere Reserve and destroy the overall

biodiversity. Therefore, it is suggested to monitor and remove the Kappaphycus on priority basis with help of Self Help Groups.

b. Removal of all major invasive species especially Prosopis 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. There should not be any introduction of exotic species in the region even the commercially important exotic fishes.
g. It is also suspected that there are occurrences of some more 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

Disaster Management

The Gulf of Mannar Biosphere Reserve comes in the "Semi-Arid" under the classification of the bioclimatic zones of India. Therefore, it is prone to drought. It comes under the 'East-Coasts (8B)' zone in the bifurcation of the different biogeographic zones of India classification by Rodgers et.al. (2002) and biogeographic province of Deccan Peninsula-Deccan South (6E).

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 capsize of marine vessels with chemical hazards etc. In this background, the GOMBR management plan has included this Disaster Management plan for the period 2018-2027.

1. 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.

2. 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 inprinciple 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 Sethusamutharam 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 occured 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.

Climate Change Adaptation Plan

The coastal and marine Protected Areas with corals, seagrasses and mangroves are considered as one of important mitigations measures to the ongoing climate change. However, these coastal habitats are also vulnerable to climate change if corrective measures are not taken on time. In this context, this Management Plan has identified corals, seagrasses, dugongs, sea turtles and mud flats as highly vulnerable habitats/species to climate change and it would adversely affect the livelihoods of local communities in long run. This Planis built on four main objectives that aimed to maximise the resilience of the marine ecosystems of GoMBR to a changing climate: Targeting science, building ecosystem resilience, supporting adaptation of fishing industries and communities, and reducing climate footprints.

1. Activity in the National Park and the Biosphere Reserve should be closely monitored and regulated such that no alteration or dilution is carried out on the existing zone of influence (buffer zone) so as to buffer the National Park and thereby conserve the biodiversity of the area. Thus, GoMBRT should be strengthened with extending its activities till Kanyakumari and also along Palk Bay coast in near future.
2. Maintenance of a Mangrove plant nursery, so that if somehow mangrove plants on island and along coast die due to climate change or disease. In this condition we can manage the green cover.
3. Strengthening the people participation in the management of Buffer Zone
4. Promote drought resistant crops in these coastal districts.
5. Partnership with GoMBRT and other line agencies would enable valuable advances in adaptation, especially in the development and testing of strategies for building ecosystem resilience.
6. **Ecosystem based Approach:** A healthy National Park and Biosphere Reserve enhances the resilience of the ecosystem to adverse impacts of climate change; a resilient ecosystem reduces the vulnerability of fishing industries and communities that depend on the Biosphere Reserve.
7. Ecosystem-based adaptation strategies should minimise other anthropogenic stresses that have degraded critical ecosystems and thereby undermined their resilience to climate change. Such stresses include unsustainable harvests, habitat degradation, non-native species and pollution.
8. Ecosystem-based adaptation measures are more successful when the local population participates in both planning and implementation. Therefore, it is suggested to involve local communities, school and colleges, religious groups and working class to help in creating better involvement.

9. Ecosystem-based adaptation presents a tangible opportunity to solve climate change problems by aligning conservation, development and poverty alleviation interests. Benefits are shared through the collaboration between local communities, conservationists, natural resource managers, private sector stakeholders, and the various levels of government and non-government institutions involved in social development and conservation issues.
10. Successful adaptation depends on integrating ecosystem based adaptation initiatives with other risk management components, such as early warning systems and awareness-raising, and in some cases with physical infrastructure. It is important to encourage and enable technology transfer and dialogue between planners and practitioners with expertise in hard engineering and in ecosystem management.
11. A core objective of the Adaptation Strategy of National Park is to improve the capacity of managers to build the resilience of the various marine ecosystems of National Park and Biosphere Reserve ecosystem. In this context, objectives will be met by activities that focus on reducing or offsetting risks, and developing tools to support management decisions.
12. Communication plays a critical role in nearly every aspect of climate change adaptation. A foundational objective is effective communication to support implementation of our Adaptation Strategy. Therefore, it is suggested to improve the accuracy, availability and delivery of communication materials to support climate change adaptation of Gulf of Mannar Marine National Park.
13. Collaboration with local communities, educational group, industry groups and other organizations that influence or are influenced by the Marine National Park will be essential in successfully carrying out activities to support the strategy objectives.

Interpretation, Education, Eco-Tourism and Visitors Management Action Plan

Eco-tourism known to promotes the National Integration and Internatioanl understanding and also creats awareness among people about the importance of biodiversity and their ecological services. The World Conservation Union [IUCN] defines ecotourism as "environmentally responsible travel and visitation to relatively undisturbed natural areas, in order to enjoy and appreciate the nature (and any accompanying cultural features-both past and present) that promotes conservation, has low negative visitor impact, and provides for beneficially active socio-economic involvement of local communities. Therefore, this Management Plan prescribes various actions that would mutually beneficial for both National Park and People through 'Eco-Tourism' inside and outside the National Park.

The coastal landscape and seascape in the Gulf of Mannar Biosphere Reserve with multifarious tourist attractions and 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.

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 consider 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 suppor 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-visuals, 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.

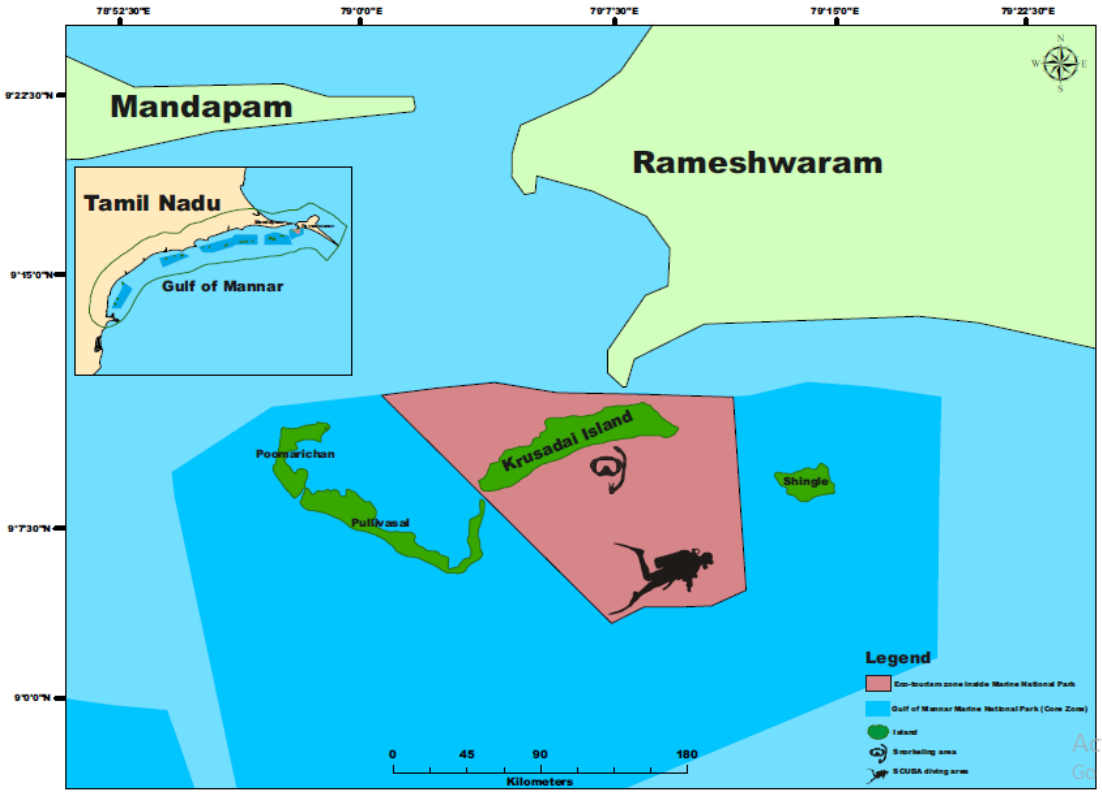
The proposed state of the art **Marine Conservation Interpretation cum Education Center(MARCONI)** and Information centers were recommended in the previous Management Plan too but it was not implemented probably due to logistic constraints. But, they are still relavant and required, therefore, it is herewith recommended to establish MARCONI and information centers 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. Idle site for MARCONI is near Mandapam, which is close to the Kurusadai Island (Tourism Zone).

Zoning

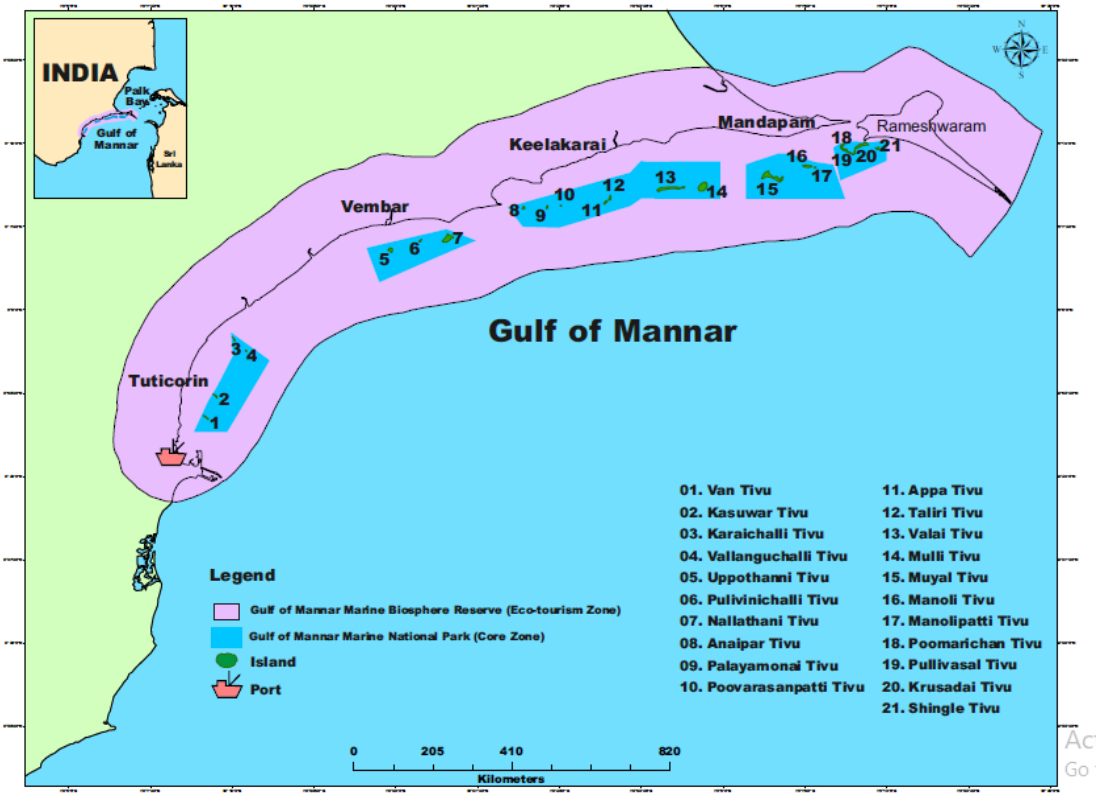
It is the principle method used to deploy visitors and hence it is critical in achieving the appropriate combination of concentration and dispersal. It involves decisions about the type of recreational opportunity that would be provided and in which area of the Biosphere Reserve. It can also be temporal i.e. an area set aside for different uses at different times seasonally. Zoning is an essential part of all protected area management plans, from the tourism point of view resourse 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 below. 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 reecreatinal tourism activities. Mandapam can be developed as

an important tourism site from where these coral reefs can be assessed by glass bottomed boats.

Kurusadai Island and its surrounding sea areas as mentioned in the map (below) is the only area inside the National Park has been identified for tourism zone inside the National Park. All eco-tourism activities need to be resitricted only inside the tourism zone i.e. Kurusadai Island, buffer zone (Biosphere Reserve) and reefs around the Rameshwaram Island.



Entire tourism zone should be a plastic free zone and there should not be any concrete structure established for tourism on the Kurusadai Island except two watch towers, one at eastern most point and another at western most point of the island. One patrolling and monitoring camp need to be established for the forest staff using fibreglass materials as a porta cabin. All facilities for tourists such as changing rooms, cafeteria, toilets, etc should be made by the bio-degradable materials largely using plant products. Tourists should be allowed inside the Kurusadai between 6 am and 4 pm.



Carrying Capacity

Kurusadai Island Tourism Zone

1. Five glass bottom boats with capacity of 10 persons/boat (each sortie will lost for 15 minutes on chargeable basis. Maximum 5 sortie permitted per boat per day)
2. Snorkling – maximum 200 peoeple/day
3. Discovery Scuba Diving – maximum 50 people/ day
4. Open water Scuba Diving – maximum 50 people /day
5. Sea walk – maximum 50 people/ day
6. Visit to Island – 500 people /day

Tourism in Buffer zone of Biosphere Reserve

1. Twenty glass bottom boats with capacity of 10 persons/boat. Maximum five boats per entry point such as Tuticorin, Keelakarai, Ervadi, etc.
2. Snorkling – maximum 300 peoeple/day (cumulative number from all entry points to Biosphere Reserve)
3. Discovery Scuba Diving – maximum 200 people/ day(cumulative number from all entry points to Biosphere Reserve)
4. Open water Scuba Diving – maximum 50 people /day(cumulative number from all entry points to Biosphere Reserve)
5. Sea walk – maximum 100 people/day
6. Visit to Buffer zone – maximum 1000 people /day (for water sport, angling, etc)

Marine Tourism around Rameshwaram Island

1. Five glass bottom boats with capacity of 10 persons/boat

2. Snorkling – maximum 200 peoeple/day
3. Discovery Scuba Diving – maximum 100 people/ day
4. Open water Scuba Diving – maximum 50 people /day
5. Sea walk – maximum 50 people/day
6. Visit to Island – maximum 500 people /day

Creating and mainstanance website of GoMBRF (www.gombrf.org)

a. An exclusive website for GOMBRF needs to be developed and this website should be linked to the websites of Tamil Nadu Forest Department, Tamil Nadu Tourism Corporation, Incredible India etc.
b. GoMBRF website should provide all information required all kind of visitors and stakeholders of GoMBRF, regarding the significant of Sanctuary, threats, management approach, guide to tourists, etc

Finance: 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.,

Establishment of Interpretation cum Education Center

Main topic of the interpretation center: 'Window to the Gulf of Mannar Biosphere' anchored by 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. Mandapam would be appropriate site 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, water sports lovers, and casual visitors.

Main thems of the Interpretation Center
Theme 1: Biophysical setting of the Gulf of Mannar Biosphere Reserve
Theme 2: Aquarium
Theme 3: Mammalian and reptile fauna
Theme 4. Flora
Theme 5: Unique fauna and flora of the Gulf of Mannar
Theme 6: Culture
Theme 7: Avifauna

Theme 8: Historical account on the GOMBR
Theme 9: Important places in and around the GOMBR
Theme 11: Association between local community and Biosphere Reserve
Theme 10: Management

Audio-Visual Facilities

- A small Auditorium with capacity of 50-100 people needs to be established that can be used for awareness programme, training and nature camp activities.
- Audio-visual facilities should be established inside this Auditorium.
- Short films or documentaries on the Gulf of Mannar Biosphere Reserve about its importance, threats and its mitigation can be prepared with strong visual content.
- Commentary can be made in Tamil for the use in villages and areas where people are more comfortable with the language as compared to English.
- English commentary can be superscripted for use in the Interpretation centre. The film/documentary should be professionally done on DG Beta Pro format and sound recorded on DAT [Digital Audio Tape]. The DVD is easy to handle and maintain.
- This can be shared with the local communities and with visitors.
- This film can also be telecasted through local cable TV networks, State tourism hotels TV networks, Private Hotels TV networks etc.

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.

Signages
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.

Most importantly, the National Highways Authority may be requested to place direction board with distance details at the Rameshwaram junction on the Kanyakumari-Chennai NH. Minimum five signages on the National Highways would be beneficial to tourists to know about the Marine National Park who travel to Madurai, Kanyakumari and Rameshwaram by roads.

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.

Visitor 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

Table : Media message matrix for interpretation and conservation education.

Activities	Information center	Interpretation center	Hoardings	Tran slides	Way-side Kiosk	Brochures, posters,	Orientation Films &	Touch and Feel	Nature Guides	Outreach programmes	Field guides	Organized safaris	Marine aquarium &	Organized cruise	Quizzes, competitions,	Nature trails & beach walk	Board walks	Watch towers	Check lists	Website (www.gombr.com)	Others (Souvenir shop,
Informing and Welcoming visitors to facilities and activities within Reserve	√	√	√	√	√	√	√		√		√		√							√	√
Making visitors understand the ecological process and importance of flora and fauna	√	√			√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√
Do's & Don'ts & to be a eco-visitors	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Land,	√	√			√				√												

people, customs and Traditions																				
Visitors and tourism resources	√	√			√	√	√		√		√		√	√				√		√	√
Assistance in visitation planning	√	√				√			√		√		√	√						√	√
Conservation orientated activities	√	√			√	√	√		√		√		√	√						√	√
Visitors survey and feedback	√	√																		√	√
Nature club, Green club and Nature camps activities	√	√				√	√													√	√

Eco-Tourism and Visitors Management

The major objectives of eco-tourism in GoMBR are a) To promote conservation awareness amongst the visitors and local people through conservation education and interpretation and b) to find harmonious relationship between the place, the visitor and the host community. Following actions are recommended to achieve these objectives;

Information for visitor center

Open and closed seasons of the reserve's tourist areas if any that 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 broachers available in the tourist information centers of the reserve.GoMBRF website should provided all required information to tourists including online booking of visits to Natioal Park.

A. Suggested Coral reef based eco-tourism
   a) No tourism and its related activities will be allowed inside the Core Zone of the Biosphere Reserve i..e. in the Marine National Park.
   b) Eco-tourism can be allowed in the buffer zone of the Biosphere Reserve
   c) 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.
   d) 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.
   e) 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**
Kurusadai Island	**Inside NP**	√	√	√
Keelakarai	Inside BR	√	√	√

Sethukarai	Inside BR		√	
Tuticorin	Inside BR	√	√	√
Pamban	Outside BR	√	√	
Mandapam (Palk Bay side)	Outside BR	√	√	√
Rameswaram Island Palk Bay side (other than Pamban)	Outside BR	√	√	√

B. Establishment of State of Art World class Marine Aquarium at Pamban / Mandapam (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 GOMBR, 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 Malayasia' 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 – Danuskodilands 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 – Uvary - 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 – Uvary – 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.

Eco-development Plan for Livelihood Generation

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, 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. Of these, 139 villages have organized democratic institutional structures in the form of municipalities and panchayats. Eco-development committiees have been established in 210 villages. 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.

This Plan has also identified the villages along the Gulf of Mannar Biosphere Reserve in the two other distrcts such as Tirunelveli and Kanyakumari, where the process of micorplan and VMC development needs to be taken up gradually during this 10 year Plan period.

Conservation of Biosphere Reserve and its rich biodiversity such as coral reefs, seagrass beds, oyster beds etc require the resolution of conflicts among its users, which should be interactive in nature to arrive at agreeable regulations in different areas of use by keeping the conservation and livelihood benefits to co-exist especially in the buffer zone and it should be a sustainable mechanism aided by people participation. In this context, several informal consultations carried out with the dependent fisherfolks, and they expressed 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 build collaboration of surrounding village communities and other stakeholders in the management of Biosphere Reserve so as to generate their long term support for the reserve

2. 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
3. Planning for resource substitution
4. Socio-economic upliftment of the target population
5. Involving local communities in conservation by adopting a “Community participatory” system of management, so as to elicit public support for conservation
6. 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
7. 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
8. 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 2018-2027.

2. Suggested guidelines for establishment and implementation of the Eco-development plan

a. Establish and empower community based institutions and these insituttions need to be facilitated by GoMBRT.

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 mariculturepro grammes 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

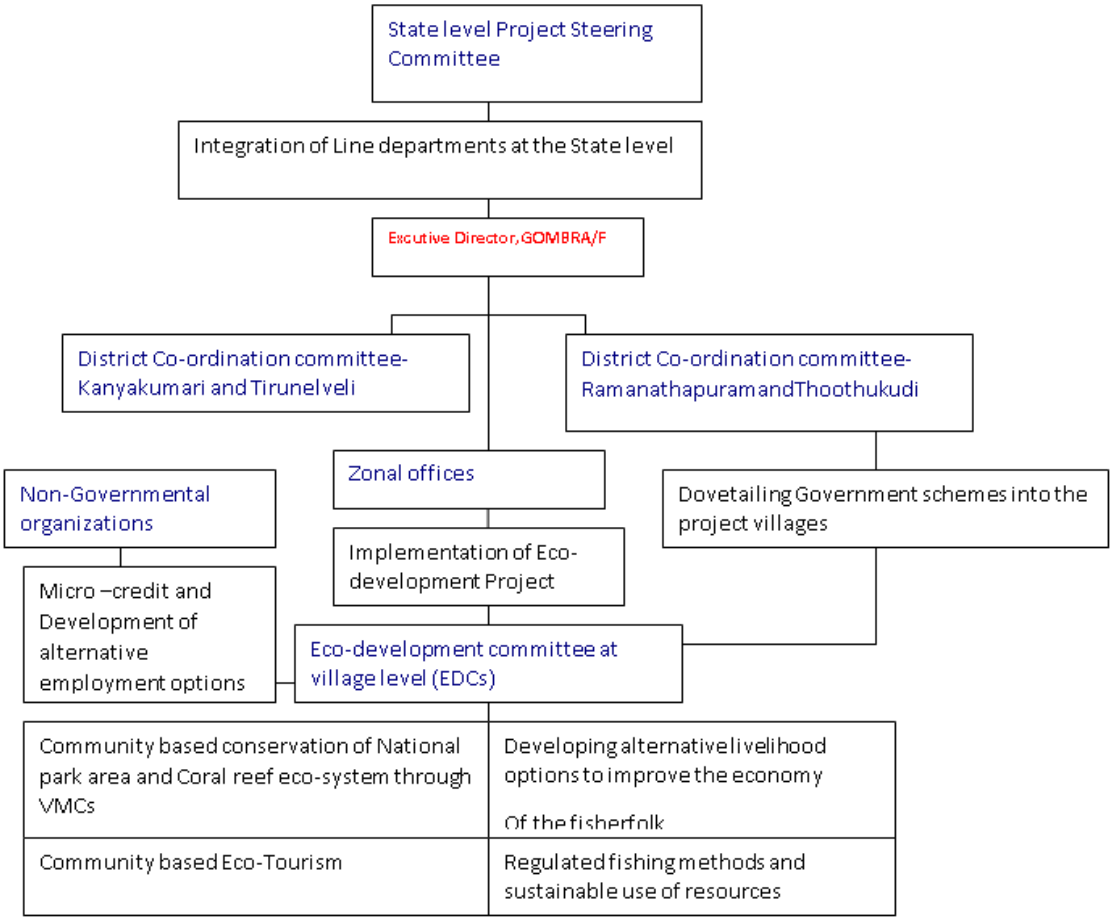


Figure 1 The suggested frame work for implementation of Eco-development plan in the Gulf of Mannar Biosphere Reserve region

While the broad framework for the implementation of the Eco-development plan is already under implementation by the Gulf of Mannar Biosphere Reserve Trust, an appropriate revised framework proposed herewith.

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 (from GOMBRA) and with one Inspector of Fisheries (from Fisheries Department) 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

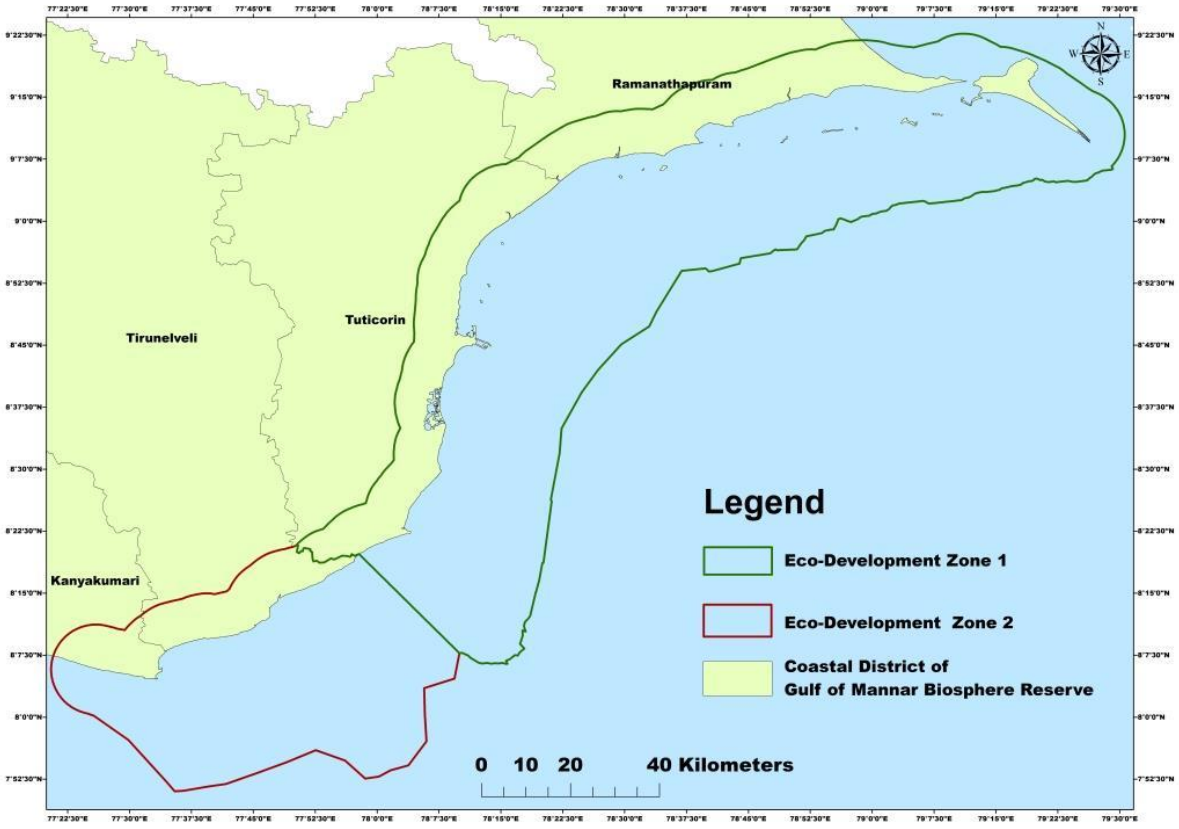
gender equity. All the decisions taken by the Eco-development committee will be routed through the executive committee in the form of resolutions.

The following activities are to be taken up by the eco-development committee.

- Disbursal of soft loans to the EDC members for undertaking alternative employment options.
- Vocational Training to the fisher folk especially women.
- Capacity building of EDC members.
- 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.
- 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.
- Formation of community based conservation zones to regulate the activities in their respective zones and to promote sustainable harvest of marine resources.
- 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 Programme in Ramnathapuram and Tuticorin districts (Zone I). 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 next phase of Eco-development Programme in Tirunelveli and Kanyakumari districts (Zone II) as early as possible. 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 DovelopmentComitees 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

All depended 125 villages have been covered under the Eco-development programme. More than 210 EDCs have been formed and coordinated by GOMBRT. The functioning of GoMBRT in facilitating these EDCs was significantly reduced in the recent past due to lack of adequate resources and supports from the Government of Tamil Nadu, which is not good for the long term conservation of Biosphere Reserve that is going to be the important lifeline of future of Tamil Nadu especially for the southern coastal districts. Therefore, it is important for the Government of Tamil Nadu to support the GoMBRT with

adequate logistic resources to implement this Management Plan. 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.

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 alivelihood 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 financers. 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, eventhough 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 eratic.

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 *Prosopisjuliflora*; already villagers have started this activities in Ramanathapuram and Tuticorin district. Removal of these invasive species also enables native vegetation to florish 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 fisheing gears etc. a range of feasible alterative 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.

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 reauired 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 bidoversity. 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 coverting 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

There is a move to eradicate the invasive prosopis from the region due to its negative impact in the landscape. But, prosopis is seems to be one of additional livelihoods of the region. Therefore, charcoal making using *Prosopisjulifloras*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 (*Borasusflabellifer)* the State tree of Tamil Nadu. Though almost 100% of this tree is utilized traditionally by people in someway or other, production of value added handcrafts made out of palm leaves can bring in an option of alternate livelihood. Though this is in practice in some coastal villages, efforts needs 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 MannarBiosphoere 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 *Salicorniabrachiata*and *Salicorniabrachiata*. Such natural vegetation origin salt are in high demand in the ayurvedicpharmaceutic industries. Such halophyte plantations also helps in desalining 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 memners 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 husbandary 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 democgraphic 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 involvementof professional institutions fromt he Tamil Nadu fisheries Department, CMFRI Mandapam and Tuticorin Fisheries College may be involved in proving 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 licelihood 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 NaculaTikina 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 was proposed in the previous Management Plan , to be selected and Village Marine Conservation (VMC) plans prepared and the alternative livelihood options may be tested in thse 'Model villages' first and upon getting successful results, the similar VMC plans be developed for other villages along the Gulf of Mannar Biosphere Reserve. However, this was not implemented that needs to be intiated in this Management Plan period.

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 Depearments 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 Nationla 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 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. giving detail of indicators, means of verification, who can do this and what is to be done.

14. 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.

Research, Monitoring and Training

It is important to build and manage a ‘’Knowledge Management System’ of GoMBR for better monitoring of ecological functioning of GoMBR. In this context, Research and Monitoring of the biodiversity, water quality and socio-economic condition of dependent communities of GoMBR is required at regular intervals. This would ensure the ecological services of GoMBR to the people and also help to evaluate and review the management effectiveness of this Management Plan.

Research matrix and establishment of ‘Marine Research and Monitoring Centre’: 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.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.

In-house research and outsourced specialized research

Research and Monitoring Centre (RMC) was recommended by the previous Management Plan to take care of all inhouse biodiversity and ecological monitoring but due to lack of fund it was implemented in very shoddy manner. But, many research programs have been outsourced to regional institutions during this period. However, it is important to establish RMC for GoMBR, and 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. RMC should be linked to Tamil Nadu Advanced Institute for Wildlife Conservation at Chennai for data base management and coordination of all research activities. 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.

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 Foundation 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'.

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 Foundation. RMC should also review the progress of the 'implementation program' by the Authority in every six months interval in its Research Advisory Committee meetings.

RMC Research personnel

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 Foundation. 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.

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.

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.

Capacity Building

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.

Further, officers and frontline staff of the Biosphere Reserve required to be trained regularly on marine biodiversity monitoring and management in India as well as in abroad to get the best scientific skills to manage the Gulf of Mannar Biosphere Reserve more efficiently.

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 Foundation. 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.

Annual research seminar

Biosphere Reserve Foundation 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 Foundation research and documentation centre and data base. Tamil Nadu Advanced Institute for Wildlife Conservation and the Gulf of Mannar Biosphere Reserve Foundation jointly can organize this ARS.

Establishing a Learning Centre.

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. Coordinating all research programs of Biosphere Reserve with the Advanced Institute of Wildlife Conservation, Tamil Nadu.
2. Compile existing data to describe the resources and provide baseline information;
3. Encourage continual information exchange among the organizations and agencies undertaking research and making decisions that affect the Biosphere Reserve;
4. 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;
5. Encourage multidisciplinary studies that integrate research efforts in the coastal, estuarine, near shore, open ocean, and deep sea ecosystems;
6. 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;
7. Initiate a monitoring program to assess environmental changes due to natural and human processes;
8. Identify the range of effects on the environment that would result from proposed or predicted changes in human activity or natural phenomena;
9. Incorporate research results into an Interpretive Education Program in a format useful for the general public; and
10. Evaluate the effectiveness and efficiency of the research program and its integration with resource protection and education objectives.

Research Advisory Committee

1. Chief Wildlife Warden, Tamil Nadu - Chairman
2. Executive Director, GOMBRF - Member Secretary
3. Director, AIWC, Tamil Nadu - Member
4. VC/Director or his Representative of Anna University, MKU, CASMS - Member
5. IGF (WL) or his representative from MoEFCC, GOI - Member
6. Director or his representative, WII - Member
7. Director or his representative, SACON - Member
8. National NGOs – BNHS & SDMRI - Member
9. Director, Core Zone and Buffer Zone, GoMBR - Member
10. Wildlife Warden, Marine National Park - Member
11. Director, Pollution Control Board, Tamil Nadu - Member
12. Director, Fisheries Department, Tamil Nadu - Member

13. Director, Department of Environment, Tamil Nadu - Member
14. Three more special invitee by the Chairman - Member

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.

Summary prescriptions for research, monitoring and training programme of the GoNP

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.
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.
3. Research and Monitoring Center (RMC) of the Gulf of Mannar Biosphere Reserve needs to be set up with aimed to;

    a. Compile existing data to describe the resources and provide baseline information;
    b. Encourage continual information exchange among the organizations and agencies undertaking research and making decisions that affect the Biosphere Reserve;
    c. 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;
    d. Encourage multidisciplinary studies that integrate research efforts in the coastal, estuarine, near shore, open ocean, and deep sea ecosystems;
    e. 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;
    f. Initiate a monitoring program to assess environmental changes due to natural and human processes;
    g. Identify the range of effects on the environment that would result from proposed or predicted changes in human activity or natural phenomena;
    h. Incorporate research results into an Interpretive Education Program in a format useful for the general public; and
    i. Evaluate the effectiveness and efficiency of the research program and its integration with resource protection and education objectives.

4. 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.
5. A detail long term and short term research activities have been identified which needs to be carried out as per the priority.

6. In-house research programmes such as monitoring the habitats/species can be taken up by RMC with the help of professional institutions.
7. Basic research programmes need to be outsourced but it should be facilitated by the Authority through RMC.
8. RMC should help to develop the human resources in the field of 'Management of Marine Protected Areas and its biodiversity'.
9. Higher level of community participation is recommended in all the research programmes as per the prescribed above.
10. Guidelines for research activities in the Gulf of Mannar Biosphere Reserve need to be strictly implemented.
11. 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.

FRAMEWORK FOR MONITORING HEALTH OF GULF OF MANNAR BIOSPHERE RESERVE

TABLE 1. GOMBR HEALTH INDICATORS AND METHODS OF ASSESSMENT

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
1.	**ECOSYSTEM INTACTNESS**						
1.1	Upland land use change	The land use practices in the adjacent land have a strong influence on the health of BR. High human activities and encroachments in the surrounding lands indicate low connectivity and disturbed ecosystem. Encroachment causes loss of riparian vegetation, floodplain, and catchment and negatively affects ecosystem value.	Assessment of land use through village survey, participatory mapping, secondary information from local governance bodies such as revenue department, *Panchayat*. Assessment of land use through high resolution remote sensing images and observations in field.	Urban or rural land use/encroachment within 100 m of the high tide line of BR boundary and intensive human activities.	Rural/urban land use outside 200 m of high tide line of BR with moderate human activity	Rural/urban land use with buffer of around 500 m of the boundary of high tide line of BR with negligible human activities	2 BR 0 NP

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
1.2	Extent of catchment and watershed remaining under natural vegetation cover (Thamirabarani River)	The natural capital in terms of biodiversity and its intactness would ensure sustainability and higher resilience against anthropogenic and natural functional degradation.	Assessment of secondary data from Forest departments. Examination of survey of India maps, higher resolution remote sensing images and onsite field observations.	< 50% area remaining under natural vegetation cover	50-70% area remaining under natural vegetation cover	70-100% area remaining under natural vegetation cover	1 BR
1.3	Habitat connectivity	Connectivity among surrounding aquatic, riparian and forest habitats in the floodplains and catchment and well as inter and intra-basin connectivity. Connectivity enhances habitat variability, biodiversity value and buffers habitat alteration.	Assessment of land use through village survey, participatory mapping. Examination of survey of India maps, higher resolution remote sensing images and onsite field observations.	Connectivity with other wetland/river, forest and grassland disrupted wholly. Or Linear connectivity between upstream and downstream of a river or stream disturbed by barriers without Environmental Flow and Fish passes	Connectivity exists only in rainy season otherwise no connectivity with other wetland/river/forest. or Linear connectivity between upstream and downstream of a river or stream disturbed by barriers but with MEF and Fish passes	Connectivity with other wetland/river, forest and grassland exist. or Linear connectivity between upstream and downstream of a river or stream undisturbed by barriers	1BR
1.5	Siltation rate	Siltation is common when surrounding	Bathymetry.	Major silt deposit in the wetland causing a general reduction	Minor silt deposits but there is no significant	No reduction in wetland area or average depth or hydroperiod due to	2 BR

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
		land or catchment has been cleared/disturbed, especially in areas with a steep gradient. It significantly reduces the depth of the water column.		(>5%) of wetland area or average depth or hydroperiod.	reduction (<5%) in wetland area or average depth or hydroperiod in last 20 years.	siltation in last 20 years.	
1.6	Width of the drawdown zone	Greater width of the area between shoreline and upland provides buffer from shock.	Examination of survey of India maps and higher resolution remote sensing images and field surveys.	Drawdown zone perceived or actual declination of more than 25% or disturbed due to other land use in last 10 years.	Drawdown zone perceived or actual declination of about and less than 25%-, or disturbed due to other land use in last 10 years.	Negligible/ No change in the drawdown zone in last 10 years.	2 BR
1.7	% Littoral zone (shallow water zone <2 m)	A measure of intactness of the BR as this zone is most productive.	Examination of survey of India maps and higher resolution remote sensing maps and field surveys. Bathymetry.	Littoral zone (shallow water zone <2 m), perceived or actual reduced by more than 25% or got disturbed due to other land use in last 10 years.	Littoral zone (shallow water zone <2 m) perceived or actual, reduced by about or less than 25% or got disturbed due to other land use in last 10 years.	Negligible/ No reduction in the original littoral zone in last 10 years.	3 BR
2.	**HYDROLOGICAL INTEGRITY**						
2.1	Hydrological connectivity with floodplain, catchment and other wetlands/ rivers/tributaries	Undisturbed connectivity between wetland and catchment is	Monitoring inlet and outlet of wetland and its connectivity with catchment using	Substantial change in inflow and outflow of water between catchment and wetland and vice	Moderate change in inflow and outflow of water between catchment and	No change in inflow and outflow of water between catchment and wetland and vice versa.	1 BR

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
		critical for survival of wetland.	Survey of India map and remote sensing data and site survey.	versa.	wetland and vice versa.		
2.2	Water depth	Natural seasonal depth variations provide habitat variability and support biodiversity. Any deviation would cause change in hydro-period, habitat loss and biodiversity loss.	Depth gauge, sonar. Consultation with local communities.	Substantial change (>25% deviation from the average flow/depth of last 10 years) in flow regime or water depth.	Moderate change (<25% deviation from the average flow/depth of last 10 years) in flow regime or water depth.	Negligible change in flow regime or water depth.	2 Thamirabarani River
3.	**WATER QUALITY**						
3.1	Visible water pollution	Lowering of water transparency, greenish/greyish colour, obnoxious odourare indicators of pollution. Presence of floating waste debris also indicates lowly aesthetics and poor health of wetland.	Site level inspection based on observer's perception.Sechhi Depth for water transparency assessment	Pungent odour in water, brownish colour, floating solid non-biodegradable waste, sewage/industrial effluent discharge	No odour, greenish/greyish colour, floating macrophytes	No odour, no colour, very few floating macrophytes	3 BR 3 NP

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
3.2	Algal bloom	Affects dissolved oxygen (DO) level available for ecological processes and affects aesthetic value.	Fluorometer and site level inspection based on Phytoplankton abundance survey.	Accumulation of microalgae layer>1 cm thick is evident.	Accumulation of microalgae layer 0.1 to 1 cm thick is evident.	Accumulation of microalgae layer<0.1 cm thick is evident.	3 BR
3.3	Extent of pesticide, herbicide, inorganic manure used in the surrounding urban/ agricultural area	Increased pesticide residue and heavy metals in the water and sediment may lead to bioaccumulation and environmental toxicity. Major pesticides and major Heavy Metals to be analyzed as prescribed in IS: 10500: 2012	Survey of agricultural land surrounding wetlands and rivers, Pesticide analysis by Gas chromatography-Mass spectrophotometry (GC-MS) Heavy metal analysis by Atomic absorption Spectrophotometry (AAS).	Pesticide use in more than 25% of the catchment area. Presence of pesticides and Heavy Metals more than the permissible limits as described in IS: 10500: 2012	Pesticide use in <25% of catchment area. Presence of pesticides and Heavy Metals JUST within the permissible limits as described in IS: 10500: 2012	Negligible (<10%) pesticide used in the catchment. Presence of pesticides and Heavy Metals very less than the permissible limits/Not Detected (ND) as described in IS: 10500: 2012	3 NP 3 BR
4.	**BIOTIC COMMUNITY – FLORA**						
4.1	Free floating invasive species (% wetland area)	Affects native biotic communities	Ocular estimation	>50% of the wetland is colonized by weeds/ invasive species	Some weed incursion into the wetland resulting from edge colonization, however >50% of the wetland remains FREE of	No weeds/ invasive present in the wetland.	2 BR 2 NP

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
					weeds/ invasive species.		
4.2	Rooted invasive species (% wetland area)	Affects native biotic communities	Plot method (1 m x 1 m)	More than 50% wetland area covered with weeds or invasive plants.	Some weed incursion into the wetland resulting from edge colonization and/or incursion from roads and tracks, however >50% of the wetland remains free of weeds.	Less than 5% of the wetland and its boundary is affected by weeds.	3
4.3	% shorerline area covered with vegetation	Indicates wetland integrity	Ocular estimation	No vegetation or 50% of shore vegetation degraded.	Less than 25% shore vegetation degraded.	Intact and no degradation of shore vegetation.	1
4.4.	Mangrove cover (ha)	Indicates habitat integrity	Satellite and ground trothing, mapping	Decreased (in last 10 years)	Stable (in last 10 years)	Increased (in 10 years)	2
4.4.	Seagrass cover (ha)	Indicates habitat integrity	Satellite and ground trothing, mapping	Decreased (in last 10 years)	Stable (in last 10 years)	Increased (in 10 years)	1
5.	**5. BIOTIC COMMUNITY – FAUNA**						
5.1	Vertebrate – Richness and abundance of native fish species	Indicates intactness of site specific native biotic community	Netting, fish traps where possible. Secondary data from fishermen on % fish catch and survey of local fish market.	Decreasing trend in native species	Stable	Increasing trend in native species	1
5.2	Vertebrate – Richness and abundance of all water bird species	Indicates intactness of site specific	Standard water bird survey	Decreasing trend	Stable	Increasing trend	1

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
		native biotic community					
5.3	Vertebrate – Dugong populations	Dugong populations indicates health of BR	survey/ Monitoring colonial breeding bird and nest	Decreasing trend	Stable	Increasing trend	1
	Vertebrate – sea turtle populations	Sea turtles populations indicates health of BR	survey/ Monitoring colonial breeding bird and nest	Decreasing trend	Stable	Increasing trend	2
5.4	Abundance of aquatic invasive fauna	Affect native biotic community	Standard survey for benthic communities and fish catch	Increasing trend of invasive faunal species in the wetland.	Decreasing trend of invasive fauna in the wetland.	No invasive species in the wetland.	Not fauna
4.5	Coral cover (ha)	Indicates habitat integrity	Satellite and ground trothing, mapping	Decreased (in last 10 years)	Stable (in last 10 years)	Increased (in 10 years)	1 BR 2 NP
5.5	Habitat potential	Overall habitat quality for the species of conservation significance	Standard habitat assessment for wildlife value of species of conservation significance.	Important habitat parameters required for species of conservation concern have degraded.	A few habitat parameters required for species of conservation concern have degraded.	Most of the key habitat parameters required for species of conservation concerns are met.	2 NP 1 BR
6.	**ANTHROPOGENIC DISTURBANCE**						
6.1	Presence of solid biodegradable and non-biodegradable waste of anthropogenic origin in water and on shoreline	Directly impact BR health in terms water quality and aesthetic value.	Field survey based on observer's perception.	Major portion of the wetland have scattered biodegradable and non-biodegradable litter.	Negligible litter in the wetland	Wetland free of scattered biodegradable or non-biodegradable litter.	1 NP 2 BR
6.2	Numbers of untreated sewage and industrial water active outlets/overflows/drains/storm water canal	Sewage and industrial effulentsdirectly affects water quality and	Field surveys along the waterways. Secondary data from	Substantial number of active treated and untreated wastewater outlets/overflows/drains/ storm water	Not more than 2 active treated outlets/storm water canal at the wetlands.	No wastewater treated or untreated discharge into the wetland.	1 NP 2 NP

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
		degrades wetland and river health.	CPCB/SPCB/PCCs.	canal draining into wetland.			
6.3	Quality and quantity of sewage inflow	Sewage directly affect water quality and degrade wetland and river health.	Sampling and analysis as proposed in IS: 3025- Part I (1987). The standard limit is depicted in The Environment (Protection) Rules, 1986, Rule 3A and Schedule VI, General standards for discharge of environmental Pollutants Part A : Effluents, discharge limit for Inland surface water	Higher than the specified standards.	JUST fulfilling the specified standards.	No sewage coming into the wetland Or All effluents well below the specified limits	3 NP 1 BR
6.4	Quality and quantity of industrial discharge	Industrial discharge directly affect water quality and degrade wetland and river health	Field survey and sample analysis using IS: 3025- Part I (1987). The effluent standards will be industry specific and “Standards for Emission or Discharge of Environmental Pollutants from various	Higher than the specified standards.	JUST fulfilling the specified standards.	No industrial waste coming into the wetland Or All effluents well below the specified limits	1 BR 3 NP

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
			Industries" by CPCB should be strictly followed.				
6.5	Extent of fishing in the BR	Overfishing may affect biodiversity and resource availability.	Perception of local fishermen. Fishing landing and market surveys.	Indiscriminate fishing using large numbers of modern gear and crafts	Fishing with mechanized crafts with large number of people	Traditional fishing with moderate number of fishermen	1
6.6	Extent of other biomass extraction (BR)	Affects provisioning service value, causes disturbance	Field surveys. Household interviews. Perception of the observer.	Substantial biomass extraction from the wetland for sale as well as consumption. Removal of rare, endangered or threatened plant species.	Occasional biomass extraction from the wetland for consumption only. No removal of rare, endangered or threatened plant species.	Minimal/Negligible/sustainable (?) biomass extraction from wetland.	1 BR 2 NP
6.7	Extent of grazing in the BR	Grazing causes high disturbance and changes plant species composition	Field survey to check number of livestock grazing in the wetland area. Availability of alternative grazing grounds and fodder sources.	Grazing animals have access throughout the wetland, established tracks throughout the wetland, dung widespread, major damage to vegetation	Grazing animals have access to around or less than 50% the wetland, some established tracks, dung uncommon , moderate damage to vegetation.	Grazing animals have partial access (less than 25%) to the wetland and little damage to the vegetation or no current signs of grazing.	2 BR 0 NP
6.8	Sand mining, Stone query	Affect natural shoreline feature, enhance siltation and alter habitat for nesting	Field surveys. Perception of the observer.	Substantial sand or boulder mining on the bank and in water for commercial purpose by both manual and mechanized tools.	Sand and boulder mining on the bank and in water using traditional methods, primarily for	No sand or boulder mining on the bank and in water.	2 BR 3 NP

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
		reptilians like turtles and crocodiles.		Intensity of mining.	local subsistence.		
6.9	Boat wave or wake	Boat wave or wake caused by the movement of the boat through the water, the faster the speed, the larger and more damaging the effect of the wash on river banks and shorelines. Boat wave has potential to erode and undercut banks, causing severe damage to the riparian zone	Field observations.	Powered vessels frequent the waterway, and are found travelling above 'no wash' speeds. Erosion and undercutting of banks is severe in places within the study site.	Few small powered vessels are found on the waterway, travelling only at 'no wash' speeds of below 4 knots. Some erosion of the bank may be evident within the study site.	No powered vessels are permitted or found on the waterway. No erosion or undercutting of the bank is evident at any location in the study site.	1 BR 2 NP
6.12	Oil and grease from motorized boats for ferry and tourism	Leakage of oil and grease from motorized boats could lead to mortality of planktonic biota and suffocate fish	Sampling and analysis as proposed in IS: 3025- Part I (1987). The standard limit is depicted in The Environment (Protection) Rules, 1986,	> 10 mg/L	Maximum 10 mg/L	Well below 10 mg/L	-

	Criteria and indicators	Explanation	Methods of assessment	Thresholds			Current status
				Poor (Score: 1)	Fair (Score: 2)	Good (Score: 3)	
		and other aquatic life.	Rule 3A and Schedule VI, General standards for discharge of environmental Pollutants Part A : Effluents, discharge limit for Inland surface water				

BOX 1: ASSESSMENT SCORING SYSTEM

From Table 1, the scores for all assessed individual indicators should be summed up and the sum of indicator scores needs to be expressed as a percentage of the maximum achievable score. The actual percentage shows the degree of the deviation of a wetland from its natural condition.

Maximum Percentage for a Very Good wetland is 100% =
(Sum of Scores of the wetland / (Number of Indicators Assessed X 3)) X 100

Class A (Very Good) Percentage of Maximum is >90%
Class B (Good) Percentage of Maximum is 76 – 90%
Class C (Fair) Percentage of Maximum is 51-75 %
Class D (Poor) Percentage of Maximum is < 50 %

Conditions: Minimum number of Indicators need to be assessed for a wetland is 24 that should include minimum four indicators from each criterion.