ADDITIONAL INFORMATION

FLORA OF GoMBR

Scientific name	Common name (optional)	Position in range / endemism / other (optional)
Borassus flabellifer L.	Asian palmyra palm	Common
Heliotropium curassavicum L.	Salt heliotrope	Common
Arthrocnemum indicum (Willd.) Moq.	Glasswort	Common
Suaeda maritima (L.) Dumort.	Annual Sea-Blite	Common
Suaeda monoica Forssk. ex Gmel.	South-Indian Seepweed	Common
Suaeda vermiculata Forssk. ex J.F. Gmel.	Seablite	Common
Ipomoea pes-caprae (L.) R.Br.	Goat Foot Vine	Common
Aeluropus lagopoides (L.) Trin ex Thw.	Mangrove Grass	Common
Atriplex repens Roth	Saltbush	Common
Pandanus odoratissimus L.f.	Fragrant screw-pine	Occasional
Sesuvium portulacastrum (L.) L.	Sea Purslane	Common
Prosopis juliflora (Sw.) Dc.	Mesquite	Common/Exotic
Avicennia alba Blume	Indian Mangrove	Rare
Lumnitzera racemosa Willd.	Black Mangrove	Occasional
Excoecaria agallocha L.	Blinding Tree	Occasional
Pemphis acidula Forst.	Small-leaved Mangrove	Rare
Ceriops tagal (Perr.) Robins	Tagal Mangrove	Rare
Ceriops decandra (Griff.) Ding Hou	Tagal Mangrove	Rare
Enhalus acoroides (L.f.) Royle	Tape seagrass	Rare
Halophila ovata Gaudich.	Dugong grass	Common
Halophila stipulacea (Forssk.) Asch.	Broadleaf seagrass	Common
Halophila decipiens Ostenf.	Caribbean seagrass	Common
Halodule uninervis (Forssk.) Boiss.	Narrowleaf seagrass	Common
Oceana serrulata (R.Br.) Byng & Christenh.	Serrated ribbon seagrass	Common
Syringodium isoetifolium (Asch.) Dandy	Noodle seagrass	Common
Acanthophora spicifera (M.Vahl) Børgesen	Marine red algae	Common
Caulerpa laetevirens Montagne	Sea Grape	Common
Caulerpa taxifolia (M.Vahl) C.Agardh	Sea Grape algae	Common
Codium tomentosum Stackhouse	Velvet horn	Common
Cystoseira trinodis (Forsskål) C.Agardh	Long Reef	Common
Gelidiella acerosa (Forsskål) Feldmann & Hamel	Chaffweed	Common
Gracilaria crassa Harvey ex J.Agardh	Cylindrical red algae	Common
Gracilaria edulis (S.G.Gmelin) P.C.Silva	Sea Lettuce	Occasional
Gracilaria foliifera (Forsskål) Børgesen	Gracilaria seaweed	Occasional
Hormophysa triquetra (C.Agardh) Kützing	Rumput laut	Occasional
Hydroclathrus clathratus (C.Agardh) M.Howe	Hydroclathrus algae	Common
Hypnea musciformis (Wulfen) J.V.Lamouroux	Hooked red algae	Common
Hypnea valentiae (Turner) Montagne	Cylindrical red alga	Common
Laminaria angustata Kjellman	Devil's apron	Common
Laurencia papillosa (C.Agardh) Greville	Laurencia seaweed	Common
Sarconema furcellatum Zanardini	Sarconema seaweed	Common

Scientific name	Common name (optional)	Position in range / endemism / other (optional)
Sargassum tenerrimum J.Agardh	Brown seaweed	Common
Turbinaria conoides (J.Agardh) Kützing	Brown seaweed	Common
Ulva lactuca Linnaeus	Sea lettuce	Common
Ulva reticulata Forsskål	Sea lettuce	Common
Undaria pinnatifida (Harvey) Suringar	Thin Leaf Lettuce	Common

FAUNA OF GoMBR

Balanoglossus, the unique link between the invertebrates and invertebrates and extremely rare occurs only near Krusadai Island. *Chlamydotorax ceylonensis*, *Ptychodera flava* and *Chlamydothorax* (Ptychodera) *krusadiensis* are reported around Krusadai Island (Horst, 1932). **Balanoglossus** *Ptychodera flavo* is reported from Mandapam and Keezhakarai groups of islands. Fringing Coral reefs on the east, north and western side, occur at a distance of 300 meters from the shore. Live coral coverage is about 46%. *Pocilopora damicornis, Acropora formosa, Montipora digitata, Montipora foliosa, Favia pallida, Favia valenciennesi, Favites abdita, Leptastrea transversa, Platygyra lamellina, Galaxea fascicularis, Porites solida, Pocillopora damicornis, Echinopora sp. Goniastrea pectinata, Goniastrea retiformis, Acropora hyacinthus, Acropora humilis, Goniopora planulata, Coscinarea monile, psammocora contigua*

Gorgonids: 14 species are recorded. Dominant genera include *Subergorgia, Muricella, Thesea*, *Junceella, Echinogorgia* and *Gorgonella*

Polychaeta: 75 species are recorded. Dominant genera include *Iphione, Chloeia, Eulalia, Eunice, Onuphis*, *Malacoceros, Syllis and Perinereis*

Chank beds: There are about ten pearl banks. Most preferred species of pearl oyster is *Pinctada fucata*. There are four species of pearl oysters. *Pinctada fucata* is abundant in Tuticorin and the pearl banks are locally called "*parai*". It was observed that spat falls of pearl oysters get periodically replenished by larvae carried by currents from Sri Lankan coasts and the Sri Lankan beds gets transported by the larvae from the Indian sides.

Crabs: 210 species are reported (CMFRI, 1969a and 1998). Dominant genera include *Acanthosquilla*, *Anchisquilla, Cloridopsis, Gonodactylus, Oratosquilla, Carinosquilla* and *Lysiosquilla*.

Lobsters: *Panulirus homarus, Panulirus ornatus, Panulirus longipes, Panulirus polyphagus* and *Puerulus sewelli* and are recorded here. *Panulirus homarus* and *Panulirus polyphagus* are commercially exploited in fisheries (George 1968 and Deshmukh 1964).

Sea snakes: 12 species have been reported from this region. Nine species are true sea snakes belonging to the family Hydrophiinae. Studies show that population of sea snakes in the Indian seas is declining. Snakes are killed by the fishermen due to fear. A public awareness programme for fishermen in Gulf of Mannar is proposed to conserve these species using posters etc. Sub family **Hydrophiinae**: *Hydrophis spiralis, Hydrophis cyanocinctus, Hydrophis ornatus, Hydrophis gracilis, Hydrophis caerulescens Hydrophis fasciatus, Hydrophis lapemoides, Thalassophina viperina, Lapemis curtus, Pelamis platurus, Acrochordus granulatus* and *Cerberus rynchops*.

Elasmobranchs: Elasmobranch represents the numerous cartilaginous fishes of class Chondrichthyes having 5 to 7 gill slits on each side, dermal denticles for scales and a small respiratory opening called a spiracle behind each eye. Examples: Sharks, Rays, Skates, Sawfish and Chimaeras. Various **rays** belonging to the genera *Rhinopterajavanica, Pateobatisjenkinsii, aculabatisgerrardi, Aetobatusocellatus, Brevitrygonimbricata, Himanturauarnak, Urogymnusgranulatus* are **reported** from the **region**. Different types of guitar fishes include *Rhinaancylostoma, Rhinobatosannandalei, Glaucostegus granulates, Rhynchobatusaustraliae, Rhynchobatusdjiddensis* and *Pristiszijsron*.

Molluscs

Bivalves: *Trisidos tortuosa*, *Circe scripta*, *Donax faba*, *Isognomon isognomon*, *Atrina pectinata*, *Placuna placenta*, *Pholas orientalis*, *Paphia malabarica*, *Paphia textile*, *Crassostrea madrasensis*, *Pinctada fucata*, *Malleus malleus*, *Cucullaea labiata*, *Pteria avicular*, *Solen roseomaculatus*
Gastropods: *Architectonica perspectiva*, *Lophiotoma indica*, *Bulla ampulla, Harpulina lapponica*, *Conus amadis*, *Conus tessulatus*, *Conus betulinus*, *Conus monile*, *Laevistrombus canarium* ,*Tibia curta*, *Lambis lambis*, *Lambis truncata*, *Monetaria (Cypraea) moneta*, *Monetaria (Cypraea) caput serpentis*, *Haustellum haustellum*, *Chicoreus ramosus* ,*Agaronia nebulosa*, *Ancilla cinnamomema*, *Phalium glaucum*, *Phalium bisulcatum*, *Pugilina cochlidium*, *Natica tigrina*, *Ficus ficus*, *Harpa major*, *Turritella attenuata* (Reeve,1849), *Duplicaria duplicata*, *Bufonaria rana*, *Babylonia zeylanica*, *Cymatium perryi*, *Turbinella pyrum*, *Murex carbonnieri* etc.

Sea Cucumbers (**Holothurians**): *Holothuria scabra* and *Holothuria spinifera* were among the species being fished in the Gulf of Mannar and Palk Bay region till recently. It has been taken over by *Holothuria atra* by which is now recognised as commercially profitable species. They are collected by hand during low tide, in the intertidal regions and lagoons, where depth of water is less than a meter. **Holothuridae**: *Actinopyga echinites, Actinopyga miliaris, Bohadschia marmorata, Bohadschia tenuisimma, Holothuria* (Halodeima) *atra*, *Holothuria* (Halodeima) *edulis, Holothuria* (Lessonothuria) *pardalis*, *Holothuria* (Mertensiothuria) *leuospilota, Holothuria (Metriatyla) scabra, Holothuria (Microthele) fuscogilva, Holothuria (Selenkothuria) moebii, Holothuria (Semperothria) cinerascens, Holothuria (Theelothuria) kurti, Holothuria (Theelothuria) spinifera, Holothuria (Thymiosycia) hilla, Holothuria (Thymiosycia) impatiens, Holothuria(Thymosyicia) Arenicola.*

First account on marine gastropods of Gulf of Mannar was reported by Melville and Stander (1878). Successively, 8 Common Molluscs of Gulf of Mannar works on molluscs of the Gulf of Mannar include Thurston (1895); Iyengar and Parthasarathy (1927); Thomas (1972); Satyamurti (1952); Nayar (1955); Alagarswami (1966); Appukuttan (1972); Nair and Rao (1974) and Nair and Dharmaraj (1980). Investigation on the mollusc (after 1990s) was carried out, Jeyabaskaran et al.,1996; Shaul Hameed and Somasundaram, (1998); Fernando and Fernando, 2002; Hylleberg and Nateewathana, 2002; Subba Rao, 2003; Samuel et al 2005; Melkani et al., 2007; Kannaiyan and Venkatraman, (2008) and GoMBRT, (2012).

Teleost Fishes
Ten Pounders: *Elops machnata*; **Tarpons**: *Megalops cyprinoides*; **Bony fish**: *Albula vulpes*

Shads, Sprats & Sardines: *Anadontostoma chacunda, Dussumeieria acuta, Escualosa thoracata, Hilsa ilisha, Ilisha melanostoma, Nematolosa nasus, Opisthopterus tardoore, Pellona ditchela, Raconda russeliana, Sardinella albella.*

Anchovies*: Coila dussemieri, Setipinna taty, Stolephorus bataviensis, Stolephorus commersonii, Stolephorus devisi, Stolephorus indicus, Stolephorus macrops, Stolephorus waitei, Thryssa dussumieri, Thryssa malabarica, Thryssa mystax, Thryssa setirostris.*

Other Clupeoids: Wolf Herrings, Milk Fish, Lizard Fish, Catfishes, Catfish eel, Gar fishes (Half Beaks and Full Beaks), Flying fishes, Tiger Perches, Flute Mouths, Cardinal Fish, Mullets, Threadfins, Sea Perches, Sea basses and Reef Cods, Black Pomfrets, Moon fish, Dolphin fish, Sweetlips and Grunters, Mojarras, Job fishes, Emperor Breams, Silver Breams, Wrasses, Seer fishes, Ribbon fishes, Moorish Idol, Unicorn fishes, Sailfishes (Marlins), Scorpion fishes, Swordfish, Sea Robins, Porcupine fishes, Frog fishes, File fishes, Bat fishes, Puffer fish, Squirrelfishes and Barracudas.

Other Marine Mammals of the Biosphere Reserve

Scientific Name	**Common Name**	**IUCN / other status assessment**
Balaenoptera musculus	Blue whale	EN
Orcinus orca	Killer whale	DD
Globicephala macrorhynchus	Pilot whale	DD
Steno bredanensis	Rough toothed dolphin	LC

Stenella attenuata	Pantropical Spotted Dolphin	LC
Stenella longirostris	Spinner Dolphin	DD
Delphinus delphis	Common Dolphin	LC
Neophocaena phocaenoides	Finless Porpoise	VU
Physeter macrocephalus	Sperm whale	VU

Other Invertebrate Fauna Benthic fauna include shrimps, lobsters, crabs, molluscs etc

Benthic fauna

Saccostrea cucullata
Solen lamarckii
Tellina nobilis
Tellina sp

Crustaceans

Acartia sp
Alpheus malabaricus
Ampithoe ramondi
Apseudes chilkensis
Apseudes gymnophobia
Apseudes sp.
acclivirostris
Atylus minikoi
Balanus amphitrite
Calanus sp.
Calappa sp.
Cheiriphotis megacheles
Clibanarius sp.
Cymadusa pathyi
Diogenes sp.
Erictiwnius brasiliensis
Eriopisa abhilashi
Eriopisa chilkensis
Eriopisa sp.
Eriopisella sp.
Eurydice sp.
Gammaropsis esturinus
Gammaropsis sp.
Graniderrella gilesi
Hyale honoluluensis
orientalis

Penaeid prawns

Solenocera crassicornis
Solenocera hextii
Solenocera indica
Metapenaeopsis stridulans
Metapenaeus affinis
Metapenaeus brevicornis
Metapenaus dobsoni
Parapenaeopsis

Parapenaeopsis. hardwickii
Prapenaeopsis maxillipedo
Prapenaeopsis stylifera
Prapenaeopsis Uncta
Penaeus canaliculatus
Penaeus indicus
Penaeus japonicus
Penaeus latisulcatus
Penaeus merguiensis
Penaeus monodon
Penaeus semisulcatus

Non-penaeid prawn

Acetes indicus

Lobsters

Panulirus homarus
Panulirus ornatus
Panulirus. versicolor
Rama Eral, Thenus

Stomatopod: *Oratosquilla nepa*

Crabs: *Calappa lophos, Scylla serrata, Portunus pelagicus, Chrybdis cruciata, Chrybdis edwardsi*

Isopods: *Paracalliope indica, Parorchestia morini, Quadrivisio bengalensis, Talorchestia martensii*, *Tanaeus sp, Oithona rigida, Urothoe sp, Veliger larvae*

Porifera (Sponges)

Heteronema erecta
Dentriela cactus
Sigmadocia fibulata
Sigmadocia pumila
Echinodictyum clathratum
Microciona aceratoobtusa

Optulitaspongia rimosa
Phycopsis sp
Spirastrella coccinea
Cliona celiba
Cliona orientalis

Phytoplanktons

Diatoms	97 species	(37 genera)
Dinoflagellates	16 species	(6 genera)
Blue green Algae	7 species	(5 genera)
Green Algae	3 species	
Total Phytoplanktons	**126 species**	

CNIDARIA

1. Order: **Scleractina**

Acroporidae
Acropora cytherea
Acropora digitifera
Acropora echinata
Acropora humilis
Acropora hyacinthus
Acropora intermedia
Acropora microphthalma
Acropora millepora
Acropora muricata
Acropora rudis
Acropora secale
Acropora valenciennesi
Acropora valida
Astreopora myriophthalma
Montipora aequituberculata
Montipora digitata
Montipora edwardsi
Montipora explanata
Montipora exserta
Montipora foliosa
Montipora hispida
Montipora informis
Montipora jonesi
Montipora manauliensis
Montipora millepora
Montipora monasteriata
Montipora spumosa
Montipora tuberculosa
Montipora turgescens
Montipora venosa
Montipora verrucosa
Agaricidae
Pachyseris rugosa
Pavona cactus
Pavona clavus
Pavona decussata
Pavona varians
Asterocoeniidae
Madracis kirbyi
Faviidae
Cyphastrea microphthalma
Cyphastrea serialia
Echinopora lamellose
Favia favus
Favia pallida
Favia speciosa
Favia stelligera
Favites abdita
Favites bestae
Favites complanata
Favites halicora
Favites pentagona
Goniastrea pectinata
Goniastrea retiformis
Leptastrea purpurea
Leptastrea transversa
Leptoria phrygia
Montastrea valenciennesi
Platygyra daedalea
Platygyra sinensis
Fungiidae
Cycloseris cyclolites
Merulinidae
Hydnophora exesa
Hydnophora microconos
Mussidae
Symphyllia radians
Siderastreidae
Coscinaraea monile
Psammocora contigua
Pseudosiderastrea tayami
Oculinidae
Galaxea astreata
Galaxea fascicularis
Pectiniidae
Mycedium elephantotus
Pocilloporidae
Pocillopora damicornis
Pocillopora eydouxi
Pocillopora verrucosa

Dendrophylliidae	
Turbinaria mesenterina	**Poritidae**
Turbinaria peltata	*Goniopora planulata*

Zooplanktons	360 species
Copepods	223 species
Amphipods	52 species
Ostracods	57 species
Isopods	18 species
Decapod larvae	8 species
Cumacea	10 species

ECOLOGICAL CHARACTERISTICS

The origin of the island chains which constitute Gulf of Mannar is the product of complex bio geomorphic processes that began in the last interglacial period, when during the lag phase, the sea level regressed up to 6 to 8 meters, thereby exposing the sandy substratum around the island system. This initiated the coral growth around the present-day islands. When the sea level began rising, coral arose too, keeping in pace with the sea level increase; thus, developing the barrier island system. Due to the tectonic movements, a certain area of land emerged in the Gulf of Mannar (Ramasamy, 1996). Infilling of lagoon with reef sediment and the evolution of incipient cay gave shape to the island. Mangroves, Coral reefs and Sea Grass ecosystems are the three important and sensitive ecosystems along coastal zones. GoMBR is no exception and possesses all these unique ecosystems and has become significant because of the presence of other associated resources such as fishes, sponges, gorgonids, holothurians, pearl beds, chank beds, sea horses, turtles and the sea cow, *Dugong dugon*. The floral components comprise of economically viable species of seaweeds such as *Gracilaria* sp., *Gelidiella* sp., *Caulerpa* sp, *Sargassum* sp. and *Turbinaria* sp. The sea grass communities of GoMMBR tops the list of marine flora of India, with the highest number of sea grass species recorded, providing important feeding grounds for the endangered *Dugong dugon*.

The topography is diverse; including beaches, spits, beach ridges, swales, backwaters, mudflats offshore islands flanked by coral reefs, wave cut platforms, sea cliffs, sea caves, and water-logged land. **Sand Dunes and beaches:** Sand dunes represent flexible barriers that absorb wave energy, during high waves and storms by moving and adjusting their shape and position. Dunes are essentially sand reserves, where sand accumulates during normal conditions and then released to the beach and offshore zone during high waves and storms. It also acts as ground water reservoir, supporting freshwater to the vegetation, in the island chains and prevent salt water intrusion. Dunes in Gulf of Mannar are mostly small to medium scale with creepers. In the current scenario, where there is sea-level rise, stabilized sand dune along the beaches acts as natural barrier for the low-lying islands. Beaches are extensively developed along the entire coast of Gulf of Mannar except at some places. The shore between Tuticorin to south Sippikulam (2.04 km²), Vaippar and Gundar River (2.56 km²), Gundar and Palar River, (2.64 km²), Palar and Kottakkarai River (2.189 km²), Kottakkarai and Marakkayarpattanam (2.18 km²) southern coastal parts of the Rameswaram Island (2.91 km²) and the western part of Rameswaram Island from Pamban to Peikkarumbu are observed as important beach areas in Gulf of Mannar coast. Along the shoreline the beaches are gently sloping and marked with altered crusts and troughs that are formed due to wave action. There are also beaches available along the coasts of Tirunelveli and Kanyakumari districts, which forms a part of the Biosphere Reserve.

Spit: Formation of spit is a feature formation of recent age. South of Tuticorin coastal region two spit formations have been observed. It appears to have been built by the sediments brought by longshore current, during southwest monsoon. Gulf of Mannar being on the leeward side of northeast monsoon, here is no longshore drift from the northeast, that might cause inward curving of this spit (Ahmad 1972). Southwestern shore line of Rameswaram has a tongue shaped spit. Rameswaram spit may have been the result of littoral current from Palk Bay, to Gulf of Mannar during northeast monsoon period.

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

Sea cliff and sea cave: Along the coast of Gulf of Mannar, cliffs have been observed in Mandapam, Rameswaram, Pudhumatam and Appa Island. The sea cliff and caves are made up of calcareous sandstone and located at high water level. Intense action of waves on cliffs at some places, lead to the formation of sea caves. Such caves have been observed near Mandapam coastal area and Southwestern and Southern coastal areas.

Beach Ridges: Beach Ridges are moderately undulating terrain of marine depositional type, formed during Pleistocene to current, in the plains of Gulf of Mannar coastline. Coastal areas between Mandapam and East of Vaippar River are covered by well-developed beach ridges. There are twelve beach ridges in the region. All beach ridges are parallel to each other, covering an area of 155.49 km² running from East to West and Northwest to South Westerly direction. Based of the nature and dispositions of beach ridges, they can be grouped into (i) Beach ridges South of Vaigai River, (ii) Beach

ridges between Kotangudi River and Palar River, (iii) Beach ridges between Palar River and Gundar River system, (iv) Beach ridges between Gundar River and Vaippar River and (v) Beach ridges South of Vaippar River.

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

Wavecut Platform: Wavecut Platform are common along the coast of Mandapam, Ramaswami Matam, Pudhumatam, Valinokkam etc. At Pudhumatam, hard and tough sandstone platform occupies the intertidal zone. South of Valinokkam coast, extensive wavecut platforms have been observed and erosional features are widely seen.

Strand lines: Along Gulf of Mannar coastline from Tiruppullani to Mandapam, eight series of strandlines in curvilinear form have been observed. The general trend of the Strand line is in an eastern to western direction. Curvilinear strandlines have also been observed in the South of Rameswaram.

CLIMATIC FEATURES

Indian subcontinent has always been vulnerable to natural disasters on account of its unique geo-climatic conditions, floods, droughts, cyclones; tsunami, earthquakes and landslides have been a recurrent phenomenon. About 60% of the Indian landmass is prone to earthquakes of various magnitudes; over 40 million hectares of landmass is prone to floods; about 8% of the total area is prone to cyclones, 68% of the area is susceptible to drought and the entire coast of India is prone to tsunami.

The Gulf of Mannar Marine National Park and Biosphere Reserve is vulnerable to natural disasters, particularly originating from the marine environment such as cyclonic storms, tsunami and flood. The area is also prone to recurrent droughts.

Global warming is a widely accepted fact, due to which there is a rise in sea level worldwide. Coral reef ecosystems are suspected to be under severe threat, reflective of which two islands have already submerged, the prime suspect being global warming. The island of **Villanguchalli** with an area of 0.95-hectare and15 km off the port city of Tuticorin got submerged a few decades ago. There are isolated patches of thin coral reefs, along the south eastern side of the island. Coral mining was the reason for this island to get submerged. Further, there is a looming threat in the form of sea level rise due to global warming for this island. 2015 became the hottest year on record. Elevated sea temperatures seem to directly affect the metabolism of the sea grass, photosynthesis and respiration, acting as a limiting factor in determining the abundance and distribution of sea grass meadows.

In April 2019, massive blooms of *Trichodesmium erythraeum* (8×10 5 filaments/ml) forming several long chains extending up to few kilometers, were observed nearby Mandapam group of islands, Bloom of *Synechococcus* sp. (3×10 5 cells/ml) was also recorded near the Kundukal jetty, Mandapam region merely. The "**blooms**" might have been favoured and triggered by increase in temperature and salinity. However, seasonal monitoring of water quality parameters and observations on these blooms are underway to evaluate the ecological impacts of these ***cyanobacteria*** **species** on coastal fauna for devising management strategies.

Mass mortality of the sea urchin, *Salmacis virgulata* scattered over the periphery of Dhanushkodi beach, was observed on **February 13, 2019**. More than **100** numbers of recently dead and dying specimens were found within a 10 m2 area on the sandy beach. Beach profiles indicated several hundreds of exoskeletons of such previously dead *Salmacis virgulata* washed ashore and buried in the sand and withering sea grasses. The causative agent responsible for mass mortality of *Salmacis virgulata* is yet to be identified. However, observations on wave approach toward shore indicated possible evidence that it could be due to a combination of strong near shore waves and currents. This observation raises a critical research concern to investigate etiology of *Salmacis virgulata* for species conservation. Sea urchins are important grazing invertebrate communities in shallow and deeper marine waters and are the well-studied echinoderms for their ecological significance in reef and sea grass ecosystems. Heavy wind speed, extensive wave action, and sediment transportation were observed during the study.

WATER REGIME

The landscape is dotted with beaches, algal beds, minor deltas, backwater areas, creeks, mudflats, sea grass beds, coral reef, salt marshes and mangroves. Beaches are extensively spread along the entire coast of Gulf of Mannar. It is gently sloping and marked with altered crusts and troughs formed due to wave action.

The coastal areas between Mandapam and East of Vaippar River are covered by twelve well-developed beach ridges. Sand spits are observed in the southern side of Tuticorin and in the southwestern shore of Rameswaram. Swales and backwater zones are seen between coastal plains of Mandapam and Kottakkarai River. Mudflats are observed near Vaippar River mouth, around Valinokkam backwater lagoon, Kallar River mouth and Gundar River mouth. The 21 off shore islands are made up of a calcareous dead reef and sand. Coral reefs extends from south of Rameswaram to Tuticorin. It is believed that Gulf of Mannar region was once covered with thick mangrove forests.

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

Stratification and Mixing Regime: The porous formations can be grouped into three aquifer groups, viz., Cretaceous sediments, Tertiary sediments and Quaternary sediments. Cretaceous aquifer is semi confined to confined in nature and consists of two zones. The top unit which is fossiliferous sandstone, red in color and compact, whilst bottom is pinkish or grayish sandstone, intercalated with shales. The aquifers are characterized by freshwater and occurs at the depth range of 116-407 and 205-777 meters bgl (below ground level) and has thickness ranging between 68 to 535 meters. The aquifer is made up of compact sandstone and the potential is limited. However, due to the presence of potential shallow tertiary aquifer, this aquifer has not been extensively developed. Cuddalore Sandstone of Tertiary sediments consists of Sandstone, Clay and Conglomerate. They are encountered at depths between 15-75 meters bgl, with thickness from 20 to 70 meters. The groundwater occurs under unconfined condition, with thickness varying from 15-20 meters and under confined condition in deeper depths. Water-bearing properties of crystalline formation lack primary porosity and depend on the extent of development of secondary intergranular porosity. Ground water occurs and move in these rocks and are confined to such spaces. These aquifers are highly heterogeneous in nature, due to variation in lithology, texture and structural features even within short distances. Ground water usually occurs under phreatic conditions in the weathered mantle and under semi confined conditions in the fissured and fractured zones at deeper levels. Thickness of weathered zone ranges from 4 to 15 meters. The depth of the wells ranged from 10.00 to 15.00 meters below ground level.

SEDIMENT REGIME

Rapid coastal development in the Gulf of Mannar causes land runoff. A number of small hamlets and villages have sprung up along the coast of the Gulf of Mannar, during the last few decades. This has resulted in sedimentation and caused destruction of coral reefs. Dynamite fishing which was practiced by fishermen many years ago has also generated large quantities of silt and upon sedimentation killed the corals. However, this practice is strictly banned and prohibited in the area. Use of trawl nets during fishing also cause disturbance by stirring the bottom sediments which again leads to siltation. Sedimentation of fly- ash occurs in the salt pans of Tuticorin. Abundance of luminous bacteria ranging between 100 to 850 cells/gram, in inshore sediments has been recorded (R. Palaniappan *et al*., 2003). The five different species of luminous bacteria are *Vibrio fischeri, Vibrio harveyi, Vibrio orientalis, Vibrio splendidus* biotype 1 and *Photobacterium leiognathi*. Another study which identified the nature and distribution pattern of heavy minerals was carried out along Kanyakumari to Mandapam. Results showed predominant distribution of opaques, followed by zircon, garnet, chlorite, biotite, muscovite and monazite; whereas the accessory minerals like rutile, kyanite, hypersthene, hornblends, andalusite, apatite, topaz, silimanite, constitute the heavy mineral assemblages. Abundance of heavy minerals was found to differ between the different regions, within the biosphere reserve. Textural parameters of the sediments show a characteristic variation in mean size and sorting in the zones of wave divergence and convergence. At wave divergent zones, sediments are of fine, moderately sorted, negatively skewed and mesokurtic in nature. Coarse sediments of well sorted, negatively skewed and mesokurtic

nature are the characteristics of sediments in convergent zones. Chlorite, sillimanite, mica, few hornblendes and kyanite are characteristic of Mandapam block while biotite and glaucophane for Valinokkam block, euhedral zircon, hypersthene, tourmaline for Tuticorin block, broken zircon, andalusite and topaz for Manappad block and rounded zircon, rutile and monazite for Kanyakumari block. Chlorite, mica and other flaky minerals are dominant in Mandapam and Manappad blocks, whereas in Kanyakumari and Valinokkam block, minerals like zircon, garnet and other denser heavy minerals are abundant. Granular minerals like zircon and garnet, are presumed to have been derived from the recycled sediments. However, the immediate hinterland has not shown any presence of ancient sedimentary formations which are likely to be the source for recycled sediments. In Kanyakumari sector in the south, the heavies are concentrated in coarser sands, in the central Tuticorin sector in medium sands, and in the northern Mandapam sector in fine sands. Weight percentage distribution of heavies shows poor concentration at Mandapam that can be ascribed to strong progradation activity and wave-divergent conditions. A higher concentration of heavies in the ephemeral stream mouths in Tuticorin sector is due to the arcuate nature of the coastline, strong convergence of orthogonal and a basinal structure, all of which enable trapping of sediments carried by littoral currents. The poor concentration of heavies in Manappad sector, despite wave-convergent condition, is due to the straight alignment of the coastline without any arcuate bays. The enrichment of heavies in Kanyakumari sector is attributable to the arcuate coastline and a down warped basinal structure. Areas between Kanyakumari - Kuttankuli and Kallar - Vaippar are located at the point of junction of two different convergent blocks leading to the formation of a depositional basin in these areas. It aids the trapping of sediments and protects the heavy minerals from the longshore drift, though there is a clear-cut displacement along the shoreline. Relatively pristine reefs are located around uninhabited Islands or ban-ier type reefs located away from population centers. Sedimentation, dredging and coral mining are damaging near shore reefs, while the use of explosives and bottom nets in fishing are damaging off shore reefs in specific sites.

The nature of sediment in GoMBR region except Valinokkam island is generally coarse to fine sandy. 0.5 to 40% by dry weight of the sediments is made up of calcium, derived from coral and molluscan organisms, due to weathering process.

Erosion – Soil erosion due to excessive mining has led to Vilanguchalli now lies 1 meter below mean low tide level. The islands have fringing and patch reefs around them. Krusadai group of Islands serve as windbreaks and help to prevent soil erosion.

DISSOLVED ORGANIC CARBON

The nature of sediment in GoMBR except Valinokkam area is coarse to fine sandy, while fine sandy to clayey in Palk Bay. It shows a mean value of 0.08784±0.022%, ranging from 0.0286-0.2413% in the subsurface. The soil carbon density of coastal sediments in Gulf of Mannar is lesser than Palk Bay. It is presumed that higher settlement of seagrass leaf litter and organic matter in the bay region and also a wider area of sea grass cover. A study conducted in 1998, showed organic carbon content (1.38 to 9.11mg/g) of the reef sediments, which was comparatively lower than that of seagrass beds.

DIFFERENT SURROUNDING AREAS

The Biosphere Reserve includes a chain of 21 islands and the surrounding sea scape. Hence it is a combination of land, associated landforms and sea. The low and narrow coastline is usually sandy, while few islands have rocky coast. The raised reef terraces and wave terraces found in some of the islands clearly indicate sea level rise and tectonic activities in the past. Mining of coral reefs around the islands for construction and industrial purposes, have resulted in strong waves directly hitting the shores, especially along the windward side. There is extensive erosion and have reduced in size and even shifted their positions, from their original position. The topography is also diverse consisting of beaches, beach ridges, spits, swales, backwaters, mudflats, wave cut platforms, strandlines and sea cliffs.

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

In **Van Island,** more than 40 fully grown trees of *Prosopis* occur. The ground vegetation has halophytic herbs, creepers and grasses. Degraded seagrass patches are seen near the island. About ¼ area of this island has already become submerged due to the removal of coral reefs. There are few depressions on this island and the mangroves are absent. The open areas have been planted with *Thespesia*, Pungan, Neem*, Delonix alata* and are getting established. **Kasuwari Island,** *Prosopis* and *Salvadora* trees are dominant on the terrestrial region. Ground vegetation has herbs, creepers and grasses. Due to excess removal of corals over the last decade, about ¼ of this island is sinking under water. Fresh coral debris and sand accretions are taking place in other portions also and plant succession with ground vegetation and grasses are establishing over the newly built-up land portions, due to the control exercised over removal of corals. The same vegetation as in **Kariachalli** island. Few important species like *Caralluma circarii* are absent. Natural depressions have good growth of *Avicenna* species and *Suaeda* are seen, although on another depression, mangroves are absent. *Pithecellobium dulce*, Vagai and *Thespesia* have grown well. **Velanguchalli Island** This submerged island looks like a small sand mound, due to the removal of coral reefs around this island in the past. Currently, good fringing corals have been observed around this island. There are good seagrass patches present in the shallow waters around the island. **Upputhanni Island** has good and natural growth of vegetation. *Thespesia* and Neem are the main trees and grow from cut stumps. Large depression in the southern side of the island caused by coral mining about two decades back, has stagnation of rain water and sea water and has become a natural heronry for sea birds. **Nallathanni Island** in an area of 35 hectares, there were 1600 coconut and 2000 palmyra palms planted by the Maraickayar family in 1993, but now there are about 150 coconut trees and 300 palmyra palms. Surrounding **Anaippar Island,** there are good coral reefs and patch coral formations. There are no mangroves along the shore. Man-made depressions within the island, where once salt making activity was carried out and around there is luxuriant growth of *Avicennia officinalis*. The predominant vegetation is *Prosopis* and occasionally Salvadora.

S.No	Land Use/Land Cover	Area (sq.km)
1	Agriculture (Crop Land)	76.87
2	Agriculture (Fallow Land)	856.78
3	Agriculture (Plantation)	778.8
4	Barren Land	51.32
5	Carnatic Umbrella Thorn Forest	20.69
6	Littoral Forest	35.11
7	Mangrove Forest	4.22
8	*Prosopis*	63.35
9	Other Vegetation	107.25
10	Marsh Land	18.17
11	Mud Flat	24.52
12	Saline Land	16.32
13	Salt Pan	103.7
14	Sandy beach	402.43
15	Water Body	7,652.64

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