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GLIMPSES OF AQUATIC BIODIVERSITY

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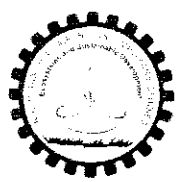

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PRESENT STATUS ON CONSERVATION AND MANAGEMENT OF MANGROVE ECOSYSTEMS IN THE ISLANDS OF GULF OF MANNAR REGION, TAMILNADU

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Mangroves are the salt tolerant forest ecosystems distributed mainly in tropical and sub-tropical inter-tidal regions of the world. They consist of coastal wetlands; swamps, forestlands within and water spread areas. In the mangroves along the coastline various species of marine organisms get themselves adapted to grow under the influence of both salt and brackish water. Mangrove resources/areas are used as a breeding and nursery grounds for many aquatic organisms. The importance of mangrove resources which provides high potential for fisheries and collection of seeds of cultivable and economically important fin fishes and shellfishes for aquaculture in addition for reducing coastal erosion.

The mangroves grow luxuriantly in alluvial soil substrates, which are fine textured, loose mud or silt, rich in humus and sulphides and they develop in low lying and broad coastal plains where the topographic gradients are very small and tidal amplitude is large. Their distribution is limited by temperature and they prefer moist atmosphere and freshwater inflow, which brings in abundance nutrients and silts from terrestrial source. The mangroves occur in sheltered shores as waves and currents damage the mangrove seedlings. Repeatedly flooded but well drained soils support good growth of mangroves, but impeded drainage is detrimental.

The mangrove ecosystem being the interphase between terrestrial forests and aquatic marine ecosystems it includes diversified macro habitats such as mangrove dominant forests, litter laden forest floors, mudflats, adjacent coral reefs and contiguous water courses which may be rivers estuaries, bays, inter-tidal waters and channels and backwaters. Thus, this ecosystem offers innumerable microhabitats for large number of species. In recent years, nature conservation of mangrove reserves and habitats has assumed great significance in developing countries in the context of the role of conservation in socio-economic development and the recognition of its functional role. The other values attached to this aesthetic and cultural.

Distribution of Mangroves in India

In India mangroves are distributed in about 6,470 sq.km that constituted 7% of the world mangroves and 8% of total Indian Coastline. The area-wise distribution of mangrove forests in India has been reviewed. Status of mangroves along the Arabian Sea has been reviewed. There are three different types of mangroves in India viz., deltaic, backwater-estuarine and insular categories. The deltaic mangroves occur on east coast (Bay of Bengal) where the mighty rivers make deltas. The backwater-estuarine type of mangroves exist in the west coast (Arabian sea) which is characterized by typical funnel shaped estuaries of major rivers (Indus, Narmada and Tapti) or backwaters, creeks and neritic inlets. The insular mangroves are present in Andaman and Nicobar Islands where many are estuaries, small rivers, neritic islets and lagoons which support a rich mangrove flora.

Of the Country's total area under the mangrove vegetation 70% was recorded on the east coast, and on the west coast 12%. The bay islands (Anadaman and Nicobars) account for 18% of the Country's total mangrove area. The mangroves have a vast existence on the east coast of India due to nutrient rich alluvial soil formed by rivers- Ganga, Brahmaputra, Mahanadhi, Godavari, Krishna and Cauvery and perennial supply of freshwater along the deltaic coast. But, the deltas

with alluvial deposits are almost absent on the west coast of India, only funnel shaped estuaries or backwaters are present.

In India mangroves comprise approximately 59 species of higher plants from 41 genera belonging to 29 families. Of these, 32 species belonging to 24 genera and 20 families are present along the west coast. The species viz., *Sonneratia caseolaris, Suaeda fruticosa, Urochondra setulosa* have been reported only from west coast. The eastcoast of India and Andaman and Nicobar islands show high species diversity. There are 45 species in 27 genera of mangroves in the bay islands. The species like *Ceriops decandra, Xylocarpus spp., Lumntizera littoria and Nypa fruticans, Phoenix paludosa, Cerbera manghas* are limited to east coast. The common species in India coastline are *Rizophora mucronata, Ceriops tagal, Bruguiera gymnorrhiza, Lumntizera racemosa, Sonneratia apetala, acanthus ilicifolius, Avicennia marina, A.officinalis, Excoecaria agallocha* and *Acrostichum aureum*. Totally 37 species of exclusive mangroves and about 25 associated species occur in the coastal and inland regions.

In Tamilnadu mangroves exist on the Cauvery deltaic areas. Pichavaram has well-developed mangrove forest dominant with *Rizophora spp., Avicennia marina, Excoecaria agallocha, Brugaiera cylindrical, Lumnitzera racemosa, Ceriops decandra and Aegiceras corniculatum*. Mangroves also occur near Vedaranyam, Kodaikarai (Point Calimere), Muthupet, Chathram and Tuticorin.

Extent of Mangroves in Gulf of Manna

A survey on the distribution of various species of mangroves in Shingle, Krushadi, Poomarichan, Manoli- putti, Manoli, Hare, Muli, Poovarasanpatti, Anaipar, Upputhanni, Kasuwar, Valai, Appa, Nallathanni, Karaichalli, Vantivu, Talayari, Valimunai, Puluvinichalli, Vilanguchalli and Rameswaram islands of Gulf of Mannar was conducted during January 1995- December 1997. The various species of mangroves such as *Avicennia marina, Rhizhopora mucronata, Bruguiera cylindrical, Ceriops decandrus, Luminitzera recemosa, Exoecaria agallocha* and *Suaeda spp.*, are distributed in these islands surveyed. It may be revealed that Krushadai, Manoli and Poomarichan islands are found to be more productive in mangroves vegetation when compared to other islands of Gulf of Mannar. Survey on fish and prawn seed resources was undertaken in the mangrove areas of selected islands and Rameswaram (Pamban) to find out the influence of mangroves on the seed abundance of fish and prawns in the non-mangrove areas ie, marine habitat of the above islands was carried out for comparative studies.

Mangroves Species Biodiversity

The composition of the mangrove species changes with depth, salinity, wave action, intertidal exposure etc. Diversity in the structural formation and zonation of mangrove forests can be witnessed along the latitudinal gradients and probably also along the longitudinal gradients that reflect climatic, especially rainfall gradients. Across the latitudinal gradients, air temperature and across the longitudinal gradients, water, soil fertility appears to be the most important factors in determining the growth patterns of mangrove populations.

Nutrient Dynamics that Influence the Biodiversity Potential

Mangroves produce nutrients and enrich the coastal sea. Mangroves also help in recycling of carbon, nitrogen and sulphur. It is perhaps the only biotic system that recycles sulphur in nature and makes it available in an assimilable form to other organisms. Thus, mangrove waters are rich in organic and inorganic nutrients. For example, Pichavaram mangrove waters (Tamil Nadu) contain 4 times more of nitrate, 20 times more of suspended organic matter and inorganic phosphates as compared to adjoining seawater of the Bay of Bengal. When the nutrient-rich mangrove waters mix with the sea, results in increased fertility of the sea (Kathiresan, 1994). The organic detritus enriched

Table 1: *Distribution of Mangrove Vegetation in Islands of Gulf of Mannar*

Species	Van	Kasuwar	Vilanguchaili	Karaichalli	Upputhanni	Pulivinichalli	Nallathanni	Anaipar	Valimunai	Poovarasanpatti	Appa	Talairi	Valai	Mulli	Musal	Manoli	Manoliputtti	Poomarichamm	Pullivasal	Krusadai	Shingle
1. Avicennia marina	+	+	+	+	+			+				+		+	+	+	+	+	+	+	+
2. Rhizophora mucronata					+									+	+	+	+	+	+	+	+
3. Ceriops tagal														+	+	+	+	+	+	+	+
4. Bruguiera cylindrica														+	+	+	+	+	+	+	+
5. Lumnitzera racemosa															+	+		+			+
6. Pemphis acidula	+	+		+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
7. Exoecaria agallocha																					
8. Aegiceras corniculatum																					
9. Rhizophora apiculata																					
Associated Species																					
10. Salvadora persica	+	+		+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
11. pandanus sp.															+	+	+			+	+
12. Sesuvium sp.	+	+			+	+	+	+	+			+	+	+	+	+	+	+	+	+	+
13. Scaevola plumieri	+	+			+	+	+	+	+			+	+	+	+	+	+	+	+	+	+
14. Suaeda sp.												+	+					+	+	+	+
15. Salicornia brachiata							+					+	+		+		+				
16. Thespesia populnea	+	+		+	+	+	+	+	+			+	+	+	+	+	+	+	+	+	+

Mangrove species of the East Coast of India West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Andaman &Nicobar

Acanthus ebracieatus	*Cerbera manghas*	*Phoenix paludosa*
Acanthus ilicifolius	*Ceriops roxburghiana*	*Porteresia coarctata*
Acrostichum aureum	*Ceriops tagal*	*Rhizophora mucronata*
Aegialitis rotundifolia	*Ceriops decandra*	*Rhizophora apiculata*
Aegiceras corniculatum	*Cyaomatra remiflora*	*Salicornia brachiata*
Aeluropus lagopoides	*Cyperus spp.*	*Scyphiphora hydrophyllacea*
Archrocnemum indicum	*Derris pentafoliata**	*Sesuvium portulacastrum*
Avicennia officinalis	*Excoecaria agallocha*	*Sonneratia caseolaris*
Avicennia marina	*Heretiera fomes*	*Sonneratia apetala*
Avicennia albe	*Heretiera minor*	*Sonneratia alba*
Bruguiera parviflora	*Heretiera littoralis*	*Sporobolous spp.*
Bruguiera cylindrical	*Hypa fruiticans*	*Suaeda mudiflora*
Bruguiera gymnorhiza	*Kandelia candel*	*Suaeda maritime*
Carape obovata	*Lumnitzer littorea**	*Urochendra setulosa*
Cenchrus spp.	*Lumnitzer racemes*	*Xylocarpus granatum*
Cerbera odollum	*Myriostachya wightiana*	*Xylocarpus moluccensis*

Mangrove species of the West Coast of India Gujarath, Maharastra, Goa, Karnataka, Laccadive

Accanthus ilicifolius	*Bruguiera cylindrical*	*Rhizophora apiculata*
Acrostichum aureum	*Cerbera manghas*	*Salicornia brachiata*
Aegiceras corniculatum	*Ceriops tagal*	*Sesuvium portulacastrum*
Aeluropus lagopoides	*Ceriops decandra*	*Sonneratia caseolaris*
Avicennia officinalis	*Kandelia candel*	*Sonneratia acida*
Avicennia marina	*Lumnitzera racemosa*	*Sonneratia apetala*
Avicennia albe	*Myriostachya wightiana*	*Sonneratia alba*
Bruguiera gymnorhiza	*Porteresia coarctata*	*Sporobolous spp.*
Bruguiera parviflora	*Rhizophora mucronata*	

Source: Untawale, A.G., 1985, Mangroves of India: Present Status and Multiple Use Practice, Goa.

with biomass of bacteria, fungi and protozoans, gives rise to protein-rich particulate organic matter and this forms the energetic food of crabs, worms, shrimps and small fishes, which in turn, form prey to large fishes. The mangrove leaves also produce secondary metabolites as "chemical weapon" to fight against pathogenic microorganisms (Kathiresan, 1996).

Faunal Assemblages near Mangroves of Gulf of Mannar

Mangrove systems are among the most productive natural ecosystems on the earth. The sources primary productivity are the mangrove vegetation themselves, algal colonies associated with the mangrove root surfaces and the moist forest floor and the phytoplankton communities in the associated bay and lagoons. Algae observed in the inter-tidal regions of mangroves are very rich and diverse in both quality and quantity. The benthic algae of the mud surface are represented by the green filamentous species of *Entromorpha, Rizocolonium, Monostroma* and *ulva*. The mangrove environment provides living space for a dependent biota of more than two thousand species of flora and fauna of resident, semi-resident or migratory mode of lie. The mangrove associated fauna, being a composite of terrestrial, estuarine and marine organisms constituting representatives of almost all invertebrates phyla and fishes have to face numerous interactions between animals of terrestrial and aquatic biotopes. As such, the mangrove fauna with its lower species diversity but relatively large number of individuals is highly characteristic in nature. The primary food source for aquatic organisms in most mangrove-dominated estuaries occurs in the form of particulate organic matter (detritus) derived chiefly from decomposition of mangrove litter fall. The annual litter fall normally ranges from 10,000 to 14,000 kg dry weight per hectare. Dissolved organic compounds of mangrove region provide an additional source of nutrition. The predators feed on the detritus feeders and form important food source for both aquatic as well as terrestrial wild life in addition to forming food resource for human beings.

Mangrove support rich faunal resources. Among invertebrates, more than 500 species of insects and Arachnida, 229 species of crustacea, 21 species of molluscs, 50 species of nematodes, and 150 species of planktonic and benthic organisms are known from Indian mangroves. Vertebrate fauna are represented by 300 species of fish, 177 species of birds, 36 species of mammals and 22 species of reptiles. Recently, 41 species of invertebrates and 52 species of fishes of Indian mangroves have been assessed and four species of invertebrates and only one species of fish have been categorized as endangered. It has been estimated that yield of mangrove-cum-estuarine dependent fisheries of India to the tune of 30,000 tonnes of crustaceans per annum. Roughly about 60% of Indian coastal marine fish species are dependent on the mangrove estuarine complex. Some of the most common fishes of mangroves are species of *Liza, Mugil, Polynemus, Ilisha* and *Etroplus*. Prawns are represented by species of *Penaeus* and *Metapenaeus* while molluscan resources are species of *Crassostrea, Meretrix, Telescopium* and *Cerethedia*.

Table 2: *Mangrove-Associated Finfish Communities in Islands of Gulf of Mannar*

Ambassis commersoni	*A. gymnocephalus*
Arius subrostratus	*Boleophthalmus boddarti*
Chanos chanos	*Epinephelus tauvina*
Lates calcarifer	*Lethrinus nebulosus*
Liza parsia	*Lutjanus fluviflammus*
Mugil cephalus	*psasmmaperca waigiensis*
Siganus canaliculatus	*Signus javus*
Therapon jarbua	

Table 3: *Mangroves- Associated shellfish Communities in Islands of Gulf of Mannar*

Shrimps:		
Penaeus indicus	*Penaeus monodon*	
P.semisulcatus	*P. merguiensis*	
Crabs:		
Scylla serrata	*Thallamitta sp.*	*Sesarma sp.*
Gastropods:		
Littorina scabra	*Nassa dorsata*	*N. stolata*
Trochus radiatus	*Architechtonica perpectiva*	*Cellana radiata*
Angaria plicata	*Turbo intercostalis*	*Terebralia palustris*
Bivalves:		
Perna viridis	*Modiolus metcalfeii*	*Ostrea forskalii*

Threats to Gulf of Mannar Biodiversity

Depletion of mangrove covers in some of the islands of Gulf of Mannar by the onslaught of other interest groups might not only threaten the habitat for many species of fisheries and birds but would result in ecological imbalance. Hence taking proper steps on that people's participation support, which is very essential for the conservation and management of mangroves, should mitigate the pressure on the mangrove cover. Due to the conflicts, use with the coastal zone related island ecosystems of Gulf of Mannar and surrounding habitats are being increasingly tampered with on behalf of activities such as commercial fishing, navigation, energy exploitation, national defense, recreation and quarrying for industrial needs. Thus conservation of habitats will thus turnout to be the most biologically non-destructive means of reaching "Zero habitat loss". Public opinion, participation in protecting nature and endangered species run high. Hence, the status on mangrove habitats in the island ecosystem of Gulf of Mannar region will help in the formation of future suitable monitoring strategies for conservation and management.

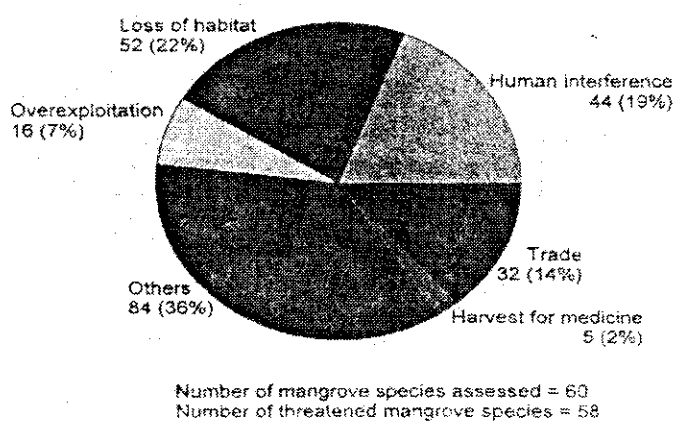

Fig. 1: *Threats Affecting Mangrove*

Table 4: *Area Declined and the Loss of Biodiversity*

Region & state	Present area	Major region of Mangrove form	Status of Ecosystem
Gujarat	370	Gulf of Kuch	Most degraded
Maharashtra	210	Ratnagiri and Raigarh dist.	Degraded
Karnataka	50	Haldi, Kolar &Chakra estuarine complex, Coondapur	Degraded
Kerala	Negligible few km^2	Kollam, Kumarhon &Kunhimangalam	Totally degraded
Tamil Nadu	100	Killai, Muthupet Chatrom Puthupatinam, Talanayer	Degraded
Andhra Pradesh	200	Godavari &Krishna delta, Coringa, Gumtu dist.	Partially degraded
Orissa	210	Mahanadi delta	Partially degraded
West Bengal	1200	Sunderbans, 24 pargana district	Moderate
Andaman & Nicobar Group (Andaman sea)	780	Middle north & little south Andamans, Baratang Nicobar	Good
Lakshadweep Group	Negligible	Minicoy island	In the process of formi

No.	Name of Mangroves	Status (based on IUCN)
1.	*Agiceras corniculatum*	Critically endangered, exists only in Kurusadai Island
2.	*Avicennia marina*	Vulnerable, stunted growth in all islands except in Mandapam group of islands and Kundugal Island
3.	*Bruguiera cylindrical*	Endangered
4.	*Excoecaria agallocha*	Critically endangered, exists only in Mandapam group of Islands
5.	*Lumnitzera racemosa*	Endangered
6.	*Rhizophora apiculata*	Critically endangered, exists only in Kundugal Island
7.	Rhizophora mucronata	Endangered, exists in Kundugal and Mandapam group of Islands

Environmental Characteristics in the Mangrove Habitats

There are five important factors that influence mangroves, namely, temperature, salinity, tides, rainfall and winds; each having its own effect. Temperature influences the development and survival of the mangroves in the early stages. Salinity determines the distribution and zonation of the species within the ecosystem since each species has got its salinity tolerance. Tides act jointly with salinity in the dispersion and zonation; and the tidal amplitude determines the landward extension of the mangroves. Rainfall is important in the zonation of mangroves on flat coasts and the productivity of the mangrove ecosystem is elated to the frequency and volume of freshwater supply by rainfall. Wind is important in regulating the seasonality of litter fall, which is the major pathway of energy from terrestrial, to aquatic system. Mangrove colonize on variety of substrata that include silty and clayey mud, calcareous mud, quartz sand, calcareous sand or mixture of these. Occasionally they may colonize coastal coral reef as well as cracks and hollows of rocky substrata. They prefer sediments that have been brought by rainwater or transported by tidal currents.

The mangrove soils are generally slightly acidic. The anaerobic condition in the soils helps sulphate-reducing bacteria to produce hydrogen sulphide. The characteristic black or grey colour of the soil is due to reduction of ferric compounds to ferrous sulphides.

In general atmospheric mean temperature of most mangrove habitats in the Bay of Bengal varies from 29- 33°c while surface soil temperature ranges from 30- 34°c and surface water temperature from 28-33°c. Salinity of mangroves fluctuates considerably ranging from 3 to 33 ppt. The pH of the water fluctuates from 6.5 to8.0 and dissolved oxygen content usually very low ranging from 1.7 to 3.8 mg/l. However in the seaside, it may reach even 10mg/l. The primary productivity of the mangrove water is very high. The productivity rates from 0.2 t 0.8g C/ml/day in northern Andaman, slightly higher values from 0.5 to 1.0g C/m^3/day in the shallow mud flats and mangroves of Car Nicobar and higher productivity rates from 2.0 to 3.6mg/C/m^3/day in and around the mangroves of Port Blair. In recent years, the mangrove environment is getting polluted with different kind of effluents and other contaminants from the factories and industrial wastes. Heavy metals pose a serious problem due to their environmental persistence and toxicity to aquatic organisms even at lower concentration. Hence, it is very important to monitor heavy metal pollution by taking suitable managerial measures to protect the valuable mangrove resources: Increase human pressure for domestic needs and development of industries are virtually destroyed large areas of virgin mangroves all over world. Reclamation of mangroves for housing, agriculture and salt evaporation site, grazing of cattle, removal for fuel, sewage discharge with high BOD, discharge of industrial effluents an excessive release of pesticides and aquaculture practices have threatened most of the mangroves and some are in h verge of extinction. The degraded area need to be restocked and fresh mud –flats need to be afforested with suitable mangroves. Silvicultural techniques like regeneration, restoration and afforestation of mangroves can be the only answer to these problems.

Like any other types of forests, mangroves form the national wealth of a nation. Timber produced from mangrove is of great value. Wood *Rhizophora* is used for boat building, which is resistance to termites and boring animals. Mangrove trees are used as wood or for charcoal. Mangroves are main source of tannin industry once but now gradually replaced by synthetic tannin. A black dye is also extracted from the bark of mangrove trees. Seeds of *Cerebra odlun* are poisonous and fish poisons are extracted from it. Mangroves are good breeding and feeding ground for variety of fishes and prawns. It provides nutrition for various aquatic organisms through recycling of plan and animal remains. Of course, mangroves give protection to the coastline and minimize the disaster due o cyclones. Aquaculture practices in the mangrove sites of many countries are flourishing even now. Protection of birds sanctuaries and endangered species of wild life (crocodiles and tigers) is the other important aspects of mangroves. Mangrove ecosystems, with their variety of subhabitats, offer range of recreational opportunities such as boating, hunting, bird watching, wild life observation, education trips for specimen collections, photography etc. A part from these, fishery activities (culture and capture) in many coastal regions of the tropics are highly dependent upon the mangrove-dominated estuaries. Aquaculture in mangroves signifies a case of necessity rather than suitability. In specific cases of aquaculture in the mangrove ecosystem economic and social benefits may outweigh management problems. A major part of primary production enters the mangrove food-web a dead organic ecosystem or transported into adjoining water body in a degraded form and the estuaries and backwaters fringed by mangroves have long been used for rearing or flattening of bivalves, prawns and fishes.

Management Strategies for Conservation of Mangroves

In India mangroves are under pressure due to increasing population, development of ports, saltpan and aquaculture, dumping of industrial wastes and affluent, development of fertilizer plants and exploitation for petrochemical activites. Conservation of mangrove areas for aquaculture and

residential purposes is also leading to loss of his important ecosystem. Based on the above observations, a concentrated and co-coordinated effort is necessary to undertake management measures to conserve these natural resources. With view to prevent further destruction of mangrove forest, it s felt that an integrated the first step towards achieving this goal.

The conservation of mangrove habitats has attained great significance in developing countries in context of its functional role in ecological and socio-economical sustainable development.

i. Need for rapid expansion in taxonomy in order to interpret, manage, conserve and usebiodiversity/mangrove sustainability and the need to pool together the existing data from all sources by farming an information network of all agencies in the country.

ii. Priority for the mangrove conservation/ biodiversity to be given to the important genes, species and habitats.

iii. Improve the methodologies for different programme, evolve more effective policy and target with priority.

iv. Practice of the conservation/biodiversity programme with precise definition and clear targets.

v. Recognition of the traditional rights of coastal communities to use the natural resources in their surrounding natural habitats for their livelihood while formulating and implementing regulations and conservation measures on priority basis.

vi. Application of anthropogenic objectives of maintaining biodiversity of mangroves so that it is possible value to the mankind.

vii. Integration of all elements of management, from planning and design to implementation, that is, construction and installation, operation and maintenance, monitoring and feedback and evaluation over time.

viii. Integration of management resources of the agencies and entities involved.

Recommendations

1. Priority should be given to the little known species of mangroves for propagation.
2. Preparation of distributional maps of each species could be considered.
3. Preparation of a list of endangered and threatened genera and species of genetic, ecological, economical and social significance with their status and perceived threats to them with a view to make them target species for conservation.
4. Development of mangrove nursery banks for propagation purposes.
5. Identification of suitable sites to pave the way for planting green mangrove coverage/ Propagation.
6. Environmental monitoring in existing mangrove areas of the islands of Gulf of Mannar should be considered.
7. Conservation efforts to be prioritized based on the available expertise and information depending on species representation, richness, uniqueness, endemism and threat to a gene pool.
8. Mangrove species of global significance both in ecological and economic value need to be identified in the region and threat such species need to be looked into.

level both at micro and macro level. This should include both anthropogenic and natural factors.

10. The impact of environmental and human interference (Pollution, Sea erosion, over exploitation and pathogenic conditions) on marine flora and fauna of Biosphere of Gulf of Mannar need to be assessed.

11. Institutional mechanisms must be ensured on the management of resources, environmental factors affecting the resources and social obligation and mobilization needed for the conservation and sustainable utilization of resources.

12. The Institutional set up between the government agencies, research institutes, local bodies, non-governmental organization and environmentalists need to be strengthened.

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