DATABASE ON GULF OF MANNAR BIOSPHERE RESERVE

By

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1. Introduction

The Gulf of Mannar, the first Marine Biosphere Reserve (GOMMBR) in the South and South East Asia, running down south from Rameswaram to Kanyakumari in Tamil Nadu, India is situated between Longitudes 78008 E to 79030 E and along Latitudes from 8035 N to 9025 N (Figs.1 & 2). This Marine Biosphere Reserve encompasses a chain of 21 islands (2 islands already submerged) and adjoining coral reefs off the coasts of the Ramanathapuram and the Tuticorin districts forming the core zone; the Marine National Park and the buffer zone includes the surrounding seascape and a 10 km strip of the coastal landscape covering a total area of 10,500 Km^2, in the Ramanathapuram, Tuticorin, Tirunelveli and Kanyakumari Districts with a long coastline of 364.9 Km. The importance of the Gulf of Mannar region dates back to the 2nd Century AD because of its highly productive pearl oyster banks and other religious significance. In India, the Gulf of Mannar region in Tamil Nadu is one of the four major coral reef areas and the others are Gulf of Kutch in Gujarat, Lakhsadweep and Andaman and Nicobar islands.

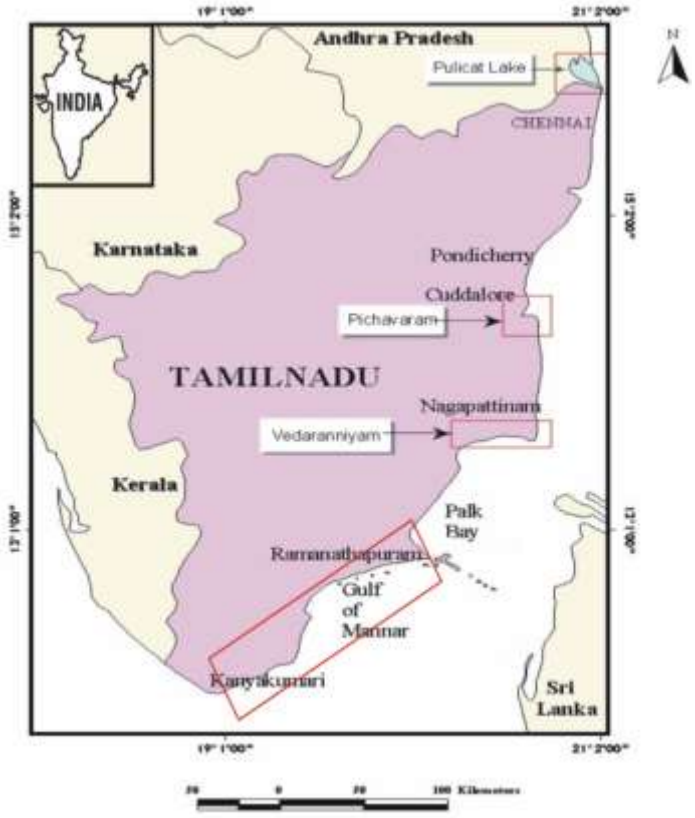

Fig.1: Map showing Tamil Nadu state with Gulf of Mannar location

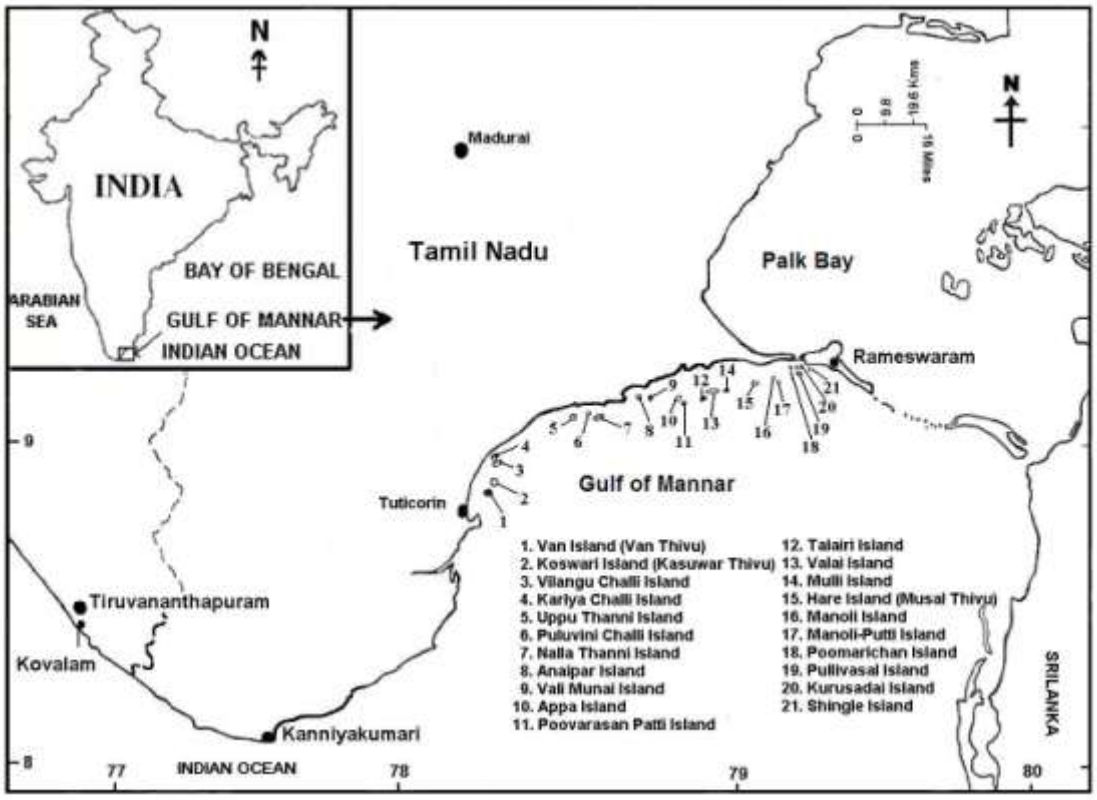

Fig.2: Map showing the Gulf of Mannar with 21 islands

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 about 4223 species of various flora and fauna, part of this Gulf of Mannar between Rameswaram and Tuticoirin covering 21 islands and the surrounding shallow coastal waters has been declared as a Marine National Park in 1986 by the Government of Tamil Nadu and later the first Marine Biosphere Reserve of India in 1989 by the Government of India.

Several research organizations like Central Marine Fisheries Research Institute (CMFRI), Suganthi Devadasan Marine Research Institute (SDMRI), Fisheries College and Research Institute, Tuticorin, Madurai Kamaraj University, Zoological Survey of India (ZSI), Anna University, Annamalai University, Wildlife Institute of India (WII) and others have conducted various studies in the Gulf of Mannar maining on the biodiversity which have confirmed the richness of the marine biodiversity in this region.

Besides key coastal habitats like coral reefs, seagrass beds and mangroves, the Gulf of Mannar Biosphere Reserve supports several globally important species such as the critically endangered *Dugong dugon* (sea cow), all protected sharks (IWPA, 1972) including whale shark, sea horses, green and hawksbill sea turtles, dolphins and sea cucumbers and several endemic species of Balanoglossus, sea grass, crabs and mangroves. The swamp near the Kodandaraman Temple near Rameswaram gives shelter to a flock of about 10,000 flamingos every year, during the months of December to March along with various many other species of waders and wetland birds. Exploitation of fishery resources in the inshore waters had been the sole occupations for several thousand families living along the coast of Gulf of Mannar for centuries. They have been in such close intimacy with the coastal and marine environment that their life-style, culture and social life all centres around the sea.

2. Ecological characteristics of Gulf of Mannar

2.1 Beach

Beaches are extensively developed along the entire coast of Gulf of Mannar except at some places. The shore between Tuticorin to south Sippikulam (2.04 km^2), Vaippar and Gundar Rivers (2.56 km^2), Gundar and Palar Rivers (2.64 km^2), Palar and Kottakkarai Rivers (2.189 km^2), Kottakkarai River and Marakkayarpattanam (2.18 km^2) southern coastal parts of the Rameswaram Island (2.91 km^2) and the western part of the Rameswaram Island from Pamban to Peikkarumbu are observed as a important beach areas in Gulf of Mannar coast. All along the shore the beach is observed to be gently sloping and marked with altered crusts and troughs that are formed due to wave action. There are also good beaches available along the coasts of Tirunelveli and Kanyakumari districts which also a part of the Biosphere Reserve.

2.2 Spit

Among the various depositional landform features encountered, the formation of spit is a significant feature of recent age. South of Tuticorin coastal area two spit formations have been observed. It appears to have been built by the sediments brought by long shore current during southwest monsoon. The southwestern shore of Rameswaram has a tongue shaped spit.

2.3 Beach ridges

Beach ridges are moderately undulating terrain features of marine depositional type, formed during Pleistocene to Recent age, in the plains of Gulf of Mannar coast.The coastal areas between Mandapam and East of Vaippar River are covered by well-developed beach ridges. There are twelve beach ridges observed in the region. On the basis of the nature and dispositions of beach ridges, it can be grouped into (i) Beach ridges south of Vaigai River, (ii) Beach ridges between Kotangudi River and Palar River, (iii) Beach ridges between Palar River and Gundar River system, (iv) Beach ridges between Gundar River and Vaippar River and (v) Beach ridges south of Vaippar River.

2.4 Swales and backwater zone

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

2.5 Mud flat

The mudflats are observed near Vaippar River mouth, around Valinokkam backwater lagoon, Kallar River mouth and Gundar River mouth. The area

2.6 Off shore islands and coral reefs

A chain of 21 low islands has been observed along the offshore region of Gulf of Mannar Marine National Park.It extends from south of Rameswaram to Tuticorin. All islands are made up of a calcareous framework of dead reef and sand. They have a low and narrow

sandy coast and some of them have rocky coast. Around all offshore islands, well-developed coral reefs have been noticed. Geomorphologically, coral reefs in this area are of fringing type, though some patch corals are also observed in Keezhakkarai and Tuticorin coasts.

The outside GOMMNP, the area between Tuticorin and Kaniyakumari, it is reported vast patch corals, gorgonian and seagrass beds. The patch corals are located about 7-10 km away from the shore, while gorgonian beds are located upto 4-5 km from the shore. However no detailed data available (Patterson et al., 2009).

2.7 Wave cut platform

Wave cut platforms are common in the coast of Mandapam, Ramaswamimadam, Pudumatam, Valinokkam etc. At Pudumadam coast, hard and tough sandstone platform occupies the intertidal zone. South of Valinokkam coast very extensive wave cut platform has been observed and erosional features are widely seen.

2.8 Sea cliff and sea cave

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

2.9 Waterlogged land

Water logged lands have been observed around the northern part of Rameswaram Island. In the areas like Pillaikulam, Surantidal and Mangaud, this type of features has been observed.

2.10 Strandlines

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

2.11 Currents

The current in the area are swift. The sea is rough between April and August. During June to august it is very stormy. It is calm during September to March. The October to December months have North east monsoon with occasional gales. The current movement normally changes depends on monsoon. During Southwest monsoon the current pattern is from south to north and during Northeast monsoon, the current movement is from north to south.

2.12. Soil

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

2.13 Geographical/Geomorphological Features

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

2.14 Climates and Rainfall

The area comes under the spell of both south-west and north-east monsoon. The south- west monsoon contributes only very little towards the annual rainfall of the area. Rain fall is moderate to heavy during October to mid December with occasional gales. The annual

rainfall varies from 762 mm. to 1270 mm year to year. The monthly average annual atmospheric temperature varies from 27^0C to 33^0C with the maximum and minimum in April/May and January respectively.

2.15 Water resources

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

3. The off shore islands, its ecology, coral diversity and importance in the Biosphere Reserve

The ecological conditions of the 21 islands (including two submerged islands) and coral biodiversity as per the Management Plan (2007-2016) documents are detailed below.

3.1. Vaan Island

The ground vegetation has halophytic herbs, creepers and grasses. About ¼ area of this island has already become submerged due to the removal of coral reefs. The heavy biotic interference due to its nearness to Tuticorin town and nearby villages and frequent fires caused by fisherman is the main reason for degradation of this island's biodiversity. There are a few depressions on this island and the mangrove species are absent. The open area of this island has been planted with Thespesia, Pungan, Neem, *Delonix alata* with 35% survival.

The live coral cover in this island is considered as 'fair' and the order of dominance of live coral categories is CM>CB>ACB>CF>ACT>CE. The average percentage occurrence of live coral categories of he Vaan Island resulted is ACT 3.26%, ACB 3.71%, CB 5.07%, CE 2.81%, CF 3.45% and CM 12.82%. Among the live coral categories, coral massive (CM) is dominant. The percentage of Acropora and Non-Acropora was recorded as 6.97% and 24.16% respectively. The coral sub massive (CS) was totally absent in Vaan Island. Live corals are seen in the southern side of the island, while the dead corals are found to be as substrate for many types of seaweed. The rubbles are found sprayed on the southern side having 3.04%. The reef flat was dominant by *Acropora* sp. and *Montipora* sp., where reef

slope was dominant by *Favia* sp., *Favites* sp., *Hydnophora* sp., *Goniopora* sp., *Platygyra* sp. and *Porites* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) - 3.05 Km^2 and Dead Coral (DC) - 1.77Km^2 (Fig.3).

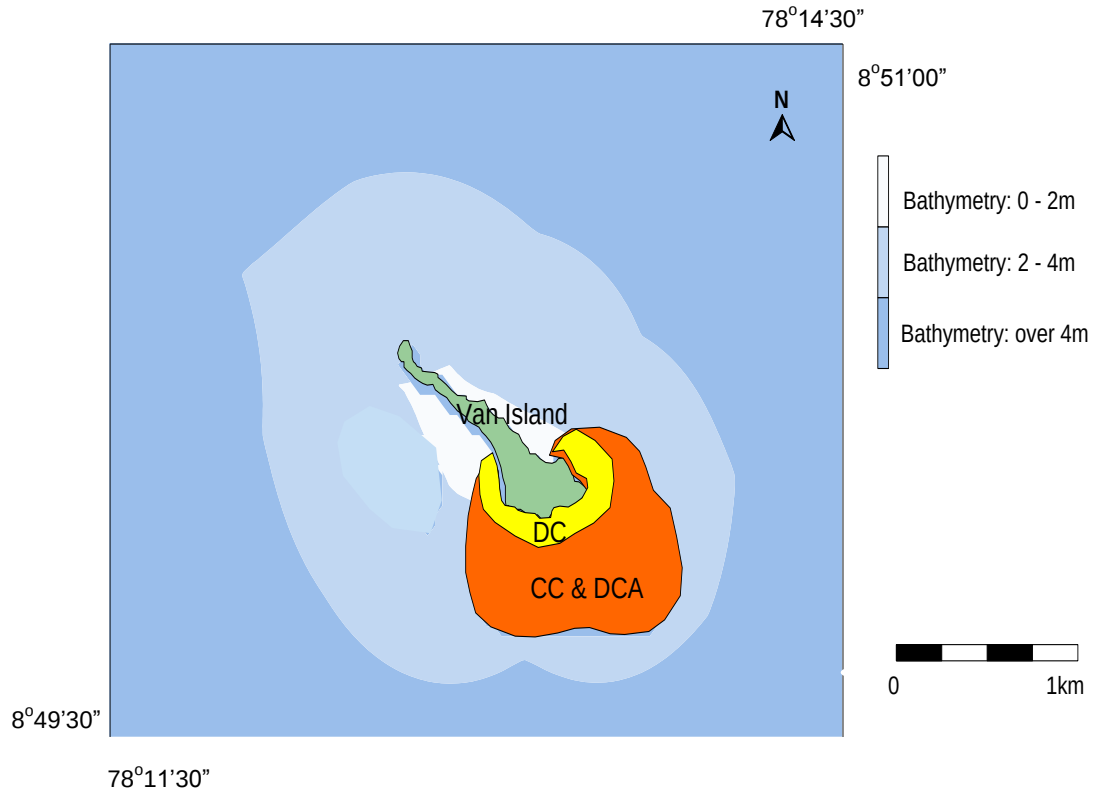

Fig.3: Map showing distribution of coral reef around Vaan Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

3.2. Koswari Island

Prosopis and *Salvadora* trees are dominant on the terrestrial part of the island. The ground vegetation has herbs, creepers and grasses. Due to excess removal of corals over the last decade, about ¼ of this island is sinking under water. Due to the control exercised on coral mining, fresh coral debris and sand accretions are taking place in other portions also and plant succession with ground vegetation and grasses isestablishing over the newly built up land portions. In a natural depression, good growth of *Avicenia* species and *Suaeda* are seen. The Afforestation done during 92-93 has about 40% survival. *Pithacalobium dulce*, Vagai, thespesia have come up well. The area surrounding this island is famous for chank due to good sacred chank beds, which attract near by fishermen illegal collection of chanks.

The live coral cover of this island is considered as 'poor' and the order of dominance of live coral categories is CM>CE>CB>CF>ACB>ACT. The percentage occurrence of live coral categories of this island follows is ACB 1.21%, CB 2.87%, CE 3.51%, CF 1.6%, CM 6.1% and ACT 0.21%. Among the live coral categories, coral massive (CM) is dominant while the coral sub massive (CS) is totally absent in this island. The percentage of Acropora and Non-Acropora is recorded as 1.17% and 14.09% respectively. Illegal mining of corals for the last 2-3 decades have brought deleterious effect on the corals and are responsible for decrease of coral diversity. The percentage of rubbles covers in this island is 7.05%. Live coral cover is seen in the southwest, south and southeast direction of the island. The reef flat consists of live coral colonies including branching types represented by *Acropora* sp., and *Montipora* sp while massive types represented by *Porites* sp., *Favitis* sp., and *Favia* sp. seen in the reef crest and reef slopes. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) - 3.54 Km^2 and Dead Coral (DC) – 2.73Km^2 (Fig.4).

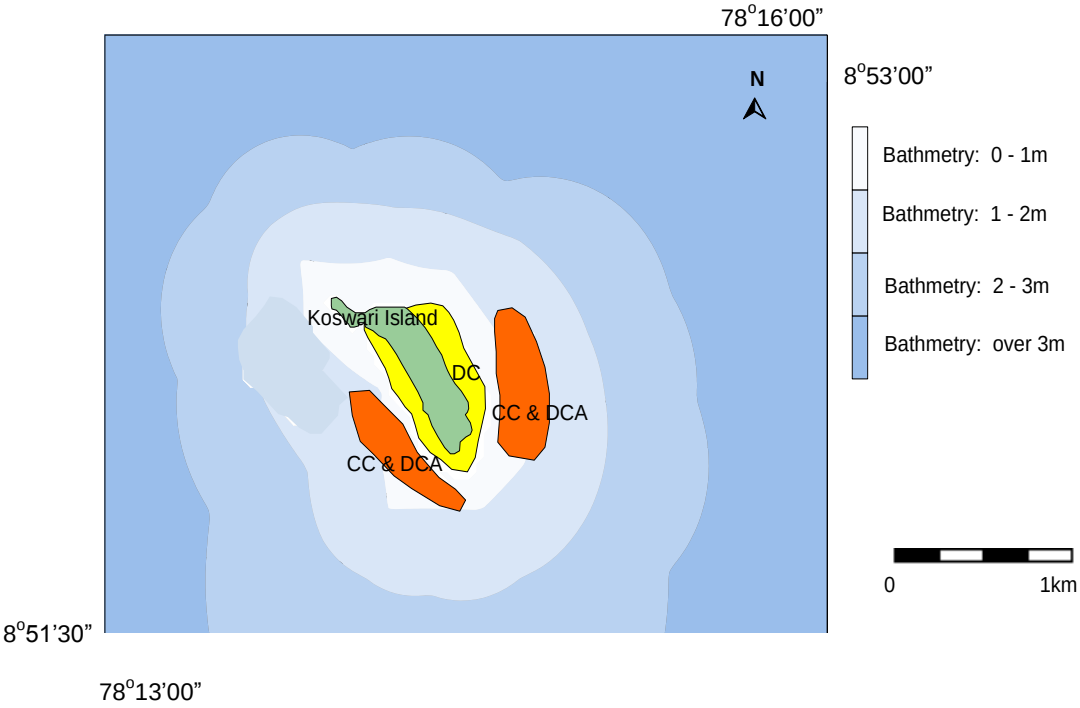

Fig.4: Map showing distribution of coral reef around Koswari Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

3.3. Vilanguchalli Island

This submerged island looks like a small sand mount due to removal of coral reefs around this island in the past. Currently, good fringing corals have been observed around this island.

The live coral cover of this island is considered as 'poor' and the order of dominance of live coral categories is CF>CM>ACT>CE>ACB>CB. The live coral categories of this island resulted is ACT 5.04%, ACB 0.99%, CB 0.91%, CE 3.02%, CF 8.74% and CM 5.62%. Among the live coral categories corals foliose (CF) is dominant, while coral sub massive (CS) is totally absent. The percentage of Acropora and Non-Acropora is recorded as 6.04% and 18.30% respectively. The massive corals are seen in south and southeastern direction of the submerged island, while table coral are seen in western direction. Most of the dead coral boulders are covered with algae. The common coral species seen in this island are *Acropora* sp., *Turbinaria* sp, *Platygyra* sp and *Porites* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 0.98 Km^2 and Dead Coral (DC) – 1.35Km^2 (Fig.5).

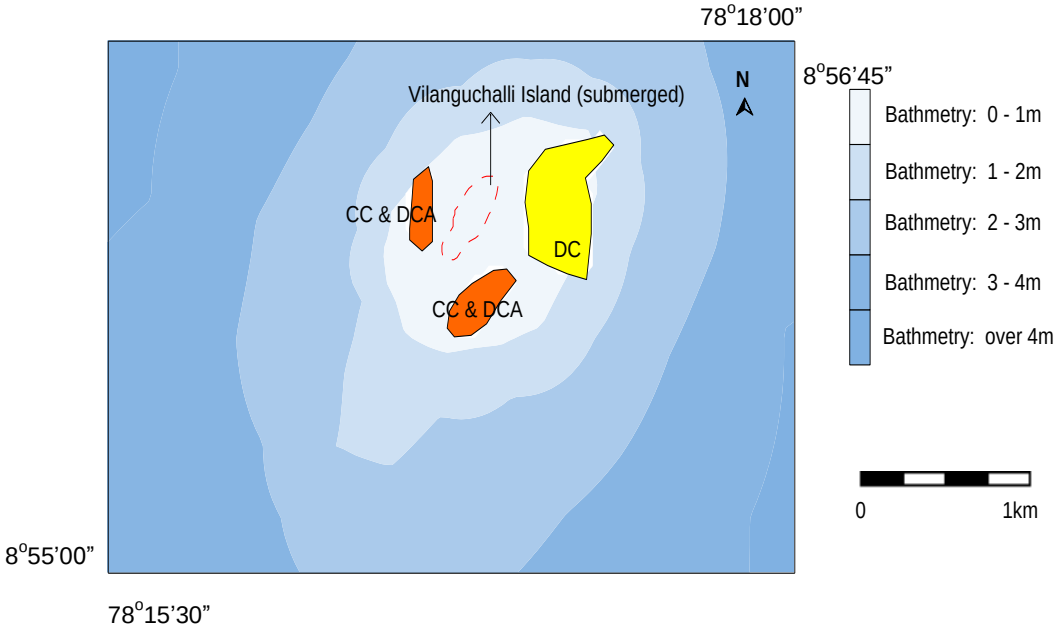

Fig.5: Map showing distribution of coral reef around Vilanguchalli Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

3.4. Kariyachalli Island

This island which had an original area of 16.46 ha, had only an estimated 12.70 ha in 1993 and this might be due to excessive removal of corals from this island which has resulted in submergence of some portions. This island has scanty vegetation at present consisting of grasses, climbers, few Salvadora and few Prosopis trees.

The live coral cover of this island is considered as 'fair' and the order of dominance of live coral categories is CM>CF>ACT>ACB>CB>CE. The average percentage occurrence of live coral categories is ACT 6.19%, ACB 5.03%, CB 4.18%, CE 3.23% CF 7.24% and CM 20.73%. This island contains higher percentage of live corals when compared with the other islands in the Tuticorin group.

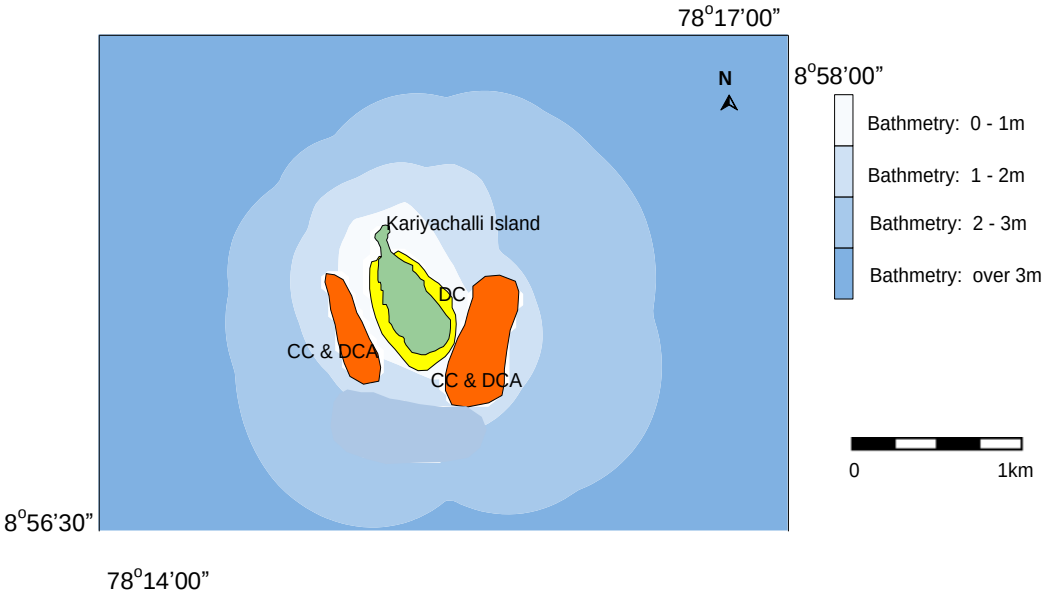

Fig.6: Map showing distribution of coral reef around Kariyachalli Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

Among the live coral categories, coral massive (CM) is the dominant, while coral sub massive (CS) is totally absent. The percentage of Acropora and Non-Acropora is recorded as 11.23% and 35.37% respectively. The percentage of rubble covers in this island is 4.75% and dead coral with algae are found as rim along the shoreline. The reef flat zones have branching forms of *Acropora* sp. and *Montipora* sp., while the reef crest and reef slope consist of dominantly massive corals such as *Favia* sp, *Favites* sp, *Hydnophora* sp, *Platygyra* sp., *Goniastrea* sp., *Symphyllia* sp. and *Goniopora* sp,. Sea grass beds are seen outside of the coral reef along southern side of the island. The sea grass, *Thalassia* sp is a common species

in this island followed by the sparse distribution of *Halimeda* sp. Better diversity of the coral species is recorded in this Island, when compared to the other 3 islands in the Tuticorin group. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 3.37 Km^2 and Dead Coral (DC) – 1.63Km^2 (Fig.6).

3.5. Upputhani Island

This island of around 30 ha area has good natural growth of vegetation. Thespesia and neem are the main tree species and are growing from cut stumps. The large depression in the southern side of the island caused by coral mining about two decades back, has stagnation of rain water and sea water and has become a natural heronry for sea birds. There is good growth of *Avicenia* around this depression. There are good deposits of coral debris due to stoppage of coral removal. Patch and fringing coral reefs are also giving protection to the island shores.

Reef developments are extensive on the southeast to southwest direction of the island. The live coral cover of this island is considered as 'fair' and the order of dominance of life form categories is CM>CE>CB>ACB>ACT>CF. The percentage occurrence of life forms categories is CM 11.69%, CE 4.03%, CB 3.88%, ACB 2.78%, ACT 2.52% and CF 0.23%. The percentage of Acropora and Non-Acropora is recorded as 5.29% and 19.83% respectively. The life form has many corals represented by certain non-branching forms of *Porites* sp., *Favia* sp., and *Goniastea* sp., and branching form of *Acropora* sp. and *Montipora* sp. Most of the dead coral boulders are covered with macro algal assemblage on northeastern direction with *Sargassum gracillaria* sp., *Calurepa* sp, and *Padina* sp. dominated at the reef crest area. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 2.12 Km^2 and Dead Coral (DC) – 3.92 Km^2 (Fig.7).

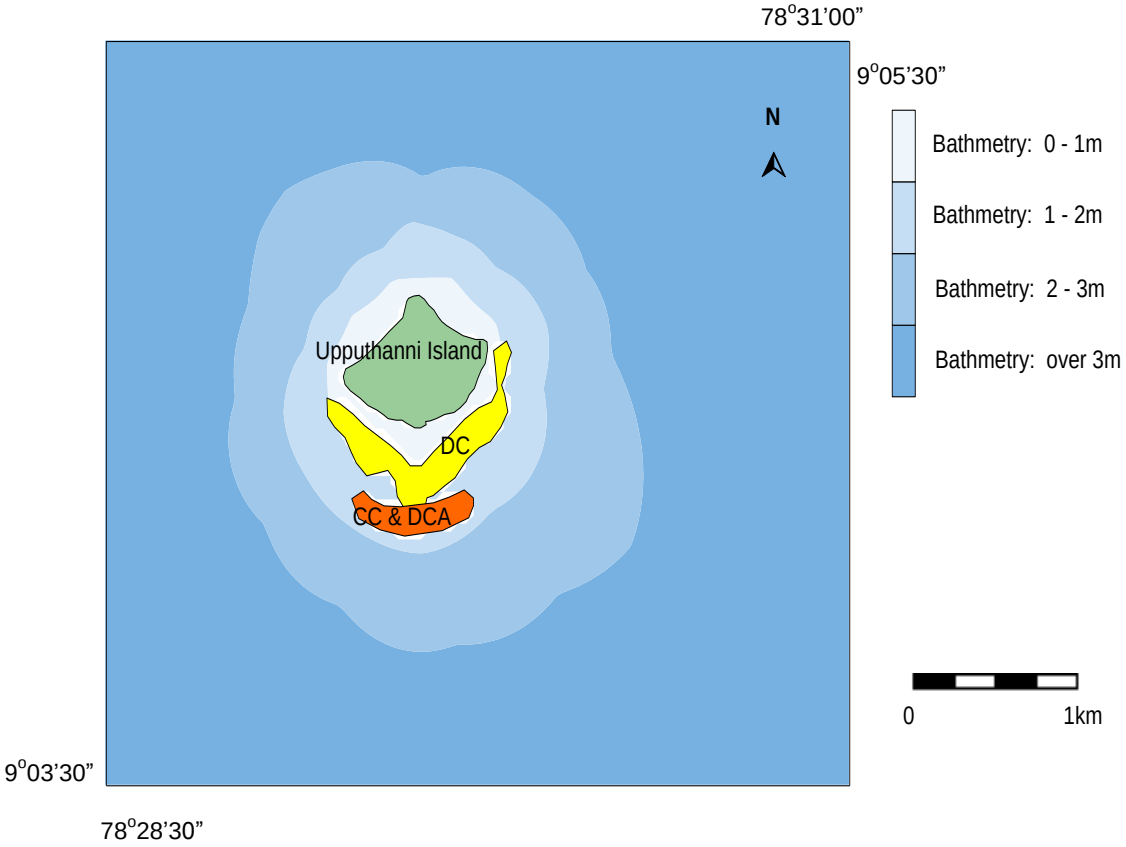

Fig.7: Map showing distribution of coral reef around Upputhanni Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

5.6. Puluvinichalli Island

This island has an area of about 6 ha. and fairly good halophytic vegetation. Thespesia, Salvadora and Neem have come up well from cut stumps. There are no mangroves or natural depressions on this island. There has been no afforestation activity on this island so far.

The live coral cover of this island is considered as 'good' and the order dominance of live coral categories is ACB>CM>CE>CE>CB>ACT. The average percentage occurrence of live coral categories is ACB 30.79%, CM 15.17%, CE 3.95%, CF 3.63%, CB 3.27% and ACT 1.98%. Among the live coral categories, Acropora branching (ACB) is the dominant. The percentage of Acropora and Non-Acropora is recorded as 32.77% and 26.01% respectively.

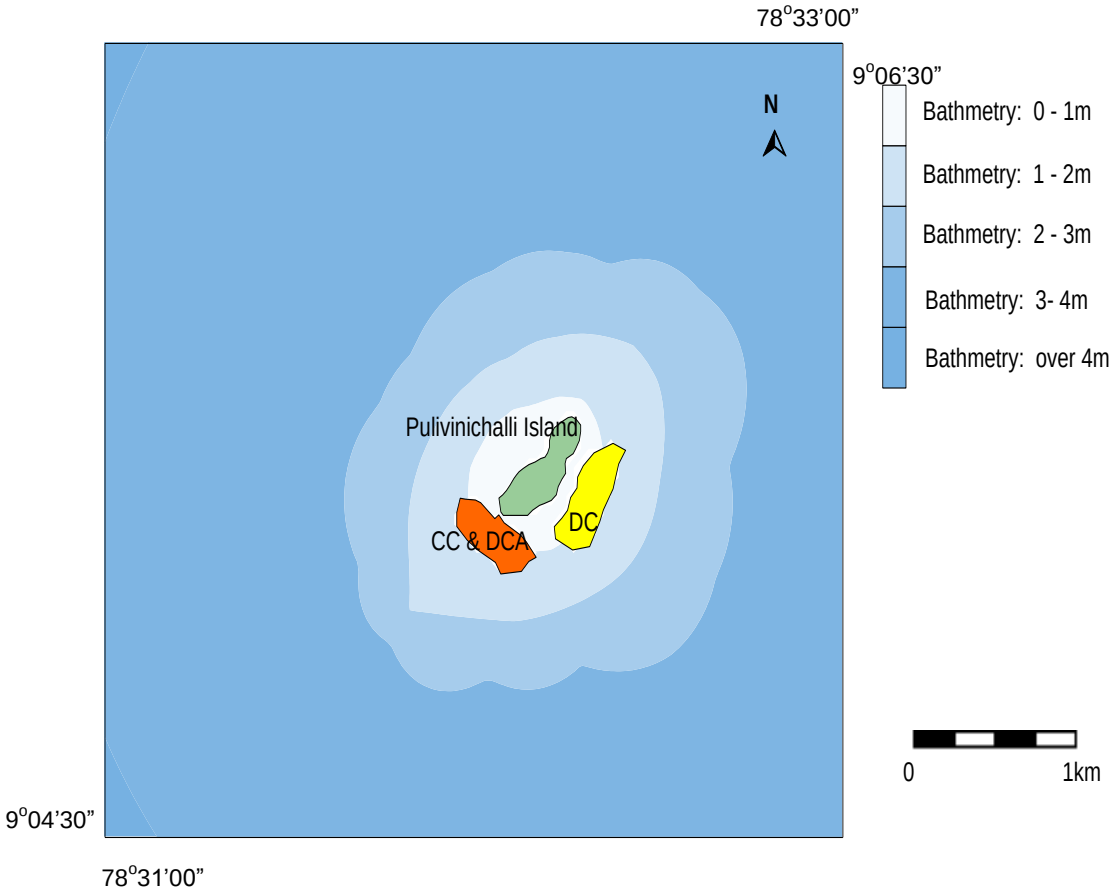

Fig.8: Map showing distribution of coral reef around Pulivinichalli Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live corals are present in the southeast to southwest direction of this island. This shallow reef is changing from *Acropora* sp. dominance to *Porites* sp. dominance. Reef crest and reef slope consists of Coral Massive (CM), Acropora Branching (ACB) and Acropora Table (ACT). The dominant corals of this island are represented by *Acropora* sp, *Montipora* sp, *Favia* sp *Platygyra* sp, *Galaxea* sp *Pocillopora* sp, and *Goniastrea* sp. The reef crest often gets exposed during low tide. Good diversity of the coral species is recorded in this Island, when compared to the other Vembar group Islands. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 2.15 Km^2 and Dead Coral (DC) – 2.21 Km^2 (Fig.8).

5.7. Nallathanni Island

With an area of about 110 ha, it is situated about 2 km from Mundal fishing village. In about 35 ha. of area planted by the Maraickayar family, there were 1600 coconut and 2000 palmyra palms in 1993 but now there are around 150 coconut trees and 300 palmyra palms present which are taken care by a lady who takes care the Muniswaran temple built in this island. Many locals come to this temple for worship by private boats. Every year, in the month of March, this temple festival attracts nearly 200-300 pilgrims from nearby fishing villages. There is heavy growth of Prosopis on this island. Big trees of Tamarind, Ficus, Thespesia, Salvadora and coconut were seen with top portions dried up. This is the only island where good potable water is available at upto 5 depth in one portion of the island.

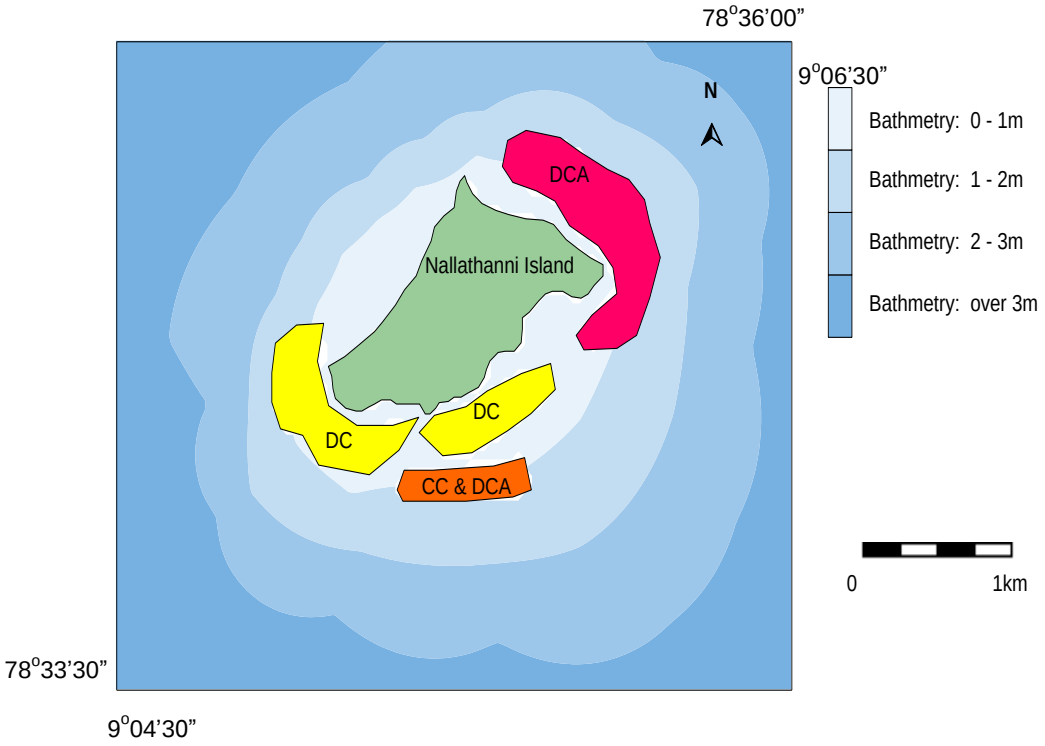

Fig.9: Map showing distribution of coral reef around Nallathanni Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'poor' and the order of dominance of live coral categories is CM>CE>CF>ACT>CB>ACB. The average percentage occurrence of live coral categories is CM 7.76%, CE 1.92%, CF 1.42%, ACT 0.51%, CB 0.30% and ACB 0.16%. The percentage of Acropora and Non-Acropora was recorded as 0.66% and 11.40% respectively. Among the live coral categories, coral massive (CM) is dominant while

the coral sub massive (CS) is totally absent. The northeast and southeast directions of the island have dead coral with algae at the reef flat area. Very few species of live corals are seen in this island, which includes *Porites* sp. and *Acropora* sp. in the reef flat area of southern direction. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 7.77 Km^2 and Dead Coral (DC) – 4.55 Km^2 (Fig.9).

5.8. Anaippar Island

This has an area of 11 ha. There are good coral reefs and patch coral formations around the island. There are no mangroves along the shore of the island. There are man made depressions in the island where once salt making was done and around this, *Avicenia avicinalis* growth is present. The vegetation mainly consists of prosophis and occasionally Salvadora. There are patches of depressions where rain water and salt water accumulate during monsoon resulting in stagnation. Human interference was not much on this island though it is near to Valinokkam because of absence of good quality sea weeds.

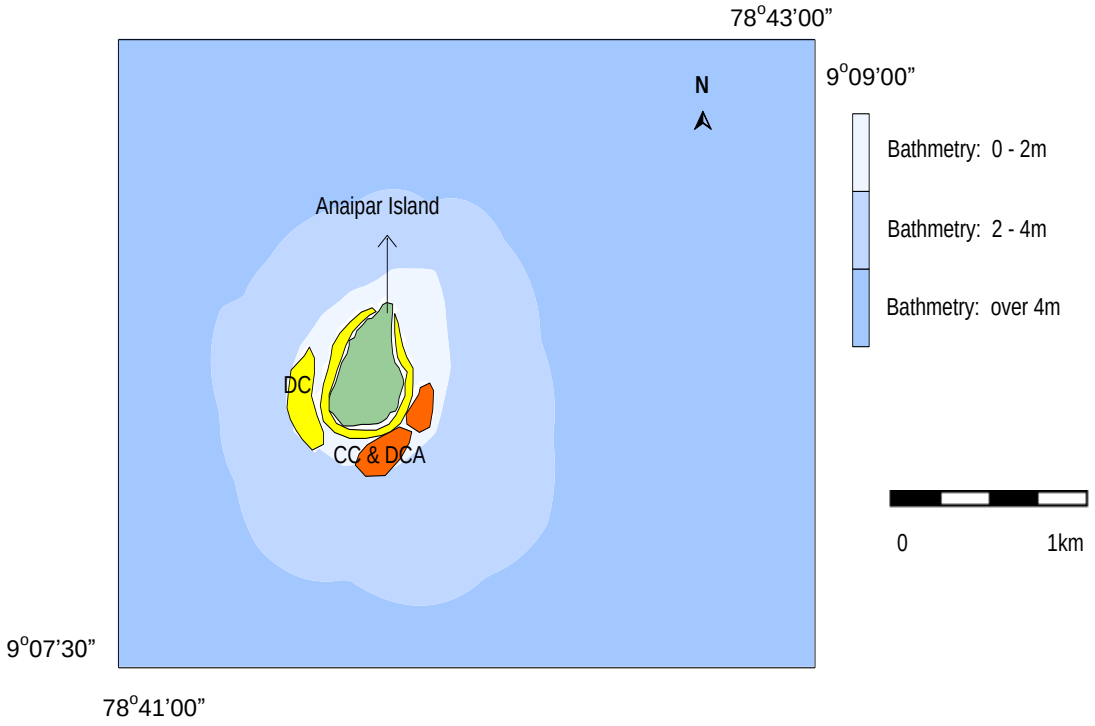

Fig.10: Map showing distribution of coral reef around Anaipar Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'fair' and the order of dominance of live coral categories is CM> ACT> CF> CE> ACB> ACF> CS> ACD> ACE. The average percentage occurrence of live coral categories is CM 14.38%, ACT 11.74%, CF 5.91%, CE 5.45%, ACB 4.29%, ACF 3.53%, CS 2.08% and ACD 0.41%. The percentage of Acropora and Non-Acropora is recorded as 20.11% and 27.81% respectively. Among the live coral categories, Coral massive (CM) 14.38% is the dominant. The reef flat on south and southeastern side of the island consists of live branching corals and non-branching coral. The coral population of this island is represented by *Acropora* sp., *Porites* sp., *Favia* sp., *Favities* sp., *Platygyra* sp., *Leptoria* sp., *Echinopora* sp. and *Montipora* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 1.91 Km^2 and Dead Coral (DC) – 2.15 Km^2 (Fig.10).

5.9. Valimunai Island

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

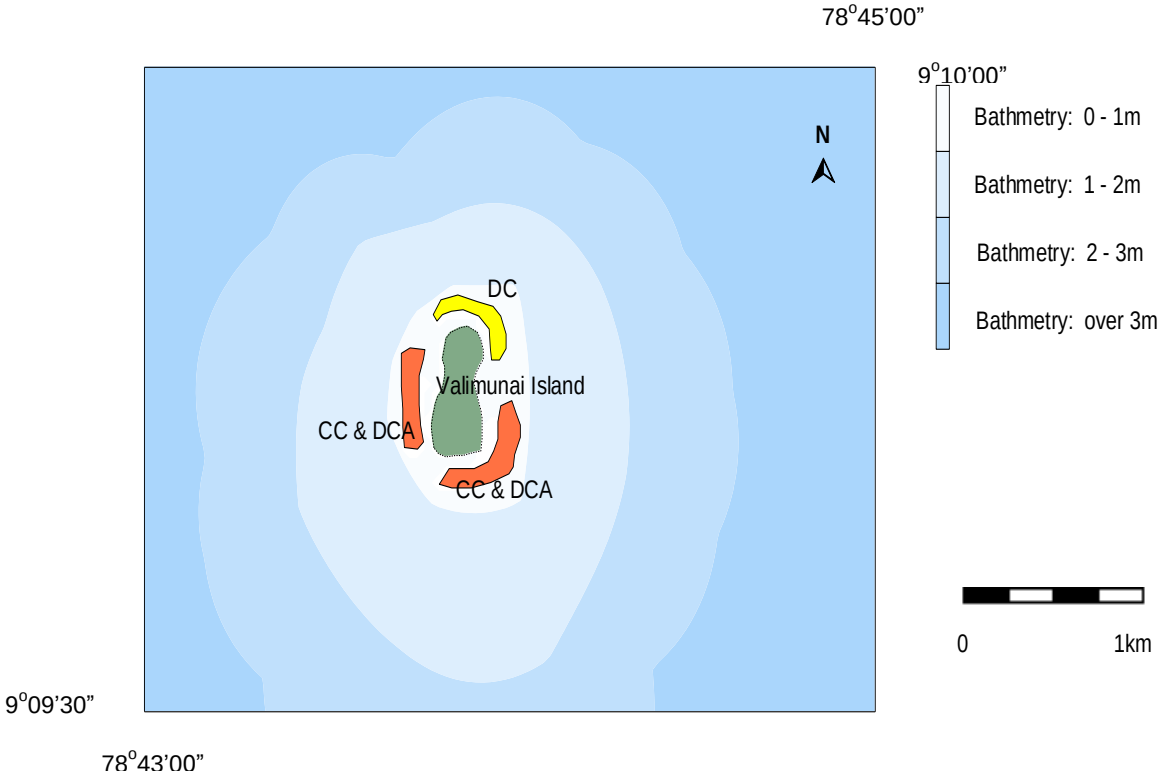

Fig.11: Map showing distribution of coral reef around Valimunai Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'fair' and the order of dominance of live coral categories is CM> ACB> ACT> CE> CS> CF> ACE> ACD> ACF. The average percentage occurrence of live coral categories is CM 13.94%, ACB 7.78%, ACT 4.87%, CE 1.44%, CS 0.39%, CF 0.34%, ACE 0.28%, ACD 0.20% and ACF 0.15%. The percentage of Acropora and Non-Acropora is recorded as 13.29% and 16.11% respectively. Among the live coral categories, Coral Massive (CM) 13.94% is dominant. Branching and non-branching live corals are seen on reef flat zone of southwest to southeast direction of the island. The coral population in this island is represented by *Porites* sp., *Favia* sp., *Favities* sp., *Acropora* sp., *Montipora* sp., *Pocillopora* sp., and *Goniastrea* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 2.83 Km^2 and Dead Coral (DC) – 1.11 Km^2 (Fig.11).

5.10. Poovarsanpatti Island

This island is submerged about 3 decades ago due to excessive quarrying of corals from its surroundings. The area where island was said to be present (09 09 5040N 78 45 2010E to 09 09 5080N 78 45 1890E) in the past, is now submerged at a depth of about 1.5M during low tide. This is surrounded by a good growth of corals, sea grass and sea weed beds. A shifting sand mound is present near this island, which is seen during low tides.

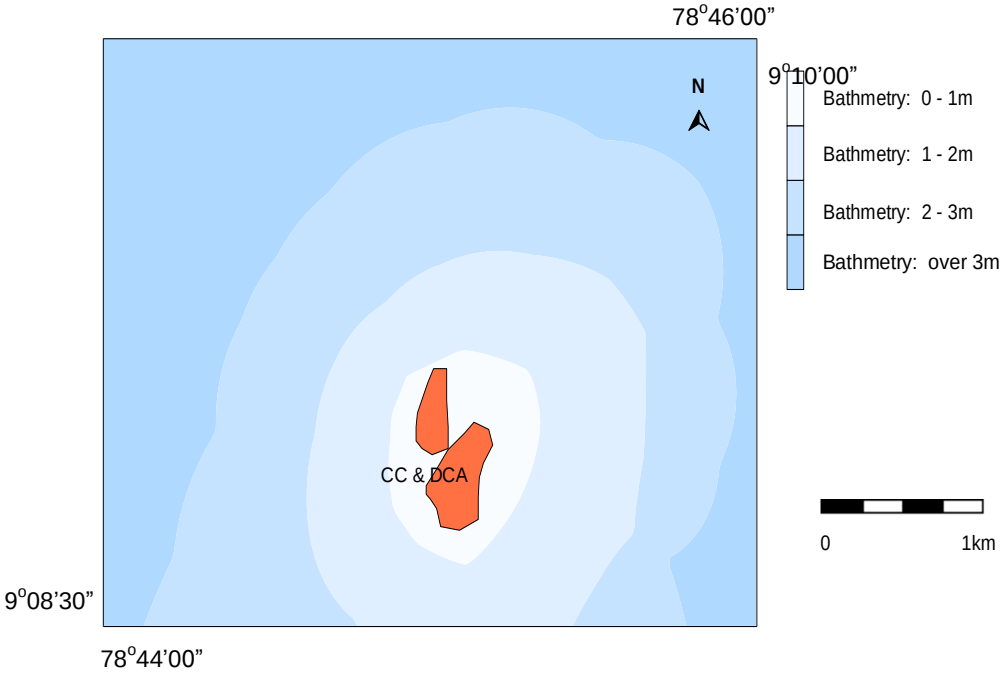

Fig.12: Map showing distribution of coral reef around Poovarasanpatti Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'fair' and the order of dominance of live coral categories is ACD>ACT>ACB>CM. The average percentage occurrence of live coral categories is ACD 16.35%, ACT 5.31%, ACB 3.85%, CM 3.57%. The percentage of Acropora and Non-Acropora is recorded as 25.50% and 3.57% respectively. Among the live coral categories, *Acropora digtata* (ACD) is the dominant with 16.35%. The coral population in this island is represented by *Porites* sp., *Favia* sp., *Goniasterea* sp., *Acropora* sp. and *Montipora* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 1.48 Km^2 (Fig.12).

5.11. Appa Island

It is in 2 blocks which is separated by a sand bar with shallow water permitting crossing on foot between the two blocks. The main vegetation is Prosophis with occasional Salvadora and Thespesia. There are no mangrove patches and Pemphis growth to protect the island shores. One part of the island is of coral base with sand deposition where it is entirely Prosophis growth. In the other part due to constant wave action, the sand has been washed away and the underlying coral rocks have been exposed to wave action. There is good coral reef growth in continuation to the island.

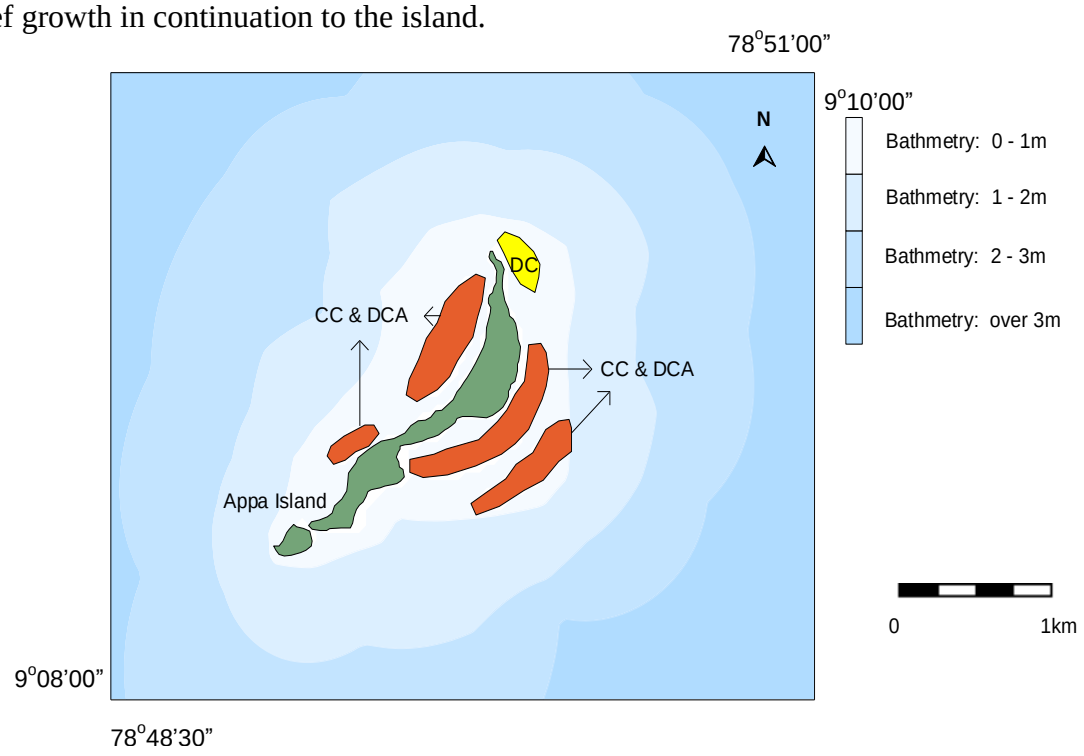

Fig.13: Map showing distribution of coral reef around Appa Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'good' and the order dominance of live coral categories is ACD> CF> ACB> CB> CM> ACF> CS> ACE> ACT. The average percentage occurrence of live coral categories is ACD 17.24%, CF 13.53%, ACB 10.63%, CB 7.73, CM 4.83%, ACF 3.11, CS 1.86, ACE 0.35% and ACT 0.32%. The percentage of Acropora and Non-Acropora is recorded as 31.75% and 27.95% respectively. Among the live coral categories, *Acropora digtata* (ACD) is the dominant (17.24%). Branching and non-branching live corals are seen on the reef flat zone of southeast and northwest direction of the island. The coral population in this island is represented by *Galaxea* sp., *Porites* sp., *Favia* sp., *Favities* sp., *Platygyra* sp., *Leptoria* sp., *Acropora* sp., *Pocilopora* sp., *Montipora* sp., *Echinopora* sp., *Merulina* sp., *Pavona* sp., and *Turbinaria* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 4.82 Km^2 and Dead Coral (DC) – 0.95 Km^2 (Fig.13).

5.12. Thalayari Island

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

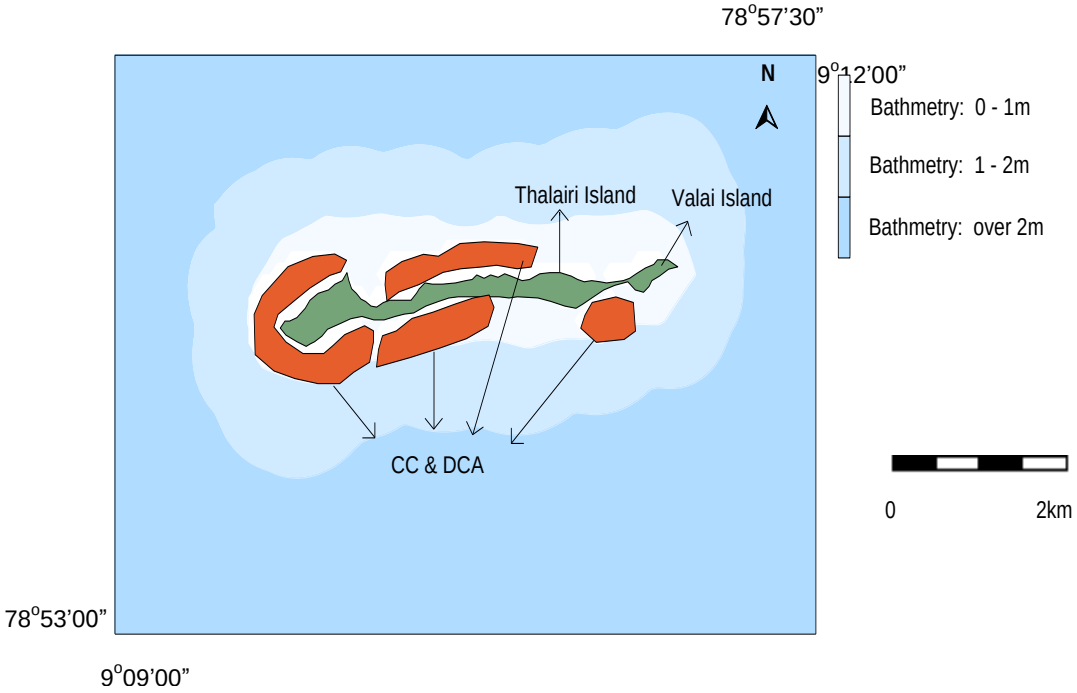

Fig.14: Map showing distribution of coral reef around Thalaiyari Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'fair' and the order of dominance of live coral categories is CM> ACB> ACD> ACT> ACF> CS> CE> ACE> CF> CB. The average percentage occurrence of live coral categories is CM 25.43%, ACB 6.59%, ACD 5.41, ACT 3.60%, ACF 3.12%, CS 1.74%, CE 1.57%, ACE 0.86%, CF0.16%, CB 0.05%. The percentage of Acropora and Non-Acropora is recorded as 19.57% and 28.95% respectively. Among the live coral categories, Coral Massive (CM) is the dominant (25.43%). Branching and non-branching live corals are seen on reef flat zone of the island. The coral population in this island is represented by *Porites* sp., *Favia* sp., *Favities* sp., *Platygyra* sp., *Pavona* sp., *Pocilopora* sp., *Acropora* sp. and *Montipora* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 5.90 Km^2 (Fig.14).

5.13. Valai Island

The Valai island has an area of 10.15 ha. There is a sand bar connecting this to Thalaiyari island. It is has good protection on either side by patch and fringing coral reefs. The shores are protected mostly by good growth of *Pemphis acidula*. The vegetation is quite good with Salvadora and Thespesia as the most predominant species. Ground level halophytic grass and other flora are also good. There are small patches of vacant areas with no tree growth.

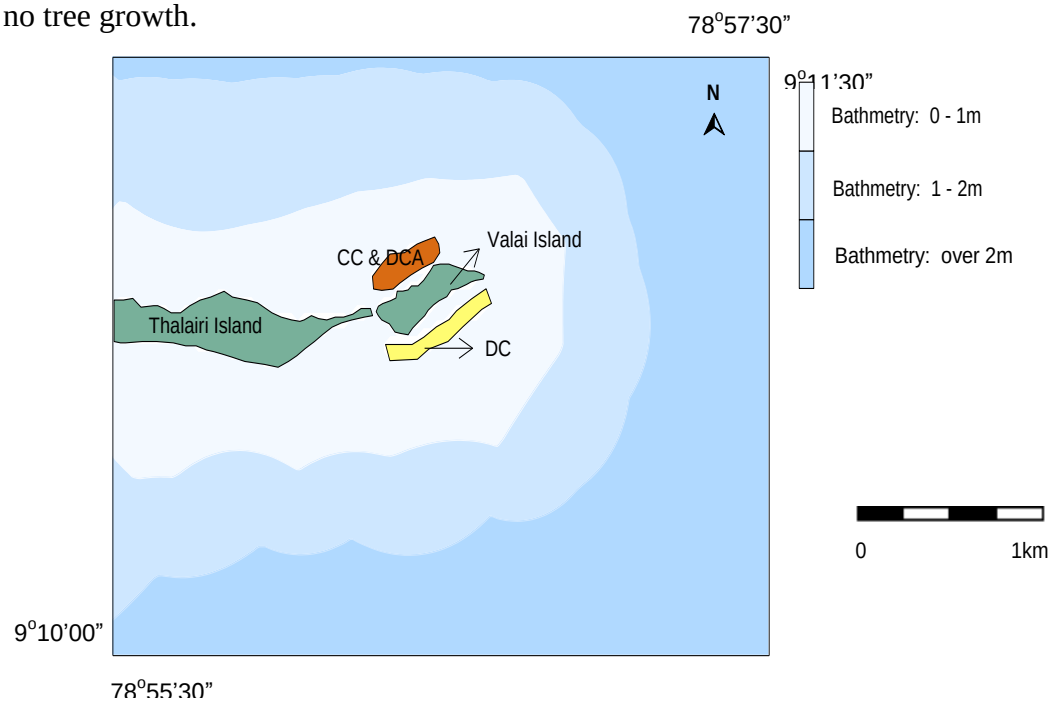

Fig.15: Map showing distribution of coral reef around Valai Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'fair' and the order of dominance of live coral categories is CM>ACD>ACB>ACT>CE>CF>CB. The average percentage occurrence of live coral categories is CM 19.10%, ACD 8.29%, ACB 6.93, ACT 6.46%, CE 3.71%, CF 3.57%, CB 0.35. The percentage of Acropora and Non-Acropora is recorded as 21.67% and 26.74% respectively. Among the live coral categories, Coral Massive (CM) is the dominant (19.10%). Branching and non-branching live corals are seen on the reef crest and reef slope of northwest direction of the island. The coral population in this island is represented by *Porites* sp., *Favia* sp., *Favities* sp., *Goniastrea* sp., *Pocilopora* sp., *Acropora* sp. and *Montipora* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 1.20 Km^2 and Dead Coral (DC) – 1.41 Km^2 (Fig.15).

5.14. Mulli Island

The area is 10.20 ha and the island is protected by both patch and fringing coral reefs. The vegetation is sparse with mostly ground level grasses, climbers. Salvadora and Thespesia are present which are seen sprouting from heavily lopped 2 year old stumps. There are two depressions inside the island and around the large depression, good growth of *Avicenia avicinalis* is seen.

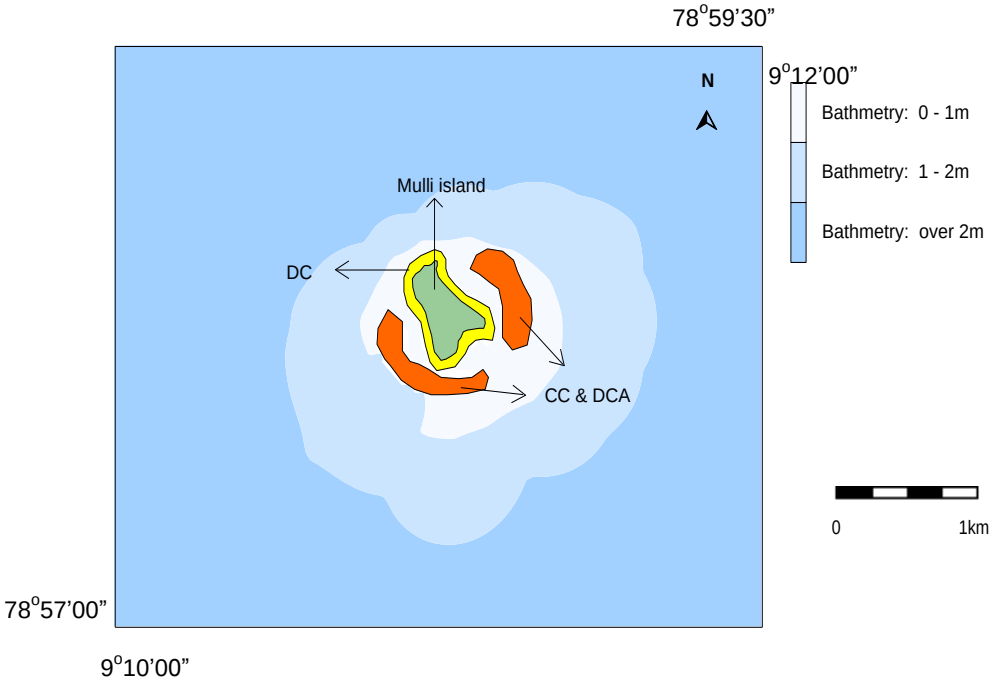

Fig.16: Map showing distribution of coral reef around Mulli Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'fair' and the order of dominance of live coral categories is ACD>CM>ACB>CB>ACT>CS>CE. The average percentage occurrence of live coral categories is ACD 25.25%, CM 6.23%, ACB 5.73%, CB 4.07%, ACT 1.41%, CS 0.10%, CE 0.04%. The percentage of Acropora and Non-Acropora is recorded as 22.03% and 20.00% respectively. Among the live coral categories, *Acropora digtata* (ACD) is the dominant (25.25%). Branching and non-branching live corals are seen on the reef flat of northeast, southeast and southwest direction of the island. The coral population present in this island is represented by *Porites* sp., *Favia* sp., *Favities* sp., *Platygyra* sp., *Echinopora* sp., *Pavona* sp., *Pocilopora* sp., *Acropora* sp. and *Montipora* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 2.21 Km^2 and Dead Coral (DC) – 1.12 Km^2 (Fig.16).

5.15. Hare Island

This island is frequented by local people. In total, about 2050 coconut trees and 1800 Palmyra trees are available in this island. There are good *Pemphis acidula* growth skirting the periphery. There is a large depression surrounded by mangrove vegetation and which is a beautiful heronry where plenty of sea birds congregate. Prosophis and other halophytic vegetation are also good.

The live coral cover of this island is considered as 'fair' and the order of dominance of live coral categories is ACD>CM>ACB>ACT>CB>CS>ACF> CF>ACE. The average percentage occurrence of live coral categories is ACD 12.31%, CM 5.86%, ACB 5.64%, ACT3.88%, CB 2.02%, CS 1.03%, ACF 1.02%, CF 0.48%, ACE 0.32%. The percentage of Acropora and Non-Acropora is recorded as 23.18% and 9.40% respectively. Among the live coral categories, *Acropora digitata* (ACD) is the dominant (12.31%).

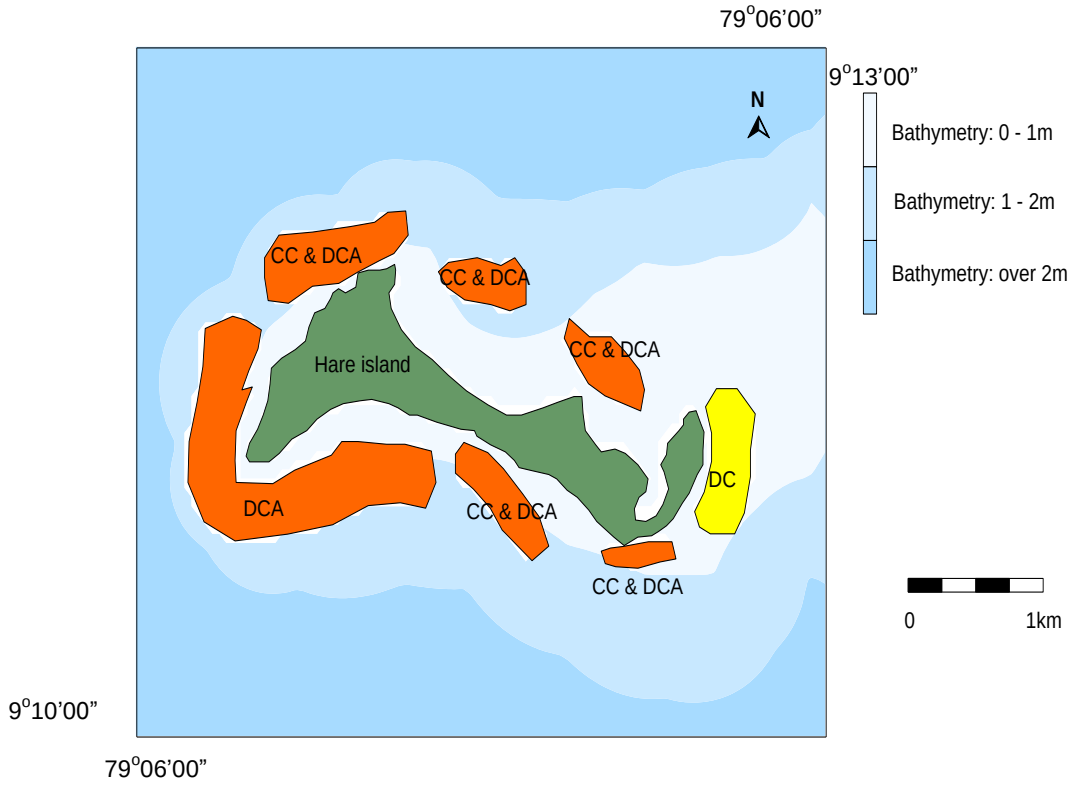

Fig.17: Map showing distribution of coral reef around Hare Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

Two patches of mono-specific group of Acroporides are seen along the southern side of the reef flat. Dead coral with algae (DCA) is seen on the reef flat of southwest direction of the island. Patches of live coral and dead coral (DCA) are seen along the north and northeast direction of the island. The coral population in this island is represented by *Porites* sp., *Favia* sp., *Favities* sp., *Platygyra* sp., *Acropora* sp., *Echinopora* sp. and *Montipora* sp. Area cover (Km^2): Dead Coral with Algae (DCA) – 5.35Km^2, Coral Cover (CC) and Dead Coral with Algae – 6.56 Km^2 and Dead Coral (DC) – 1.86 Km^2 (Fig.17).

5.16. Manoli Island

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

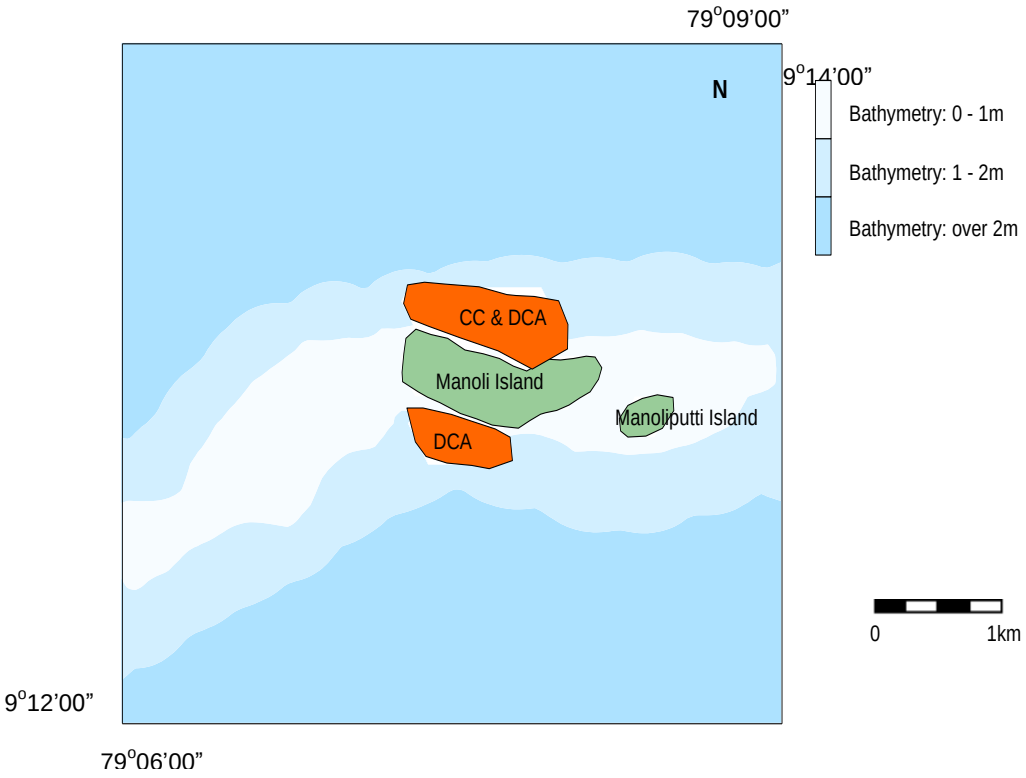

Fig.18: Map showing distribution of coral reef around Manoli Island

(CC- Coral Cover and DCA- Dead Coral with Algae)

The live coral cover is considered as 'fair' and the order of dominance of live coral categories is ACB>ACD>CM>CF>ACF>ACT>CB>CE> CS. The average percentage occurrence of live coral categories of Manoli Island is ACB 13.18%, ACD 8.57%, CM 7.12%, CF 6.45, ACF 2.28%, ACT 1.98%, CB 0.75%, CE 0.23% and CS 0.10%. The percentage of Acropora and Non-Acropora is recorded as 26.02% and 14.66% respectively. Among the live coral categories, Acropora Branching (ACB) is dominant (13.18%). The reef crest and reef slope on the northern side of the island consists of branching corals and non-branching coral. The coral population in this island is represented by *Porites* sp., *Favia* sp., *Favities* sp., *Platygyra* sp., *Acropora* sp., *Echinopora* sp. and *Montipora* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 2.35 Km^2 and Dead Coral with Algae (DCA) – 1.97 Km^2 (Fig.18).

5.17. Manoliputti Island

This is a very small-island separated by a shallow channel from Manoli. There is fairly good natural vegetation on this island including Pemphis and occasional mangrove species.

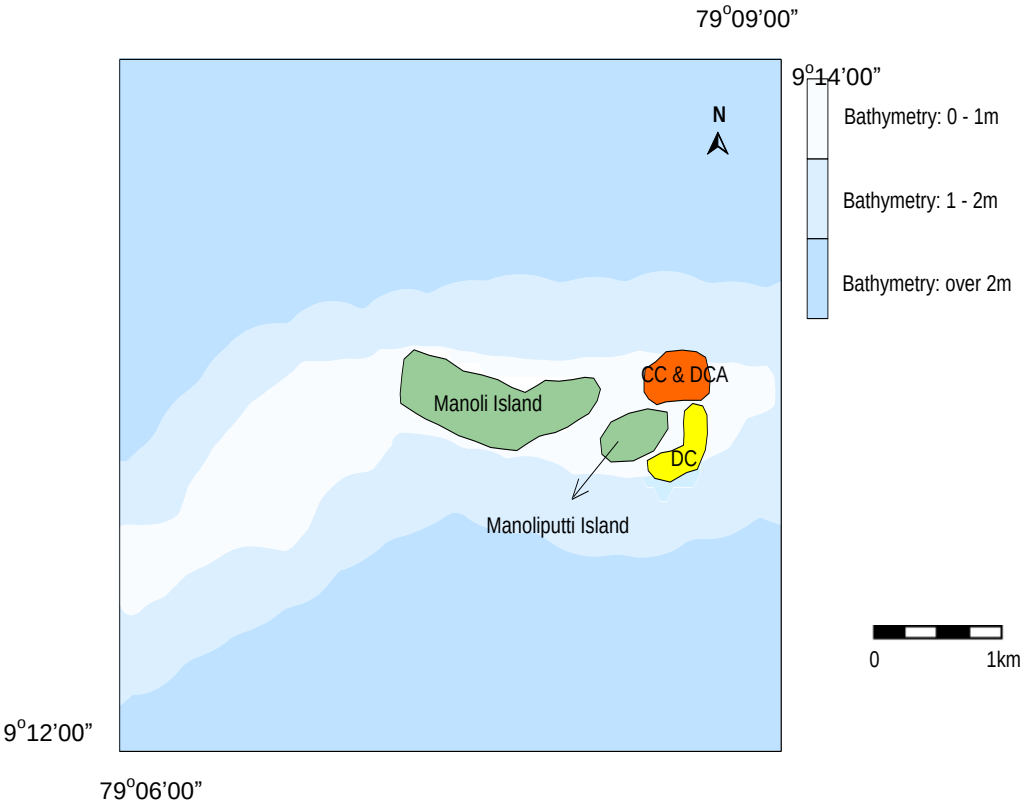

Fig.19: Map showing distribution of coral reef around Manoliputti Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'fair' and the order of dominance of live coral categories is CM>ACT>ACD. The average percentage occurrence of live coral categories of is CM 20.35%, ACT 4.04%, and ACD 2.87%. The percentage of Acropora and Non-Acropora is recorded as 6.92% and 20.25% respectively. Among the live coral categories, Coral massive (CM) is the dominant (20.35%). The reef flat on the northeast side of the island consists of non-branching coral, which is dominant by *Porites* sp. colonies. The coral population in this island is represented by *Porites* sp., *Favia* sp., *Favities* sp., *Acropora* sp., *Montipora* sp. and *Pocillopora* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 1.83 Km^2 and Dead Coral (DC) – 1.57 Km^2 (Fig.19).

5.18. Poomarichan Island

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

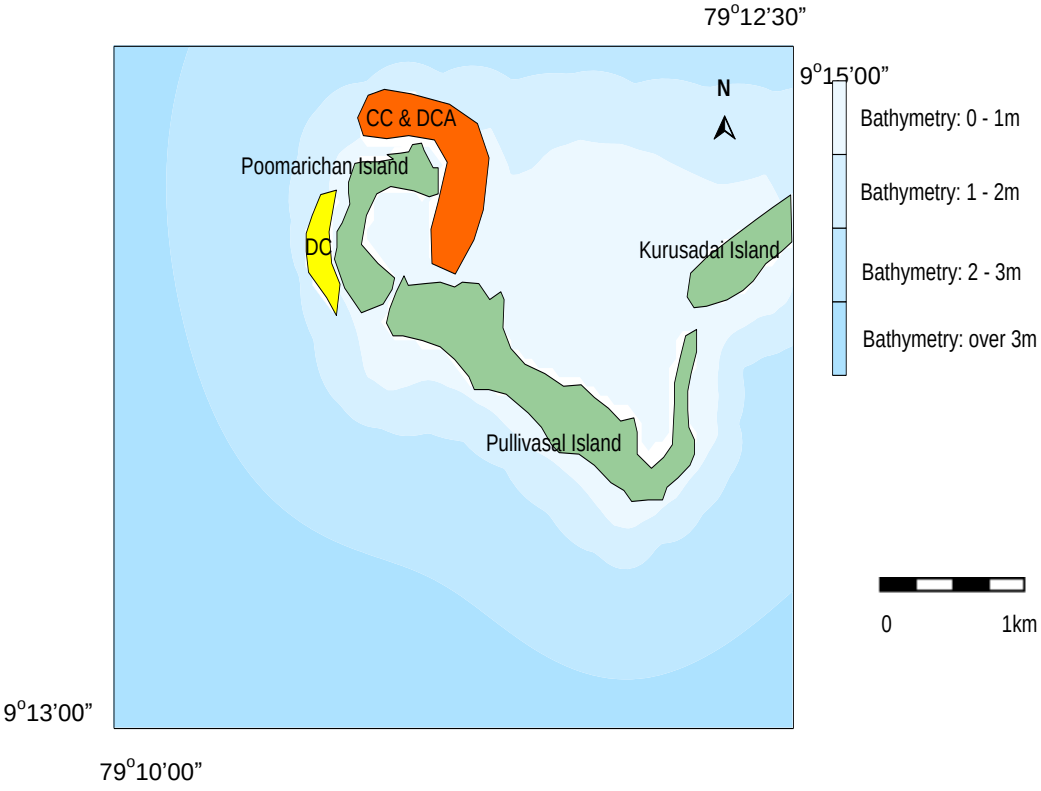

Fig.20: Map showing distribution of coral reef around Poomarichan Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'fair' and the order dominance of live coral categories is CM> CF> ACD> ACT> CE> CB> CS> ACF> ACE> ACB. The average percentage occurrence of live coral categories is CM 15.80%, CF 2.13%, ACD 1.74%, ACT 1.69%, CE 1.64%, CB 1.28%, CS 0.51%, ACF 0.49% and ACB 0.05%. The percentage of Acropora and Non-Acropora is recorded as 4.20% and 21.34% respectively. Among the live coral categories, Coral Massive (CM) is dominant (15.80%). The reef crest on the north and northeast side of the island consists of branching and non-branching coral, which is dominant by *Porites* sp. The coral population in this island is represented by *Porites*

sp., *Favia* sp., *Favities* sp., *Platygyra* sp., *Acropora* sp., *Echinopora* sp. and *Montipora* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 3.16 Km^2 and Dead Coral (DC) – 0.96 Km^2 (Fig.20).

5.19. Pullivasal Island

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

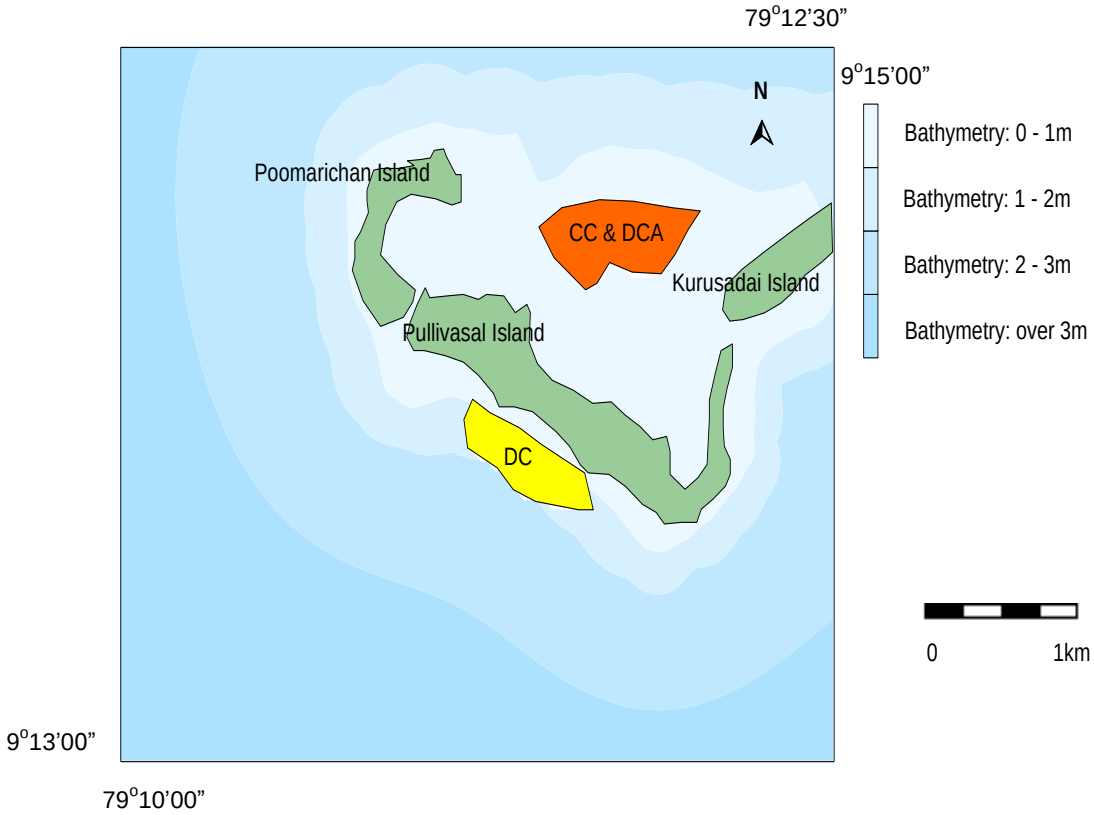

Fig.21: Map showing distribution of coral reef around Pullivasal Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The live coral cover of this island is considered as 'fair' and the order dominance of live coral categories is CM> ACD> ACT> CB> ACB> ACF> CF> CS> CE> ACE. The average percentage occurrence of live coral categories is CM 12.12%, ACD 11.86%, ACT

5.92%, CB 5.17%, ACB 3.48%, ACF 3.40%, CF 3.20%, CS 0.59%, CE 0.44% and ACE 0.19%. The percentage of Acropora and Non-Acropora is recorded as 24.85% and 21.52% respectively. Among the live coral categories, Coral Massive (CM) is the dominant (12.12%). The reef crest and reef slope on the north and northwest side of the island consists of branching and non-branching coral, which is mainly dominant by *Porites* sp. colonies. The coral population in this island is represented by *Porites* sp., *Favia* sp., *Favities* sp., *Turbinaria* sp., *Acropora* sp., *Echinopora* sp. and *Montipora* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 2.32 Km^2 and Dead Coral (DC) – 2.13 Km^2 (Fig.21).

5.20. Krusadai Island

Known traditionally as a paradise for zoological collections, the fauna around this island has been extensively depleted since many decades. *Ptychodora flava*, the enteropneust worm and Spirula sp. (Cephalopoda) are unique representatives on this island. There is an old Marine Biological laboratory with few other buildings and a dilapidated old museum. There is good vegetation of Palmyra, Prosopis and other natural species like Thespesia, Salvadora etc. Good coral reef growth is seen around this island. There is a new sand bar developed connecting Kundukal point which is 17 ha. in area. Planting of Salvadora and Thespesia and sowing of Avicenia seeds will help in afforestation of this sand bar. Fencing the linking portion of this sand bar to prevent livestock entry and planting native species will stabilize this sand bar.

The live coral cover of this island is considered as ‘fair’ and the order dominance of live coral categories is ACB>CM>ACT>ACD>CB>CF>ACF. The average percentage occurrence of live coral categories is ACB 14.47%, CM 8.13%, ACT 5.87%, ACD 4.31%, CB 4.29%, CF 0.69% and ACF 0.63%. The percentage of Acropora and Non-Acropora is recorded as 25.27% and 13.04% respectively. Among the live coral categories, Acropora Branching (ACB) 14.47% is dominant. *Acropora* sp. is seen on the reef flat of northeast direction of the island, while the northwest reef crest consists of massive corals. The coral population in this island is represented by *Porites* sp., *Favia* sp., *Favities* sp., *Platygyra* sp., *Pavona* sp., *Pachyseris* sp., *Merulina* sp., *Acropora* sp., *Echinopora* sp. and *Montipora* sp.

Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 4.26 Km^2, Coral Cover (CC) - 1.12 Km^2 and Dead Coral with Algae (DCA) – 3.15 Km^2 (Fig.22).

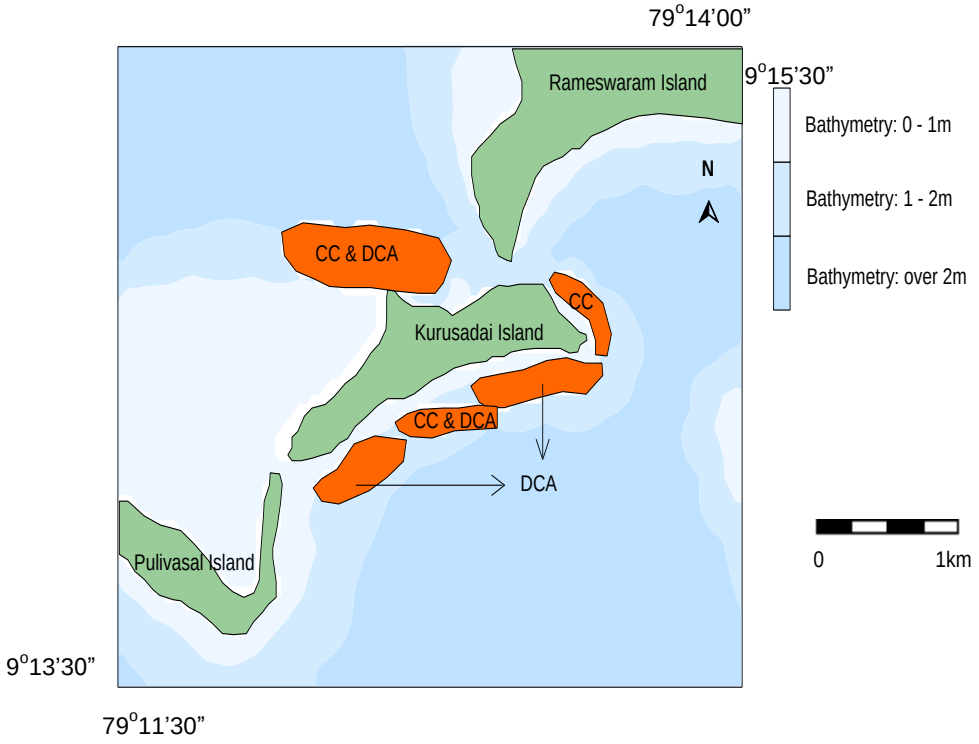

Fig.22: Map showing distribution of coral reef around Krusadai Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

5.21. Shingle Island

This has an area of about 13 ha. and has a heavy deposition of coral debris built up year after year. There is no vegetation skirting the periphery. Mangrove growth is seen only in a small depression in the northern corner of the island. There were no tree growth and good vegetation except *Pemphis* spp due to heavy anthropogenic pressure since it is nearer to the shore. This island seems to be known for open vegetation mainly covered with grasses.

The live coral cover of this island is considered as 'fair' and the order dominance of live coral categories is ACD>ACB>CM>ACT>CB>ACF>CE>CS. The average percentage occurrence of live coral categories of Shingle Island is ACD 18.44%, ACB 11.75%, CM 4.35%, ACT 3.98%, CB 2.86%, ACF 2.67%, CE 0.76% and CS 0.13%. The percentage of Acropora and Non-Acropora is recorded as 20.11% and 27.81% respectively. Among the live

coral categories, Coral Massive (CM) 14.38% is dominant. The reef flat of the entire island consists of branching and non-branching coral, which is mainly dominant by *Montipora* sp. colonies. The coral population in this island is represented by *Porites* sp., *Favia* sp., *Favities* sp., *Platygyra* sp., *Acropora* sp., *Echinopora* sp. and *Montipora* sp. Area cover (Km^2): Coral Cover (CC) and Dead Coral with Algae (DCA) – 2.16 Km^2, Dead Coral (DC) - 0.86 Km^2 and Dead Coral with Algae (DCA) – 0.91 Km^2 (Fig.23).

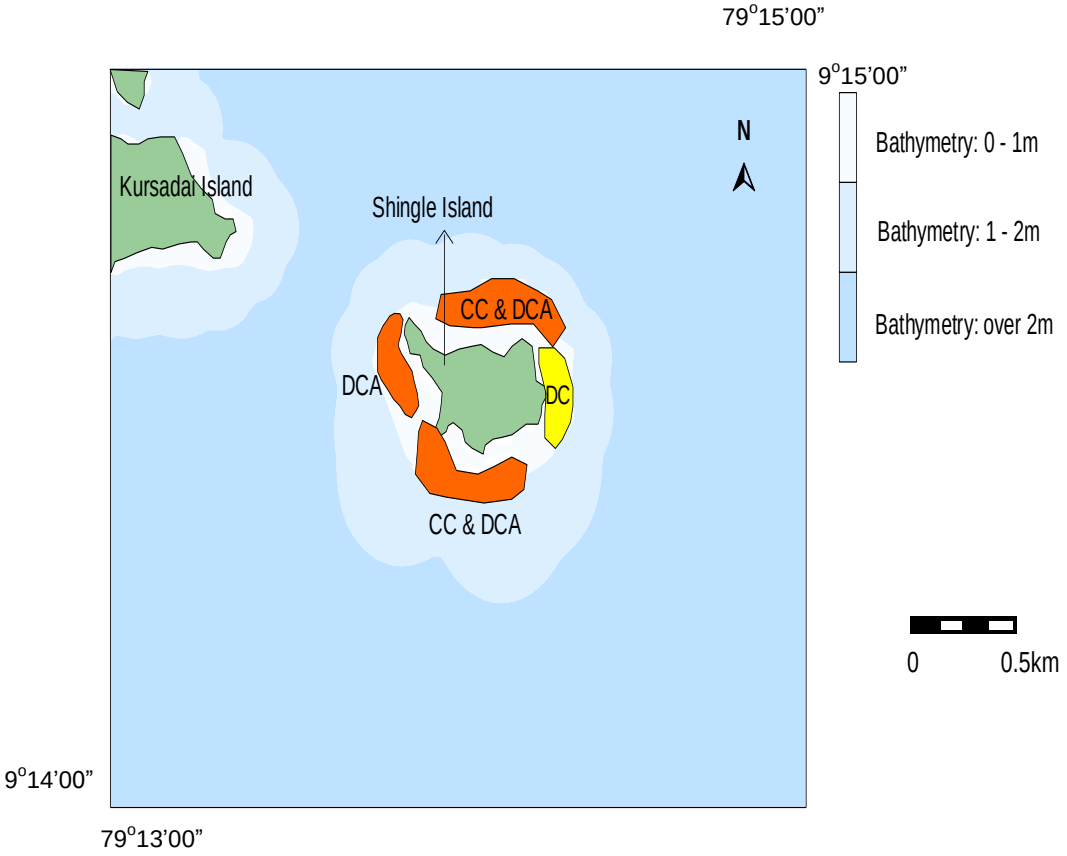

Fig.23: Map showing distribution of coral reef around Shingle Island

(CC- Coral Cover, DCA- Dead Coral with Algae and DC-Dead Coral)

The following Table - 1 gives the details of Live coral cover, degraded area in Gulf of Mannar Islands in 2005 (Patterson et al., 2007)

Sl. No.	**Island**	**Live coral cover (%)**	**Live Coral Cover Area (km^2) including dead coral with algae (DCA) with recruits**	**Degraded Area (Km^2)**
1.	Shingle	44.96	3.07	0.86
2.	Krusadai	38.37	8.13	-
3.	Pullivasal	46.38	2.32	2.13
4.	Poomarichan	25.55	3.16	0.96
5.	Manoliputti	27.27	1.83	1.57
6.	Manoli	40.68	4.32	-
7.	Hare	32.58	12.21	1.86
8.	Mulli	42.03	2.21	1.12
9.	Valai	48.72	1.2	1.41
10	Thalaiyari	48.52	5.90	-
11.	Appa	59.71	4.82	0.95
12.	Poovarasanpatti	29.08	1.48	-
13.	Valimunai	29.4	2.83	1.11
14	Anaipar	47.92	1.91	2.15
15.	Nallathanni	12.06	7.77	4.55
16.	Puluvinichalli	58.8	2.15	2.21
17.	Upputhanni	25.12	2.12	3.92
18.	Kariyachalli	46.61	3.37	1.63
19.	Vilanguchalli	24.35	0.98	1.3
20.	Koswari	15.27	3.54	2.73
21.	Vaan	33.13	3.05	1.77
Total			**78.37**	**32.23**

Table 1: Live coral cover, degraded area in Gulf of Mannar Islands in 2005 (Patterson et.al., 2007)

4. Biodiversity profile of the Gulf of Mannar

The biodiversity profile of Gulf of Mannar is given below based on the publication titled “Coastal and Marine Biodiversity of Gulf of Mannar, Southeastern India - A comprehensive updated species list” by Gulf of Mannar Biosphere Reserve Trust (Balaji et al., 2012).

Biodiversity plays a vital role in maintaining the health and stability of earth’s environment. Biodiversity issues have become increasingly important as the human population grows and the demand for natural resources increases as it represents an important economic resource. Considering the importance of marine biodiversity conservation, the United Nations declared Marine Biodiversity as the theme for the International Day for Biological Diversity in 2012. The Gulf of Mannar region is enriched with productive habitats such as coral reefs, seagrasses, mangroves, estuaries, rocky shores and sandy beaches. The diverse nature of ecosystems in the Gulf of Mannar supports a wide variety of significant species including 181 species of seaweeds,15 species of seagrasses,117 species of corals, 158 species of arthropods, 856 species of molluscs, 1147 species of finfishes, 5 species of sea turtles apart from the seasonally migrating marine mammals like whales, dolphins, porpoises and turtles. A unique endemic species of Balanoglossus - Ptychodera fluva, a living fossil that links invertebrates and vertebrates, has been recorded only here at Kurusadai Island. Even though Gulf of Mannar is one of the biologically rich areas in the world, it has been exploited heavily over the past 3-4 decades. The human induced threats to biodiversity are mainly overexploitation of marine resources, habitat destruction, marine pollution and destructive fishing. Moreover due to the aforementioned human induced threats coupled with mining of corals, the fishery potentials of this region have been significantly reduced. The number of chanks collected from this province started dwindling slowly from 1.67 million in 1982 to 0.03 million in 1992.

As per popular quotes by many research organizations and the scientific communities, more than 3,600 species of flora and fauna have been identified in the Gulf of Mannar area. Through searching and researching, information once thought to be non-existent were identified. Presently, a total of 4223 species has been recorded surpassing the usually cited number of 3600 species (addition of 623 species). This updated species list on the biodiversity of Gulf of Mannar will not only provide the baseline information on the number

of species of organisms identified so far, but also help the researchers and conservation managers to prepare strategies for effective conservation of these precious resources. Table 2 provides the updated biodiversity check list of Gulf of Mannar.

Sl.No.	**Group**	**Species Number**
1.	Protista	48
2.	Phytoplankton	65
3.	Seaweeds	181
4.	Seagrass	15
5.	Mangrove	11
6.	Flowering Plants	201
7.	Zooplankton	66
8.	Porifera	77
9.	Coelentrata	262
10.	Nematoda	3
11.	Platyhelminthes - Trematoda	2
12.	Annelida - Polychaeta	151
13.	Bryozoa	37
14.	Chaetognatha	18
15.	Arthropoda	158
16.	Echinodermata	153
17.	Mollusca	856
18.	Tunicata - Ascidacea	373
19.	Tunicata - Thaliacea	78
20.	Hemichordata	4
21.	Cephalochordata	2
22.	Pisces	1147
23.	Reptiles – Turtles	5
24.	Reptiles - Snakes	13
25.	Aves	290
26	Marine Mammals	7
	Total	4223

Table 2: Updated biodiversity check list of Gulf of Mannar

4.1. Key coastal habitats and endangered / threatened fauna

4.1.1. Coral Reefs

Coral reef system is known as rain forest of the sea. They play an important role in global biochemical processes and are also important breeding, spawing, nesting, and feeding areas for many economically important varieties of fishes and other marine organisms. Coral reefs act as a barrier against wave action along coastal areas thus preventing coastal erosion. The people living along the coast obtain a considerable proportion of their food and earnings from the productivity of coral reefs.

There are 117 coral species identified so far in Gulf of Mannar (Patterson at al., 2007). They belong to 40 genera and 14 families. Of this, 106 species grouped in 30 genera are hermatypic and 11 species grouped in 10 genera are ahermatypic. The conspicuous species belong to the families Acroporidae, Poritidae and Faviidae.

Reefs in Gulf of Mannar are developed around a chain of 21 uninhabited islands that lie along the 140 km stretch between Tuticorin and Rameswaram of Tamilnadu, Southeast coast of India. These islands are located between latitude $8^{o}47'$ N and $9^{o}15'$N and longitude $78^{o}12'$E and $79^{o}14'$E and the average distance of these islands from mainland is about 8 km. They are a part of the Mannar Barrier reef, which are 140 km long and 25 km wide between Pamban and Tuticorin. Different types of reef forms such as shore, platform, patch and fringing type are observed in the Gulf of Mannar. The islands have fringing and patch reefs around them. Narrow fringing reefs are located mostly at a distance of 50 to 100 m from the islands. On the other hand, patch reefs rise from depths of 2 to 9 m and extend to 1 to 2 km in length with width as much as 50 meters. Reef flat is extensive in almost all the reef areas

in the Gulf of Mannar.

The coral reefs in the Gulf of Mannar was degraded due to human interference such as coral mining, destructive fishing methods, seaweed collection, commercial shell collection, introduction of exotic seaweed cultivation, changing land use practices, deforestation and industrial waste input etc. and natural activities like monsoon, wave action, ocean current and tides were identified as the agents that increase the sedimentation and turbidity in coastal waters of Gulf of Mannar.

LIST OF SCLERACTINIAN CORALS OF GULF OF MANNAR, SOUTHEASTERN INDIA

PHYLUM : COELENTERATA Frey and Leuckart, 1847

Subphylum : CNIDARIA Hatschek, 1888

Class : ANTHOZOA Ehrenberg, 1834

Subclass : ZOANTHARIA de Blainville, 1830

Order : SCLERACTINIA Bourne, 1900

I – Suborder : ASTROCOENIINA Vaughan and Wells, 1943

Family : POCILLOPORIDAE Gray, 1842

1. Genus: POCILLOPORA Lamarck, 1816

1. *Pocillopora damicornis* (Linnaeus, 1758) *
2. *Pocillopora verrucosa* (Ellis and Solander, 1786) *
3. *Pocillopora eydouxi* Milne Edwards and Haime, 1860 *

2. Genus: MADRACIS Milne Edwards and Haime, 1849

4. *Madracis interjecta* v. Marenzeller, 1906 *
   (= *Madracis kirbyi*, Veron and Pichon, 1976)

Family : ACROPORIDAE Verrill, 1902

3. Genus: ACROPORA Oken, 1815

5. *Acropora* formosa (Dana, 1846) *
6. *Acropora intermedia* (Dana, 1846) **
7. *Acropora valenciennesi* (Milne Edwards and Haime, 1860) *
8. *A. microphthalma (Verrill, 1869)**
9. *Acropora* sp.novo **
10. *Acropora corymbosa* (Lamarck ,1816) *
11. *Acropora nobilis* (Dana, 1846) *
12. *Acropora humilis* (Dana, 1846) *
13. *Acropora valida* (Dana, 1846) *
14. *Acropora hemprichi* (Ehrenberg, 1834) **
15. *Acropora hyacinthus* (Dana, 1846) *
16. *Acropora stoddarti* Pillai and Scheer, 1976 **
17. *Acropora indica* (Brook, 1893) *
18. *Acropora millepora* (Ehrenberg, 1834) *
19. *Acropora diversa* (Brook, 1893) *
20. *Acropora brevicollis* (Brook, 1893) *
21. *Acropora cytherea* (Dana, 1846) *
22. *Acropora hebes* (Dana, 1846) ***
23. *Acropora echinata* (Dana, 1846) ***
24. *Acropora nasuta*(Dana, 1846) ***
25. *Acropora abrolhosensis* (Veron, 1985) ***
26. *Acropora pillaii* sp. nov **

4. Genus: MONTIPORA de Blainville, 1830

27. *Montipora subtilis* Bernard, 1897 *
28. *Montipora digitata* (Dana, 1846) *
29. *Montipora divaricata* Bruggemann, 1897 *
30. *Montipora venosa* (Ehrenberg, 1834) *
31. *Montipora spumosa* (Lamarck, 1816) *
32. *Montipora tuberculosa* (Lamarck, 1816) *
33. *Montipora monasteriata* (Forskal, 1775) *
34. *Montipora jonesi* Pillai, 1986 *
35. *Montipora granulosa* Bernard, 1897 *
36. *Montipora exserta* Quelch, 1886 *
37. *Montipora turgescens* Bernard, 1897 *
38. *Montipora manauliensis* Pillai, 1969 *
39. *Montipora verrucosa* (Lamarck, 1816) *
40. *Montipora hispida* (Dana, 1846) *
41. *Montipora foliosa* (Pallas, 1766) *
42. *Montipora verrilli* Vaughan, 1907 *
43. *Montipora aequituberculata* Bernard, 1897 ***
44. *Montipora* sp. Novo ***

5. Genus: ASTREOPORA de Blainville, 1830

45. *Astreopora myriophthalma* (Lamarck, 1816) *

II Suborder : FUNGIINA Verrill, 1865

Super family : AGARICIICAE Gray, 1847

Family : AGARICIIDAE Gray, 1847

6. Genus: PAVONA Lamarck, 1801

46. *Pavona duerdeni* Vaughan, 1907 *
47. *Pavona varians* (Verrill, 1864) *
48. *Pavona decussata* (Dana, 1846) *
49. *Pavona divaricata* Lamarck, 1816 (= *P.venosa*) *

7. Genus : PACHYSERIS Milne Edwards and Haime, 1849

50. *Pachyseris rugosa* (Lamarck, 1801) *

Family : SIDERASTREIDAE Vaughan and Wells, 1943

8. Genus : SIDERASTREA de Blainville, 1830

51. *Siderastrea savignyana* Milne Edwards and Haime, 1850 *

9. Genus : PSEDOSIDERASTREA Yabe and Sugiyama, 1935

52. *Psedosiderastrea tayami* Yabe and Sugiyama, 1935 *

10. Genus: COSCINARAEA Milne Edwards and Haime, 1849

53. *Coscinaraea monile* (Forskal, 1775) **

11. Genus : PSAMMOCORA Dana, 1846

54. *Psammocora contigua* (Esper, 1797) *

Super family : FUNGIICAE Dana, 1846

Family : FUNGIIDAE Dana, 1846

12. Genus: CYCLOSERIS Milne Edwards and Haime, 1848

55. *Cycloseris cyclolites* (Lamarck, 1801) *

Super family : PORITICAE Gray, 1842

Family : PORITIDAE Gray, 1842

13. Genus: GONIOPORA de Blainville, 1830

56. *Goniopora stokesi* Milne Edwards and Haime, 1851 *
57. *Goniopora planulata* (Ehrenberg, 1834) *
58. *Goniopora minor* Crossland, 1952 **
59. *Goniopora stutchburyi* Wells, 1955 (*Goniopora nigra*, Pillai,1969) *
60. *Goniopora* sp. novo ***

14. Genus: PORITES Link, 1807

61. *Porites solida* (Forskal, 1755)
62. *Porites mannarensis* Pillai, 1969 *
63. *Porites lutea* Milne Edwards and Haime, 1851 *
64. *Porites lichen* Dana, 1846 *
65. *Porites exserta* Pillai, 1969 *
66. *Porites compressa* Dana 1846 *
67. *Porites complanata* ***
68. *Porites nodifera* ***

III Suborder : FAVIINA Vaughan and Wells, 1943

Super family : FAVIICAE Gregory, 1900

Family : FAVIIDAE Gregory, 1900

15. Genus: FAVIA Oken, 1815

69. *Favia stelligera* (Dana, 1846) *
70. *Favia pallida* (Dana, 1846) *
71. *Favia speciosa* (Dana, 1846) *
72. *Favia favus* (Forskal, 1775) *
73. *Favia valenciennesi* (Milne Edwards and Haime, 1848) *
(= *Montastrea valenciennesi*)

74. *Favia matthaii* Vaughan, 1918 **

16. Genus: FAVITES Link, 1807

75. *Favites abdita* (Ellis and Solander, 1786) *
76. *Favites halicora* (Ehrenberg, 1834) *
77. *Favites pentagona* (Esper, 1794) *
78. *Favites melicerum* (Ehrenberg, 1834) *
79. *Favites complanata* (Ehrenberg, 1834) *
80. *Favites flexuosa* (Dana, 1846) **

17. Genus: GONIASTREA Milne Edwards and Haime, 1848

81. *Goniastrea pectinata* (Ehrenberg, 1834) *
82. *Goniastrea retiformis* (Lamarck, 1816) *

18. Genus: PLATYGYRA Ehrenberg, 1834

83. *Platygyra daedalea* (Ellis and Solander, 1786) *
84. *Platygyra sinensis* (Milne Edwards and Haime, 1849) *
85. *Platygyra lamellina* (Ehrenberg, 1834) *
86. *Platygyra* sp. Novo ***

19. Genus: LEPTORIA Milne Edwards and Haime, 1848

87. *Leptoria phrygia* (Ellis and Solander, 1786) *

20. Genus: HYDNOPHORA Fischer de Waldheim, 1807

88. Hydnophora microconos (Lamarck, 1816) *
89. Hydnophora exesa (Pallas, 1766) *

Subfamily: MONTASTREINAE Vaughan and Wells, 1943

21. Genus: LEPTASTREA Milne Edwards and Haime, 1848

90. *Leptastrea transversa* Klunzinger, 1879 *
91. *Leptastrea purpurea* (Dana, 1846) *

22. Genus: CYPHASTREA Milne Edwards and Haime, 1848

92. *Cyphastrea serailia* (Forskal, 1775) *
93. *Cyphastrea microphthalma* (Lamarck, 1816) *
94. *Cyphastrea japonica* ***

23. Genus : ECHINOPORA Lamarck, 1816

95. *Echinopora lamellosa* (Esper, 1795) *

24. Genus : PLESIASTREA Milne Edwards and Haime, 1848

96. *Plesiastrea versipora* (Lamarck, 1816) *

Family : RHIZANGIIDAE d'Orbigny, 1851

25. Genus: CULICIA Dana, 1846

97. *Culicia rubeola* (Quoy and Gaimard, 1833) *

Family : OCULINIDAE Gray, 1847

26. Genus: GALAXEA Oken, 1815

98. *Galaxea fascicularis* (Linnaeus, 1767) *
99. *Galaxea astreata* (Lamarck, 1816) (= *G. clavus*) *

Family : MERULINIDAE Verrill, 1866

27. Genus: MERULINA Ehrenberg, 1834

100. *Merulina ampliata* (Ellis and Solander, 1786) *

Family : MUSSIDAE Ortmann, 1890

28. Genus: ACANTHASTREA Milne Edwards and Haime, 1848

101. *Acanthastrea echinata* ***

29. Genus: Lobophyllia de Blainville, 1848

102. *Lobophyllia corymbosa* (Forskal, 1775) ***

30. Genus: SYMPHYLLIA Milne Edwards and Haime, 1848

103. *Symphyllia radians* Milne Edwards and Haime, 1849 *

104. *Symphyllia recta* (Dana, 1846) *

Family : PECTINIIDAE Vaughan and Wells, 1943

31.Genus : MYCEDIUM Oken, 1815

105. *Mycedium elephantotus* (Pallas, 1766) *

IV Suborder : CARYOPHYLLIINA Vaughan and Wells, 1943

Family : CARYOPHYLLIIDAE Gray, 1847

Subfamily : CARYOPHYLLIINAE Gray, 1847

32. Genus: POLYCYATHUS Duncan, 1876

106. *Polycyathus verrilli* Duncan, 1876 *

33. Genus: HETEROCYATHUS Milne Edwards and Haime, 1848

107. *Heterocyathus aequicostatus* Milne Edwards and Haime, 1848 *

34. Genus: PARACYATHUS Milne Edwards and Haime, 1848

108. *Paracyathus profundus* Duncan, 1889 *

V Suborder : DENDROPHYLLIINA Vaughan and Wells, 1943

Family : DENDROPHYLLIIDAE Gray, 1847

35. Genus: BALANOPHYLLIA Searles Wood, 1844

109. *Balanophyllia affinis* (Semper, 1872) *

36. Genus: ENDOPSAMMIA Milne Edwards and Haime, 1848

110. *Endopsammia philippinensis* Milne Edwards and Haime, 1848 *

37. Genus: HETEROPSAMMIA Milne Edwards and Haime, 1848

111. *Heteropsammia michelini* Milne Edwards Haime, 1848 *

38. Genus: TUBASTREA Lesson, 1834

112. *Tubastrea aurea* (Quoy and Gaimard, 1833) *

39. Genus: DENDROPHYLLIA de Blainville, 1830

113. *Dendrophyllia coarctata* Duncan 1889 *
114. *Dendrophyllia indica* Pillai, 1969 *

40. Genus : TURBINARIA Oken, 1815

115. *Turbinaria crater* (Pallas, 1766) *
116. *Turbinaria peltata* (Esper, 1794) *
117. *Turbinaria mesenterina* (Lamarck, 1816) (= *T. undata*) *

(Source : * *Pillai, 1986 recorded; ** Patterson et al., 2005 recorded; ***Patterson et al., 2007 recorded.)*

New records in Gulf of Mannar (Patterson *et al*., 2007)

1. *Acropora hebes*
2. *Acropora echinata*
3. *Acropora nasuta*
4. *Acropora abrolhosensis*
5. *Montipora aequituberculata*
6. *Montipora* sp. novo
7. *Goniopora* sp. novo
8. *Porites complanata*
9. *Porites nodifera*
10. *Platygyra* sp. novo
11. *Cyphastrea japonica*
12. *Acanthastrea echinata*
13. *Lobophyllia corymbosa*

4.1.2 Seagrasses

Seagrasses (or sea-grasses in British English) are flowering plants from one of four plant families (Posidoniaceae, Zosteraceae, Hydrocharitaceae, or Cymodoceaceae) which grow in marine, fully saline environments. In Gulf of Mannar, a total of 15 seagrass species were identified.

Seagrasses are a mixed group of flowering plants which grow submerged in shallow marine and estuarine environments worldwide. Structurally, seagrasses are more closely related to terrestrial plants, having specialized tissues that perform specific tasks within each plant. Seagrasses possess true roots that not only hold plants in place, but also are specialized for extracting minerals and other nutrients from the sediment. However, they do not possess the strong, supportive stems and trunks.

Vast seagrass beds are observed in Gulf of Mannar between mainland and islands and towards seaward side from the islands. The seagrass species, *Halodule uninervis* is extensively distributed in Gulf of Mannar and is the dominant and primary species in the intertidal belt. It occurs both on sandy and muddy substratum with a thin layer of sand. It is also observed on coral debris. *H. uninversis* plays an important role both as stabilizers and sediment accumulator and occurs either as a bed of monospecific community or a mixed vegetation with *Cymodocea rotundata*, *Cymodocea* serrulata, *Halophila ovalis* and *Enhalus acoroides*. *Cymodocea serrulata* occurs extensively in most of the islands of Gulf of Mannar and forms a significant browsing ground for the endangered dugong. *Thalassia hemprichii* and *H. uninervis* beds are the important habitat for Holothurids commonly known as sea cucumbers. The studies on seagrass in Gulf of Mannar are very limited and the baseline data has be collected recently on the stuatus, density, diversity and distribution. The present major threat to seagrass meadows in Gulf of Mannar is destructive fishing activities, deterioration of water quality and climate change.

4.1.3 Mangroves

The Gulf of Mannar harbours mangroves with a considerable diversity which supports a variety of biological organisms. It is believed that the region was once covered with thick mangrove forests. There are indications that there was over-exploitation that led to vanishing of mangroves species. As a result, species such as *Bruguiera gymnorrizha* and *Acanthus ilicifolius* collected earlier in Rameswaram have not been re-collected in recent years, and similar are the cases of *Pemphis acidula* in Pamban and *Acanthus ilicifolius* on Krusadai Island. The increase in the extent of salt pans is yet another factor leading to the shrinkage of mangroves particularly around Tuticorin (Kathiresan, 2008; Kathiresan *et al*., 2007; Daniel and Uma Maheswari, 2001). In Gulf of Mannar, a total of 11 mangrove species, 17 mangrove associates and 196 flowering plants were identified.

4.1.4. Seaweed Resources

A total of 181 seaweed pecies are known so far; 40 species are found growing in abundance around the islands.The standing crop was estimated for the coastal and off-shore islands and the values were given in wet weight in tons.

The algal productive area along the coast line from Mandapam Camp to Kanyakumari is put at 17,125 ha. The stand crop estimate is about 22,050 tons within limited zones of intertidal area for the coastal stretch from Mandapam till Kanyakumari. *Gelidiella acerosa* is the most exploited species. On the coastal belt, the standing crop of large algal batch was maximum in the region from Mandapam to Kilakkarai and minimum from Kilakkarai to Mukkaiyur. The algal production of offshore islands and mainland coastal stretches has also been taken into consideration. The contributory factors for the maximum production are due to the presence of the many islands of this coastline enhancing the productive intertidal area. The minimum productive area is from Tuticorin to Kanyakumari stretch (1,732 ha.). The mean density for the entire coastal stretch (of the Gulf inclusive of its islands) would be about 0.11 $kg.m^2$ wet weight. The algae were sampled from surface to a maximum depth of 4 meters. The alginophytes were maximum in Mandapam to Kilakkarai area. The Pamban Pass is well known for its algal wealth; similarity to a lesser extent Kundagal Point and Puma Channel. On Krusadai and shingle islands very rich algal beds of Litho thamnion (calcareous alga), Padina, Caulerpa (ten species), Ulva reticulate, Sargassum, martensia, Clandia, anadyomene, etc., are found. The algal species composition on the coral reefs is different from that found in the lagoons.

4.1.5. Sacred Chank Beds

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

4.1.6. Pearl Banks

The Gulf of Mannar is famous for its Chank and pearl fisheries. They are states monopoly. There were about ten pearl banks. There are four species of pearl oysters and the most preferred species of pearl oyster is *Pinctada fucata* which is abundant off-Tuticorin and the banks of pearls are called in Tamil parai. It is transliterated in English as ‘Pear’. Tutiocorin region is known for pearl fishery, but now there is no pearl fishery in Gulf of Mannar.

4.1.7. Sea turtles

The Gulf of Mannar is the only ecosystem in India where all 5 sea turtle species have been reported. Four of the seven species of sea turtles found world wide are reported. These are the olive ridley *(Lepidochelys olivacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys mbricate*) and leatherback (Dermochelys coriacea). The Loggerhead turtle (Caretta caretta) occurrence was recorded, but no nesting has been observed so far. All the sea turtles that occur in these coastal waters are protected under Schedule I of the Indian Wildlife Protection Act (1972), as well as listed in Appendix I of Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) which prohibits trade in turtle products by signatory countries. At present there exists no commercial or international trade of marine turtles or turtle products in India. However, incidental capture in trawls is a well-known cause of mortality for sea turtle.

4.1.8. Sea Cow

Dugong dugon are commonly known as sea cows and are the only species in the genus *Dugong* which comes under the order Sirenia. In India, the dugong occurs in the Gulf of Mannar and Kutch, the Palk Bay and in the Andaman and Nicobar Islands. All these areas have sea grass beds, which are good foraging ground for the Dugongs. The most favored dugong habitats are the Gulf of Mannar and Palk Bay.

Dugongs are seagrass specialists, uprooting whole plants when they are accessible, but feeding only on leaves when the whole plant cannot be uprooted. Dugongs prefer seagrasses, the genera *Halophila* and *Halodule*, which are lowest in fibre and highest in available nitrogen and digestibility.

Dugongs are vulnerable to anthropogenic influences because of their life history and their dependence on seagrasses that are restricted to coastal habitats and are often under pressure from human activities. The seagrass ecosystems on which dugongs depend are very sensitive to human influence.

4.1.9. Other Fauna

Mud skipper Periothalmus and Boleopthalmus are found in plenty on the lower branches of the mangrove trees fringing the shore. Sea snake (Hydrophia and Enhidrina) are also seen here and a total of 11 sea snakes inhabit in this regions. Milk fish *Chanos chanos* spawn here in season and the larvae are seen in millions here in the month of March to May. Balanoglossus Ptychodera mbric the unique link between the invertebrates and ertebrates which is said to be so rare is seen to occur only near Kurusadai island and in only one other place in the world.

Seahorses are fish belonging to the Syngnathidae family which also includes sea dragons, sea moths, and pipe fish. Seahorses are a saltwater vertebrate fish belonging to the order Perciformes, family Syngnathidae, meaning with jaw, genus Hippocampus, literally horse of the sea. 4 species of sea horses and 7 species of pipefish are found to occur in Gulf of Mannar region. Most Seahorses are found in coastal waters, typically at depths of 1 - 15 meters, occurring in relatively sheltered environments among seagrasses, kelp beds, rocky reefs, mangroves and coral reefs. Unfortunately these are some of the most vulnerable of marine environments, highly susceptible to disturbance caused by human activities. Seahorses feed on brine shrimp, tiny fish and plankton.

Sea horses are primarily used in traditional Chinese medicine. They are said to cure asthma, skin ailments, relieve heatiness, joint and stomach aches, cleanse the blood, and strengthen the kidneys. Seahorse consumption is surprisingly common among Malay fishing communities. They also believe that dried seahorses worn with string around the neck of

newborns or toddlers or hung in their home, act as omens to dispel evil spirits. Japanese and Korean traditional medicine which are hundreds of years old believe that sea horses are credited with having a role in increasing and balancing vital energy flows within the body, as well as a curative role for such ailments as impotence and infertility, high cholesterol, mbric and skin afflictions such as severe acne and persistent nodules. They are also reported to facilitate parturition, act as a powerful general tonic and as a potent aphrodisiac. In the Gulf of Mannar, four species (*Hippocampus trimaclatus, H.kuda, H.spinosissimus and H.fuscus)* of sea horses occur and most of the seahorses are landed as bycatch of shrimp trawling.

Sea cucumbers are economically and ecologically important echinoderms**,** which are exclusively marine and inhabit in habitats such as rocky shores, sandy beaches, muddy flats, coral reefs, mangrove swamps, sea grass and sea weed beds. They are exploited commercially, for the raw body-wall or viscera, but mostly for processed dry product called 'beche-de-mer'. Apart from the nutritional importance, they are of much greater value in the biomedical research. Due to high demand from international market, these resources were over exploted and depletion in population was noted. In Gulf of Mananr, 28 species have been reported and among this only seven are commercially important. The Ministry of Environment and Forests, Government of India, imposed a total ban on both fishery and trade of sea cucumbers and also listed all sea cucumber species under Schedule 1 of the Wild Life Protection Act of 1972 since 2001.

4.1.10. Endangered / Protected Animals

Schedule - I Part - I

Marine - Mammals

1. Zoological Name: Order – Cetacea (All Species)
   Common Name: Whales
   Vernacular Name: Thiminkilam
2. Zoological Name: Order – Cetacea (All Species)
   Common Name: Dolphin (Toothed Whale)
   Vernacular Name: Onki

3. Zoological Name: *Neophocaena phocaenoides*

Common Name: Little Indian Porpoise (or) Black Finless Porpoise

Vernacular Name: Onki

4. Zoological Name: Dugong dugong (Order-Syrenia)

Common Name: Sea Cow

Vernacular Name: Kadal Pasu, Avulia

Part – II Amphibians and Reptiles

Marine – Turtles

1. Zoological Name: *Chelonia mydas*

Common Name: Green Sea Turtle

Vernacular Name: Par Amai, Pal Amai

2. Zoological Name: *Eretmochelys imbricata*

Common Name: Hawksbill Turtle

Vernacular Name: Alunk Amai

3. Zoological Name: *Dermochelys coriacea*

Common Name: Leather Back Turtle

Vernacular Name: Alukku Amai, Dhoni Amai, Yelu vari Amai

4. Zoological Name: *Caretta caretta*

Common Name: Logger Head Turtle

Vernacular Name: Perunthalai Amai

5. Zoological Name: *Lepidochelys olivacea*

Common Name: Olive Ridley Turtle

Vernacular Name: Kanga Matteya Amai

Part – II A- Fishes

1, Whale Shark

Zoological Name: *Rhineodon typus*

Common Name: Whale Shark

Vernacular Name: Panai Meen (or) Ammani Uluvai

2, Shark and Ray

Zoological Name: *Anoxypristis cuspidata*

Common Name: Pointed Saw Fish

Vernacular Name: Vezha, Velameen

Zoological Name: *Carcharhinus hemiodon*

Common Name: Spinner - Shark

Vernacular Name: Pal Sura

Zoological Name: *Glyphius glyphius*

Common Name: Speartoothed Shark

Vernacular Name: Sura

Zoological Name: *Glyphius gangeticus*

Common Name: Ganges Shark

Vernacular Name: Gangai Sura

Zoological Name: *Himantura fluviatills*

Common Name: Scaly String - Ray

Vernacular Name: Savukku Thrukkai

Zoological Name: *Pristis microdon*

Common Name: Small-Toothed Saw Fish

Vernacular Name: Vala Meen

Zoological Name: *Pristis zijsron*

Common Name: Green Saw-Fish

Vernacular Name: Vella Sorrah, Vezha

Zoological Name: *Rhynchobatus djiddensis*

Common Name: White-Spotted Shovel-Nose Ray

Vernacular Name: Pal Uluvai, Padanangan, Palunga, Kachu Uluvai

Zoological Name: *Urogymnus asperrimus*

Common Name: Thorny Ray

Vernacular Name: Kallu Thirukkai, Mullam Thirukkai

3, Sea Horses (All Syngnathidians)

Common Name: Sea Horse and Pipe fish (All Species)

Zoological Name: *Hippocampus* and *Syngnathus*

Vernacular Name: Kadal Kuthirai and Kadal Palli

4, Giant Grouper (*Epinephelus lanceolatus*)

Zoological Name: *Epinephelus lanceolatus*

Common Name: Giant Grouper

Vernacular Name: Perunk Kalava

Part – IV A Coelenterates

Corals

Common Name: Reef Building Coral (All Species)

Zoological Name: Family- Scleractinians

Vernacular Name: Pavala par

Common Name: Black Coral (All Species)

Zoological Name: Family- Antipatharians

Vernacular Name: Pavala par

Common Name: Organ Pipe Coral (All Species)

Zoological Name: *Tubipora musica*

Vernacular Name: Pavala par

Common Name: Fire coral (All Species)

Zoological Name: Family - Millipora

Vernacular Name: Pavala par

Common Name: Sea Fan (All Species)

Zoological Name: Family – Gorgonians

Vernacular Name: Kadal Visiri

Part – IV B

Mollusca

Zoological Name: *Casis corunuta*

Common Name: King Shell

Vernacular Name: Mattuthalai

Zoological Name: *Hippopus hippopus*

Common Name: Pink Coloured Clam Shell

Vernacular Name: Philippines Sippi (or) Periya Pal Matti

Zoological Name: *Cyprecassis rufa*

Common Name: Pine Apple Shell

Vernacular Name: Annacipazha Sangu

Zoological Name: *Tridacna squamosa*

Common Name: Clam Shell

Vernacular Name: Adukku Sippi

(Not recorded in Gulf of Mannar)

Zoological Name: *Nautilus pompilius*

Common Name: Chambere's Nautilus

Vernacular Name: Yanaikai

Zoological Name: *Conus millnedwardsii*

Common Name: Glory of India

Vernacular Name: Vazhaipoo

Zoological Name: *Charonia tritonis*

Common Name: Frog Shell (or) Titon's Trumpet

Vernacular Name: Rajali, Thiri Sangu

(Not recorded in Gulf of Mannar)

Zoological Name: *Tudicla spirilus*

Common Name: Spiral Chank

Vernacular Name: Manthival, Vellapoondu

Zoological Name: *Tridacna maxima*

Common Name: Giant Clam

Vernacular Name: Samosa Sippi

(Not recorded in Gulf of Mannar)

Part – IV C – Echinodermata

Sea Cucumber (All Holothurians)

Common Name: Sea Cucumber (All Species)

Vernacular Name: Kadal Attai

Shedule – III

20. Sponges (All Calcareans)

Common Name: Sponges (All Calcareans) (All Species)

Vernacular Name: Mattuthalai

Shedule – IV

19. Mollusca

Zoological Name: *Cypraea mappa*

Common Name: Map Shell

Vernacular Name: Map Kowri

Zoological Name: *Cypraea lamacina*

Common Name: Spotted Shell

Vernacular Name: Pulli Sovi

Zoological Name: *Cypraea talpa*

Common Name: Bar Shell

Vernacular Name: Anil Sovi

Zoological Name: *Harpulina arausiaca*

Common Name: Striped Shell

Vernacular Name: Vari Kuruvi, Oori

Zoological Name: *Fasciolaria trapezium /Pleuroploca trapezium*

Common Name: Trapezoid Shell

Vernacular Name: Kuthirai Mulli

Zoological Name: *Lambis chiragra*

Common Name: Spider Shell

Vernacular Name: Nattuvakkali

Zoological Name: *Lambis truncata*

Common Name: Spider Conch

Vernacular Name: Kannanur Iviral

Zoological Name: *Lambis chiragra arthritica*

Common Name: Arthritic Spider Conch

Vernacular Name: Aruviral, Nattuvakkali

Zoological Name: *Lambis crocea*

Common Name: Orange Spider Conch
Vernacular Name: Senthel Sangu
Zoological Name: *Lambis scorpius*
Common Name: Scorpion Shell
Vernacular Name: Thel Sangu
Zoological Name: *Lambis millipeda*
Common Name: Millipede Conch
Vernacular Name: Maravatta Sangu
Zoological Name: *Strombus plicatus sibbaldi*
Common Name: White Conch
Vernacular Name: Veranchan
Zoological Name: *Trochus niloticus*
Common Name: Commercial Top Shell
Vernacular Name: Seetha Kondai
(Not recorded in Gulf of Mannar)
Zoological Name: *Placenta placenta*
Common Name: Window Pan Oyster
Vernacular Name: Appala Sippi, Gikuna Sippi
Zoological Name: *Turbo marmoratus*
Common Name: Turban Shell
Vernacular Name: Naththai, Nila Thoppi
(Not recorded in Gulf of Mannar)

5. Threat to biodiversity

5.1 Population Growth

The Gulf of Mannar Biosphere Reserve Trust initiated research survey during 2008-2009 reaveled that the population growth between 1989 and 2009 along the coast of Gulf of Mannat increased about 34%. Accordingy, the number of crafts have also been incrased. However, the fisher folk use the same fishing ground and are over exploting the resources using destructive fihing methods.

5.2 Fishing

Unscientific and uncontrolled fishing and fisheries related activities are the major threats to the reefs and associated biodiversity. Though reef areas are protected, illegal fishing was using destructive fishing practices near the reef area and boat anchoring on the corals cause mechanical damage to the reefs and associated fauna and flora.

Traditional fishers who form the majority population have increased in numbers during the last decades. Crowded fishing grounds, increasing demand for fisheries products, and declining catch deprive artisanal fisher families of livelihoods and food security (Deepak Samuel *et al.* 2002, Bavinck, 2003). In general, the fisher communities are characterized by low literacy rate, lack of awareness of environmental issues, low income and a resulting reluctance among fisher folk to take up livelihood options other than fishing and this lead them to involve in more effective but illegal, destructive and unsustainable fishing practices, such as shore seine, purse seine and push net fishing, dynamite fishing and cyanide fishing (Patterson et al., 2007).

A number of fishermen have taken up the illegal and very destructive coral mining practice as a supplement to fishing. In Gulf of Mannar, two islands (Poovarasanpatti and Vilanguchalli) are already submerged due to excessive mining and erosion noticed in several other islands (Vaan, Koswari and Kariyachalli) (Patterson et al., 2007). The bottom trawling by big mechanized boats using banned gears (roller madi, and pair trawler madi), which completely sweep the seafloor, depleting fishery resources and causing damage to critical habitats, such as corals reefs and seagrass beds (Bavinck, 2003). Trap fishing for marine ornamental fishes is practiced near reef area. Indigenously fabricated fish traps are set in and around the reef areas. To keep safe the traps in the reefs, the nearby live and dead corals are broken. There by the reefs are disturbed while laying and retrieving the traps. In most cases, the traps are laid mainly to catch reef dwelling herbivore fishing (e.g. Parrot fish), which in turn cause the proliferation of algae over live coral colonies due to lack of predator, leading to coral mortality and also ecological imbalance.

5.3 Poaching of Dugongs and Turtles

Killing of dugongs and dolphins (both these are locally called as Avolia and Kadalpandir) and turtles for sale for meat has stopped currently, owing to the effective implementation of the Wildlife (Protection) Act 1972 and the publicity given about the protection accorded to these animals in the Act. However stray incidents of poaching and of incidental catches of these by the fishermen are known to still occur.

5.4 Seaweed and shell Collection

Seaweed collection is also a major threat in the Manadapam, Keezhakkarai and Vembar coasts. Fisher folk mostly women, collect tons of seaweeds daily around the islands damaging the corals. They break the corals while collecting the sea seeds. In Gulf of Mannar Marine National Park, both live and dead corals are found together around the shallow areas of the islands. The sea weeds grow mainly on the dead corals. The dead corals also form suitable substratum for attachment of new coral recruits (coral larvae).

- The seaweed collectors mechanically plug or scrap the seaweeds attached to the dead corals and so the collectors remove the entire seaweed along with dead corals. Due to the removal of seaweed along with dead corals, the new coral recruits attached to dead corals also removed along with seaweeds. This is affecting the coral growth and live coral cover.
- Since dead corals are removed from reef area along with seaweeds, there is substrate instability and so no chance of further new coral recruit attachment and this will lead into reduction of live coral area.
- Since dead corals are found along with live corals, the collectors while collecting seaweeds mechanically damage the nearby large number of live coral colonies especially branching corals.
- Breakage of corals lead to stress and it affects the growth, survival and spawning.
- Since seaweeds are plugged along with dead corals, the seaweed resources are drastically depleted due to minimal possibility for proliferation.
- Seaweeds are part and parcel of the coral reef ecosystem as it serves as very good feed for various associated herbivorous animals including fishes. When the seaweeds are removed and live corals colonies are damaged, the associated dependent fishery resources vanish from the reef area due to lack of food and habitat.
- Several people (more than 10 people) involve in seaweed collection in an area at a time and so the live coral damage is very severe and the collectors also disturb the reef environment due to their activities, causing increase of turbidity and sedimentation in the reef area. Due to this, sediment deposition on the live coral colonies is more which leads into coral mortality.
- The seaweed collectors also anchor their boat on the reef area. The anchoring also causes very severe mechanical damage to the live coral reefs continuously.

Mollusk shell collection through skin diving is also causing mechanical deleterious threat to the reefs in the Gulf of Mannar. Due indiscriminate exploitation illegally in the reef areas, the standing stock and productivity is also badly affected.

5.5 Coral mining

The corals were collected from the seabed earlier days for use in construction or as raw material for the lime industry. In addition, corals have always been collected for ornamental purposes. For a long time the collection of corals did not pose an obvious threat to the resource as there were large reef areas in good condition in the Gulf of Mannar. However, gradually the extraction of coral became too intensive and the deterioration of the reefs was obvious to anyone.

In the early 1970's it was estimated that the exploitation of corals was about 60,000 cubic meters (about 25,000 metric tones) per annum from Palk Bay and GoM together (Mahadevan and Nayar, 1972). In 2001, the federal government included all Scleractinan, Antipatharian, *Millipora* sp., gorgonians and *Tubipora musicace* under schedule I of the Wildlife (Protection) Act, 1972. In 2005, honourable Supreme Court stayed the coral mining activities. As a result of various conservation and protection measures, the coral mining was completely stopped in Gulf of Mannar since 2005. The Indian Ocean tsunami in December 2004 has also helped in make aware the local fisher community about the role of coral reefs and islands in coastal protection.

Due to the 3-4 decade long coral mining activity upto 2005, the Gulf of Mannar lost about 32 km^2 reef areas. However, an increase in live coral cover from 37% in 2005 to 43% in 2009 was observed possibly due to a reduction in human disturbance in the area, in particular a complete halt to coral mining, in combination with high recruitment rates and proper enforcement of law.

5.6 Pollution and other hazards

The southern part of the Gulf of Mannar region has occupied with many industries, factories and power plants. Tuticorin for example is the city which harbors a major Port, thermal power plants, Heavy water plant (HWP), many chemical industries, chain of salt pans and pollution from untreated sewage. The northern region of Gulf of Mannar basically suffers from domestic sewage let out directly into the sea.

5.7 Climate change and corals

In 1998, severe coral bleaching was reported in Gulf of Mannar due to elevated sea surface temperature (SST). The reef areas of Gulf of Mannar have faced annual elevated sea surface temperature and resultant coral bleaching during summer since 2005, significant coral mortality was only recorded in 2010 when elevated temperatures (32.2 to 33.2^{0}C) persisted for four months (April to July). An estimated amount of 9.99% live coral colonies bleached and more than 50% mortality among the bleached colonies. The coral species which died because of bleaching include *Pocilopora damicornis*, *Acropora formosa*, *A. intermedia*, *A. nobilis*, *A. cytherea*, *Montipora digitata, Montipora foliosa*, *Favia* sp. and *Echinopora* sp. Recovery was primarily noted in the partially bleached colonies of coral species species, *Pocillopora damicornis*, *Acropora formosa*, *A. nobilis*, A. cytherea, *Montipora foliosa* and *M. divaricata* The live coral cover increased to 37.31% during 2011 which was also predominantly due to coral recruits (0-10 cm) and young adult colonies (11-40 cm) as they were relatively unaffected by bleaching. The live coral cover during 2003-2005 was 36.98% and increased gradually to 42.85% in 2009. During 2010, coral cover decreased to 33.2% due to severe bleaching and mortality, however it started to recover and was 37.31% in 2011 (Patterson et al., 2012).

5.8. Impact of tsunami

There were no significant impacts on coral reefs and on associated habitats including resources apart from some minor transitional damages due to 2004 Indian Ocean tsunami. Due to strong waves, a few table corals (*Acropora cytherea*) were tilted and branching corals (*Acropora intermedia* and *Acropora nobilis*) were broken. The damage was estimated to about 1-2% of the total live table and branching corals. Fine sand had been deposited (layers of 4-6 cm) in almost all cup corals (*Turbinaria* sp.) in the patch reefs. Fragments of seaweed and seagrass had been washed ashore. In the Keezhakkarai group of islands, fragments of seaweed and seagrass were entangled with branching corals. Beach erosion had increased in two islands (Thalaiyari Island in Keezhakkarai group and Krusadai Island in Mandapam group) and a few trees were uprooted. However, no deposition of sand and debris on table, branching and massive corals nor on seaweed and seagrass beds could be observed there.

5.9 Algal Bloom

Fishermen from the villages, Muthupettai, Kalimankundu, Periapattanam of Keezhakkarai coast of the Gulf of Mannar noticed The algal blooming, by the dinoflagellate, *Noctiluca scintillans,* on 06.10.2008 in Gulf of Mannar and the subsequent breakdown of these depleted dissolved oxygen level in the water caused marine mortality including fin and shellfishes and other organisms. The physical parameters such as temperature, turbidity and Total Suspended Solids (TSS) showed high values in Keezhakkarai coast. The oxygen level was very low in Keezhakkarai coast in all surveyed locations (for example: 1.2 and 0.7 mg/l in surface and bottom water Valai Island). The number of dead fish and other dead organisms were more on the seaward side of the Valai Island (Over 5000 dead fish and bivalves were observed) and this is considered as "major" marine mortality. The major dead fishes in the islands (Valai, Mulli and Appa) were *Siganus sp*., (Rabbit fish), *Congresox sp.* (Anjaala), *Scarus sp.,(Parrot fish)* and *Lutjanus sp*.(Snapper**).** The underwater survey revealed that there was a complete absence of fish around Valai, Mulli and Appa islands. At the shallow area (0.5 -0.75 m depth) of the seaward and shoreward sides, partial and complete coral bleaching was observed in Mulli, Valai and Thalayari islands, but corals remain healthy at areas above 1 m depth. Vast seagrass beds also degraded in the shoreward side of Mulli, Valai and Thalaiyari islands (Patterson et al., 2009).

5.10. Coral disease

In the Gulf of Mannar Marine National Park, disposal of domestic sewage and other wastes from fish processing units and fish landing sites is steadily increased and it caused depletion of quality of water in the reef environmental and increased chances of microbial contamination and disease prevalence. The percentage of coral disease prevalence is increased from 8.9 in 2007 to 10% in 2008. Nine types of coral diseases (white band, white plague, black band, white spot, black spot, pink spot, yellow spot, yellow band and tumour) are identified so far in Gulf of Mannar. Among these, black-band disease spread vastly, which can kill 3 cm coral surface area in a month in a colony when the temperature and nutrient values are higher. Some of the reef sites, where sewage disposal is minimal witness very low percentage of diseases.

5.11. Invasive exotic species

The emerging threatening issue like bio-invasion of exotic seaweed *Kappaphycus alvarezii* in the reefs and seagrass areas of Gulf of Mannar, which was noted in 2008 is

posing severe threat to the reefs, associated marine life and livelihood of fisher folk. Initial survey revealed that *Kappaphycus* invaded into coral reef colonies of Shingle, Krusadai and Poomarichan Islands in Mandapam Coast and now it has also invaded in Kilakarai coast.

The *Kappaphycus,* native to the Philippines grows in thick mats or clumps on reef flats or reef edges. It is a tough, fleshy and firm marine algae (seaweed) and is among the largest tropical red algae, with a high growth rate (can double in biomass in 15 to 30 days). It causes shifts from diverse coral reef to a seaweed-dominated, low-diversity reef and changes the bottom structure of the reef, reduces access to crevices and holes. Thus the habitat loss will impact on fisheries.

Though Government of Tamil Nadu issued orders in December 2005 [G.O. Ms. No.229, E & F (EC.3) Department dated 20.12.2005] that *Kappaphycus alvarezii* which is an exotic seaweed species from Philippines can be cultivated only North of Palk bay and South of Tuticorin coast, this does not give expected result as cultivation is practiced on the seagrass beds (another ecologically sensitive habitat) in the Palk Bay which are very nearer to coral reef areas of GoM.

Table 3 gives brief information on issues and its reason and its effect on coastal management practices.

Sl.No.	**Issues**	**Reasons**	**Effects on Coastal Management**
1.	Population Growth	Coastal area provides livelihood option	Heavy dependence
2.	Livelihood	Fishery resources	Heavy dependence
3.	Destructive fishing practices	Same fishing grounds, but more fishing pressure due to increase in number of crafts and gears	Damage to key habitats Depletion in resources Illegal use of restricted gears
4.	Over exploitation	- Do -	- Do -
5.	Poaching of selected species/animals (sea cucumber, sea horses, mollusks, sea cow, sea turtles)	High demand in international market for sea cucumber, sea horses and mollusks Gish demand in domestic market for sea cow, sea turtles for its meat	Illegal exploitation and further depletion of endangered species Make difficult to revive the natural stock
6.	Seaweed collection	Livelihood to fisher women	Illegal exploitation and damage to key habitat

		Back up support from Seaweed industries for obtaining raw materials No commercially viable and demonstrated culture technologies in India	like coral reefs
7.	Ornamental fish collection	Livelihood to few fisher men High demand in domestic and international market Many aquariums and research institutes need specimen No commercially viable culture technologies in India Back up support from traders	Illegal exploitation Damage to key habitat like coral reefs Depletion of reef associated ornamental fishes Loss of ecological balance
8.	Cultivation and bio-invasion of exotic species, *Kappaphycus alvarezii*	Fast growth and focused to livelihood As no commercially viable and demonstrated culture technologies for native seaweed is available in India, several research institutes are encouraging this exotic seaweed species.	Bio-invasion in reef areas Damage to corals Once invaded, not possible to remove permanently Must have regular monitoring and manual removal programme with adequate funds
9.	Pilgrimage tourism	Pilgrimage	Waste accumulation on the beaches Interest to purchase several protected species
10.	Pollution	No proper treatment system for domestic sewage Several industries along the coast release treated / untreated effluents	The environmental health affected Loss of biodiversity
11.	Unscientific development activities	- Do -	- Do -
12.	Climate change	Global warming	Coral bleaching and

			mortality Loss and migration of fish species Impact on livelihood More destructive fishing practices by fisher men
13.	Lack of awareness	Illiteracy	Destructive fishing practices
14.	Lack of adequate manpower for protection		
15.	Lack of adequate infrastructure for protection		
16.	Lack of adequate capacity for protection and management		
17.	Lack of comprehensive baseline data on resources	Baseline data not available in the area between Tuticorin and Kanyakumari More focus was only to Marine National Park area between Tuticorin and Rameswaram	No effective action to conserve and manage the resources No further monitoring to update the health and status of the resources

Table 3: Issues and its reason and its effect on coastal management practices in Gulf of Mannar

6. Conservation and management of Gulf of Mannar

The Government of Tamil Nadu in 1986 declared the 21 islands and surrounding shallow waters as Gulf of Mannar Marine National Park (GOMMNP) for the purpose of protecting marine wildlife and its environment. The islands in the Gulf of Mannar are classified into four groups for management purposes.

1. Mandapam Group (7 islands): Shingle, Krusadai, Pullivasal, Poomarichan, Manoliputti, Manoli, Hare.
2. Keezhakkarai group (7 islands): Mulli, Valai, Thalaiyari, Appa, Poovarasanpatti (submerged), Valaimunai and Anaipar.
3. Vembar Group (3 islands): Nallathanni, Pulivinichalli and Upputhanni.
4. Tuticorin Group (4 islands): Kariyachalli, Vilanguchalli (submerged), Koswari and Vaan.

Overnment of India declared the Indian part of Gulf of Mannar as "Marine Biosphere Reserve", covering an area of 10,500 sq.km in 1989.

6.1. Protection

The GOMMNP manangement employed anti poaching watchers with the assistance given by Gulf of Mannar Biosphere Reserve Trust, Ramanathapuram from 2006. Joint patrolling has been organized with fisheries department, coastal guard and coastal security guard to prevent poaching (and trespassing) inside the park area with the assistance of Gulf of Mannar Biosphere Reserve Trust from 2006

The Ministry of Environment, Forests and Climate Change, Government of India under various schemes such as Conservation & Management of Coral Reefs and Mangroves, National Parks and Biosphere Reserves provides funding for protection, awareness creation, capacity building and research.

Infrasturure has been strengthed for regular patrolling. Training has been given to the park staff on the identification of various protected marine species under Wildlife Protection Act, 1972 and in SCUBA diving and Snorkeling.

Park management is closely working with Gulf of Mannar Biosphere Reserve Trust (GOMBRT) and other research institutes for various research activities.

6.2. Enforcement mechanism

We have adequate laws to protect the reef ecosystem and its resources from illegal practices, however implementation part need to be strengthened. It is also essential that the coastal people should be made aware of various aspects of laws and the need for implementation, also the stakeholders must be convinced that the regulations are only for their benefit. If the regulations are explained / provided in local language, it would reach the people more easily.

The government since 1982 has banned coral mining and recently in the year 2001, federal government has included all Scleractinan, Antipatharian, *Millipora* sp., gorgonians and *Tubipora musicace* under schedule I of the Wildlife (Protection) Act, 1972.

6.3. Alternative / additional livelihood

Majority of the fisher folk who live on the coasts of reef areas know only fishing as their sole occupation for daily livelihood. Due to the increase of population growth, they need to share the fishing ground and resources which ultimately force them into illegal destructive practices. Hence, viable alternative / additional livelihood options are introduced among the coastal folk to reduce the pressure on the marine ecosystem.

6.4. Awareness and Capacity building

The park management is making aware all stakeholders about the importantance of the resources and need for conservation. The park staff are also trained to develop their skills in Snorkeling, SCUBA diving and also marine biodiversity identification. They are also trained in rescuing standed turtles and mammals.

6.5. Community participation

The community participation is vital in all process of reef ecosystem protection, conservation and management. If the communities realize that they are the custodians of the ecosystem and it is their duty to protect the resources from destruction, then the process is very simple and viable. The traditional knowledge coupled with scientific management would definitely bear good results. Village Marine Conservation and Eco-development Committies (VMC&EDCs) formed through GOMBRT is playing key role in community based management practices.

6.7. Baseline data

Baseline status data on the diversity, distribution and abundance of key coastal habitats like coral reefs, seagrass beds and mangroves have been developed.

6.8. Long term monitoring

The practice of long term and regular monitoring would help to know the state of health of the marine ecosystem, for any immediate remedial requirements / protection to the ecosystem / resources.

Long term monitoring of all reef and seagrass areas in 21 islands has been carried out continuously by SDMRI since 2005 with the financial support from GOMBRT and other agencies.

6.9. Coastal habitats rehabilitation

The key coastal habitats such coral reefs, seagrass bedsand mangroves in Gulf of Mannar are vital for the food security of coastal communities, nurseries and fishing grounds for artisanal fisheries. The rehabilitation of such degraded habitats would help to bring back the recological functions.

The park management is involved in coral rehabilitation, seagrass rehabilitation nad mangrove afforestation in Gulf of Mannar successfully. The Gulf of Mananr is the first to initiate the successful coral and seagrass rehabilitation activities in India.

6.10. Artificial reefs

Artificial reefs are deployed in the degraded coastal areas to restore the degraded marine habitat; to increase the biological diversity, in particular fishery production in the degraded coastal area; to protect the marine ecosystem from destruction; and to help improvement of livelihood to the small scale local fisher folk. In Gulf of Mananr, pilot scale artificial reef programme was initiated to address these issues.

6.11. Sea ranching for enhancement of stock

Nowadays many species of marine organisms are included in the endangered list. Hence, the endangered and commercially important species may be cultured in laboratory and released into sea in order to protect them from extinction and to maintain natural stock. GOMMNP has been doing pilot scale sea ranching activities of sea horses cultured in the laboratory.

6.12. Marine biodiversity data management

There are voluminous research data on various aspects of marine environment in Gulf of Mannar. But the data / information can not be accessed easily for any reference because of the lack of proper integrated data management system. Hence, GOMBRT has taken up the

task of compiling all the work carried out in Gulf of Mannar and also the updated biodiversity check list has also been published.

6.13. Gulf of Mannar Biosphere Reserve Trust (GOMBRT) – The New Initiative (from Melkani, 2012)

India is a signatory Nation to the Convention on Biological Diversity (CBD). Considering the biological richness, its problem profile and the multiple users with their own mandates and aspirations in GoMBR area a workable intervention focusing on improved co-ordination among stakeholders specially securing the involvement of local communities in the conservation management in the area, the GEF-UNDP in collaboration with Government of Tamil Nadu (GOTN), and Government of India (GOI) initiated a new beginning under a project mode on "***Conservation and sustainable use of Gulf of Mannar Biosphere Reserve's coastal bio-diversity***" in 2002. The project is a pioneering initiative in the South East Asia in eliciting people's participation in marine biodiversity conservation and sustainable marine resource management. This seven year project is aided by GEF–UNDP grant funds (Approx. Rs.40 crores) along with parallel contributions from GOI, GOTN and other project partners (Approx. Rs.100 crores) and its implementation is being coordinated by a special agency, The Gulf of Mannar Biosphere Reserve Trust (GOMBRT), a registered Trust of the Government of Tamilnadu to ensure effective inter-sectoral co-ordination and facilitating main streaming of bio-diversity conservation issues into the productive sector and policy development.

The overall objective of the project is to conserve the Gulf of Mannar Biosphere Reserve's globally significant assemblage of marine and coastal biodiversity and to demonstrate in a large Biosphere Reserve with various multiple uses as to how to integrate biodiversity conservation and sustainable coastal zone management and livelihood development. The focus of the project is on empowering local communities to manage the coastal ecosystem and wild resources in partnership with Government and other stakeholders and making all accountable for the quality of the resulting stewardship. Specific Government and village-level institutional capacities will be strengthened, stakeholders will apply sustainable livelihoods, and the independent Agency the Trust will ensure effective inter-sectoral co-operation in the sustainable conservation and utilization of the GOMBR's biodiversity resources. The project is to attempt to evolve suitable strategies to establish an implement able design for participatory marine biodiversity conservation and sustainable use

of marine resource management in the Gulf of Mannar as a model which can later be adopted in many other parts in the country and across the globe (GEF-UNDP Project Doc.,2002).

The five important areas where the project initiatives have been concentrated are as follows –

1. Managing the affairs of the Trust, developing a Long Term Funding for related activities after the project close and facilitating co-ordination among various stake holders
2. Strengthening the capacity and infrastructure of the Gulf of Mannar Marine National Park for enhanced conservation and management functions.
3. Base line research and monitoring on key ecological, biological, environmental and management issues of Gulf of Mannar Biosphere Reserve.
4. Building capacity of various groups of stakeholders and
5. Eliciting local community's participation in conservation and sustainable marine resource use through use through building awareness, capacity & skill, organizing local community's at the grass root level, empowering them and to facilitate provision and adoption of alternate/enhanced livelihood options and to bring down the pressure on the fisheries resources.

Involving Local Communities in Conservation in Gulf of Mannar

Eliciting Local Communities Participation towards conservation and sustainable use of marine resources has been the key focus area of the GEF UNDP initiatives. The process and protocol of eco-development has been followed in the area which is first such attempt in the coastal belt in the country. The process of eco-development has been practiced in some of the important Tiger Reserves and other Protected Areas in the country since 1980s. The fundamental principle on which the process is based and which governs the whole participatory approach in planning and implementation of agreed actions rely on bottom up planning in active consultation of participating community and dialogue that shapes discussion and action in field realities (Melkani,V.K., 2001). Two important components of eco-development are -

- The enhanced productive of resources in the areas used by the people and

- To contain the dependence of the people on the resources through development of alternate income generation and livelihood security programmes.

The following sequence of events and steps have been initiated so far towards securing local people's participation towards conservation of marine resources and its sustainable use in Gulf of Mannar -

Organising Local Communities – Grass root level community organization - Village Marine Conservation and Eco-development Committies (VMC&EDCs) with a mandate for linking conservation and livelihood improvements have been established in 252 villages/helmets along the 160 km coastal stretch from Rameshwar in Ramanathapuram District to Periathalai in Tuticorin District in the 10 km wide buffer zone in the approach area. The VMC& EDCs are registered under the Tamil Nadu Registration of Societies Act 1975 and thus are organizations under legal a mandate. All the residents of the village/helmets are encouraged to become members in the VMC&EDC. Two members (one male and one female from a household) can join the VMC&EDC by contributing and annual subscription of Rs. 5/= per member per year. The VMC&EDC has a General Body and an Executive Committee. All the members of the VMC&EDC are members in the general body and they elect seven members (not less than 50% of whom have to be women which ensures the participation of women). The executive committee then select one of them as the Chairperson of the VMC&EDC. A staff of the Trust works as the member-secretary of the VMC&EDC.At an average 55% of the households have so far joined in the VMC&EDC's so far and the membership is on rise.

In the project villages, the already established Self Help Groups (SHG) by various local NGOs are bought under the umbrella of VMC&EDCs. Many women SHGs have been formed in the project area by various NGOs prior to the present initiative and, therefore the project initiative has focused on formation of new women SHGs wherever they are required as well as the formation of men SHGs and joint SHGs. About 2,400 SHGs are functioning in the project area. In addition, the project initiative are also focusing to develop enterprise groups from among the various SHGs considering their skills and capacity and interest and providing them options to start suitable enterprise for enhanced income.

Empowering the local communities - After establishing the VMC&EDCs, micro plans are prepared by planning teams consisting of Trust staff, local NGOs and their representatives and the villagers by adopting PRA tools and other information collected from the village. The negative and positive interactions between the Reserve and the village people are analyzed and strategies for field implementation are finalized in consultation with local fisheres. In order to facilitate required intervention in the selected VMC&EDCs, the threats to well being of marine biodiversity as imposed by that village are identified and for that purpose the villages have been categorized into high threat, medium threat and low threat categories. Rs. three lakhs, two lakhs and one lakh is disbursed as a seed capital to the bank account of the VMC&EDC for providing credit support towards alternative livelihood development for the members in high threat, medium threat and low threat categoriy VMC&EDC respectively.

Developing Sustainable Alternate Livelihood - The micro plan of VMC&EDCs focuses on various options and resources available to develop economically feasible and socially acceptable livelihood and income generation activities to assist the members with an object that such effort will bring down the resource dependency on fisheries gradually and also provide some income during the leap period and rough seasons when fisheries cannot be practiced. Presently the micro credit is provided to SHGs based on the action plans prepared by SHGs for livelihood activities. The credits are to be repaid back to the VMC&EDCs with a simple interest (@ 12% per annum). These funds are managed by VMC&EDCs as revolving funds enabling them to continue such assistance to local people for sustainable alternate livelihood on a continuous basis and to secure financial sustainability to these organisations. An amount of Rs.4.72 crores has been released to the VMC&EDC's so far as the seed capital to be managed as the revolving fund and 1,400 SHG's have availed benefits of varied amounts credits to start various alternate and income generating livelihood activities and the repayment of credits due is timely with no default. 52 types of activities are being pursued by various groups presently (MTE Report of the Project , May 2008).

Enhancing Awareness About Marine Biodiversity Conservation - The project initiatives have high focus on awarenss creation among the local communities about the value and need of conservation in GoM. Various media for awareness generation - folk, audio-visual, puppetary, All India Radio, local TV networks, cultural programmes, print media and materials – information booklets, manuals, pamphlets, brochures etc.on the biodiversity

values and issues related to GoM, the problems faced by the Conservation Management and the role of communities in supporting conservation and imbibing the sense of ownership for the long-term welfare of of GoM are being very actively pursued with the active support and involvement by experienced local and outside NGO's.

Building Capicities - In order to enable the local communities to adopt various alternate livelihood activities concurrent action is being taken to upgrade the skills and to provide new skills wherever required. The local institutions and NGOs are primarily roped in the for such efforts.

Investment on the future generation for improved conservation in GoM - The project initiatives has a pioneering component of providing vocational training to the fisher youth (both boys and girls) in order to equip them in new skills which shall assist them in adopting alternative livelihood. Based on the interest of the youth (youth who have passed SSLC, and plus two school level examination) are encouraged to opt for a vocational training course in the field of their interest. The vocational courses ranging from three months to one year and organized at recognized and approved institutions of the Government make the youth passing out with a new vocational skills better placed in securing related jobs and to pursue a career. The ongoing vocational training programme are - computer education (hardware and software), AC mechanics, plumbing, electrical works, marine engineering and technology, DTP printing, driving of heavy and light vehicles, village health assistant, tailoring and embroidery, dress designing and beautician course and many other types of vocational trainings based on the liking of the youth. Out of the 118 youth trained during 2007, 70% have already received employment orders from various agencies and are now working mostly outside the project area. During 2008, 640 youth have been identified for various such courses and the courses are ongoing. This initiatives will go a long way in ensuring that in the coming years the reduction on pressure on fishing can be achieved by encouraging the youth to adopt other vocations to assist their lives.

Institutional Linkages - For the activities where the initial investments are larger the SHGs and VMC&EDCs are linked with the bank. During 2007 three SHGs were linked with the SBI Ramanathanpuram wherein the 75% of the acitivity cost was provided by the bank and 25% support by the Trust on a three year repayment period for undertaking sea weed cultivation of indigenous sea weed (*Gracilaria edulis* and *Gelilidila acerosa*). Similarly

one SHG was provided similar support for undertaking Solar Fish Dry and Marketing Enterprise. In addition 12 joint SHGs were linked with the District Rural Development Agencies.

Facilating Coordination – It has been one of main objectives of the project to bring all and often conflicting departments and agencies in one forum and to sort out the differences and to build a new focus for conservation and to bring in a changed mind set among them. To achieve this the Trust has developed number of training manuals, booklets and awareness materials predominantly in the local vernacular for use by variety of stake holders for easy understanding of information.The initiatives equally focus on the capacity building of other stakeholders – Line Departments, NGOs, Industries and others. The efforts made have sensitized the other stakeholders equally towards the various issues related to the conservation and sustainable use of marine resources in GoM. Various Government departments and agencies are sensitized enough to provide critical attention towards biodiversity conservation in GoM while developing their action plans for the area. The access of local communities for securing help, information and technical assistance from these agencies has also improved. The officials and field staff of departments of Forests, Fisheries and Coastal Security Police have now started joint patrolling in the area to improve the protection of marine resources. The Board of Trustees chaired by the Chief Secretary to the Government of Tamil Nadu and various other higher officials of key departments, NGO's and people's representatives provides guidance and support for successful implementation of the project activities. The State Level Co-ordination Committee (SLCC) provide directions and interventions for improved another inter departmental co-ordination and co-operation which helps in project implementation and its outcome.

In two project districts, District Level Co-ordination Committees (DLCCs) have been established by the Government to facilitate another departmental cooperation and coordination as well as to ensure that various developmental activities required in the project villages are taken on priority basis through the line department. These committees are chaired by the respective District Collectors. The Chairpersons of VMC&EDCs are members in these committees on rotation basis and they have an access to represent their problems to the district administration. Four VMC&EDCs Chairpersons are also members in the Empowered Sub Committee (ESC) of the Trust under the chairmanship of Chief Wildlife Warden. One of the important functions of ESC is to approve the annual work plans for the

project initiatives. The presence of VMC&EDCs representatives in ESC is helpful to provide a forum to local community representatives to provide their views and needs to be incorporated in the work plans and various strategies for project implementation.This is also a part in empowering the local communities representatives.

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