

## CHAPTER 01

### INTRODUCTION TO THE AREA

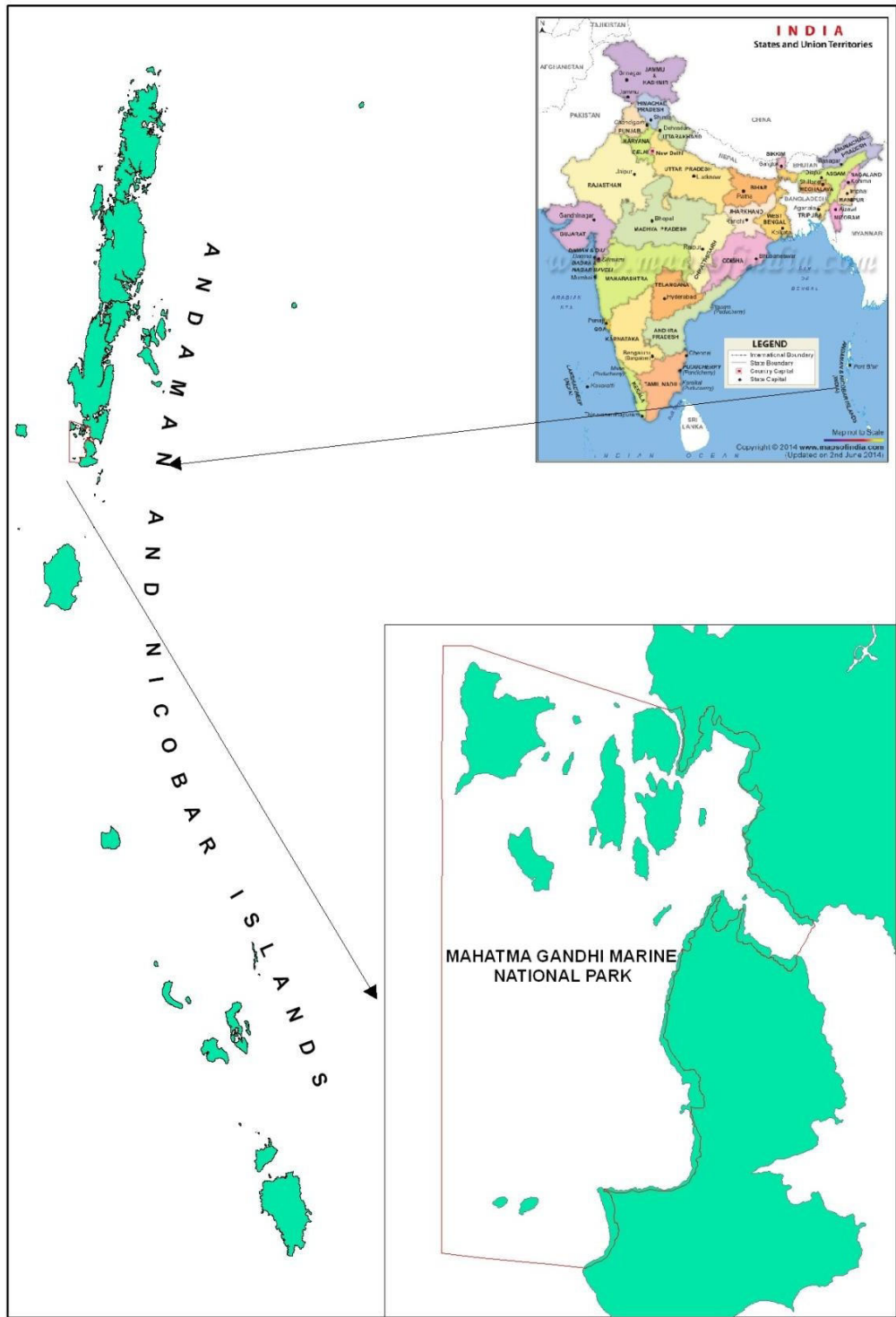
#### 1.1 Name, Location and Constitution

Recognized in 1983, the Mahatma Gandhi Marine National Park (MGMNP), located between 11° 22' 06" to 11° 36' 34" N latitude and 92° 30' 00" to 92° 40' 33" E longitude in the Bay of Bengal, is the first Marine National Park of Andaman & Nicobar Islands (ANIs.). Situated in South West coast of the South Andaman district of Andaman Islands, the intention of creating the Marine National Park under Section 35(1) of the Wildlife (Protection) Act, 1972, was declared by the Andaman and Nicobar Administration vide intention notification No. 314/83/CF/WL/43-Vol.I on May 24, 1983 (Annexure-I) and the final notification was issued vide notification No. 192/99/F. No. CWLW/WL/61 dated 18.10.1999 (Annexure-II).

#### 1.2 Approach and Access

The Andaman & Nicobar group of islands consists of 836 Islands, islets and rocky outcrops. Majorly, there are 324 named islands in Andaman group and 24 in Nicobar group, situated between 6° to 14° North latitude and 92° to 94° East longitude. Flanked by the Bay of Bengal on the West and North, the Andaman Sea on the East and the Indian Ocean in the South, the Andaman and Nicobar Island group form a chain extending over 754 km from North to South. The total geographical area of these islands is 8249 km<sup>2</sup> of which 7171 km<sup>2</sup> area is covered with forests. The total coastline of these islands is 1962 km long which is longest in India. Out of the 836 islands, only 36 islands are inhabited.

MGMNP, located in South-West of the main South Andaman Island, is approximately 30 km from Port Blair, the capital city of Andaman and Nicobar Islands. Port Blair is approachable from Kolkata and Chennai by air and from Kolkata, Chennai and Vishakhapatnam by sea routes (Fig. 1). Well developed facilities such as hotels, markets, hospitals, post and telegraph office, airport, seaports etc. exist at Port Blair. Many big and small accommodation facilities, thriving markets, etc. have also mushroomed around MGMNP at Wandoor and New Wandoor village. The park is under direct control of the Deputy Conservator of Forests



**Fig: 1 Location of Mahatma Gandhi Marine National Park**

(Wildlife Division- I), whose headquarter is at Port Blair. MGMNP Range HQ is located at Wandoor and is connected by well laid black-topped road from Port Blair. Situated at the North-western tip of the National Park, Wandoor serves as the main entry point to MGMNP. Regular bus and taxi services are available to reach the Park's Range Headquarters at Wandoor.

There is one Forest Rest House with three suites at Wandoor. A helipad is also located at New Wandoor, in the Wandoor village. Tourist boats ply from the Wandoor jetty to Jolly Buoy and Redskin Island, two Islands are open to public visitation and they feature as two of the prime tourism destinations of Andaman and Nicobar Islands.

### 1.3 Extent of Area

The Mahatma Gandhi Marine National Park is spread over approximately 281.5 km<sup>2</sup> area and comprises of 15 islands of the Labyrinth group, situated between South -West coast of South Andaman Island and North-East Coast of Rutland Island.

Out of the park's total area of 281.5 km<sup>2</sup>, only about 60 km<sup>2</sup> is landmass, which includes 10 large/medium sized islands (150 ha. to 2333 ha.), 4 small islands (less than 50 ha.) and about 600 ha. of 100 meter strip of varying breadths in notified Reserve Forest and Protected Forest above High Tide line, running along the coast of main South Andaman Island and Rutland Island. Rest about 220 km<sup>2</sup> comprises of open sea spaces and creeks (Fig. 2).

### 1.4 Background

Considering the rich floral, faunal and marine diversity of the area, it was decided to constitute `Marine National Park\_ comprising the sea and Labyrinth group of Islands. Accordingly intentional notification of Protected Area named `Marine National Park\_ was issued. But later it was decided to rename it as the `Mahatma Gandhi Marine National Park\_ to commemorate the 125th birth anniversary of Mahatma Gandhi on 2nd October 1994.



**Fig: 2 MGMNP Boundary**

## 1.5 Legal Status of land

Fifteen Islands of Labyrinth group including the Rutland Island within the MGMNP were notified as Reserved Forests vide Notification No. 59/G/635 of 1962, dated 17.4.1963 (Annexure-III). The portion of forest of Wandoor PF-IV in main South Andaman Island is a Protected Forest constituted vide Notification No. CF/HQ/2(G)S(a)570, dated 12.1.1984 (Annexure-IV) where as Portion of forest of Manglutan-Port Mout RF-I and Chidiyatapu-Bimblitan RF-I are notified Reserve Forest constituted vide Notification No. 393/84 No. CF/HQ/2(G)/5(A)569 dated 12<sup>th</sup> January, 1984 (Annexure-V).

## 1.6 Eco-sensitive Zone

The Eco-sensitive zone of MGMNP is presently extended upto 10 Km radius around the park. However a revised Eco-sensitive zone proposal is submitted to the Ministry of Environment, Forest and Climate Change, GoI for notification.

## 1.7 Major activities of People

Settlements in the form of eight Revenue villages are situated in the main South Andaman and one in Rutland Island, along the Park's eastern boundary. The major economic activities in the areas adjoining the Protected Area are fishing, tourism, agriculture and horticulture.

## 1.8 Encroachment

There are no encroachments in the forestland within the National Park boundary.

## 1.9 Interdivisional boundary

The eastern boundary of the park shares its boundary with South Andaman Forest Division in the notified forest area.

## 1.10 Statement of Significance

### 1.10.1 Global Significance

These Islands have been designated as one of the Endemic Bird Areas of the world (Statterfield et al., 1998; Islam and Rahmani, 2004). Bird Life International has identified 19 sites in A&N Islands as important bird areas and MGMNP is one of the sites and has been allotted the IBA Code as IN - AN - 11 and has been assigned the IBA criteria A1 and A2 i.e., for important threatened species and restricted range species.

The other significance of the Mahatma Gandhi Marine National Park is its unique combination of some of the richest and varied forest and marine ecosystems and habitats occurring in the tropics of the Earth. Some of these are manifested in the form of dense tropical wet evergreen, moist deciduous and littoral forests occurring on the islands of this park, harbouring many endemic plant and animal species. The marine life is unique and vast, with an equally rich assemblage of flora and fauna of the intertidal, pelagic, abyssal, and benthic zones.

The Marine National Park harbours nesting sites of all major four marine turtles species, including Leatherback Turtles, the largest species of sea turtles in the world. Leatherback turtles are not yet reported to be nesting in any other beaches of India so far, other than beaches of Galathea Wildlife Sanctuary in the Great Nicobar Island and parts of Little Andaman. This species is at present globally threatened due to destruction of its habitat, specially the nesting areas. Olive Ridleys, Hawksbill and the Green sea turtles are regular visitors to the beaches within MGMNP for nesting.

MGMNP have some of the best coral reefs and people from around the world do not miss to witness these beautiful creations of nature on their visit to A & N Islands. Coral reefs are currently one of the most threatened ecosystems in the world. The recent phenomenon of sea level rise and global sea warming, unforeseen and debilitating natural calamities along with excessive utilization of reef resources and other associated anthropogenic pressures, have resulted in decline and degradation of coral reefs of MGMNP as well as around the world.

### 1.10.2 Regional Significance

These islands represent one of the richest coral reef ecosystems in the Indo-Pacific region because of its fringing and patchy coral reefs and their associated fauna. The assemblage of flora and fauna of the marinescape has strong resemblance to the Indo-Myanmar and Indonesian regions, which is unique to Indian subcontinent.

The Andaman and Nicobar Islands are one such place in the Indian subcontinent to have two flyways of conservation importance for migratory bird species, viz., Central Asian Flyway and the East Asian- Australasian flyway. This meaning we receive migratory birds from not just Siberia, Russia and China, but also from Australia and the Pacific regions. MGMNP plays host to a wide array of such visitors.

### 1.10.3 National significance

MGMNP has got the distinction of being one of the first three Marine National Parks created in India in early eighties. The coral reefs and associated marine fauna of the Park is the richest amongst all Marine National Parks in the country. Some of the important animal species found in the Park are Estuarine or Salt Water Crocodile, Leather Back, Green, Olive Ridley and Hawksbill Turtles, White Bellied Sea Eagle, Sea cow, Manta Ray and Common Dolphin. ANIs also has some of the best remaining habitat for Estuarine or Salt Water Crocodile in India.

There are 36 marine protected areas in India, of which only 5 are specifically for the conservation of coral reefs, out of which MGMNP was the first to be established. Coral reefs not only accord protection to the coastal areas but also provide habitats for a number of animal and marine flora communities, such as sponges, crustaceans, echinoderms, molluscs, reef fishes, sea turtles, sea snakes and a host of other marine organisms.

### 1.10.4 Local significance

Being a vibrant tourist spot, MGMNP is a source of income generation for the local people. The area is also an active centre for conservation, education and recreation at the same time.

The greatest feature of MGMNP are the lush mangrove forest growing in the inter tidal zone next to the dense tropical forests, serving as a great barrier for the land against vagaries of nature and the beautiful, diverse and rich fringing coral reefs and sea grass beds, occurring in the marine environs of the Park. The association one witnesses amongst the rich tropical evergreen and mangrove forests is not just unique, but also complex at all levels. However, natural wealth like birds, reptiles, fishes and other lower animals such as insects, butterflies, many of which are rare and endemic, along with plant and marine biodiversity, is preserved in their pristine glory in MGMNP and is unparalleled in the country.

MGMNP along with the nearby Lohabarrack Crocodile Sanctuary conserves the significant mangrove ecosystem, that is important for the long-term survival of Estuarine Crocodile as an umbrella species and which aides in the survival and thriving of several other co-related terrestrial and marine species.

By creating this Marine National Park in 1983, the Andaman and Nicobar Administration has shown its concern and commitment for the conservation of coastal resources along with its unique biological diversity. This concern was re-emphasized by the Central Government in bringing out the Coastal Regulation Zone (CRZ) notification in 1991 and its subsequent amendments and renaming as 'Islands Coastal Regulation Zone\_ (Annexure-VI), coral reefs, sea grass beds, turtle nesting beaches and mangrove forest ecosystems have been classified under Category I, which have been accorded maximum protection against unsustainable and damaging developmental activities. This National Park also forms an important component of the 'Protected Area Network', and preserves a representative sample of Andaman and Nicobar Island biogeography zone.

MGMNP also performs a host of other ecological and environmental functions as well, which though not fully studied scientifically, are critical for the future well being and existence of the wildlife as well as that of the adjoining human habitation.

## CHAPTER 02

### BACKGROUND INFORMATION AND ATTRIBUTES

#### 2.1 Boundaries

The notified area of MGMNP is about 281.5 km<sup>2</sup>, located in the south-western part of the main South Andaman Island. It is bound by a line 100 meter above High Tide Line (HTL) carving out a strip of land on the South Andaman Island, except the notified Revenue areas, running parallel to the High Tide Line (HTL) from Wandoor and going in South-East direction upto Badabalu near Chidiyatapu. It then crosses over to Rutland and follows the line of 100 m above HTL upto a point on the west coast of Rutland known as Potatang. From this point the boundary follows a line over open sea towards West of Twin Islands and then goes straight northwards till it reaches a point North - West of Tarmugli Island and joins the northern boundary coming from a pillar below Forest Rest House at Wandoor. The park encompasses 15 named Islands, viz., Jolly Buoy, Malay, Pluto, Red Skin, Boat, Snob, Chester, Grub, Hobday, Alexandra, Tarmugli, Twins, Belle and Rifleman and some unnamed rocky outcrops (Table No. I).

Table No. 1: Details of Islands located inside MGMNP

| Sl. No. | Name of the Island      | Geographical Area (km <sup>2</sup> ) |
|---------|-------------------------|--------------------------------------|
| 1.      | Alexandra               | 4.97                                 |
| 2.      | Belle                   | 0.06                                 |
| 3.      | Boat                    | 7.28                                 |
| 4.      | Chester                 | 0.49                                 |
| 5.      | Grub                    | 0.47                                 |
| 6.      | Hobday                  | 5.28                                 |
| 7.      | Jolly Buoy              | 1.74                                 |
| 8.      | Malay                   | 1.94                                 |
| 9.      | Pluto                   | 0.52                                 |
| 10.     | Red Skin                | 7.07                                 |
| 11.     | Rifleman                | 0.08                                 |
| 12.     | Rutland (Western Coast) | 3.25                                 |
| 13.     | Snob                    | 1.45                                 |
| 14.     | Tarmugli                | 23.33                                |
| 15.     | Twins                   | 1.84                                 |
|         | Total                   | 59.77                                |

The total land area of MGMNP is approximately 61.5 km<sup>2</sup>, which includes a total of 59.77 km<sup>2</sup> of the land area of the 15 islands mentioned above and 1.73 km<sup>2</sup> of rocky outcrops and the remaining 220 km<sup>2</sup> area consists of mangrove lined creeks, shallow reef areas and open sea. The boundary is marked on ground, however, in the open sea it is not physically delineated. The boundary description of the park is as follows:

#### NORTH:

The park boundary originates at point 'A' located in the sea at 8.775 Km off shore the sheet rock of northern tip of Tarmugli Island and it stretches both way forming 90° angle towards west upto 8.775 Km. and at a 106° 30' towards east up to pillars 'B' located on high water mark below the Forest Rest House at Wandoor.

#### EAST:

From the above said pillar 'B' the boundary runs into a south easterly direction forming a belt of at 100 meters above the High Tide Line along Wandoor P. F. Block No. IV Manglutan, Port Mout P. F. Block No. I and then the boundary follows high level water mark along the coast below, Manglutan, Manjeri and Guptapara Revenue villages. Again the boundary forms 100 m belt above high water mark in Chidiyatapu-Bimblitan P.F. Block No.I till it reaches the pillar 'C' located at the outskirts of western boundary of Badabalu village.

#### SOUTH:

From pillar 'C' the boundary follows an imaginary line at a bearing of 210° over Macpherson Strait and meets the pillar 'D' in the northern coast of Rutland Island and then follows the western direction forming 100 mtrs belt over high water mark along the north coast and thence the belt runs over west coast of the Island till it reaches the pillar 'E' located in Potatang of Rutland island. Then from pillar 'E' at a bearing of 276° 30' the boundary runs the sea water of the Bay of Bengal upto a distance of 6.276 km.

#### WEST:

An imaginary straight line joins the west ends of both the North and South boundary line.

## 2.2 Geology, Rocks and Soil

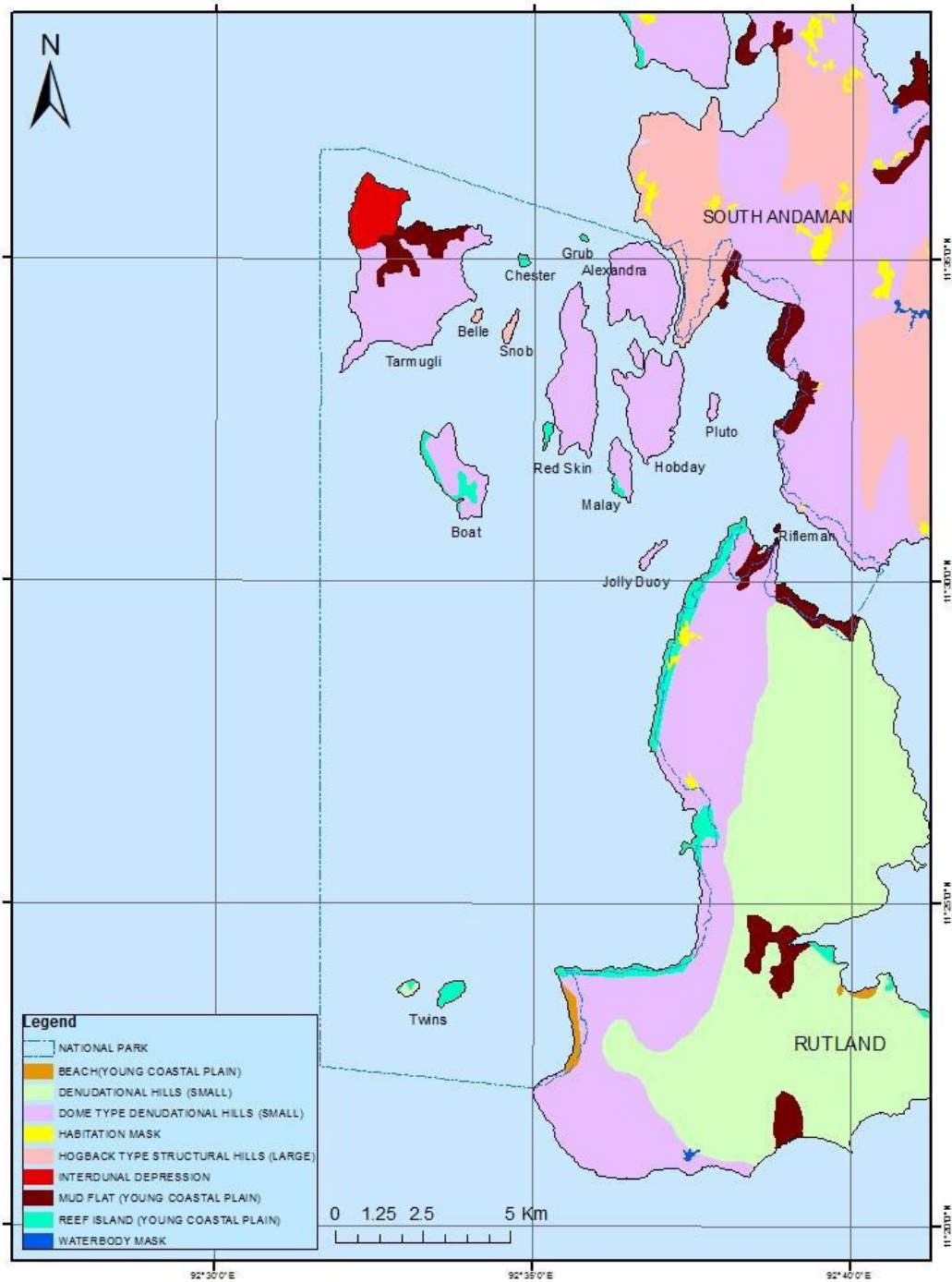
### 2.2.1 Geology

Geologically the Andaman Islands form the southward continuation of the Arakan Yoma range of Myanmar. These islands are at the fracture zone, where the Indian plate is going down below the South East Asian plate. This area is geologically unstable forming a major arc of volcanic activity. These islands are one of the younger hill ranges of the world. Andaman group of islands has older igneous rocks of both intrusive and volcanic origin. The volcanic rocks have been formed by the lava flow, forming the sub-marine range of 75-100 million years old, while the sedimentary rocks are about 75 million years old. These islands have an undulating terrain with ridges running in north-south direction. From these ridges spurs lead in east-west direction. In some places, between the main ridges, submerged valleys have formed deep inlets and creeks. The coastal strip is narrow and limited flat land is available in the Andaman group. Eastern coast has high ridges and the highest point is reached at the Saddle Peak, in North Andaman Island.

The geomorphology of MGMNP shows that most of the islands have small denudation hills. Reef Islands (Young coastal plains) are found in Boat, Chester, Twins, Malay, Red Skin and Rutland islands. Interlunar depression and mud flats are found in Tarmugli and Hobday Islands (Fig. 3).

### 2.2.2 Rocks

Geological formation of North, Middle, South and Little Andamans is mainly with intrusion of basic and ultra igneous rocks. The underlying rocks are essentially sandstone. Serpentine rocks are found in the higher altitude. The two principle rock series encountered in the South Andaman are of sedimentary origin and are distinguished as the Port Blair and Archipelago series. Some altered igneous intrusion and some volcanic rocks are also associated with these. Serpentine group comprising of ultra basic and basic rocks, such as gabroes, perioditites, dunites and serpentines are widely distributed in South Andaman. In and around MGMNP these rocks occur in Chidiyatapu, Rutland, Cinque, and Sister Islands. The islands are Eocene sediments of sandstone growing into conglomerates. Thick Eocene sediments deposited on pre-tertiary fine grained sand stones, shales, salt stones and lime stones with intrusion of basic and ultra basic igneous rocks. Sandstones are the commonest rocks, porous and



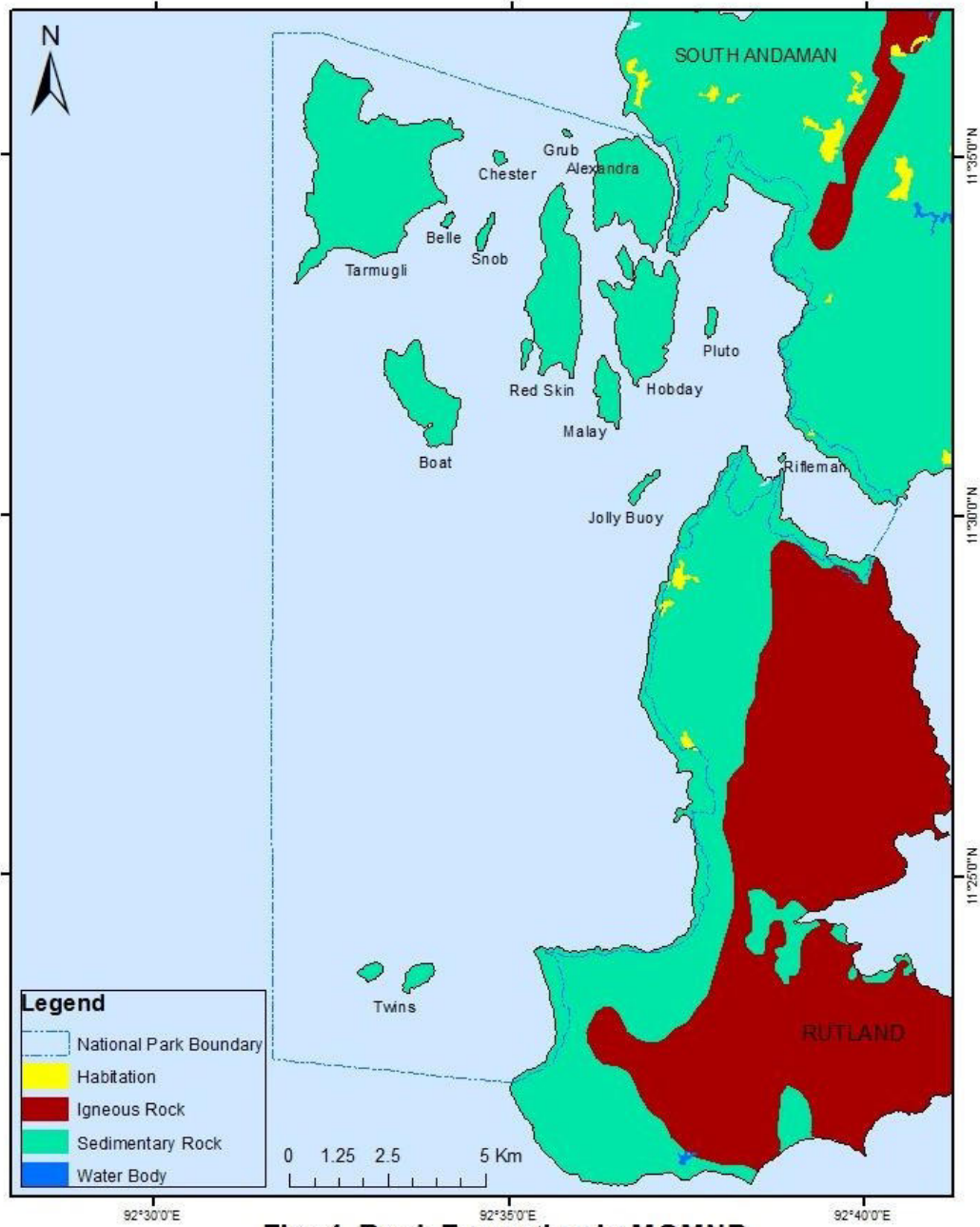
**Fig: 3 Geomorphology of MGMNP**

slightly micaceous. In hill tops of the Islands, green and red Jaspers quartzite crystalline limestone is found, occasionally with gneissic outcrops.

The Archipelago Group consists of deep water marine sediments of variable thickness. Much of it contains rich and well preserved micro- fossil assemblage. The sediments of the group are found broadly in two groups, Northern and Southern. Labyrinth Group of Islands comes in the Southern Group. The strata in the southern region are predominately calcareous being composed mainly of a monotonous sequence of mud-stones. Coral rocks and beach sands occur as local caps overlying the Archipelago group and the older rocks. Along the coastal line the lime stone and coral reef dip gently towards the sea. The occurrence of recent to sub-recent coral beds in-situ above the present sea level bears the evidence of recent eutectonic sea level changes (Fig. 4).

### 2.2.3 Soil

The soils of MGMNP and its surrounding areas are coarse textured with rapid to moderately rapid permeability. Soil texture is medium on the surface and heavy in the deeper layer. The water holding capacity of the soil is low. Sandy alluvial soil is found in the along the streams, beaches and narrow valleys. The top soil is of a high base status of less nutrient value and low exchange capacity. The soil is mainly acidic in nature. Humus and organic matter deposition in the soil is very poor. In the catchment area of the South-West of South Andaman Island the nature of soil is clayey loam. This soil type occurs in the valleys and in the lower slopes of the ridges up to a height of about 250 feet from the sea level. It is rarely found beyond 300 feet. This soil is formed by the disintegration of indurate clays and shales, limestone and conglomerates. The soil is loamy and varies from clayey loam to a coarse rubble sandy loam and is very shallow in some places (Fig. 5). There is no trace of visible humus. It loses water fast during the dry season. The other type of soil is hilly soil. The hill formation consists of stiff clayey soil of dark red loam overlying micaceous sand stones. It is moist throughout the year and gives rise to numerous perennial springs. The high and steep hills such as Mount Ford in Rutland Island, consists of hard red brown infertile soil with an underlying rock very often of an intrusive serpentine type.



**Fig: 4 Rock Formation in MGMNP**

Soil depth in valleys is only 60 cm to 90 cm. Soil is porous except in clayey and limestone areas. Due to the porous soil texture and lack of humus content, percolation and conservation of rainwater in the rainy season is not possible. At the same time it also causes erosion because of high rainfall and undulating nature of the terrain. Due to lack of conservation of soil moisture in the rainy season, the soil becomes devoid of moisture in the dry season. Scarcity of fresh water is a major problem and shortage of water is observed from February to late May till the arrival of monsoons nowadays. Under evergreen, semi-evergreen, deciduous and mixed forests the soils are slightly acidic (pH 5.5 to 6.4). Soils have become neutral in Teak plantation areas (pH 7.2), but they were distinctly acidic (pH 5.4 to 5.7) in upper 15-20 cm layers, before natural forests were replaced with plantations or arable (Dagar et al. 1995).

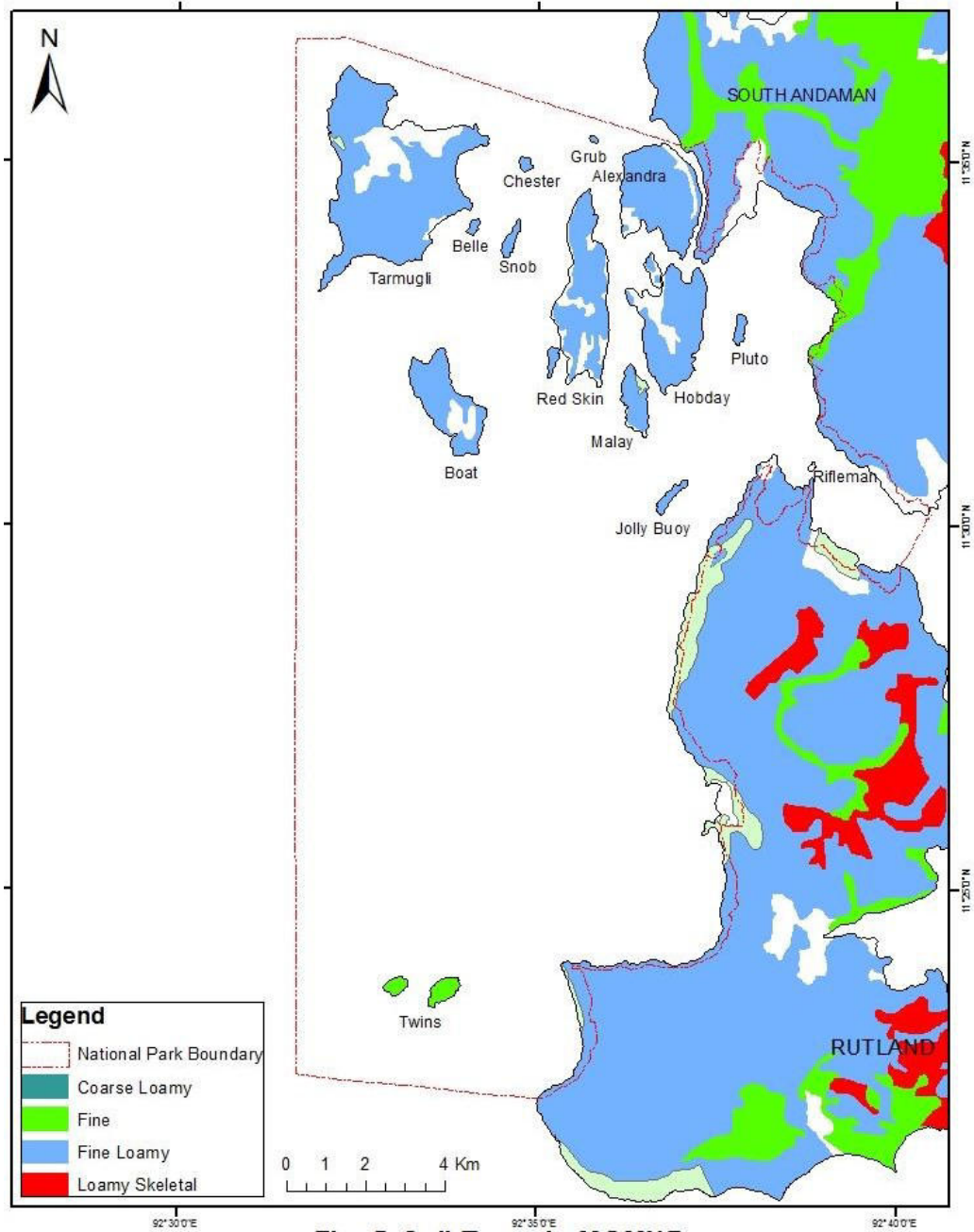
## 2.3 Topography

### 2.3.1 Terrestrial

The general topography of Andaman and Nicobar Islands, which is highly undulating, occurs only in the areas surrounding MGMNP, especially along the southern boundary of the Park in South Andaman and Rutland Islands. However, the terrain within the land area of MGMNP is almost flat with some small hillocks (Fig. 6). The general elevation varies from sea level to 80 metres. Rocky shores along with some sandy beaches occur in almost all the islands and along the main islands of South Andaman and Rutland. The islands are formed by unconsolidated marine sediments, composed of mud clay and sand with only sandstone, mudstone and shale as harder substratum. As there is no crystalline rock, weathering and erosion, is high. The sandy or crystalline substratum offers easy percolation and little surface run off, whereas in muddy and clayey substratum percolation is less and run off high, as in the Park.

### 2.3.2 Marine Area

The marine area of MGMNP is spread over 221.5 km<sup>2</sup>. It consists of shallow sheltered creeks in the northwest portion of the Park, while eastern and southern parts consist of moderately deep open sea. The average depth ranges upto 30 metres, though at places it goes down upto 50 metres. McPherson Strait passes through the



**Fig: 5 Soil Types in MGMNP**

central portion of the Park, connecting the Bay of Bengal with the Andaman Sea, between South Andaman and Rutland islands.

## 2.4 Climate

Andaman and Nicobar group of islands are situated in the tropical wet equatorial zone. Tropical climate is mostly warm, wet and humid for most part of the year. Extreme summer and winter is particularly unknown. Though there are pronounced dry and wet seasons, the tropical climate does not allow drought conditions in these islands. However, due to poor drainage, poor water holding capacity of the soil substratum and rapid run off, there is acute freshwater shortage in the islands during summer. This water shortage is more pronounced in the smaller islands of the Park, where perennial streams do not exist.

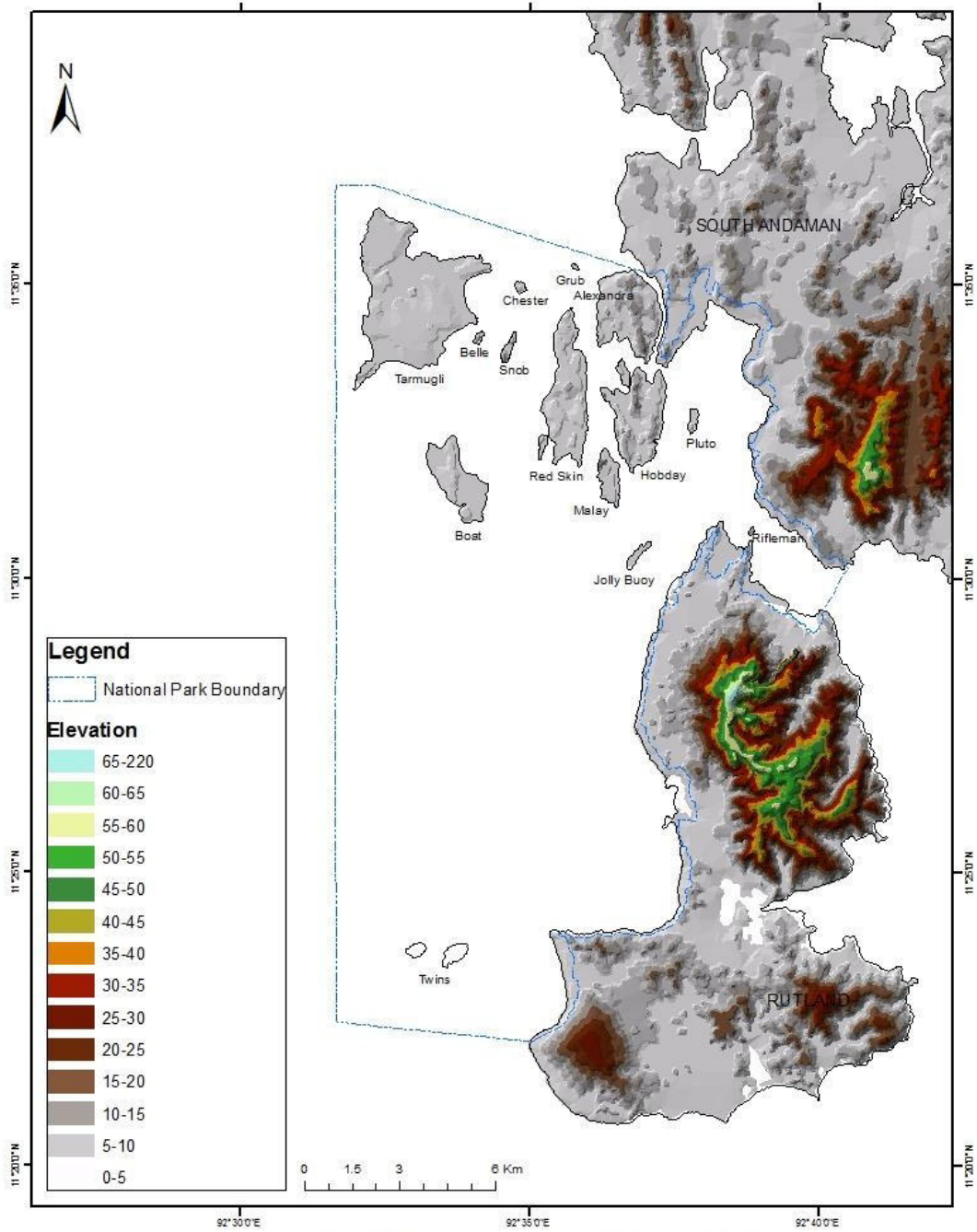
### 2.4.1 Rainfall Pattern and Distribution

The islands are exposed to both South- West and North- East monsoons, former being more prolonged and prominent, and under whose influence the islands receive maximum precipitation from May through October. The North-East or the retreating monsoon gets active over these islands between November-December. The average annual rainfall of Andaman and Nicobar Islands, calculated over 2008 till 2019 is about 3075 mm, short by 145.70 mm as compared to what was reported in the previous decade. January to April is relatively dry with high temperatures occurring during March and April. Average number of rainy days from 2008 to 2019 is recorded to be 145 (Table No. 02).

Table No. 02 : Mean annual rainfall and number of rainy days from 2009-19

| Year | Rainfall ( in cm) | Number of Rainy Days |
|------|-------------------|----------------------|
| 2008 | 325.5             | 158                  |
| 2009 | 253.16            | 151                  |
| 2010 | 312.66            | 159                  |
| 2011 | 377.16            | 166                  |
| 2012 | 342.85            | 157                  |
| 2013 | 340.54            | 158                  |
| 2014 | 287.7             | 120                  |
| 2015 | 288.79            | 136                  |
| 2016 | 283.319           | 119                  |
| 2017 | 286.66            | 142                  |
| 2018 | 295.98            | 143                  |
| 2019 | 295.443           | 131                  |

Source: Department of Economics & Statistics, A&N Adm, P/Blair

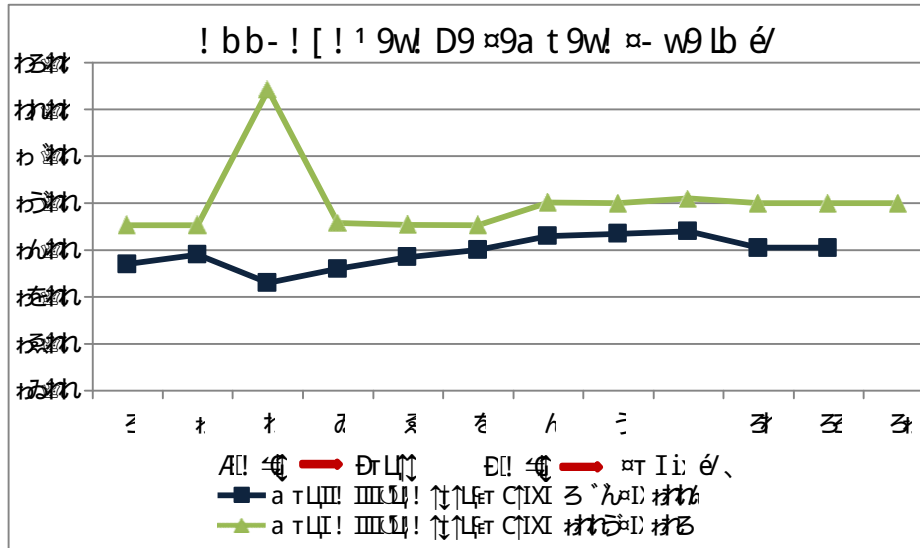


**Fig: 6 Digital Elevation Model of MGMNP**



|      |       |       |       |
|------|-------|-------|-------|
| 2013 | 24.05 | 31    | 27.53 |
| 2014 | 25    | 31.04 | 28.02 |
| 2015 | 25    | 31    | 28    |
| 2016 | 25    | 31.2  | 28.1  |
| 2017 | 25    | 31    | 28    |
| 2018 | 25    | 31    | 28    |
| 2019 | 25    | 31    | 28    |

Source: Department of Economics & Statistics, A&N Adm, P/Blair



Air temperature recorded at MGMNP by NIOT, Port Blair from 2011 to 2019 show that average temperature at MGMNP is 25.52<sup>0</sup>C which is 0.34<sup>0</sup>C less than the average temperature recorded at Port Blair during same period in the past decade. Lowest temperature was recorded during January whereas maximum temperature recorded during May (Table No. 04).

**Table No. 04 : Mean annual Air Temperature at MGMNP from 2011 to 2019**

| Year | Min. Temperature (degree) | Max. Temperature (degree) | Av. Temperature (degree) |
|------|---------------------------|---------------------------|--------------------------|
| 2011 | 26.16                     | 28.20                     | 27.18                    |
| 2012 | 25.95                     | 28.25                     | 27.10                    |
| 2013 | 25.36                     | 28.98                     | 27.17                    |
| 2014 | 25.76                     | 28.88                     | 27.32                    |
| 2015 | 26.13                     | 28.05                     | 27.09                    |
| 2016 | 25.57                     | 28.97                     | 27.27                    |
| 2017 | 26.06                     | 28.23                     | 27.15                    |
| 2018 | 25.71                     | 29.02                     | 27.36                    |
| 2019 | 27.07                     | 29.77                     | 28.42                    |

Source: NIOT, Port Blair

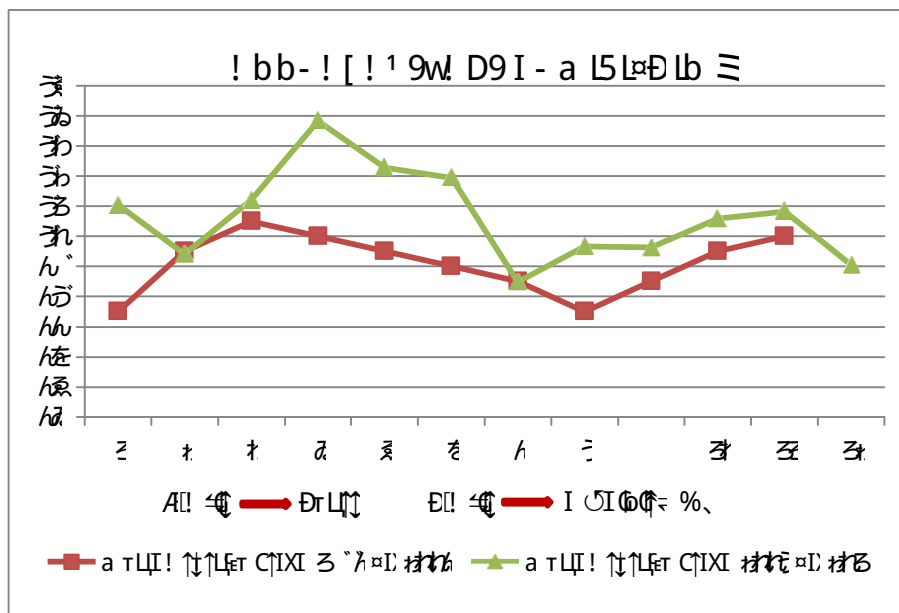
### 2.4.3 Humidity

Humidity is usually high for most part of the year with an average relative humidity of 78 %, though it shows a decrease of 1 % than the previous decade in Port Blair. The humidity of the past 12 years (2008-2019) varied from 78.98-82.28 % (Table No. 05).

Table No. 05 : Annual Mean Humidity recorded from 2008 to 2019

| Year | Humidity at 0830 Hrs (%) | Humidity at 1730 Hrs (%) | Mean Average (%) |
|------|--------------------------|--------------------------|------------------|
| 2008 | 79.83                    | 82.25                    | 81.04            |
| 2009 | 77.66                    | 81.16                    | 79.41            |
| 2010 | 79.83                    | 82.58                    | 81.2             |
| 2011 | 82.25                    | 85.41                    | 83.83            |
| 2012 | 80.83                    | 83.75                    | 82.29            |
| 2013 | 80.16                    | 83.16                    | 81.95            |
| 2014 | 76.66                    | 80.33                    | 78.49            |
| 2015 | 78.08                    | 81.25                    | 79.66            |
| 2016 | 77.83                    | 81.41                    | 79.62            |
| 2017 | 78.58                    | 82.58                    | 80.58            |
| 2018 | 78.91                    | 82.75                    | 80.83            |
| 2019 | 77.25                    | 80.83                    | 79.04            |

Source : Department of Economics & Statistics, A&N Adm, P/Blair



Average Humidity recorded at MGMNP for the period from 2011 to 2019 by NIOT is 81.16%, which is 0.47% higher than the average humidity recorded at Port Blair during same period. (Table No. 06).

Table No. 06 : Average Annual Humidity recorded at MGMNP from 2011-19

| Year | Min. Humidity (%) | Max. Humidity (%) | Av. Humidity (%) |
|------|-------------------|-------------------|------------------|
| 2011 | 77.47             | 84.38             | 80.92            |
| 2012 | 77.77             | 88.44             | 83.10            |
| 2013 | 76.80             | 80.61             | 78.70            |
| 2014 | 77.81             | 90.06             | 83.93            |
| 2015 | 79.23             | 90.77             | 85.00            |
| 2016 | 76.64             | 83.65             | 80.14            |
| 2017 | 74.56             | 83.40             | 78.98            |
| 2018 | 79.86             | 85.50             | 82.68            |
| 2019 | 73.02             | 82.86             | 77.94            |

Source: NIOT, Port Blair

#### 2.4.4 Winds

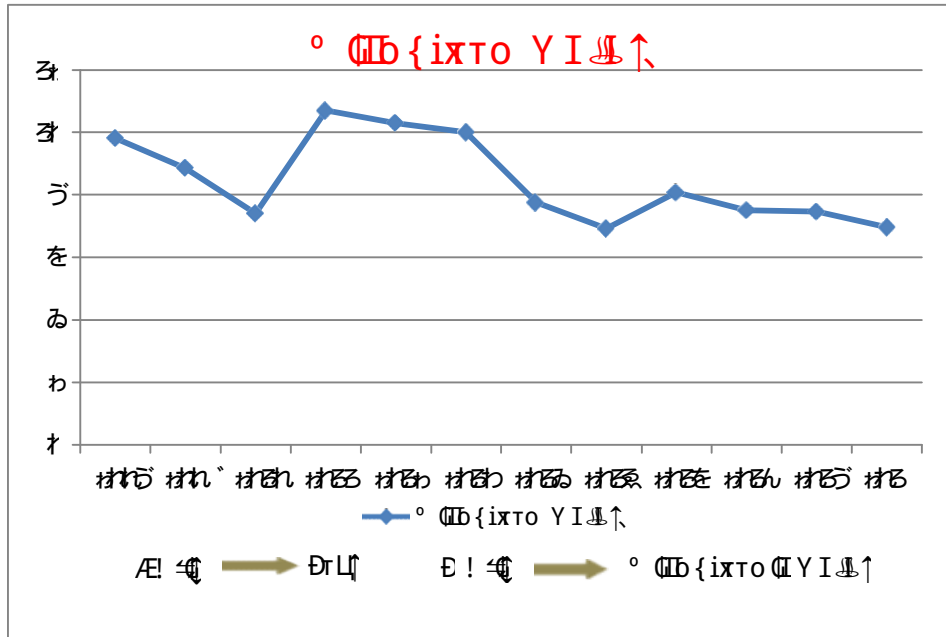
The islands receive strong South-westerly winds between the months of May and October. After Southwest monsoon ends around October, the islands receive winds from South or Southeast. A second spell of strong winds is received from Northeast between November and December. At times wind speed exceeds 25 km/hour but the usual range is between 2 to 17 km/hour in different months, with the highest wind speeds being observed in the months of July-August. Thus, the Park waters remain extremely turbulent between May and October, as the strong Southwest monsoon winds make the sea rough to very rough. The Park gets a respite during North-East monsoon as it gets shelter from waves from the main South Andaman Island, except during the high winds observed during late November till December. This trend too, however, is showing a change. Analysis of the wind speed data of the past 12 years show that we now receive high winds varying from 5-11 km/hr in the months from December till February. High winds upset the movement regime of the staff inside the Park areas, which ultimately has a telling effect on the protection efforts (Table No. 07).

Table No. 07 : Average Wind Speed recorded at Port Blair from 2008-19

| Year | Wind Speed (K m/Hr) | Year | Wind Speed (K m/Hr) |
|------|---------------------|------|---------------------|
| 2008 | 9.81                | 2014 | 7.75                |

|      |      |      |      |
|------|------|------|------|
| 2009 | 8.86 | 2015 | 6.92 |
| 2010 | 7.4  | 2016 | 8.08 |
| 2011 | 10.7 | 2017 | 7.5  |
| 2012 | 10.3 | 2018 | 7.46 |
| 2013 | 10   | 2019 | 6.96 |

Source: Department of Economics & Statistics, A&N Adm, P/Blair



Wind speed recorded at MGMNP by NIOT from 2011 to 2019 shows that average wind speed at MGMNP is 4.80 Km/hrs which is more than the average wind speed recorded at Port Blair. High wind speed is experienced during south-east monsoon particularly from June to August. During this period wind blows at an average speed of 26 Km/hrs. Lowest Wind speed recorded during the month of January to March (Table No. 08).

Table No. 08 : Annual Wind Speed recorded at MGMNP from 2011-19

| Year | Min. Speed (cm/s) | Max. Speed (cm/s) | Av. Speed (cm/s) |
|------|-------------------|-------------------|------------------|
| 2011 | 1.759             | 6.76              | 4.26             |
| 2012 | 2.23              | 8.34              | 5.28             |
| 2013 | 2.14              | 6.66              | 4.40             |
| 2014 | 1.29              | 6.99              | 4.14             |
| 2015 | 0.97              | 5.87              | 3.42             |
| 2016 | 1.84              | 6.06              | 3.95             |
| 2017 | 2.07              | 6.14              | 4.10             |
| 2018 | 0.96              | 8.62              | 4.79             |
| 2019 | 1.03              | 8.18              | 4.60             |

Source: NIOT, Port Blair

#### 2.4.5 Storms & Cyclones

Cyclonic storms regularly form during both the monsoons in the Andaman Sea and Bay of Bengal, and at times they pass over these islands. Even if they do not directly pass over the islands, during their occurrence sea conditions remain very rough around the islands. During 1792, 1844, 1891, 1941, 1969, 1978 and 1988 cyclones have passed over certain parts of these islands, causing damage to the forests and coral reefs. In the past ten years, many cyclonic storms have passed over these Islands which have led to moderate to high losses in terms of devastation of outlying protection camps and related resources of MGMNP, and severely impeded mobility (Table No. 09).

Table No. 09 : Cyclones in Andaman & Nicobar Islands

| S.No. | Name of cyclone | Month and year |
|-------|-----------------|----------------|
| 1     | Sidr            | November, 2007 |
| 2     | Nargis          | April, 2008    |
| 3     | Aila            | May, 2009      |
| 4     | Jal             | November, 2010 |
| 5     | Thane           | December, 2011 |
| 6     | Phailin         | October, 2013  |
| 7     | Lehar           | November, 2013 |
| 8     | Hudhud          | October, 2014  |
| 9     | Vardah          | December, 2016 |
| 10    | Maarutha        | April, 2017    |
| 11    | Mora            | May, 2017      |
| 12    | Pabuk           | January, 2019  |
| 13    | Bulbul          | November, 2019 |
| 14    | Amphan          | May, 2020      |

#### 2.4.6 Tsunami

Tsunami is characterized by shallow waves with large wavelengths and long periods. The word tsunami originates from two Japanese words - 'Tsu' meaning harbour and 'nami' meaning wave. Tsunamis are caused by high tidal and seismic sea waves, volcanic activities and can also be caused by non-seismic events such as landslides or meteorite impacts. Tsunami causes damage to forests and the marine ecosystem particularly coral reefs and coastal areas. An earthquake with epicenter off the coast of Sumatra and measuring 9.3 on the Richter scale caused a severe tsunami on 26.12.2004 which damaged mangroves, coral reefs and beaches in the Marine

National Park. The signs of devastation in the coastal habitat is still visible where mudflats have been created and large tracts of mangroves and coral reefs were lost.

#### 2.4.7 Local Tides and Currents

The tide range in MGMNP varies from 1.5m to 2.5m with an average of 2m. Due to the cumulative effect of tide range and channels between two/three islands, strong surface currents are generated in the Labyrinth group of Islands especially near Hobday, Malay, Alexandra, Red Skin, Pluto and Grub Islands. The freshwater runoff in the Park is very high during the monsoon period due to which salinity decreases in this region. The combined effect of tide range, surface currents and freshwater runoff brings turbid water from large creeks such as Lohabarrack, Tirur and a number of other small streams, during monsoon into the Park area.

#### 2.4.8 Hydrographical Data of Coastal Waters

##### 2.4.8.1 Water temperature

NIOT, Port Blair has installed monitoring buoy at MGMNP to monitor various parameter of air and water. Water temperature is recorded from 2011 to 2019 and from the data it was found that the average temperature of water temperature is 29.22<sup>0</sup> C. Rise in temperature above the average temperature has been noticed during the month of April and May in each year from 2011. During these two months, the average temperature has been recorded as 30.62<sup>0</sup>C, whereas during 2019, the average water temperature during April and May was 31.16<sup>0</sup>C (Table No. 10).

Table No. 10 : Water Temperature recorded at MGMNP from 2013-19

| Year | Min. Temperature (degree) | Max. Temperature (degree) | Av. Temperature (degree) |
|------|---------------------------|---------------------------|--------------------------|
| 2013 | 28.17                     | 30.58                     | 29.37                    |
| 2014 | 27.60                     | 30.20                     | 28.90                    |
| 2015 | 28.11                     | 30.67                     | 29.39                    |
| 2016 | 28.47                     | 31.19                     | 29.83                    |

|      |       |       |       |
|------|-------|-------|-------|
| 2017 | 27.92 | 30.58 | 29.25 |
| 2018 | 28.47 | 30.94 | 29.70 |
| 2019 | 28.16 | 30.93 | 29.54 |

Source: NIOT, Port Blair

#### 2.4.8.2 Current Speed

Current speed for the period from February 2011 to February 2013 was recorded and analyzed. It is found that the average speed of current was 6 m/s. The average current speed in the year 2011 was more than the average speed i.e. 7.75 m/s (Table. No. : 11).

Table No. 11 : Current Speed recorded at MGMNP from 2011 - 13

| Year | Minimum Speed<br>m/s | Maximum Speed<br>m/s |
|------|----------------------|----------------------|
| 2011 | 9.39                 | 14.97                |
| 2012 | 4.95                 | 29.17                |
| 2013 | 4.79                 | 8.82                 |

#### 2.4.8.3 Depth

The average depth of sea is around 14 mtrs and in few places adjacent to the western boundary it goes beyond 40 mtrs. Sea is very shallow around the islands of Labyrinth group. Shallow rocky patches are also present in few places which pose danger to the moving watercraft during low tide (Fig. No. : 7).

#### 2.4.9 Water Sources and Discharge

The zone of influence falling along the Park's eastern boundary in South Andaman does not have any perennial fresh water source and water is available in the streams only during the rainy season. During the rains, the streams carry water rapidly to the sea there by causing water scarcity during the summer season. Several wells exist in the villages around the Park but the water is unsuitable for drinking in the wells close to the coast as salinity is increased by ingress by sea water during summer. Therefore, the villagers are completely dependent on the Humpherygunj Reservoir for supply of potable water. During summer the water supply is erratic and the drinking water is supplied through tankers.

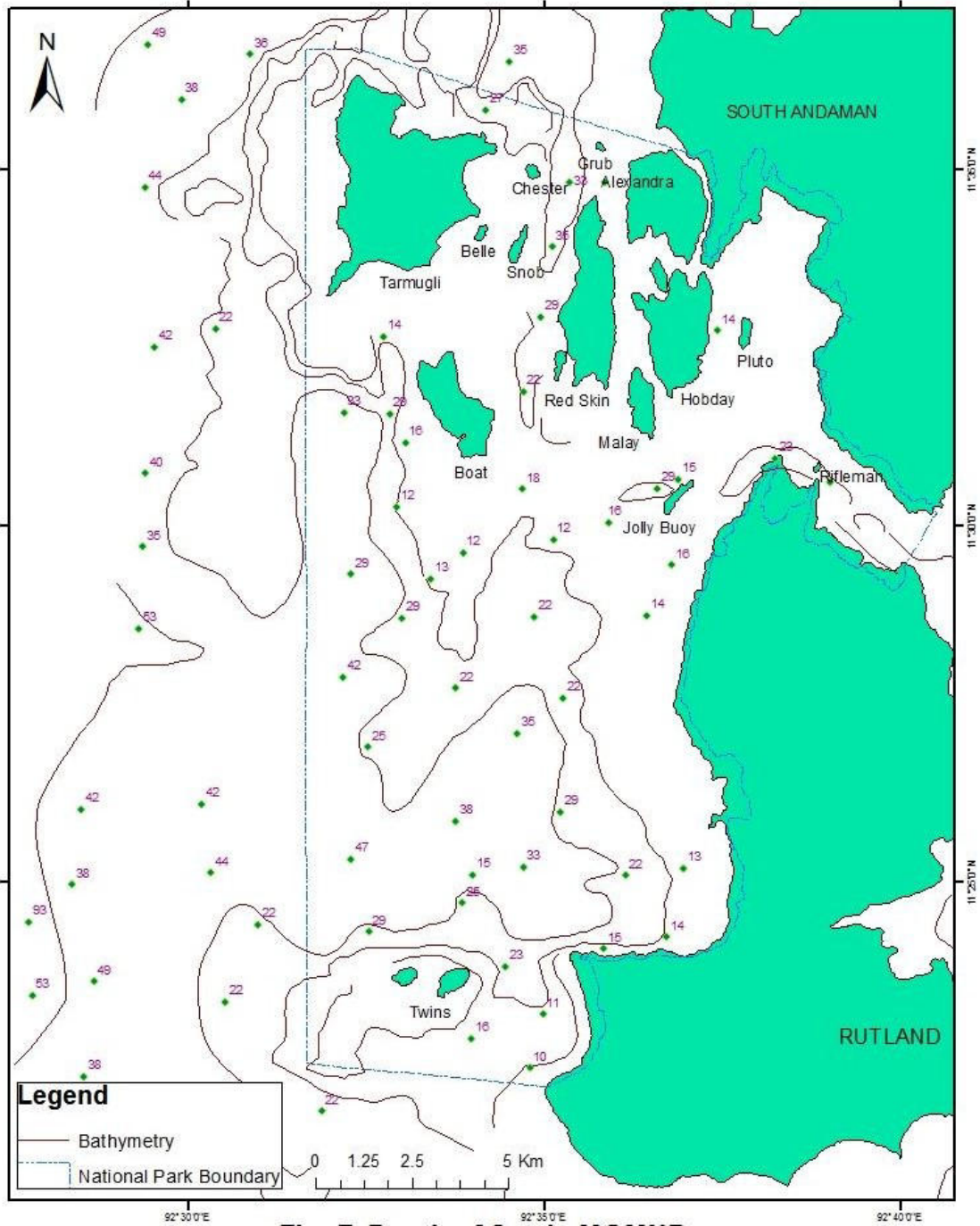
In outlying islands of the MGMNP, fresh water resources more or less non-existent during the pinch period except in the Rutland Island. In Rutland Island there are several perennial streams flowing down the western slope and draining into MGMNP. Out of these the major stream are the ones that flow through Badakhadi and Kicharnala. In Tarmugli and Red Skin Islands, seasonal fresh water ponds exist. Nevertheless, scarcity of water does not affect terrestrial wildlife such as the Wild Pig, one of the two large mammals present in MGMNP, as it is confined only to Tarmugli and Rutland which have perennial water sources. The other species, spotted deer, which is an introduced species and extremely adaptive, has spread over almost all the islands, including the ones devoid of water sources for its sheer dependence on available salt water and the vegetation, particularly the mangroves. Many of the fresh water streams present in the villages fringing MGMNP, that are active during monsoon, discharge fresh water loaded with silt and sediments into the park, resulting in decreased salinity and increased turbidity near the stream mouths.

The dissolved oxygen ranges from 4.8 ml/litre to 6.3 ml/litre in MGMNP area. The transparency during summer in vertical water column is 3.2 m to 16 m and horizontally it is 3.5 m to 11 m. The vertical transparency of sea water goes down to less than 1m to 6m during monsoon in near shore reef areas.

## 2.5 Range of Wildlife, Status, Distribution and Habitat

### 2.5.1 Floral Wealth Status, Distribution and Habitat

Tropical warm, humid and wet conditions, arising due to closeness to the equator and the impact of both south-west and north-east monsoons has given rise to dense and varied vegetation cover on these islands. The flora of these islands was first described by Parkinson (1923). He had identified five types of forests in these islands, namely Mangrove, Littoral, Evergreen, Deciduous and Hilltop tropical evergreen forests. Champion and Seth (1968) categorized the forests of these islands into 12 categories, namely, Giant Evergreen Forests, Andaman Tropical Evergreen Forests, Southern Hilltop Evergreen Forests, Andaman Semi- evergreen Forests, Andaman Moist Deciduous Forests, Andaman Secondary Moist Deciduous Forests, Brakish Water Mixed Forests, Sub-montane Hill Valley Swamp Forests, Cane Brakes, Bamboo Brakes, Littoral Forest, Tidal Swamp or Mangrove Forest.

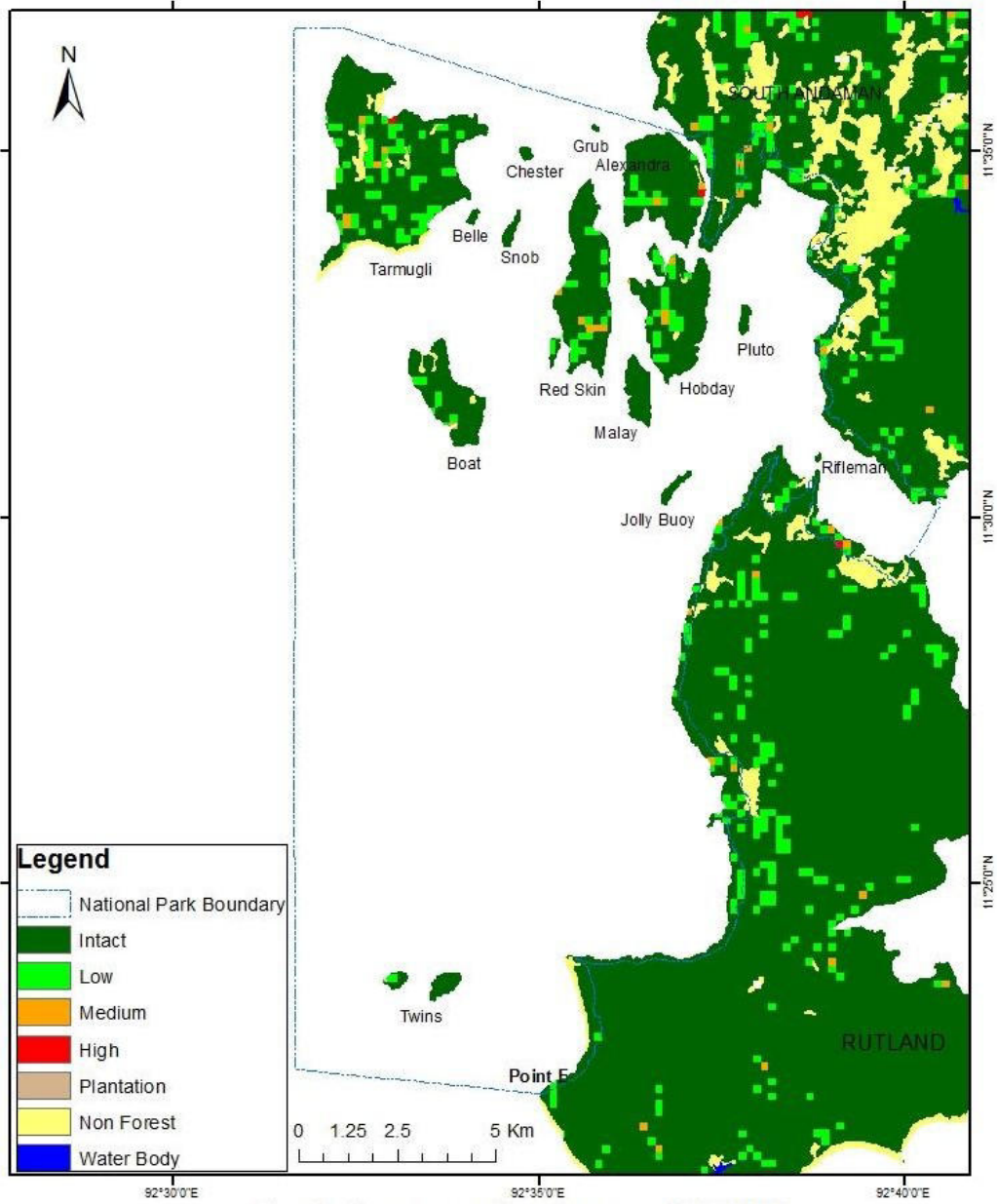


**Fig: 7 Depth of Sea in MGMNP**

The vegetation occurring on these islands can be broadly classified into Inland, Littoral and Tidal Swamp forests. The inland forest comprises of Evergreen forest, Wet and Moist Deciduous forests, Bamboo Brakes, grassy blanks and fresh water aquatic vegetation, while the Littoral forests occur along the narrow coastal belt and Tidal Swamp forests comprise of mangroves and salt marshes. Many algae and sea grasses grow in the marine environments.

IIRS (2003) conducted a landscape analysis to assess the biological diversity pattern of the islands and the vegetation type map of Andaman Islands was prepared by using satellite data and classified 32 vegetation type / land cover classes in Andaman Islands. The distribution of vegetation / land cover classes in Andaman Islands include Giant Evergreen forest, Andaman Evergreen forest, Southern Tropical Evergreen forests, Secondary Evergreen forests, Semi - Evergreen forests, Moist Deciduous forests, Bamboo forests, Rhizophora forests, Bruguiera forest, Phoenix forests, Mixed Mangrove, Arecinnia forests, Limnizera, Heritiera, Xylocarpus Rhizophora, Littoral forests, Teak, Paduak, Mixed plantation, Degraded forests, Degraded mangrove, Rubber plantation, Scrub, Forest Blanks, Sandy Beaches, Coconut, Arecanut, Red Oil Palm, Agriculture, Mudflat, Water body and settlement. However, study revealed that tropical evergreen, tropical semi evergreen, moist deciduous, mangroves and littoral forests are the most dominant phenological classes. The classified vegetation map was re-sampled to 23.5 M and parameters like porosity, fragmentation, disturbances from the roads and settlements, interspersions and juxtaposition have been generated to understand the disturbance regimes and biologically rich areas.

The major forests vegetation types have been further grouped into five levels of density namely very high (more than 80%), high (60 - 80%), medium (40 - 60%), low (20 - 40%) and very low (less than 20%). The area analysis for different vegetation types shows that in South Andaman 56.64% of Evergreen Forests, 78.56% of the Semi-evergreen Forests, 63.89% of the moist deciduous forests and 93.41% of Mangroves are under high to very high density. The landscape analysis is important for identifying disturbance regimes and biological richness of the area. The fragmentation map generated for Andaman Islands shows that 87.11% of forests are still intact. The fragmentation map generated for MGMNP is presented in Fig. No. 8. The islands forming part of MGMNP shows low degree of fragmentation.



**Fig: 8 Fragmentation Status of MGMNP**

The area analysis revealed that in MGMNP the area dominated by Evergreen forests is lying intact.

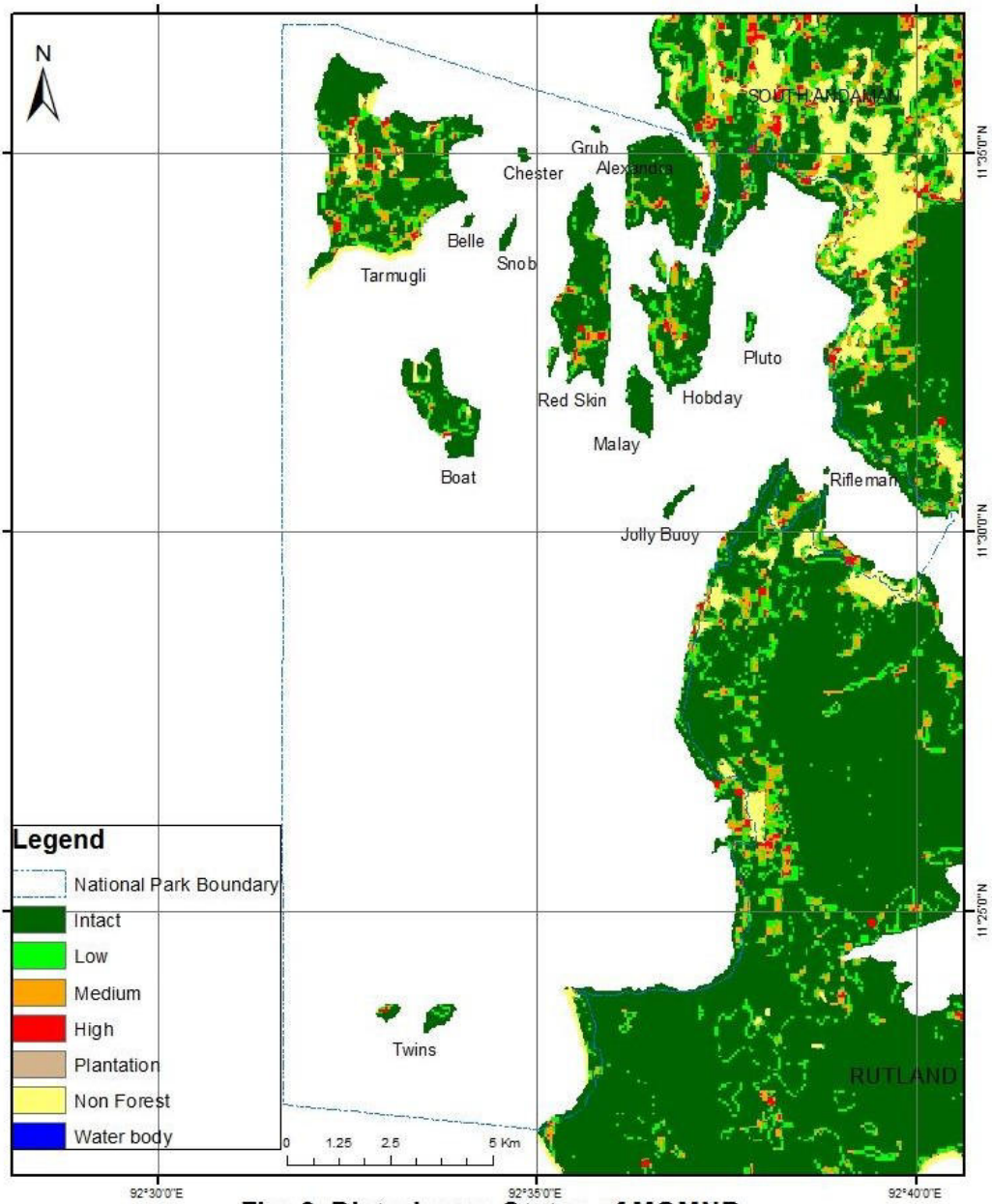
The disturbance index map obtained for entire Andaman Islands was grouped into intact, low, medium and high disturbances. The status of disturbance in south Andaman Islands indicates that 79.99 % is falling under intact zone. Among the forest types 91.05% of evergreen forests, 80.25% of semi evergreen forests, 69.74% of moist deciduous forests and 74.86% of mangroves are still intact in South Andaman. The disturbance index map for MGMNP is presented in Fig. No: 9.

The biological richness map (Fig.No: 10) indicates that tropical evergreen and the mangrove forests are falling under high to highest biological richness. The biological richness analysis for South Andaman shows that 21.6% of the area is under high to highest biological richness and 69.4% area is under moderately rich category. Most of the high richness areas are dominated by evergreen and semi evergreen forests.

#### 2.5.1.1 Forest Types

The forest types occurring on these islands are influenced by the type of soil. The forest type depends chiefly upon the nature of the underlying soil in any locality. If the soil is inundated at regular intervals by the tides, it is usually occupied by mangroves. Alluvial land out of the reach of the sea lying along the coast and in the valleys and consisting generally of deep fertile clayey or sandy loam, is usually occupied by luxuriant tall evergreen forest. Hill slopes consisting of a yellow-brown and rather stiff clayey soil of a micaceous sandstone formation are usually covered by tall evergreen forests. High and steep hills with a hard red brown infertile soil and an underlying rock often of an intrusive serpentine are usually found clothed with dense scrub-growth, bamboo and small hard-wooded trees. Following are forest types found in MGMNP, as classified by Champion and Seth for these islands.

Andaman Tropical Evergreen Forest (1A/C1): Multi-storied climax forest formations that occur mostly on low alluvial land or on moist loamy hillsides with representative trees such as *Diptocarpus* spp., *Canarium manii*, *Artocarpus* spp. and *Pometia pinnata*.



**Fig: 9 Disturbance Status of MGMNP**

Andaman Semi -Evergreen Forests (2A/C1): Contains both evergreen and deciduous trees. Representative tree species are Diptocarpus alatus, Pterygota alata, Albizia chinensis, Artocarpus lakoocha and Pterocymbium tinctorium.

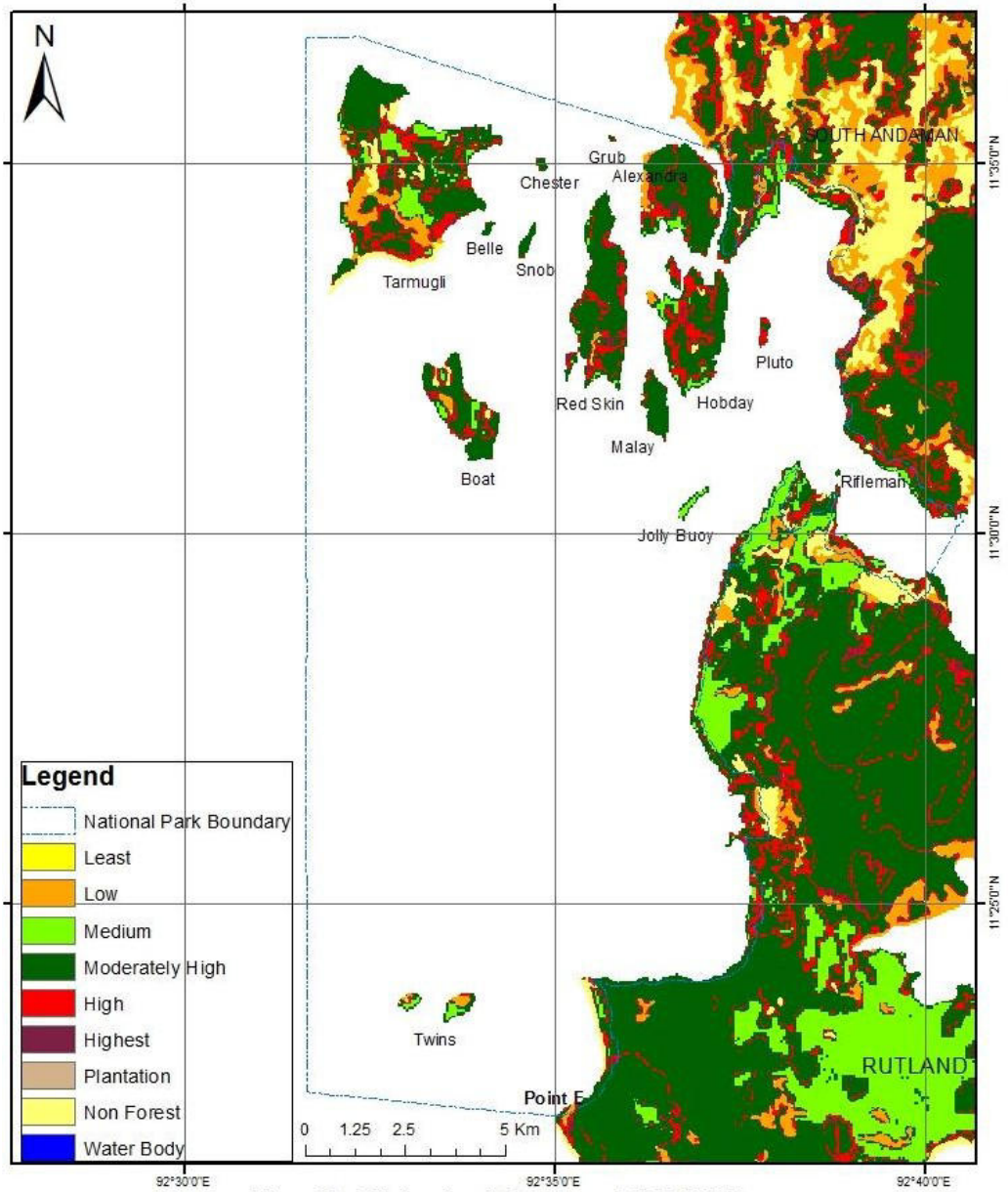
Andaman Moist Deciduous Forest ( 3A/C1 ) : Forest of lower strata growing on lower hills and in drier areas. Common species are Pterocarpus dalbergioides, Terminalia bilata, Pterocymbium tinctorium, Albizia spp. and Tetrameles nudiflora.

Andaman Secondary Moist Deciduous Forest ( 3A/C1/2S1) : This forest is characterised by pole sized uniform crop in worked over primary forest areas. The main species are Lagerstoremia hypoleuca, Canarium euphyllum, Pterocymbium tinctorium.

Littoral Forests ( 4A/L1 ) : This is typical coastal forest occurring over sandy areas above the HTL and the most characteristic species is the tall evergreen Manilkara littoralis (sea mohwa) which often forms an almost pure strand along the coast. Scattered smaller evergreen trees occur with fewer deciduous trees and these form the dominant canopy. There are numerous shrubs and where the undergrowth is light, salt tolerant grasses and surface creepers, such as Ipomoea pes-carpae binding the sand, are conspicuous.

Mangrove forest (Tidal Swamp forest) (4B/TS2) : These are typically a closed evergreen forest of moderate height, composed of trees specially adapted to survive in intertidal areas with periodic inundation and varying degree of salinity. These are distributed in mainly sheltered coast but in some areas they are present in exposed coast also. The floristic composition consists of Rhizophora mucronata, Rhizophora apiculata, Bruguiera gymnorhiza, Acanthus ilicifolius, Acanthus ebracteatus, Avicennia officinalis, Bruguiera parviflora, Ceriops tagal, Lumitzera littorea, Sonneratia apetala, Xylocarpus granatum, Xylocarpus moluccensis and Heritiera littoralis.

The forests types as found in MGMNP as per the satellite based vegetation/ forest types (IIRS 2003) are represented in Fig. No: 11.



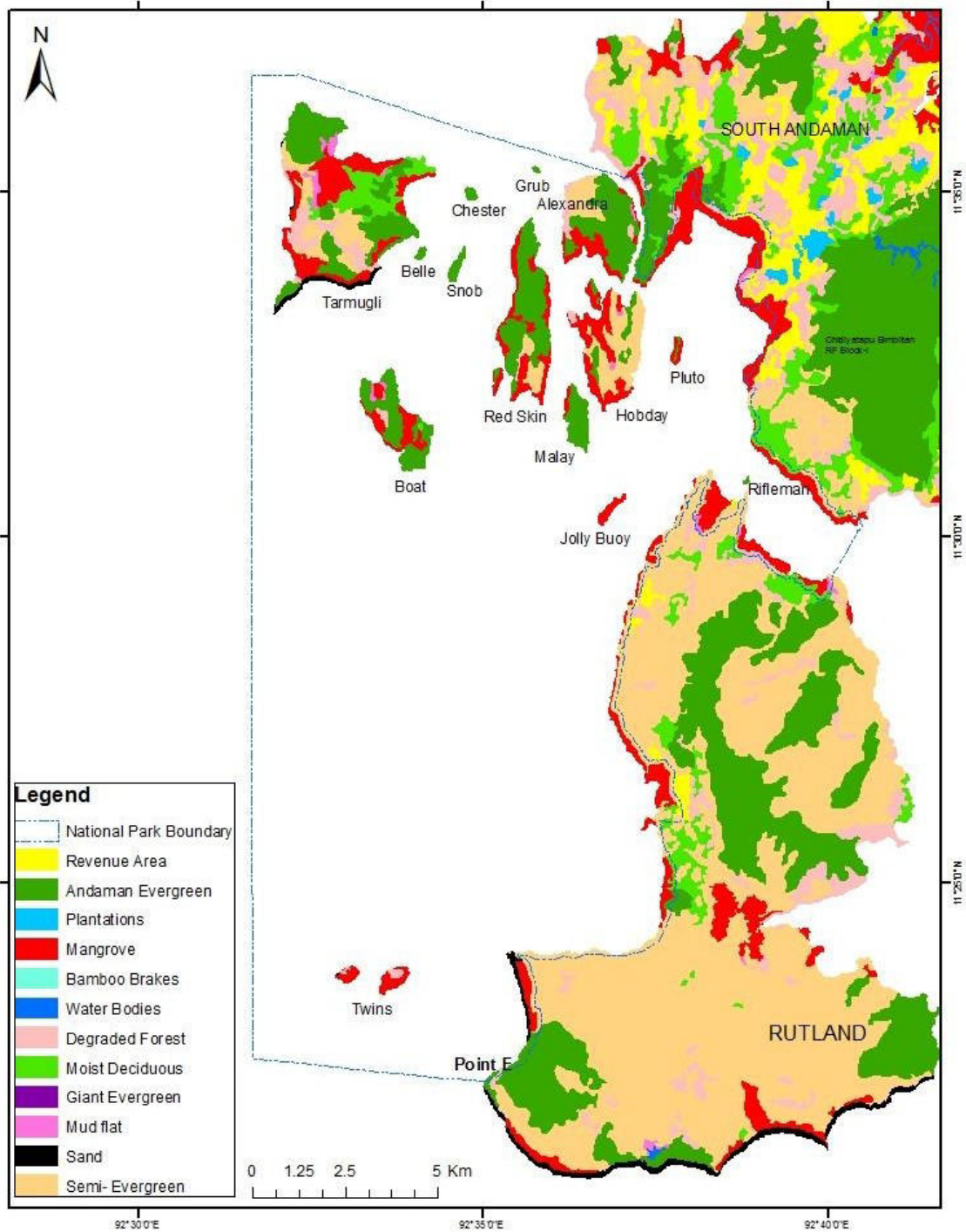
**Fig: 10 Biological Status of MGMNP**

### 2.5.1.2 Flora of Terrestrial areas of MGMNP

The flora of Andaman and Nicobar islands represents the Indo-Chinese and Indo-Malayan regions and 3552 plant species have so far been reported (Hajra et al., 1999; Sreekumar, 2002; Padalia, et al., 2004). 110 orchids are reported from these islands of which 25 species are endemic. Of the 630 species of higher plants in the Red Data Book, 46 species occur in the A&N islands (Sinha, 1999). A recent survey has recorded 406 medicinal plants including introduced ones (NBRI, 2003). 85 species are rare, endangered and threatened and whereas the World Conservation Monitoring Centre has classified 365 as threatened (WCMC, 1994; Sreekumar, 2002; Andrews and Sankaran, 2002; Jayaraj and Andrews, 2005). The flora of the MGMNP is very rich with about 298 spermatophytic taxa occurring in just 60 km<sup>2</sup> land mass. The list of species is in Annexure VII.

There are 18 endemic species recorded viz., *Semecarpus kurzii* (Anacardiaceae), *Polyalthia parkinsonii* (Annonaceae), *Alstonia kurzii*, *Tabernaemontana crispa* (Apocynaceae), *Hippocretia andamanica*, (Celastraceae), *Chailletia andamanica* (Chailletiaceae), *Garcinia andamanica* (Clusiaceae), *Actephila puberula* (Euphorbiaceae), *Derris andamanica*, *Derris wallichii*, *Tadehagi triquetrum* (Fabaceae), *Amora manii* (Meliaceae), *Psychotria andamanica* (Rubiaceae), *Manikara littoralis* (Sapotaceae), *Vitex diversifolia* (Vitaceae) and *Tetrastigma andamanicum* (Vitaceae). 6 species are rare/threatened viz., *Bombax insigne* (Boraginaceae), *Tadehagi triquetrum* (Fabaceae), *Amora manii* (Meliaceae), *Plecosperrum andamanicum* (Moraceae), *Olex imbricata* (Olacaceae) and *Pittospermum ferrugineum*, (Pittosporaceae).

The recent discovery of a new species of wild rice, *Oryza indandamanica* from Rutland Island and Saddle Peak area shows that these islands are repository of a greater biodiversity and much of it is still to be discovered. All the three gymnosperms reported from Andaman Islands are found in the MGMNP. Earlier 13 species of mangroves were recorded from the park namely *Acanthus ilicifolius*, *Acanthus ebracteatus*, *Avicennia officinalis*, *Bruguiera gymnorhiza*, *Ceriops tagal*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Lumnitzera littorea*, *Scyphiophora hydrophyllacea*, *Scyphiophora apetala*, *Xylocarpus gravatum*, *Xylocarpus moluccensis* and *Heritiera littoralis*.



**Fig: 11 Vegetation Type of MGMNP**

Later on in 2014 further three more species have been found to be growing luxuriantly within MGMNP, viz., *Sonneratia ovata*, *Sonneratia alba*, and *Bruguiera cylindrical*. Therefore, as on date there are 16 species of true mangroves reported from MGMNP.

### 2.5.1.3 Marine Flora of MGMNP

The marine flora consists of two groups- one comprises of non flowering plants, mainly marine algae and another comprises of the flowering plants adapted to grow in marine environs in totally submerged conditions, commonly known as sea grasses. Many of the algal species growing in the reef areas are often heavily calcified, particularly the red algae. The algae provide the basis for food chain of the reef, and calcareous species contribute much material to the reef sediment, which together with the skeletal remains of corals and molluscs, are the foundations of coral cays. These algae mainly occupy region of sub tidal and inter tidal area. The algal fauna is mainly represented by *Turbinaria*, *Helmida*, *Sargassum* and *Ulva* genera and so far 14 species are recorded from MGMNP namely *Chaetomorpha intestinalis*, *Galaxaura tomentosa*, *Gracillaria corticata*, *Gracillaria millardetti*, *Helmida tuna*, *Helmida peltata*, *Helmida opunitia*, *Hypnea esperi*, *Padina pavonica*, *Sargassum binderi*, *Sargassum whitii*, *Turbinaria ornate*, *Turbinaria dentata* and *Ulva lobata*.

Sea grasses form dense beds or meadows on sandy sea bottoms. The Mahatma Gandhi Marine National Park supports extensive sea grass beds of *Thalassia* sp. They trap substantial quantities of organic and inorganic sediments supporting an enormous array of reef flora and fauna and serving as a nursery ground for many reef fishes. There are a few invertebrates which also feed on sea grass leaves. Sea urchins and sea cucumbers feed on decomposed sea grass parts. Sea grass beds are the prime food source for dugongs (*Dugong dugon*) and sea turtles. These sea grasses inhabit all types of substrata from muddy to rock sheets, but the most extensive beds occur on soft sandy substrates. Sea grasses play an important role by maintaining the richness of coastal environment. The large area of shallow calcareous sand of the Park provides a suitable substrate for sea grass growth. Here sea grasses occur from inter tidal region to up to 13m depth. The dense intertwined rhizomes and roots of the sea grasses form a strong mat that penetrates the substrate and secures the plant against the water and wave motion, thereby stabilizing the bottom sediments. Of the nine

species known from Andaman and Nicobar Islands, five species have so far been recorded from MGMNP.

#### 2.5.1.4 Plant Species and Communities of Conservation Importance

##### 2.5.1.4.1 Mangroves

Mangroves are salt tolerant forest ecosystems found mainly in tropical and sub-tropical inter-tidal regions of the world. They are trees or shrubs that have the common trait of growing in shallow and muddy salt water or brackish waters, especially along quiet shorelines and in estuaries. In another way, mangroves are the tidal forests of coast wetlands, existing in the inter-tidal zones of sheltered shores, estuaries, tidal creeks, backwaters, lagoons, marshes and mud-flats of the tropical and sub-tropical regions of the world. The word 'Mangroves' is used to refer to the plants and also to the forest community is an adjective like 'Mangrove tree'. These ecosystems are also otherwise called as tidal forests, oceanic rain forests or coastal woodlands (Duke, 1992).

Mangrove ecosystem harbours a diverse organism which in some way or other directly depends on this ecosystem (Macnae, 1968). Leaf litter decomposition within the ecosystem provides an important nutrient base for food-webs leading to commercially to bio-turbation of important food fishes and invertebrates. For example, the commercially important prawns (*Penaeus monodon*, *Penaeus indicus*), fishes like snapper, grouper, milk fish (*Chanos chanos*) etc. dwell in the mangrove water for their breeding. The mangrove root system provides safe place to hide-out or to escape from predators and thus acts as custodian to juvenile fish stocks (Kathiresan, 1995).

Mangroves in the Andaman and Nicobar Islands are estimated to occupy 10.96% of the total forest cover of ANIs. An area of 616 km<sup>2</sup> is reported to be under Mangroves (ISFR 2019, FSI). This shows a marked decrease in mangrove extent since 1999. *Rhizophora mucronata* and *Rhizophora apiculata* occur in the outer zone. *Bruguiera gymnorhiza* and *Ceriops tagal* as well *Avicennia* and *Lumnitzera* form a middle zone. While some shrubs such as *Acanthus ilicifolius*, fern *Acrostichum aureum* as well as *Phoenix palustris*, a palm species, occur in the innermost zone where the tidal influence is less and salinity is low.

A study revealed that 38 species of mangroves belonging to 21 genera and 18 families are found in A&N Islands (Mall et al, 1985). However, Naskar and Mandal (1999) reported 35 true mangrove species from Indian Sub continent. Dagar and Sharma (1989) have classified the mangrove types into 19 communities and associations on the basis of structure and species composition. A total of 34 exclusive mangrove species were recorded in A&N Islands (Dagar et al., 1991) and recently Debnath (2004) reported 58 species from A&N Islands. Kathiresan in 2008 reported 36 true Mangrove species from Andaman and Nicobar Islands.

As on date MGMNP has reported considerable area under healthy and intact mangroves having 16 species, Rhizophora being the dominant species. In some islands such as South-eastern part of Malay island, South western part of Hobday Island, Northern tip of Rutland Island, Eastern part of Alexandra Island and near Manjeri village mangrove growth is patchy and degraded. Mangrove forests are highly productive ecosystems and have many ecological functions. They harbour a large number of animal species, which are partially or totally dependent on mangrove ecosystems.

According to Gopal and Krishnamurthy (1993), more than 500 species of insects and Arachnids, 229 species of crustaceans, 212 species of Molluscs, 50 species of nematodes, 33 species of polychaetes (Sunil Kumar, 2000), 150 species of planktonic and benthic organisms are known from Indian mangroves. About 300 species of fishes, 177 species of birds, 36 species of mammals were also reported from Indian mangroves. The constant wave action along the coasts gradually changes the shape of a coastline by shifting the fine grains of sand.

Vegetation along shorelines assists in the accumulation of particles by physically trapping the particles amongst their roots. Since the mangroves live in the more sheltered areas, they are able to trap many of the finer sediments like silt and clay, which take more time to settle out of the water. Mangroves are particularly effective at trapping sediments with their extensive root systems, and other plants that live in mangrove swamps, which have many tiny roots help trap many of the finer sediments and prevent them from being washed away. Mangroves provide a physical habitat for many other species of plants and animals that could not survive in the intertidal zone alone. Some organisms live within or above the muddy sediment between the trees (e.g. crabs), some organisms live attached to the trunks and lower

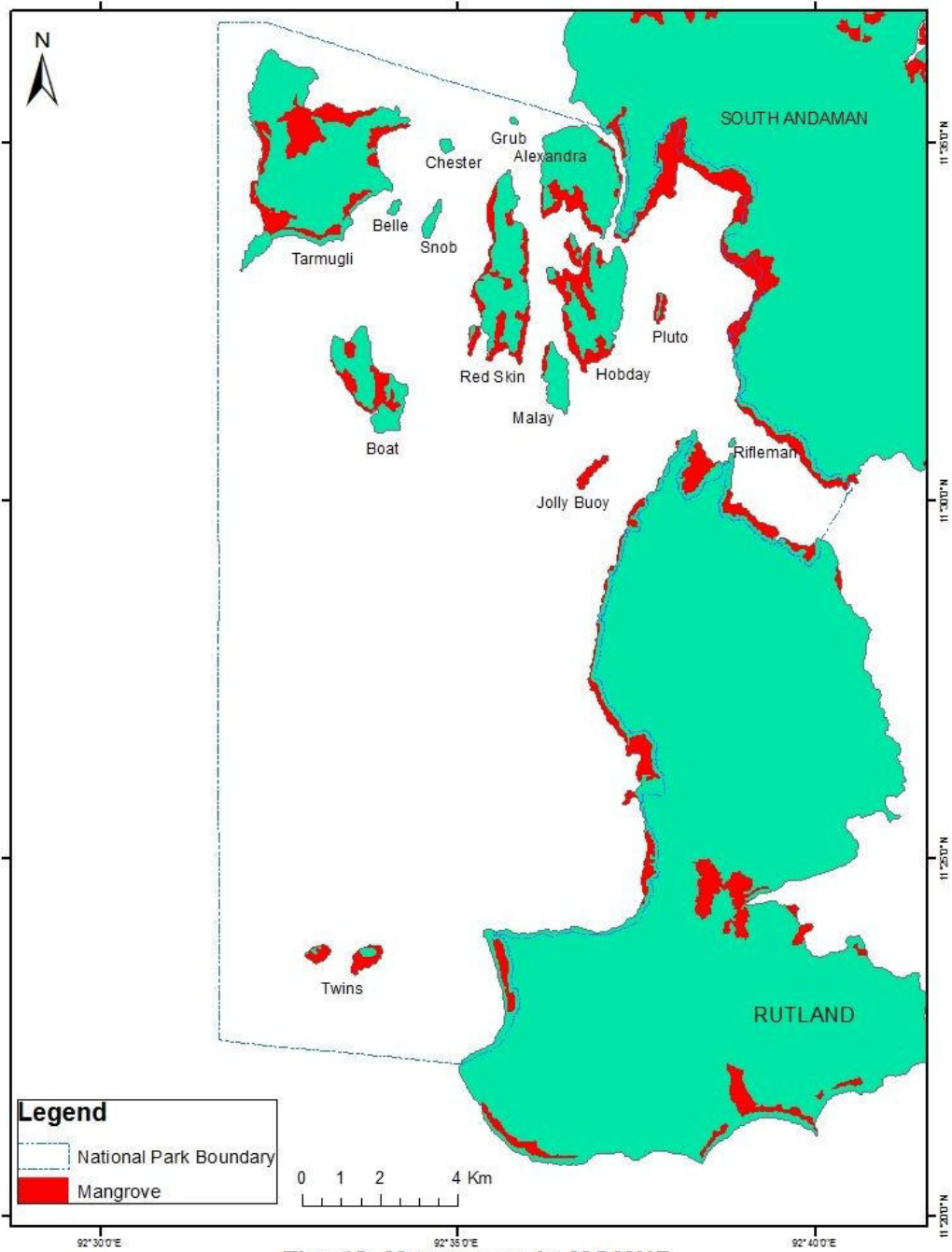
branches of mangroves, while others live higher up in the top canopy (e.g. birds). Many of these organisms rely on the mangroves for shelter, cover and food. Mangroves which serve as filter and guard off the coastline and prevent the erosion of land mass trap the sediments, which minimizes the negative impact of sediments on coral reefs; provide the nursery grounds for juvenile fishes; and provide the habitat for large number of molluscs, crustaceans and other invertebrate species.

The mangroves are the basis of all the life that live in a mangrove swamp and are the primary producers of the food chain. Mangrove leaves, stems and branches fall into the water and are broken down into detritus by bacteria, fungi and micro organisms. Filter feeders feed on the detritus and the related organisms. These small plankton feeding crustaceans (which are often in the mangrove swamp as part of their life cycles) are food for larger prawns, crabs and fish. These in turn become food for birds and humans. This is only a simple representation of food chain present in the mangrove swamp. Actually the mangrove ecosystems contain multiple, highly complex food chains, with many of the organisms dependent upon one another for their survival. Many marine species of fish that are important in both recreational and commercial fishing industries in open sea, spend a large proportion of their life cycle in the mangrove swamp. Once they have grown to a large enough size, they move out to the open sea. Thus, the mangroves are essential to maintain our fishing industries. The other important function of mangrove is that of providing an effective protective barrier against the sea wave action and coastal erosion. The conservation and protection of entire mangrove ecosystem is therefore of vital importance (Fig. No. : 12).

#### 2.5.1.4.2 Sea grass beds

Sea grasses are the sole marine representatives of the Angiosperms. They all belong to the order Helobiae, in two families: Potamogetonaceae and Hydrochariaceae. The currently accepted hypothesis of the origins of sea grasses is that they are derived from terrestrial plants, which returned to the sea.

Although they may occasionally be exposed to the air, they are predominantly submerged, and their flowers are usually pollinated underwater. A notable feature of all sea grass plants is the extensive underground root/rhizome system, which anchors them to their substrate. Sea grasses are commonly found in shallow coastal marine



**Fig: 12 Mangroves in MGMNP**

locations, salt marshes and estuaries; in the tropics they are often found associated with mangroves. Sea grass ecosystems provide habitats for a wide variety of marine organisms, both plant and animal; these include meiofauna and flora, benthic flora and fauna, epiphytic organisms, plankton and fish, not to mention microbial and parasitic organisms. The relatively high rate of primary production of sea grasses drives detritus-based food chains, which help to support many of these organisms. Birds, dugongs and turtles also directly consume sea grasses.

Although very few animals feed directly on sea grasses, in terms of detrital production they contribute significantly to coastal productivity. Andaman waters are considered to be relatively nutrient poor, and it is considered that sea grasses act as a nutrient store, releasing their nutrients as they are decomposed, as a result of detritus resuspension during storm events, apart from, directly producing organic matter. Sea grasses act as a substrate for many epiphytic organisms. On a physical level, dense sea grass meadows are believed to be responsible for extensive sediment bank build-up through a reduction in water flow.

The park supports sea grass beds, but very few areas have been explored. The known sea grass beds are from area between Red Skin and Boat Islands, intertidal area of Amdera and Wandoor and sub tidal region of Chester, Grub, Jolly Bouy, twins Islands and Tarmugli. So far 5 species of sea grasses are recorded within the Park area, viz., *Halophilia ovata*, *Halodule pinifolia*, *Thalassia hemprichii*, *Cymodocea serrulata* and *Enhalus acoroides*. Among the five species, *Thalassia hemprichii* is widely distributed at sub tidal region of South-western of Tarmugli and western of Boat Island. *Halodule pinifolia* is reported to be the best habitat for Dugong (Fig. No. : 13).

## 2.5.2 Faunal Wealth Status, Distribution and Habitat

These islands are poor in species of terrestrial mammals with the exception of bats and rats. Out of ten species of mammals reported from MGMNP, eight species are terrestrial mammals and two are marine mammals.

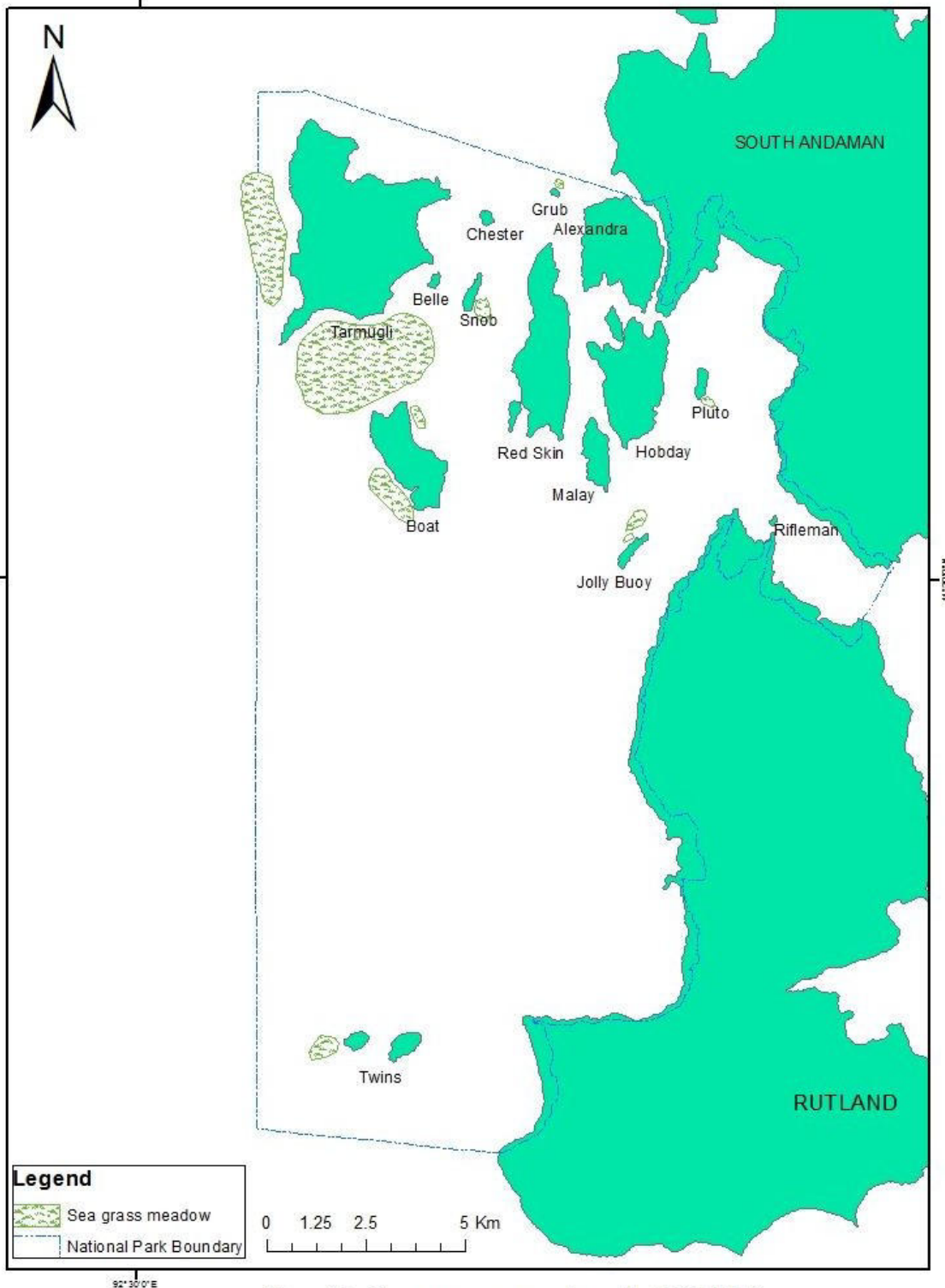
### 2.5.2.1 Terrestrial Animals

#### Mammals:

Out of 10 species of terrestrial mammals, the bats and rats constitute three and two species, respectively. The occurrence of bats and rats in these islands can be explained by the fact that the bats are endowed with the power of flight to negotiate the expanse of the sea barrier between the islands and the nearby continental land mass of South East Asia, whereas rats could have easily migrated to these islands through rafts, canoes, ships, etc. Nevertheless, some of these mammals, under changed ecological set up of the islands have evolved into endemic species. Major land mammals include Andaman Wild pig and Andaman Mask civet. The most common species is Spotted deer which has been introduced in these islands. The Andaman Mask Civet is the species of civet found only in Andaman group of islands. It is an endemic subspecies having no spots or stripes on its body. It has white whiskers and a white band on the forehead and nose. It is arboreal and omnivorous, feeding on fruits, nuts, roots and small vertebrates. It prefers to live in forests although sometimes seen near the shore perhaps to catch animals like crabs, fishes etc. It gathers its food on tree top as well as on the ground. Endemic subspecies of wild pig, namely Andaman wild pig *Sus scrofa andamanensis* occurs in MGMNP. Previous Management Plan reports restricted population in Red Skin, Tarmugli and Rutland Islands. However, in recent past, the prevalence of Andaman Wild Pig is contentious as no direct or indirect evidences have been reported by any of the patrolling parties. On the other hand, Spotted deer occurs in all the big islands of the park while rats and bats are found in some of the caves, located in Red Skin and Rutland Islands. The list of mammals of MGMNP is in Annexure -VIII.

#### Birds:

270 species and sub - species of birds have so far been reported in A & N Islands. In spite of very small landmass within MGMNP, it supports a rich avian fauna. So far 86 species of birds have been recorded in the MGMNP of which 50 are endemic to these islands (Annexure-IX). The two most endangered species occurring in the park are Andaman Teal and White-bellied Sea eagle. The Andaman Teal is endemic to the Andaman Islands. It is of the size of common teal and is seen mainly in mangrove fringed creeks in flocks of 4 to 10 and some times more. During the daytime it generally roosts amongst the mangrove trees or on rocks exposed during the low tide. There is fresh record of nesting of this bird in shrubs growing over steep rocks near Red Skin Island. The White bellied Sea Eagle is a handsome bird found in the mangrove fringed creeks and near the seashore. It preys on fish and sometimes on sea



**Fig: 13 Sea grass meadow in MGMNP**

snakes and occupies the place of top predator in the mangrove food chain along with salt water crocodile. Breeding and roosting sites of migratory birds is shown in Fig. No. : 14.

### Reptiles:

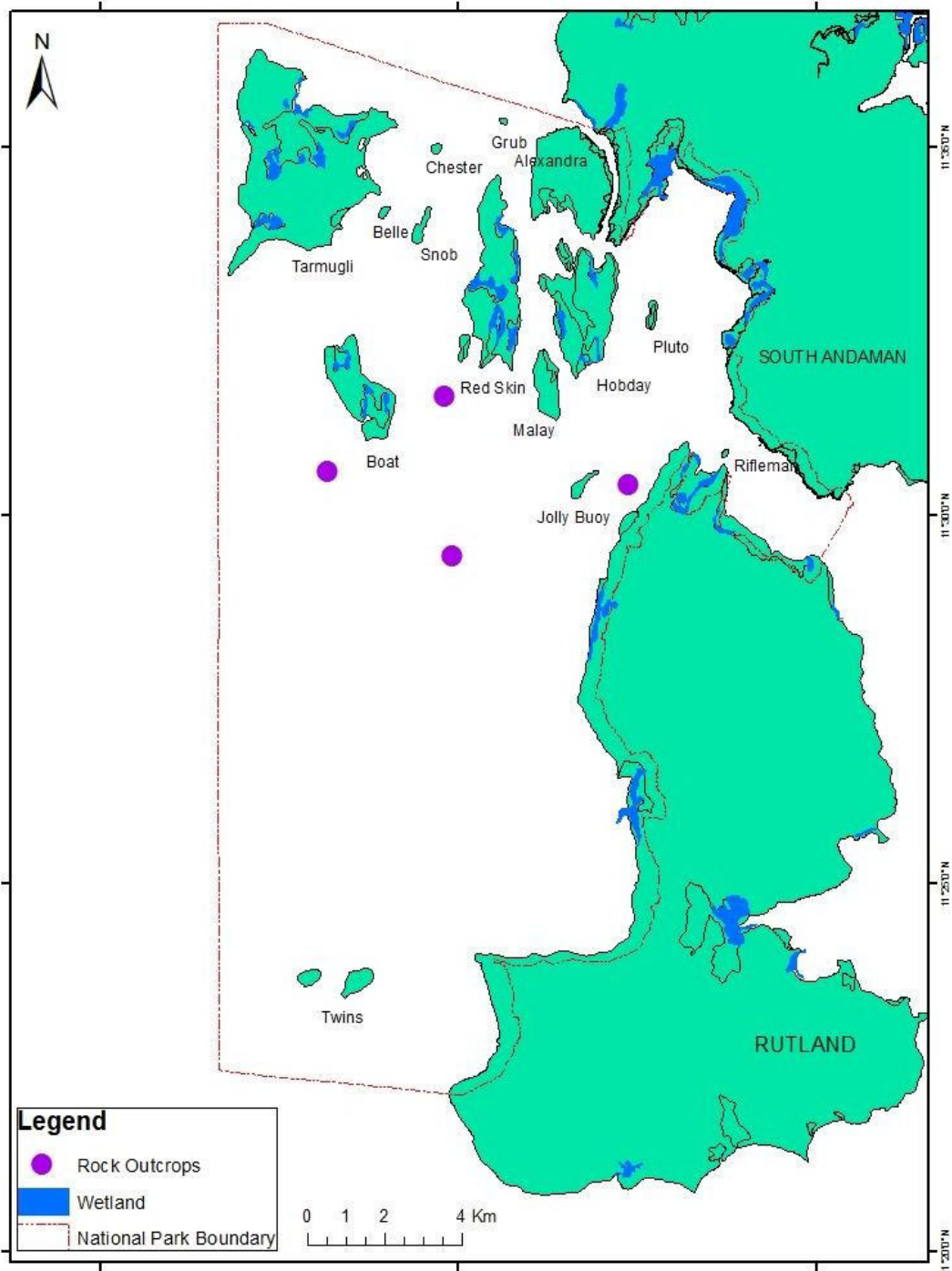
Twenty five species of reptiles have been recorded so far from MGMNP (Annexure-X). These reptiles belong to 4 species of turtles, 1 species of crocodile, 13 species of snakes and 9 species of lizards. Cobra, King Cobra, Banded krait and Pit Vipers are the venomous land snakes of MGMNP. Inland forest on the islands provide habitat for land snakes such as King cobra, Andaman cobra, Andaman Pit viper, Rat snake and Wolf snake. Some of the rocky outcrops and tree hollows and rocks in inter- tidal areas, provide resting places for Sea Kraits (*Laticuada laticauda*). Forest areas also harbour some other reptilian species, many of which are endemic, such as Andaman Day Gecko (*Phelsuma andamanense*), Andaman Giant Gecko.

### Amphibians:

Five species of amphibians had been reported in MGMNP namely *Rana cancrivora* (Saltwater frog), *Rana limnocharis limnocharis* (Paddy frog), *Rana limnocharis andamanensis* (Andaman paddy frog) of Family Ranidae, *Microhyla inornata* (Boulenger's narrowmouthed frog) and *Bufo melanostictus* (Indian toad) of Family Microhylidae However, in a recent survey, Zoological Survey of India, Port Blair updated 3 species (Annexure-XI).

### Invertebrates:

The Marine National Park provides habitat for invertebrates from terrestrial butterflies to marine corals. This wide range is due to the variety of habitats found in the Park. So far 46 species of butterflies have been recorded in MGMNP and listed at Annexure-XII. 22 species of moths are also reported from MGMNP. There is a diversity of mollusc fauna in MGMNP of which 57 species are so far identified (Annexure-XIII). Most of these are heavily exploited elsewhere in Southeast Asia and West Pacific region and in certain localities, these species have become extinct due to over exploitation.



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## 2.5.2.2 Marine Animals

### Mammals:

So far two species of marine mammals namely Common Dolphin and Dugong have been reported from MGMNP. The less disturbed sheltered water and abundance of food attracts the Common dolphin (*Delphinus delphis*) in the park area, although they are not permanent residents of the park. They are noticed in small groups (5-10) near Hobday, East of Jolly Buoy, South of Boat, North of Redskin and North of Tarmugli Islands.

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

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

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. There are reports of sighting of dugong in Boat Island and north of Tarmugli. Although the sea grass beds, the ideal habitat for dugong, are available in MGMNP, the sighting of this mammal is not reported regularly and requires intensive regular surveys in MGMNP.

### Reptiles:

Five of the seven species of sea turtles found worldwide are reported to occur in Southern Indian coastal waters (Kar & Bhaskar, 1982; Bhupathy & Saravanan,

2003). These are the olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*). All the five species of sea turtles that occur in Indian 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. However, incidental capture in fishing nets and gill nets is a well-known cause of mortality for sea turtles and are reported on and of. This park provides the feeding ground for Hawksbill and Green sea turtles. Undisturbed beaches like Jahaji, East & West Twins, Boat and Tarmugli provide nesting sites for Giant leather back turtle, Hawksbill, Olive Ridley and Green sea turtles, along the coastlines.

The mangrove fringed creeks along the main South Andaman Island near Wandoor and Manjeri and Hobday, Red Skin, Tarmugli and Rutland (Jahaji) islands are suitable habitats for salt water crocodiles. Crocodile nesting sites have been located in bigger mangrove forest patches on these islands. The salt water crocodile is a Schedule I species under Wildlife Protection Act, 1972.

All the islands in the park support good population of water monitor lizard, which is listed as a Schedule I species under Wildlife Protection Act, 1972.

### Fishes:

Over 1368 species of fishes occur in A&N Islands of which 350 species of fishes are commercially important (Krishnamurthy and Soundararajan, 1999). Of all the creatures dwelling on coral reefs, none are more active or obvious than the fishes. Perhaps more than any other single component of the reef communities, fishes provide the best opportunity to observe essential features of reef ecology. The high diversity of the fish communities in the coral reefs is maintained mainly by the complexity of these places that provide different ways for fishes to feed, live and reproduce. As many as the species numbers are the different ways of hunting, feeding, hiding, reproducing and living. The most striking feature of reef fish is their diversity, in terms of both species number and the range of morphologies. The fish fauna of MGMNP shows a high diversity of coral reef fishes with 42 families comprising of

282 species (Wood 1991; Arthur 1996; Kulkarni 2000). The most diverse families were Pomacentridae (36 sp.) followed by Chaetodontidae (30 sp.) and Labridae (29 sp.) However, in a recent survey, Zoological Survey of India, Port Blair reported 113 species Annexure - XIV.

This high diversity is partly due to the fact that coral reefs provide a wide variety of habitats, each with its own set of characteristic species. Differences in the degree of exposure to wave action, currents, light levels, the amount of algae, plankton and other food, and the abundance, shape, and varieties of coral and other shelters combine to create a large variety of different places to be exploited. These places are not only occupied by a species of fish, but by a random assemblage of a number of species of fishes. There are five major trophic categories in which reef fishes are placed viz., fishes specialized to feed on plankton forming large schools on the coral reef., including diurnal planktivores among Serranidae (groupers), Chaetodontidae (butterfly fishes), Pomacentridae (damsel fishes), and Balistidae (trigger fishes), and nocturnal planktivores among the Holocentridae (squirrel fishes and soldier fishes), Priacanthidae (big eyes), and Apogonidae (cardinal fishes); herbivorous reef fishes most characteristic of reef environments are Acanthuridae (surgeon fishes), Pomacentridae (damsel fishes), Scaridae (parrot fishes), and Siganidae (rabbit fishes), that are very essential in the control of the algal abundance; Omnivores, which appear to be primarily carnivores, influencing the composition of their prey communities including filefishes, trigger fishes and puffers and their allies feeding on a variety of well-armoured invertebrates, crustaceans, and starfishes as well as some algae, and the piscivores formed by large fishes, such as Serranidae (groupers), which survive by eating other fish.

#### Invertebrates:

The MGMNP supports important populations of several mollusc species, which are heavily exploited elsewhere in Southeast Asia and West Pacific region. In certain localities, these species have become extinct due to over exploitation. Some species of bivalves of the genus *Tridacna* are example of this. MGMNP provides fairly good populations of the four species of this family: *Tridacna gigas*, *Tridacna squamosa*, *Tridacna maxima* and *Tridacna crocea*. *Tridacna gigas*, the largest bivalve mollusc, may grow up to over a meter in length. Other species heavily collected in Andaman and Nicobar Islands but which still occur in relatively large quantities in the MGMNP are the commercial *Trochus* namely *Trochus trochus* and *T. pyramid*.

Species from six classes of the phylum Echinodermata are conspicuous member of reef fauna. Totally 40 species of this phylum are recorded (Annexure - XV) comprising of family Comatulidae (5 species), Colobometridae (1 species), Acanthasteridae (1 species), Goniasteridae (3 species), Ophiasteridae (5 species), Oreasteridae (1 species), Echinasteridae ( 1 species), Ophiotrichidae (3 species), Ophiocomidae ( 1 species), Diademataidae ( 4 species), Echinometridae 2 species), Brissidae Gray ( 2 species), Echinoneidae (1 sp.), Synaptidae Burmeister ( 1 species), Holothuriidae ( 5 species) and Stichopodidae (4 species).

MGMNP is very rich in Porifera (Sponges). There are 42 species of sponges reported at MGMNP till date. Some of the important families are Plakimidae, Agelasidae, Ancorirodidae, Chondrillidae, Clionidae etc. (Annexure - XVI)

Two species of holothurians such as *Thelenota ananas* and *Euapta goddefrii* have been recorded for the first time in the MGMNP area for Andaman and Nicobar Islands (Kulkarni, 2000).

There are eleven species of sea anemones are reported in MGMNP. Among eleven species, one species belongs to family Antinodendridae, one species belongs to family Andvakiidae, one species belongs to family Boloceroididae, one species belongs to family Actiniidae, six species belongs to family Stichodactylidae and one species of family Thalassianthidae (Annexure - XVII).

Among Octocorals, 51 species are recorded in MGMNP till date (Annexure - XVIII).

Crustaceans are less studied in this park and to date 23 species of crustaceans are reported from the water of MGMNP. Among crustaceans, thoridae and percnidae families are more prominent in park area (Annexure - XIX).

## 2.6 Habitat Quality, Quantity and Key Areas

### 2.6.1 Land

The terrestrial habitat of these Islands supports a variety of animal species. Water Monitor lizard (*Varanus salvator*) is frequently seen. Andaman wild pig (*Sus andamanensis*) occurs on the larger islands such as Rutland, Red Skin and Tarmugli Islands. The introduced Spotted Deer (*Axis axis*) is present on almost all the islands of

the Park except Rifleman and Grub Island. Trees of tropical region, shrubs, herbs, epiphytes abound on the lands here. Birds, reptiles, innumerable invertebrates colonise the available land space for survival and sustenance.

#### 2.6.2 Coastal Beach Habitat

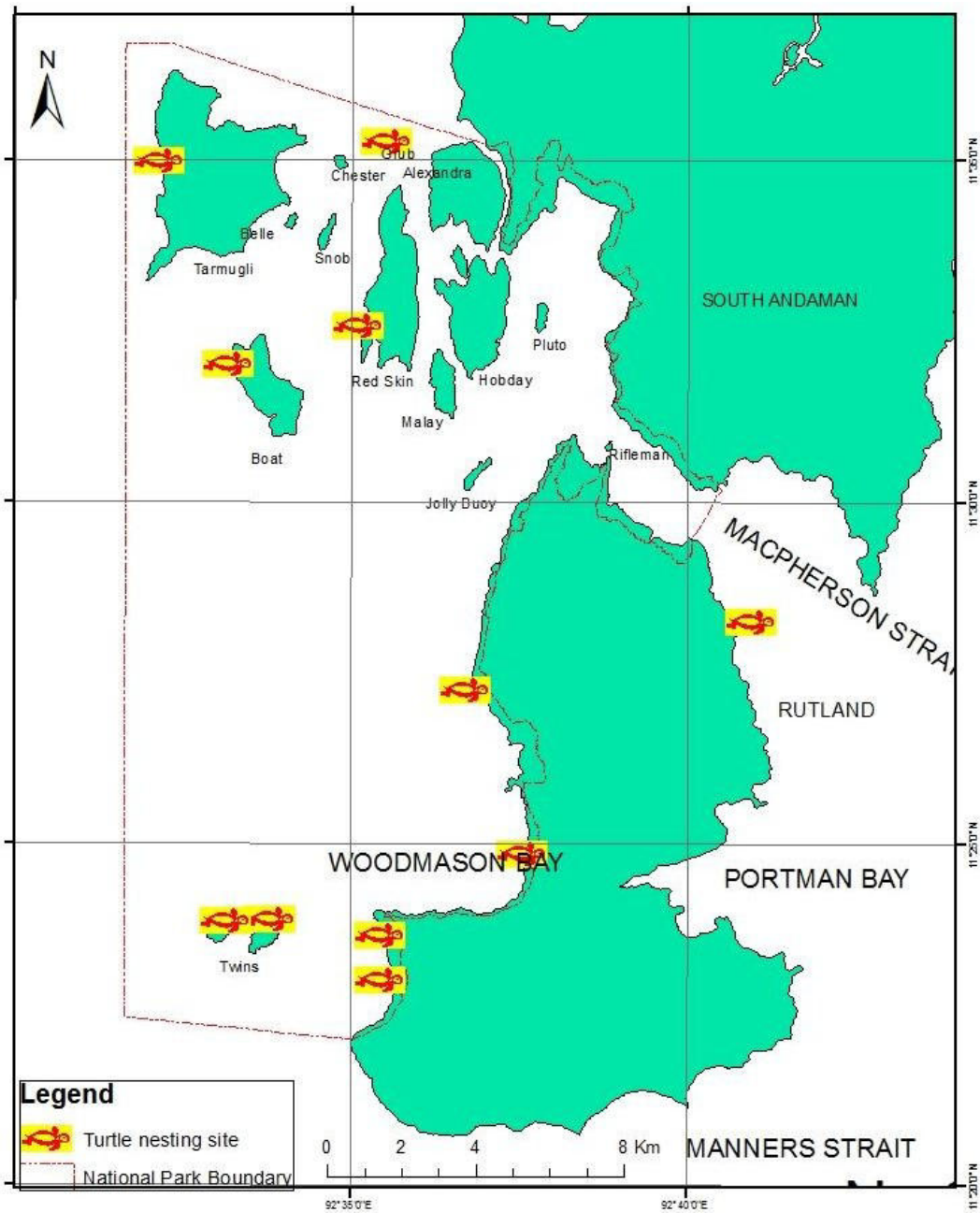
A large portion of MGMNP is coastal. Beaches with smooth, sandy stretches, or shell and coral littered along the lengths can be found on almost all the islands. However, the coastline is rough, rocky, and jagged. Sandy beaches are preferred habitat of a number of crabs. These beaches are also the nesting and pecking sites of sea turtles and of birds like terns, beach thicknee and many migratory birds. A large number of invertebrates live under the sand, including worms, bivalves, and crabs. At low tide, large areas of the intertidal zone get exposed, revealing some species of corals which can withstand the exposure and the attached mussels, limpets, various algae, sea grassers and other animals. The tidal pools are also reservoirs of life. Sea cucumbers, starfish, eels, juvenile fishes and other creatures abound there.

#### 2.6.3 Nesting Beaches of Turtle

The MGMNP provides feeding grounds for turtles and beaches as nesting sites for Leatherback, Green, Hawksbill and Olive Ridley turtles (Fig. No. : 15). The Jahaji beach in Rutland, beaches of Twin Islands, Tarmugli and Boat Island are the major turtle nesting sites. The Hawksbill's peak nesting period in these islands is January-April, with some nesting taking place round the year (Bhaskar, 1984). Most of the islands of MGMNP are within easy reach of poachers and shell divers pose a serious threat to the continued existence of the turtles and their habitats. Local communities catch turtles for meat, sell the carapace and also harvest eggs for food.

#### 2.6.4 Crocodile Habitat

Salt-water crocodile *Crocodylus porosus* inhabits the creeks of islands, like Alexandra, Tarmugli, Hobday, Rutland and Redskin (Fig. No. : 16). The population estimation of crocodile was done during 2016 and 2017. Six crocodiles were sighted during 2016 whereas three crocodiles were counted during 2017. The prime crocodile habitats in the Park are the creeks of Hobday, Tarmugli, Red Skin, Alexandra Islands and Jahaji Nalha at Jahaji beach (Rutland Island). Tarmugli Island has a tidal creek on the north eastern side and has one large (>3m) crocodile in the area. One particularly



**Fig: 15 Turtle Nesting Sites in MGMNP**

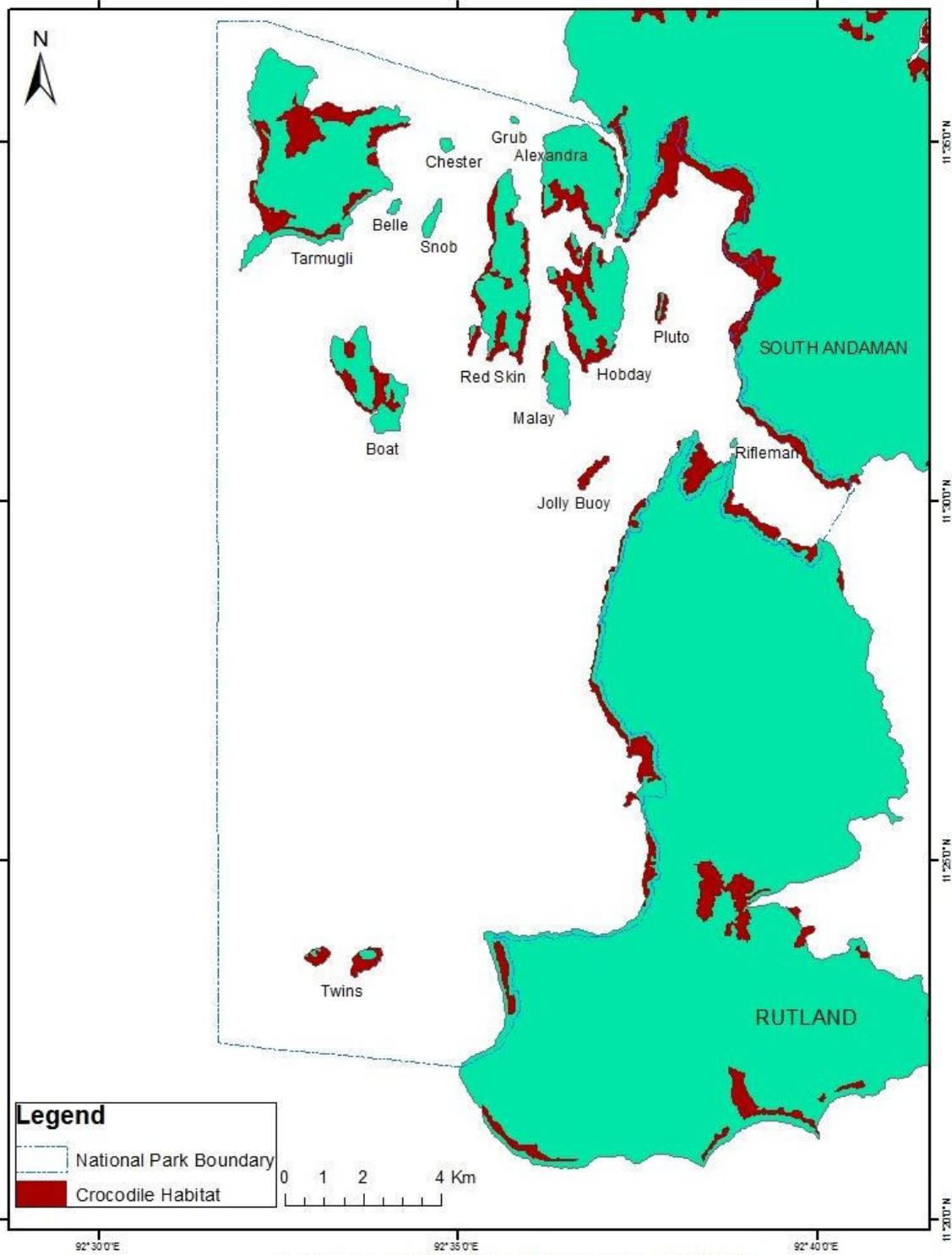
large crocodile and at times smaller crocodiles are frequently seen on the north eastern side of Alexandra Island.

#### 2.6.5 Breeding colonies of birds

Several endangered birds such as White-bellied sea eagle, Andaman Teal, Andaman Serpent Eagle and other avifauna have made the Islands of MGMNP their roosting and breeding sites. In monsoon (May-June) Andaman teals breed in the southern Red Skin and southern Tarnugli Island. They also nest on rocky outcrops, which are covered by grasses and small shrubs (South-west of Red Skin). Most of the rocky outcrops north of Pluto, South-east of Boat and South Snob Islands are used for nesting by reef egrets, beach thicknees, plovers as well as by Black Naped Tern and Boobies.

#### 2.6.6 Coral Reefs

A coral reef ranks among the most biologically productive and diverse of all-natural ecosystems. The great number of holes and crevices in a reef provide abundant shelter for fishes and invertebrates and also provide solid substrata for many bottom living organism namely clams, sponges, sea weeds, sea anemones, algae etc. Coral reef system, just like the ecosystem of the tropical rain forest, is the most matured marine ecosystems of our planet. They play an important role in global biochemical processes and in the reproduction of food resources in the tropical regions. In addition, coral reefs protect mangroves and sea grass beds in certain areas, which are the breeding and nursing grounds of various economically important fauna. Coral reefs are also important breeding, spawning, nesting, and feeding areas for many economically important varieties of fishes and other marine organisms. The people living along the coast obtain a considerable proportion of their food and earnings from the productivity of coral reefs. Coral reef ecosystems are very sensitive to external impacts both natural and manmade, which violate their homeostasis (Sorokin 1992). The majority of damage to coral reefs around the world has been through direct anthropogenic stress (Grigg and Dollar 1990). According to Bryant et.al (1998), 57% of the world's coral reefs are potentially threatened by human activity such as coastal development, destructive fishing, over exploitation, marine pollution, runoff from deforestation and toxic discharge from industries and agricultural chemicals.



**Fig: 16 Crocodile Habitat in MGMNP**

The coral reefs are unique among the marine communities in that they are built up entirely by biological activity. The reefs are essentially massive deposits of calcium carbonate that have been produced primarily by corals (phylum Cnidaria, class Anthozoa, order Scleractinia) with minor additions from calcareous algae and other organisms that secrete calcium carbonate. Although corals are found throughout the oceans of the world in polar and temperate waters as well as in the tropics, it is only in the tropics, reefs are developed. This is for the reason that there are two different groups of corals namely hermatypic and ahermatypic and it is the hermatypic corals that produce reefs; ahermatypic do not. Ahermatypic corals are distributed worldwide, but hermatypic corals are found only in the tropical regions. The distinguishing feature between the two is that most hermatypic corals have in their tissues small symbiotic (living together) plant cells called zooxanthellae, whereas most ahermatypic corals do not. The term coral reef applies to a localized shallow-water structure that remains stable under wave action. Coral species found in MGMNP is shown in Annexure-XX.

Coral reefs occur in many different sizes and shapes, resulting from the particular hydrological and geological situations that occur in different areas of the tropics. In general, coral reefs are grouped into one of the three categories; atolls, barrier reefs, and fringing reefs. Atolls are easily distinguished because they are modified ring-shaped reefs that arise out of very deep water far from land enclosing a lagoon, which itself may contain lagoon reef or patch reefs. With a few exceptions, atolls are found only in the Indo-Pacific region. Barrier reefs and fringing reefs, on the other hand, tend to grade into each other and are not readily separable. Both the types occur adjacent to a landmass by a greater distance and deeper water channel than the fringing reef. Fringing reefs and barrier reefs are common throughout the coral reef zones in all oceans. Patch refers to a semi-isolated coral structure, separated from neighbouring reefs by sand regions. These are remnants of erosion with a cover of abundantly growing contemporary corals. Reef development and zonation of reefs are strongly influenced by wave action, a product of the prevailing wind as well as depth. The known reef areas reported in MGMNP are up to 40 m depth (Kulkarni, S. 2000).

#### 2.6.6.1 Zone of Windward reef (the ranges of depths are given as averages)

#### Reef zone (40-20 m):

This zone is situated at the steep slope of the ancient platform. But through receiving optimum light it is characterized by coral growth. This results in the steep reef terraces formed by foliose or massive corals. In this zone abundant sessile fauna of sponges, bryozoans, gorgonaceans (sea fans), and hydroids flourish.

#### Buttress zone (20-8 m):

The windward reef slope is formed in this zone by spurs with grooves between them. The spurs or buttresses are 3-8m high ridges descending down the slope and are constructed by abundant coral populations, growing between the grooves, through which sediment and rubble material are moving down from the upper reef zones. The buttress zone is one of the most important elements in the coral reef ecosystem. Dissipating wave energy, the buttress system preserves communities of the outer reef slope from destruction. The spurs are places of luxurious coral growth. The coral communities here are of high species diversity with ramose corals and various sea fans (gorgonaceans) dominating.

#### Mixed zone (8-6 m):

This zone is intermediate between moat and buttress zones. The zone is characterized by rich coral growth in conditions of significant wave stress.

#### Zone of frontal moat (6-4 m):

The moat, 1-2 m deep usually extends along the outer reef edge, and is formed through inhibition of coral growth under the influence of sediment and rubble shed from the reef flat by tidal currents and surf. Its bottom is usually covered with rough sand and rubble, overgrown with periphyton. It is populated by abundant vagile benthos and by solitary corals like *Fungia*.

#### Breaker zone (0-2 m):

This represents the reef edge, subjected to maximum wave action. Normally this zone is dominated by crustose coralline algae (eg., *Helmdia* sp.).

### 2.6.6.2 Zones of Windward Reef Flat

#### Algal ridge zone:

The zone is represented by slightly sloping ridges 1030 cm high, built up by coralline algae along the windward reef edges at elevated flats and are situated in the trade wind zone experiencing permanent wave stress. The same waves repel from this zone, fish which graze on coralline algae, thus stimulating growth and formation of the ridge in this zone.

#### Zone of boulder ramparts:

The ramparts are the ridges of calcareous boulders formed from coral colonies consolidated by coralline algae. The ridges are cut by deep trenches and channels through which the transport of sediments from the reef flat passes. Behind the boulders strips of accumulated rubble and sand (the gravel trail) are situated, which form **cays** behind the ramparts.

#### Inner reef flat zone:

This is a plain and simple consolidated reef plateau. Its construction and cover differ on different reefs depending on its disposition in relation to sea level and on the height of the tides. At elevated reefs, where reef flats are exposed during ebb tides, cays of gravel are formed along their surface. It is cut by channels and covered mostly by coralline algae and by small rare coral colonies, which grow in channels and depressions. The surfaces of the flat, exposed only partially during low water is usually covered by thickets of macrophytes, opportunistic ramose corals which survive exposure, siltation and physical stress, zoantharians and ramose coralline algae. On reef with submerged flats or with depression in their middle or rear parts abundant coral communities develop on the surface, consisting of ecomorphs, which resist physical stress. Macrophytes, sea grasses and ramose Coralliniaceae cover a significant part of the submerged flats.

#### Rear or inner reef flat zone (1-4 m):

This zone stretches along the backward part of the reef flat or along the inner reef slopes facing the lagoon. The zone is structured by patch reefs - round planar hillocks

2- 20m large - which are constructed by corals and coralline algae in clam reef shallows on the sandy bottom. Their surface is often exposed during ebb tides.

### 2.6.6.3 Reef Status and Diversity

The MGMNP possesses some outstanding coral reef areas of very high diversity. The Space Application Center, Ahmedabad (SAC) in 2000 informed that the Islands exhibit narrow linear and extensively well developed fringing reefs. Based on reef classification proposed by Davies (1972), SAC classified the reefs of Andaman and Nicobar Islands as fringing reefs (that occurs adjacent to land with little or no separation from the shore) and coral pinnacles (occurring on the open shelf; usually small spreads of 10-20 m and forming broken and piled-up coral branches, colloquially called "haystacks"). The fringing reefs are found in Rutland, Jolly Bouy, Tarmugli, Boat, Redskin Islands while coral pinnacles are found around Twins, Chester, Snob and Malay Islands.

The reef flat is generally broader on the west and narrower on the eastern side. Broader reef flats are present in Tarmugli, Boat, Snob and Jolly Buoy Islands. The coral reefs are complete with wide and extensive reef flat, coralline shelf and coral heads which are an indication of continuing coral growth activity and are found in Tarmugli, Boat, Chester, Redskin and Alexandra Islands. The type and category of reefs and associated features such as reef flats, sand on reef, mud over reef, reef vegetation, coralline shelf and coral heads of the Islands in MGMNP were mapped on 1: 50,000 scale using IRS, LISS II, LANDSAT TM and SPOT MLA (SAC, 1998) (Fig. No. : 17).

Arjan Rajasuriya, et al (2000) reported that there were 203 coral species in Andaman and Nicobar Islands and reported that the bleaching event had less impact in the Islands compared with the other coral reef areas in India and reported that 56% live coral cover, 20% dead coral cover and 11% coral rubble. However, in the year 2010, followed by 2016 enormous bleaching has taken place. According to ESSO-INCOIS data for the year 2016, the temperature reached upto a maximum of 31.19<sup>0</sup> C, which was 1.97<sup>0</sup> C more than the average temperature of water.

The Integrated Coastal and Marine Area Management (ICMAM) of Department of Ocean Development carried out a survey in MGMNP to assess the coral reef status

through application of GIS and using the components of remote sensing and an external data base and to recreate an information system on coral reef and other resources.

The coral reefs in MGMNP are in the form of fringing reef and patchy reef. The detailed picture of individual reef and its status is given below:

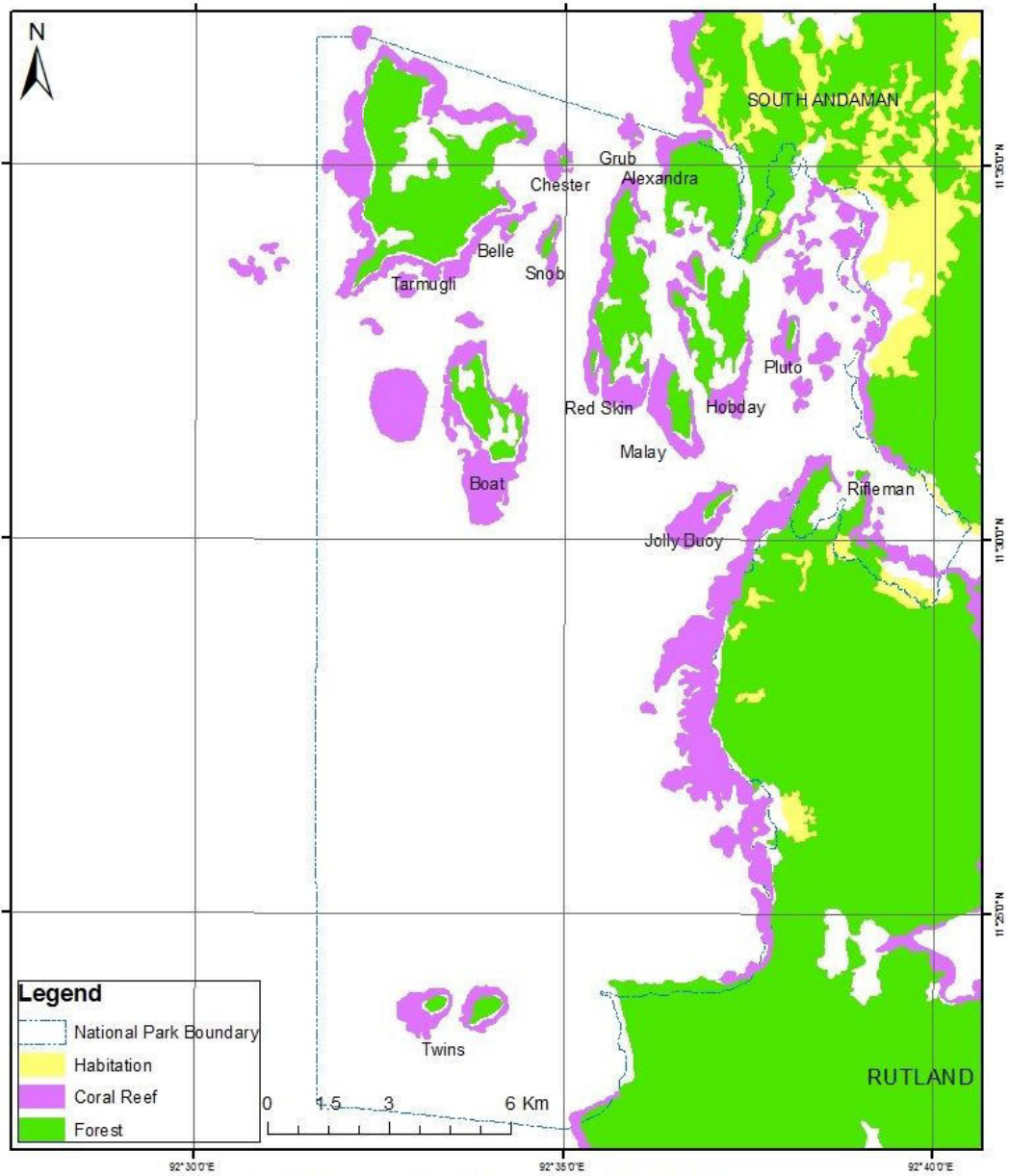
#### Alexandra Island :

The northern part of the reef is a gentle slope and reef growth is up to 10 M depth. Acropora dominates this area. This area is relatively less exposed to wave action during monsoon. In shallow water, the live coral cover is very less and dominated by algae but as depth increases the live coral cover increases.

The northwestern part of the reef has typical reef structure such as reef flat, reef slope and deeper reef. The average width of the reef flat is around 70 m and it does not have much coral growth but it is represented by some patch reefs composed of Porites, Acropora, Alveopora, Fungia, Favia and Favites. Sea grass beds of Halophyllia ovata dominate sandy area. The outer reef (2-6 m) is dominated by Acropora and Porites followed by Fungia. Reef flat is followed by steep reef slope and it continues up to 17 m depth. In this zone, the diversity of corals is very high and corals are relatively in good condition. The steep slope is followed by a gentle slope that continues up to 25-m depth and after that the seabed is filled with silt. Large brownish red Gorgorians and Sea whips dominate this deeper terrace zone. This flat area continues along the north western side of Redskin Island. The width of reef flat narrows as reef runs south and Acropora, Porites and Alveopora dominate this area. However the large colonies of this genus are dead and colonised by turf algae. The reef slope is very steep in this region; in some area the slope is vertical and does not support the coral growth but composed of limestone. The southern part of this island has shallow and flat reef, but in this area very less coral cover exists (10-15 %). The reef along the eastern part of this island occurs only in small patches and also close to mangrove growth. In this region the reef flat is very narrow and reef slope is very steep. The corals are composed of Porites, Favia, Favites, Acropora and Pectinia

#### Grub Island:

The reef around the island has very gentle slope and coral growth occurs up to 6-m depth. However, the live coral cover is more on the eastern side than the western.



**Fig: 17 Coral Reef Areas of MGMNP**

The reef on eastern side is dominated by Acropora followed by Porites and Echinopora lamellose. The reef flat in this side is also having very less live coral cover but the reef between 3-6 m has healthy coral growth. In some instances foliaceous Echinopora has covered 5060 m<sup>2</sup> area over dead corals such as rubbles and massive corals. Further north of this area, Porites and Millipora dichotoma dominate the reef; this reef stretches up to 300 m from the shoreline. The northern part of the reef has a gentle slope up to 8 m where coral reef has been observed. In this region 30 - 40 % area is covered with live coral growth. The visibility in the western part of the reef is poorer than in the eastern reef. The condition of this reef is poor as it is exposed to wave action from the southwest. The massive Porites is also present in this area, forming heads a meter or more across in deeper water. Most of the Porites colonies are alive, and other living corals were seen including Montipora and Hydnothya. This area is represented by dead Acropora, indicating that in the past this area was dominated by Acropora. The southern part of this island has calcareous sandy area with no coral growth. 75% live corals in north eastern side and 10 - 15% on the other side (ICMAM 2003).

#### Red Skin Island:

The reef in the northern part of the island has a gentle slope and it is dominated by Acropora colonies. The north eastern reef has three distinct zones such as reef flat, reef slope and deeper reef. The maximum width of reef flat is around 50-60 m. Sea grass beds exist in the sandy area and either soft corals or zooxanthids occupy dead corals. The reef slope is steep and it continues up to 25 m and afterwards gentle slope continues up to 35-m depth. The reef slope is diverse and the coral reef health is comparatively good in deeper water than shallow water. The depth of the reef decreases as reef runs towards southern direction. Most of the north eastern reefs are well protected around the islands by wave action. Reef in south-eastern part is patchy and composed of Porites, Favia, Favites, Acropora and Pectinia. The western part of the reef is narrow and the reef slope is very steep. The reef flats occur between from 10-15 m from shore and it is very narrow (20-30 m) in length dominated by Porites followed by Acropora, Faviids, Gonipora, Montipora and Fungia. The reef slope is steep up to 15-m depth and the deeper part is occupied by calcareous sand.

### Chester Island:

Around this island reef is represented by patch reef. Porties, Favites, Montipora and Pachyseris rugosa, dominate these reefs. The dead corals are composed of Acropora rubbles and massive corals. The large heads of Porites are present in these patch reefs. Some heads are around 3 - 4 m in diameter. In these large colonies, small crevices are present. Gorgonians, soft corals and some hard corals such as Galaxea, Leptoseris and Goniastrea occupy large crevices occurring in massive coral heads. The overhangs are covered by Tubustrea. The live coral cover in these patch reefs is around 20-30 %.

### Snob Island:

The reefs around this island are found in interwoven patches. The western reefs are found starting from 6 m from the shoreline growing up to 160 m towards sea. The reef has slopes at an angle of 45<sup>0</sup> up to a depth of 7 m. The live coral cover is very less (5-10%). Filamentous algae cover the dead corals comprising mainly thickets of branching Acropora. In this reef the diversity is very low. Massive Porites, Fungia, Gonipora, Montipora and Hydnohpora dominate the live coral cover. The eastern part has small patchy reef and the live coral cover is very less (5 to 10%).

### Belle Island:

The Belle Island is surrounded by coral reefs but in this island too, the health of coral reef is poor. Almost all reefs around this island are dominated by dead staghorn Acropora. The reef growth starts right from the low tide level and continues up to 30-40 m from the shoreline with gentle slope up to 6 m. Then it drops down steeply up to 12 m. Massive heads of Porites, Seriatopora hystrix, Montipora, Hydnohpora microconos, H. rigida and Pocillopora damicornis dominates the live coral cover.

### Boat Island:

The Acropora occurs in a stretch on the east side of the island from north to south for 250 -300 m. The reef at southern part is represented by reef flat (50-60 m in length) area and has gradual slope up to 5 m. The area is occupied by dead coral rocks. The northern portion of this reef is a patch reef. The depth of this patch reef is about 2.5 m, and is colonised by Porites heads. The reef slopes down at an angle of about 40<sup>0</sup> to the seabed occurring at 7m. Seabed is consisting of broken coral, coral sand and fine

silt. Large stands of dead branching *Acropora* occur in many parts of the reef slope. Filamentous algae cover most of them. Plate coral *Acropora* is also present, and *Porites* heads are also common in this region. The reef surface between the coral heads is covered in many places by a low growing *Seriatopora hystrix* together with soft corals and *Fungia*.

#### Tarmugli Island:

Along the southwestern side of Tarmugli, there is a long fringing reef that continues along the western side of the island, and goes beyond its northern end. The reef profile is almost the same along its entire length. The back reef at a depth of about 5 m consists of a very gently shelving reef. There are some low (less than 0.5 m) rounded outcrops, with clean, coarse sand in between. The live coral cover is very less (5-10%). The dead colonies of *Acropora* exist many of them are smooth due to wave action and are not covered with any algal or sponge growth. The majority of live corals are *Porites* and *Faviids*. The topography gradually changes and the reef outcrops becoming larger and grading into a low tide and gully formation with ridges about 2 m high. The western side of the island is exposed to heavy wave action and has windward reef. The reef flat has mixed sandy area and patch reef. The visibility is very good in this area. *Porites*, *Pocillopora*, *Acropora* and *faviids* dominate the live coral cover. The outer reef zone has typical surge channel. The reef slope is gentle. Rubbles and dead corals cover the reef flat area. It seems that the effect of wave action is very severe and it does not allow a healthy coral growth. The live coral cover is sparse and represented by plate *Acropora*, *Faviids*, *Galaxea*, *Gonipora* and *Porites*. The northern part has patch reef. The visibility here is very poor. It might be because of influx of decomposed material through mangrove growth in the northern portion of the island. The live coral cover in this area is around 20-30% and represented by *Porites*, *Acropora*, *Pocillopora*, *Montipora* and *Hydnophora*. Along the eastern part reef has a gradual slope and is represented by 20-25 % live coral. The dead coral cover of *Acropora* dominates this region.

Patch reefs surround the Islands. On the eastern side of the Island, reef starts from low tide level and extends to 40 m from shore. The width of the reef widens as it progresses towards the south. The northern part of this reef has a gentle slope upto 30 m and it suddenly falls up to 18 m deeper. This reef is protected by wave action but seems to be affected by sediments. The reef is dominated primarily by *Porites*

followed by Acropora, Fungia, Pectinia, Faviids, Pachyseris and Pocillopora. The remaining reef is shallow and patchy, comprising of mainly Porites and Acropora.

#### Malay Island:

The reef on the west is flat and comprised of patch reef of small colonies of Porites, Faviids, Pocillopora and Seriatopora. The reef flat extends up to 80 - 100 m from shoreline. The northern and southern region is having patch reef growth up to 6 m depth. The eastern part has a continuous reef. The width of reef increases as it grows towards south. The live coral cover is 20 - 30 %. The reef slope is very steep up to 12 m depth comprising of mainly rubbles and very less live coral such as Porites nigrescens, Montipora digitata, Pavaona decussata and Acropora.

#### Lolly Buoy Island:

The reef of this island is represented by fringing reef. The reef flat on the north eastern side of the island is around 75 m wide from shoreline. This reef flat occupies 2 - 4 m depth. The live coral cover in this area is 30-40 %. The visibility is fair. In this area Hydnothra rigida and Porites dominate the reef followed by Echinopora and Acropora. The reef slope is very steep up to 25 m and supports high diversity of corals such as Porites, Echinopora, Leptoria, Pachyseris, Pocillopora, Dendrophyllia etc. The deeper parts of the reef experience the strong currents and the coral growth of such as Achanthastrea echinita is observed at 25 m depth. Rubbles cover the sea bottom occurring at 25 m. As reef progress towards the south, the dominance of Hydnothra rigida decreases and that of Echinopora and Porites increases. At the same time steepness of reef slope also decreases. The width of the shallow reef at south and southwest and southern part of the island is around 150 - 200 m. This reef flat is having numerous tide pools and sea grass beds of Halophyllia ovata and a healthy population of echinoderms. The reef area is dominated by sandy area with little coral cover. The coral growth starts at 2 m depth and consists of Porites, Favia, Goniastra, Favites, Pocillopora and Seriatopora. The reef slope is gentle compared to the eastern side. The reef slope is exposed to severe wave action. The live coral cover is less on the reef slope and occupied by rubbles. The width of the western reef flat narrows as it progresses towards north. The reef at north starts at 10 m from shore at 1 m depth but it consists mostly of dead coral. After monsoon Turbinaria occupies the shallow area. The live coral cover increases at 4 m depth. The reef is entirely

dominated by Porites colonies, followed by small colonies of Seriatopora, Pocillopora and some Faviids. The steepness of the reef slope increases towards west. The deeper part in this reef is covered by less live cover (20 - 30 %) by mostly encrusting and plate corals.

#### Pluto Island:

The surrounding area of this island is comprised of patch reef. However this patch reef is denser in the east than in the west. The visibility in these reefs is poor due to high suspended particulate matter. Heads of massive Porites, Pectinia, Fungia, Hydnothya and Acropora dominates the reefs. The live coral cover in this area is around 30 - 40 %. The depth of this reef is about 3- 6 m.

#### Rutland Island:

The western and northern part of this island falls in M. G. Marine National Park. Except the north and eastern side, this island faces severe wave action during monsoon. The main type of reef is the fringing reef. Most of the reef flat is exposed during low tide and its width ranges from 50 to 300 m. Within this reef flat there are numerous tide pools. Substratum is of hard limestone and rubble and is mostly covered with mud and turf algae. Live coral cover very less (0-5 %), mainly comprising of small colonies of Pocillopora and faviids.

The northern side of this island is surrounded by patch reef and the live coral cover in this area is around 5 - 10 % mainly dominated by small heads of Porites. Along the north western coast, the live coral starts from 1 - 2 m depth, dominated by Porites lutea, encrusting Montipora. The outer reef slope is gentle and also having surge channels. This zone is comprised of coral rocks, rubbles and live coral of Acropora, Favia, Favites and Porites.

The bay near Barakhari is semi-exposed and the reef growth is 50 m from the shore dominated by Porites and Pocillopora. The live coral cover is 20 - 30 %. The reef slope is very gentle and water clarity is poor.

#### Rifleman Island:

The reef around this island is patchy and dominated by small colonies of Porites. In this region currents are very strong. The water depth in reef area is 2 - 4 m.

### Twins Island (West):

Reefs of this island are exposed to severe wave action, which is impacting the coral growth and community structure. The corals extend around the island from a depth of 2 to 12 m. The shallow areas comprise of low growing, fine branched *Millepora*. The live coral cover in this area is around 35 - 40 %. While progressing southwards from the islands southern rocky edged area, *Porites* grows in a scattered manner. They are up to 2 m in height and 3 - 5 m in diameter with tunnels, crevices and overhangs. Few low growing soft corals are also found in this area. In the low-lying area between the *Porites*, *Acropora*, various *Faviids* and some *Millepora* are also present. In deeper water (10 - 12 m), *Acropora* colonies are dominant with live coral cover around 10 %.

### Twins Island (East):

This island is surrounded by reef and rocky shore. The southern reef of this island is almost entirely covered by dead branching *Acropora* covered by filamentous algae. In this region the live coral cover is less (5 - 10 %). The slope towards west is gentle but currents here are very strong. Towards the north rocks protect the shoreline. Between Twins Islands, 6 m deep channel is present, which is influenced by strong current. In this channel large heads of *Porites* with tunnels, crevices and overhangs exist. The northern part has patch reef mainly composed of *Porites*, *Favia*, *Favites*, *Goniastrea* and *Acropora*.

### Wandoor:

North of Wandoor jetty has a wide fringing reef mainly comprised of live *Acropora* colonies. Visibility in this water is poor. The reef growth in this region is up to 12 m depth. As it progresses southwards, the reef flat becomes narrow. The reef slope at some places is almost vertical. The live coral cover is around 20 - 30 % dominated by fine branching *Pectinia*, *Acropora*, *Porites digitata* and massive *Porites*.

### Patch reefs of New Manglutan and Manjery:

The bay of Manjery and New Manglutan has dense growth of reef patches in shallow region. However the visibility in this area is very poor during monsoon due to sediment flow. The substratum is muddy in the north and as it progresses towards south it becomes calcareous. The live coral cover in this area is around 40 %, and is

dominated by Porites, Acropora and faviids. The intertidal area of Manjery and Pongibalu is mainly rocky. Very less live coral cover exists in this area but the area around the Pongibalu jetty has good live coral cover represented by Faviids, Pocillopora, Acropora and Porites.

## 2.7 The Limiting Factors

### 2.7.1 Climatic Variables

#### 2.7.1.1 Temperature

Reef development requires a minimum average temperature of about 20°C. Lethal maximum temperatures for corals range from 30 to 35°C, depending on location and species. No reef development occurs in waters where the mean annual temperatures are about 23-25°C. Some coral reefs can tolerate temperatures up to about 36-40°C. The relatively narrow physiological limits of reef-building corals and other reef organisms make coral reefs sensitive to changes in environmental conditions induced by climate change, disturbance of watersheds, pollution, and other factors. Water circulation, light levels, and regional temperature trends affect temperature. Therefore, changes associated with global warming (shifts in circulation patterns, increased air temperature, changes in cloudiness, etc.) would be expected to have major impacts on coral reef ecology.

In the Indian Ocean, the coral reefs around the Andaman Islands suffered bleaching events during 1998, 2002, 2005 and 2010 (Krishnan et al. 2011; PetSoede et al. 2000; Rajasuriya et al. 1999; Ravindran et al. 1998; Roy et al. 2006, 2014). After the 1998 mass bleaching event, a significant coral recovery was found and recovery was highly variable across the reef regions (Baker et al. 2008). Mass bleaching of corals occurred around the Andaman Islands during 2010 with greater intensity than 1998 (Krishnan et al. 2011). In the Andaman Sea, the effect of SST anomaly was not severe during the El Niño in 1987 and 1992, but the increase in temperature was rapid during 1998 and 2010 events (Krishnan et al. 2011; Vivekanandan et al. 2008).

In 2016, the longest coral bleaching event was recorded because of warming of sea water of tropical and sub-tropical regions around the world. Corals of

Andaman and Nicobar Islands along with coral reef of MGMNP witnessed severe coral bleaching during this period.

#### 2.7.1.2 Depth and Light

Coral reefs are also limited by depth. Coral reefs do not develop deeper than 50-70 m. Most reefs grow in depths of 25 m or less. Light is one of the most important factors limiting coral reefs. Sufficient light must be available to allow photosynthesis by the symbiotic zooxanthellae in the coral tissue. Without sufficient light, the photosynthetic rate is reduced and with it the ability of the corals to secrete calcium carbonate and produce reefs.

#### 2.7.1.3 Wave Action/Storm

In general, coral reef development is greater in areas that are subject to strong wave action. Coral colonies with their massive and dense skeletons of calcium carbonate are very resistant to damage by wave action. The wave action provides a constant source of fresh, oxygenated seawater and prevents sediment from settling on the colony. But the severe wave action resulting from storms can cause severe damage to coral reefs within a short period.

#### 2.7.1.3 Salinity

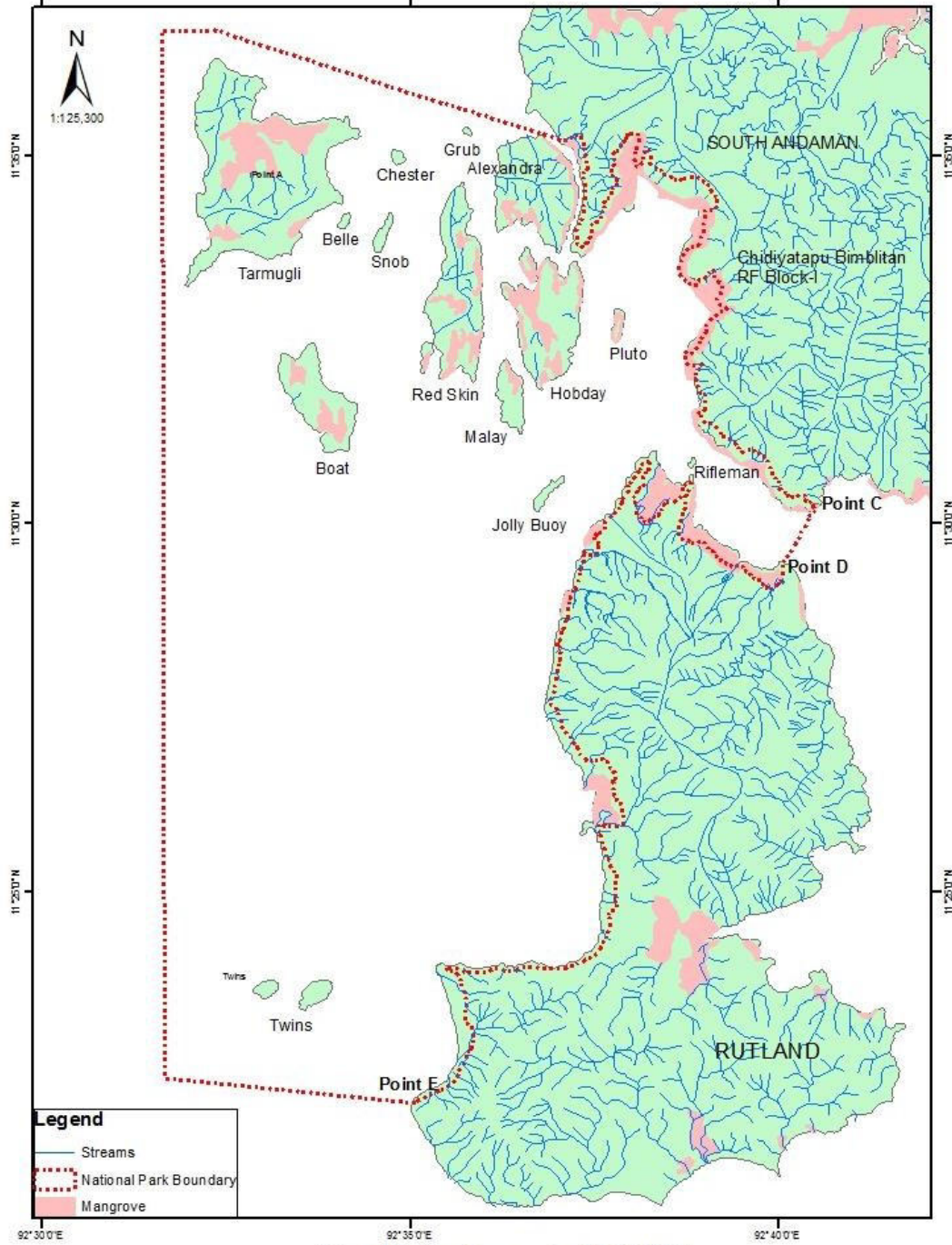
Another factor that acts to restrict coral reef development is salinity. Low salinities (less than 25-30 ‰) and high salinities (more than 50‰) also limit reef development. Wherever inshore waters are subject to continuing influx of fresh water from streams/rivers the salinity is lowered and reefs are absent.

#### 2.7.2 Sedimentation and Nutrients

Sedimentation is often co-related with run-off, sedimentation, both in water and the coral reefs have profound effect on the corals. Many corals can remove limited amounts of sediment by trapping it in mucus and carrying it off by ciliary action. Most herpatypic corals, however, cannot withstand heavy sedimentation, which seems to overpower their ciliary mucus cleansing mechanism and to smother them and clog their feeding structures. Sediment in the water has an additional adverse

effect in that it reduces the light necessary for photosynthesis by the zooxanthellae in the coral tissue. As a result, coral reef development is reduced or eliminated in areas of high turbidity. When this sediment is carried by streams/rivers, the combination of reduced salinity and excess sediment is responsible for the mortality of coral reefs. Hermatypic coral species may vary, however, in their tolerance for sedimentation; few are able to tolerate rather high sedimentation rates, and these are found in isolated condition in sedimentary areas. Sedimentation is a major factor controlling the distribution of reef organisms and overall reef development (Macintyre 1988). The reduced level of light due to suspended sediment in the water column can reduce coral growth (Hubbard et al 1986) and has an impact on natural zonation patterns (Morelock et al 1983). Excessive sedimentation can also discourage the settlement of coral larvae. Most of the studies on the effects of turbidity on corals have concentrated on anthropogenic-increased sedimentation and turbidity. Sedimentation is one of the several parameters which effect coral recruitment (Birkeland, 1977; Bak and Engel, 1979, Birkeland et al., 1981, Rogers et al., 1984). Coral larvae tend to settle on vertical surfaces possibly in response to higher sedimentation rates, as well as competition with algae, and other factors (Birkeland, 1977; Rogers et al., 1984). Coral Larvae cannot successfully establish themselves in shifting sediments. Increases in sediment input could radically alter the distributions of reef organisms, by influencing the ability of their larvae to settle and survive (Rogers 1990). Tomascik and Sander (1987) suggest that lower light levels may inhibit development of coral larvae by reducing the amount of energy available to maturing ova or embryos. Coral have a variety of mechanisms for coping with sediments including use of their tentacles and cilia, stomodeal distension through uptake of water, and entanglement of particles in mucus which later sloughs off the colony surface (Hubbard and Pocock, 1972). Corals exhibit both active and passive removal of sediment particles (Lasker, 1980). Where currents are strong, water movement will help to keep sediment particles from settling on colony surfaces, and corals will have to spend less energy in sediment rejection (Fig. No. : 18).

Since coral reefs depend on photosynthesis for survival, relatively clear water is needed for optimal coral reef development. Waters in and around coral reefs are characteristically very low in nutrients such as nitrogen and phosphorus. Low nutrient conditions are needed to prevent the excessive growth and accumulation of phytoplankton and seaweeds. Phytoplankton blooms resulting from excessive nutrient



**Fig: 18 Drainage in MGMNP**

inputs decrease the light available for coral growth. Seaweed populations stimulated by excessive nutrient levels tend to overgrow corals and other organisms on reefs. Nutrients are delivered by ground and surface water loadings, atmospheric deposition, migrations of organisms, nitrogen fixation, upwelling, and horizontal advection. Diverse and abundant populations of grazing fish and invertebrates (such as sea urchins) are also required to prevent algae (seaweed and phytoplankton) from accumulating. Excessive seaweed growth is known to decrease coral vitality and diversity. Natural predators of grazers help keep their numbers within sustainable limits. Selective removal of grazers through fishing or disease probably exacerbates or causes blooms of algae. Innumerable intricate relationships exist between coral reef organisms, some of which are no doubt crucial to the viability of the ecosystem; however, very few have been elucidated. Excessive harvest of a species or large reductions in populations by any mechanism may therefore threaten the ecological integrity of coral reefs in currently unknown ways.

## Emergence

Coral reefs are limited in an upward direction by emergence into air. Whereas abundant secretion of mucus may prevent dehydration for a short time, an hour or two, most corals are killed by long exposure to air, thus limiting their upward growth to the level of the lowest tides.

### 2.7.3 Pollution

While coral reefs are sensitive to environmental changes, they appear to be able to recover effectively from physical disturbance or temporary pollution events provided that water quality is generally high. However, community composition has not returned to conditions observed prior to sewage input due to the long lives of some key organisms, the lingering effects of nutrients and organic matter stored in sediments, and remaining non point pollution. Many reefs are buffeted by hurricanes, volcanoes, and other natural disturbances periodically, yet recover their high productivity and biological diversity. However, reefs that live in polluted water appear not to recover well from physical damage; algal blooms and other factors inhibit coral growth, and encrusting organisms that thrive on sewage may inhibit the settlement of new corals.

### 2.7.6 Anthropogenic Stress

There are 7 villages and 4 encroachment pockets at Rutland Island with the human population of approximately 6000 located in the adjoining areas of MGMNP. The disposal of waste from these villages affects the health of the reef. Increase in nutrients in reef waters and marine pollution pose as a major threat. The villages adjoining MGMNP is dominated by fishermen and large number of fishing crafts are available in Wandoor, Guptapara, Hamatabad and Manjeri. Anchors and chains damages the fragile coral environments. Frequent anchoring at places can destroy the corals. Scuba diving and snorkelling impact the reef and damages the corals.

Reef ecosystems also exist at the boundary of the park and endure much physical stress. The periodic character of natural stresses has allowed them to select and survive, and further flourish. However, anthropogenic stress is much more dangerous for them because in most cases it is not only permanent but also has a tendency to increase with time due to increasing numbers of people and/or increasing activity of those people. In conditions of cumulative impact of physical and anthropogenic stresses, the destruction of reef systems could be irreversible. Therefore, the anthropogenic impacts from fisheries, tourism, deforestation and faulty land use practices in catchments of MGMNP may have become the main factor for coral reefs degradation, as stated by Kulkarni in 2004.

Massive anthropogenic stress on reefs had begun in late 70s, when settlement started growing rapidly and resulted in the deforestation of the catchments of MGMNP. Discharge of freshwater from catchments has increased in the monsoon season. The freshwater is driven to the different reefs by currents, and increases in volume from year to year. As tidal currents are strong in the labyrinth of this group of islands, these currents plays a very crucial role in transporting fresh water and sediment from creek mouth to reef area. The soil in catchments is fine and loamy, and when it is transported to the reef by rainwater, it in does not settle down in nearest reef but is carried to more distant reefs. Freshwater and sediments not only exert a toxic effect on reef biota, but also cause some processes unusual for reef environments, such as eutrophication. The nutrients carried with the fresh water and sediment accumulate on the reef stimulate the growth of seaweeds, which inhibit and then replace the corals. This is evident in most of the dead parts of reefs such as Alexandra, Redskin, eastern and northern portion of Tarmugli, Hobday, Malay,

Barakhari region in Rutland, and the shore of South Andaman islands in MGMNP (Kulkarni 2004). The encroachment problem is more or less complicated it being not exactly inside the Park limits, but fringing in the surrounding reserved forests, adjoining the Park. These are in the main South Andaman Island and Kitchamallah, Bamboonallah, Kurmanallah and Barakhari in Rutland and are posing a major threat to the Park as the inhabitants resort to cutting of forest which leads to destruction of habitats, increase in sedimentation and disturbance to the adjacent inter-tidal area which supports good coral growth. Herbivory is a vital component to the ecological balance of coral reefs. Fishes and sea urchins are responsible for limiting the density and spatial organization of plant communities on reefs. Grazing of algae, which is competitively superior to coral, is the primary role of herbivores on reefs. Optimal grazing is a fundamental requirement for coral larvae to settle, mature, and calcify reef structures. Thus, if reef herbivores suffer population declines, slow growing coral will be quickly smothered and overgrown by algae (Glynn, 1990). The water discharged to reefs from the fields contains in addition to nutrient fertilisers also pesticides, polychlorophenols, and herbicides (high phenoxy acids). These substances accumulate in the tissues of corals and other fauna being toxic for them in minor concentrations of 0.1 mg/l. Corals get stressed and either die or, if they survive, they excrete a large quantity of mucus. It stimulates microbial growth, which then causes the mortality of corals (Glynn, 1986).

#### 2.7.7 *Acanthaster planci*

The "crown of thorns" starfish *Acanthaster planci* is a large specialised corallivore echinoderm, which feeds exclusively on scleractinian corals. Massive infestations of crown of thorns were first recorded in 1989 in MGMNP (Wood, 1989). They resulted in the catastrophic degradation of the latter. The subsequent recovery might take 10-40 years, depending on the degree of damage and on not being attacked by stars repeatedly. The attacks by this starfish on reefs could be considered as an ecocatastrophy on a large scale, triggered mainly by human activity, considered a major disturbance. The *Acanthaster planci* have very flexible motile spiny rays. By their use, they are able to crawl easily upon colonies of the corals and hold onto them.

#### 2.7.8 Coral Disease

The exposure of corals to disease was first discovered in MGMNP in 1991. Raghukumar and Raghukumar (1991) described two kinds of diseases white band and

black band. White band and black band disease could be considered as an indication of stressed environment. Kulkarni (2004) reported that corals from deeper water of Alexandra, Red Skin and Jolly Bouy waters showed symptoms of disease. He also observed the outbreaks of these diseases on reefs where corals had been destroyed by cyclones, and then bored by sponges and clams. Under the influence of siltation and pollution in zones of such an activity, the coral increase their excretion of mucus, the excess of which stimulates the development of bacteria, which then infect the corals themselves (Rogers, 1990).

Sreeraj C.R., Grinson George\*, Krishnan P., Kaliyamoorthy M. & Raghuraman R, 2015 reported that White pox disease is common in both western and eastern side of Tarmugli Island and the affected coral genera were Acropora, Porites, Platygyra and Gardineroseri. White plaque disease is also observed in Tarmugli Island and the affected coral genera include Porites, Goniastrea, Leptorea and Montipora Infection of white band disease in acropora coral species is found at Boat Island whereas dark spot disease, which normally affects branching as well as massive corals, is mainly noticed in Tarmugli Island.

#### 2.7.9 Impact of Tsunami

Coral reefs have suffered several times in the past due to natural disasters. Devastated coral reef has negative impact on fisheries and tourism. During such natural calamities, the corals undergo immense loss as they overturn and topple down, thereby impacting all the associated reef lives.

On 26<sup>th</sup> December 2004 an earthquake of intensity 9.3 on Richter scale had shaken Andaman and Nicobar Islands and soon after the earthquake a deadly natural disaster, the tsunami of 2 to 10 m followed with tremendous intensity which caused huge loss of human lives and infrastructure in the Islands. The impact of tsunami is also visible on coral reefs and coastal habitat. Dr. Sarang Kulkarni of Reef Watch has done an assessment of Tsunami impact on coral reefs and as per his interim report most affected areas are coastal habitats, coral reefs, sea grass beds and turtle nesting sites. Initial surveys indicated that, the coral reefs in several areas have been affected from severe to minimum. In most reefs, wood logs, debris had been found. After Tsunami, the average visibility in the region has reduced. Average depth of water increased from 1 to 4 m and this affected those corals that do not tolerate the reduction in light penetration. Alternately, this increase in water depth helped those

corals that were earlier found in shallow area and died due to solar radiation. As per survey reports effects of Tsunami on coral reefs inside the park were as stated under:

#### Jolly Buoy:

Coral reef of this island has been extensively damaged. In reef flat sand / slit is deposited on coral reefs. Several large colonies (larger than 2 meter in diameter) have been uprooted and scattered all over the reef, coral colonies occurring on reef edge have pushed to the deeper water upto 20 meter, broken branches of *Acropora* and *Hydnophora rigida* scattered all over. Bleaching was observed in the year 2014-16, with marked reduction in visibility, fish abundance and diversity. However, over the period of the past two years, new sprouts have been observed. The extent of beach is variable and keeps changing every year. Unlike last year, this year in 2020, scouring has been observed and a large chunk of beach area has been lost.

#### Redskin:

Same as Jolly Buoys, reef is largely destroyed. This reef is mainly dominated by massive *Porites lutea*. On reef flat, corals had little damage. However the colonies on the reef slope suffered severe damage. Some colonies are also found at the depth of 15 metre. Visibility has been reduced. The beach width has been reduced and beach slope has increased.

#### Alexandra:

Damage compared to Jolly Buoys and Redskin is lower but visibility has reduced substantially. The corals beyond 15 meters have been deposited by sand / slit. This reef earlier was dominated by *Porites* and *Acropora* however the most suffered species was of *Acropora* and few colonies of *Porites lutea* have been uprooted.

#### Grub:

Interestingly this area had very minimal impact of tsunami. Large colonies of *Acropora* were in excellent condition after tsunami. Earlier *Porites*, *Acropora* and *Echinopora lamellose* dominated the reef. Due to increase of sea temperature during 2010 and 2016, most of the *Acropora* died. However the *Acropora* on the north western side at Grub Island started recovering.

## CHAPTER 03

### HISTORY OF MANAGEMENT AND PRESENT PRACTICES

#### 3.1 General

MGMNP being largely constituted of marine habitats, the past forest management within the Park may not be of much relevance. However the land use practices, both past and present, in the forestry sector as well as settlement and colonization of people in the flat and less steep coastal areas, have influenced the coastal and marine ecosystem of the Park. Some of the earlier explorations of these islands were mainly of botanical, geological and oceanographic significance. Dr. Helfer did the first forest exploration in 1839. However, S.Kurz carried out a more significant botanical exploration, in 1870. In his 'Report on the vegetation of the Andaman Island', he did point out that "the scarcity of water on these islands makes it necessary that every precaution should be taken to prevent more jungle being cleared, than is absolutely necessary". Prior to 1857, the forests on these islands were more or less untouched, because the local aboriginal tribal inhabitants were 'hunting gatherer type' in Andaman group of islands. And this they still continue to do so. But the settlement process started in 1857, and forest tracts were cleared in the eastern parts of the South Andaman Island. The Forest Department came into existence in 1883 and the initial forestry operations were irregular fellings in the accessible areas. Plantations of important timber species such as Padauk and Teak were raised in small areas. In 1891, after the visit of the then Inspector General of Forests, H. C. Hill, instructions to prepare the Forest Working Plan were given and also measures to carry out natural regeneration of the extracted areas were suggested.

C. G. Rogers explored the Labyrinth group of islands along with Rutland and other parts of South and Middle Andaman in 1903-04 and he reported the availability of different types of timber species and their expected outturn. C. E. Parkinson studied the forest vegetation of these islands and made extensive botanical collection, which resulted in the publication of the first forest flora of these islands in 1921. In the same year clear felling system was introduced, but on finding this system unsuitable for these islands, selection system was restored after a couple of years. As advanced methods of forestry operations were introduced, quantity of extracted timber increased gradually. But perfecting the technique of regeneration of forests by B. S.

Chengappa in early 1930s, reduced some of the negative impacts of forestry operations. This system known as 'Andaman Canopy Lifting Shelter-Wood System', was practiced till recently with minor modifications.

### 3.2 History of Forest Management

The first Working Plan prepared in 1906 by F. H. Todd, was not implemented but the concepts were subsequently incorporated in the second Working Plan by M.C.C. Bonnington prepared in 1914. The main objective of this plan was to harvest the excess quantity of over-mature and mature trees from the growing stock, and to improve the forest in such a way that constant supply of Paduak is maintained. The yield was regulated by area on a 15 years felling cycle. Improvement felling was prescribed but in practice only the best trees were extracted in accessible areas. The plan prescribed natural regeneration supplemented by tunnel planting of Padauk and teak, which did not succeed. The islands within the Park were extracted during this period. Mechanical extraction using Skidder mounted on a wooden barge was used in Alexandra Island. The third Plan, which was taken up in 1925 could be completed only in 1936 by H.S.Deans. In this Plan from 1936 to 1966, the prescription of yield was low and the assessment of areas extracted was not correct. Therefore its revision was contemplated and in the interim period, Working Schemes prepared by B.S.Chengappa, were followed from 1936 to 1939. This could start for the first time the scientific management of the forests. However the decentralisation of forests into Divisions and Ranges were not effected in order to improve the management and therefore the Govt. of India ordered for a fresh working plan. Collection and compilation of data was in progress when the islands were occupied by the Japanese and evacuated in 1942 as a result of which all records were lost. From 1942 the islands remained under Japanese occupation, during which period the forestry operations were confined to the needs of Defence and no Silvicultural Systems were followed. After reoccupation of the islands from Japanese in 1945 forest working remained irregular and selective. In 1948, Chengappa was appointed as Conservator of Forests (Working Plan) to prepare a new Working Plan, which was prepared for the period from 1952 to 1968. However due to start of the rehabilitation scheme of refugees from the East Pakistan from 1952, the Plan prescriptions could not be followed, as large tracts of forests had to clear-felled for settlement till 1962. In this Plan, the Andaman Islands were divided in to three territorial Divisions namely North,

Middle and South Andamans and a separate working plan for each Division was prepared. Mangroves were recognized as a commercial crop, and a Mangrove or Tidal Working Circle was prescribed, to exploit all available poles for use as telegraph and transmission poles along with Non-tidal, Minor Forest Produce and Protection Working Circles. The Pluto Island of the Park was covered under the Tidal Working Circle. The islands namely Chester, Belle, Malay, Jolly Buoy, Twins, Rutland, Alexandra, Hobday, Rifleman, Tarmugli, Boat, Snob and Red Skin were included in non-tidal areas. The islands namely Alexandra, Hobday, Tarmugli and Red Skin were also included in minor forests produce working circle. Soon after, a fresh Working Plan was written by J.C.Varmah in 1960, as recommended by G.G.Takle, the Inspector General of Forests in 1957 and the Park area was placed under the Rutland Felling Series. But this plan was never put into practice. This was followed by A.C.D'Cruz Working Plan in 1966, which after certain changes suggested by the GOI, was finalised by B.P. Sinha and the same was approved by the Government for the period 1970-80. This Plan placed the Park area in the conversion working circle and islands such as Tarmugli, Red Skin, Boat, Hobday, Rutland and Alexandra, were kept under Rutland Felling Series. After enactment of the Wildlife (Protection) Act, 1972, a wildlife wing was created in the Forest Department in 1977 and thereafter Protected Areas were constituted in these Islands, including MGMNP.

B.K.Basu's Working Plan for the period 1990-2000 of South Andaman Division placed the Park areas in the Protection Working Circle and no forestry operations were prescribed. The same trend continued in the subsequent Working Plans by P.M. Bhatt for the period from 2000 to 2010 which was revised by M.P.Singh for the period from 2003 to 2013. The prescriptions of the current Working Plan for the Wildlife Protection Working Circle under South Andaman Division are infrastructure development, capacity building, promoting research, survey and monitoring, preparation of management plan for all the Protected Areas, awareness generation and people's participation through eco-development schemes, and improvement of protection through greater coordination among various department and enforcement agencies. Areas adjacent to MGMNP is also kept under Eco Tourism Working Circle in the current Working Plan of South Andaman Division 2016-17 to 2025-26 and the activities prescribed include reef watching, beach combing and swimming, nature trail and bird watching.

The last Management Plan specific to MGMNP was by Sh. K. Ravichandran, IFS, the then Deputy Conservator of Forests for the period of 2006-2016 which laid out the aim, objective, and strategies of conservation of the resources of the Park through various scientific interventions.

The Management was prescribed to be carried out in four zones, viz., Preservation Zone, Multiple Use Zone, Tourism Zone and Benthic Community Protection Zone.

Preservation zone included the shallow reefs and was designed to reduce conflicts and sustain critical marine species and habitats. All activities were limited except research to a limited extent that did not threaten resource protection. There were three preservation zones totaling approximately half of the MGMNP area. The Islands namely Grub, Tarmugli, Chester, Belle, Snob, Boat and Twins Island were included in the Preservation Zone. The largest among the three was the zone comprising the islands of Grub, Chester, Belle, Snob, Tarmugli and Boat along with the rocky out crops and the reef areas including the sea surrounding them. The second zone comprised of the Twins island and reef areas surrounding the island and the Jahaji beach area of Rutland, being critical turtle nesting habitat for all the four turtles. The zone also included the Rutland nallah - a habitat for the salt water Crocodile. The sea surrounding the Twins islands is the habitat for Manta rays and Dolphins. The third preservation Zone included the islands of Hobday, Pluto and Malay and the surrounding sea water including the reefs around the islands, having good mangroves at the fringes.

The Benthic Community Protection Zone comprised of large contiguous, diverse habitats for replenishment and protection of fish and other marine life. Physically, only one Benthic community Protection Zone was prescribed which included the sea areas around Alexandra, Red Skin, the Mc Phearson Strait, the shallow reef areas along the western coast of Rutland and the marine area between Boat and Twins Islands and also the area between Jolly Buoy and Twins islands. All activities were prescribed to be limited except research and to allow only non-consumptive activity namely movement of fishing dinghies of adjoining villages through this zone while going for fishing outside the limits of MGMNP and return to villages after fishing. During the Plan period, three such passages were allowed to be used by the fishing communities- Wandoor jetty- around Tarmugli - beyond National Park Boundary; Wandoor Jetty- across Jolly Bouy- beyond Boat Island; & Manjery jetty- across rifleman- beyond Rutland towards open sea.

Under tourism zone, three zones, viz., namely Jolly Buoy and Red Skin including the islands and the adjoining reef areas and the beaches and the reef area and the beach on the western coast of Tarmugli Island were prescribed. The first two areas have been put to tourism use in the Plan period. Facilities, as prescribed were improved by constructing eco-friendly change rooms, seating areas, tourist kiosk and demarcating swimming and snorkeling areas. Tourism have been carried out strictly on the basis of a carrying capacity fixed and the areas have been maintained as plastic free zones. The last area of Tarmugli was attempted to be developed as a tourist spot. Facilities of resting places and eco-hut was made, however, the approach of the Island is cumbersome, being shallow in depth towards the East and lined with fringing corals on the North-western part. This makes the approach of the Island vulnerable to the boats that would have plied for the tourists. Thus, this could not materialize.

As prescribed, the Interpretation centre has been got modified and dioramas of dugong, sea turtles, crocodiles, birds have been showcased, apart from descriptive displays of mangrove habitats and an interactive undersea assemblage of corals and fishes. A thirty minute film is shown in the audio-visual room to the tourists proceeding into the marine national park for their orientation. Shades have been erected for the public as well.

The Multiple-use Zone was intended to be for regulations while allowing for public use of the common places like the Jetty at Wandoor, Interpretation centre, other visitor amenities, the parking space, etc., by the fishermen who live in the villages adjoining the MGMNP and falling under the zone of influence namely Wandoor, Maymyo, Guptapara, Manjeri and RM Point to keep their fishing dinghies. Three multiple use zones were defined in MGMNP, viz., Wandoor multiple area Zone, Guptapara and Manjeri Multiple use Zone and RM Point Multiple use Zone.

Apart from the four different zones, separate plans for Protection and Eco-development programme were defined for furthering the cause of conservation with the support of the local public. Under Protection Plan, as per prescription, a seasonal camp for monitoring of turtles is now established every season at Jhajji beach and executive staff with mazdoors are deployed on rotational basis for protection purpose. A permanent protection camp at Tarmugli, which was destroyed during Tsunami has been revived and continuing. The area of R.M. Point is manned by the South Andaman Territorial Forest Division for its protection. A check-post alongwith camp has also been established at Ponghybalu. All the camps are connected by VHF network and manned 24X7, round the year. Research and Monitoring activities were

prescribed while describing the census methods, with an emphasis on the ecological attributes of the biodiversity. Surveys and census of crocodiles, deer and birds have been carried out in 2015-16 & 2017-18 in collaboration with ZSI, ANET, and local colleges.

### 3.3 Timber Operation

Some timber harvesting has taken place in Alexandra Island in the early twenties. After the inclusion of the Park area in the Protection Working Circle/ Wildlife Protection Working Circle in various Plans, no extraction has taken place. Regular timber harvesting has taken place in the past in the adjacent PF and RFs of Bimblitan, Manglutan and North- Western part of Rutland. In the recent past timber operations in the islands have been reduced considerably and at present timber are extracted only for meeting the local requirements and as per prescriptions in the approved Working Plan. However, settlements and encroachment have cleared tracts of forest adjacent to the Park's south-western boundary on South Andaman Island as well along its eastern boundary in Rutland Island. Some standing timbers in the allotted revenue land of the settlers were also extracted as and when required till early '90s. For the bonafide use of the settlers, certain quantity of timber free of royalty from the notified protected forest areas were also given to the settlers for construction and repair of houses.

#### 3.3.1 Silvicultural System and Tending Operations

The forests were worked under Andaman Canopy Lifting Shelter wood System in the past. Since more than fifty percent forest area of the South Andaman Division had never been worked, suitable areas were designated for felling as Periodic Block-I in two felling series of Conversion Working Circle. The objective was to convert suitable areas to normal crop with concentrated natural regeneration as prescribed under Andaman Canopy Lifting System. Conversion of under stocked or blank areas were provided aided artificial regeneration by under or gap planting of commercial species for enrichment of the crop. Tending operations include tending and thinning operations in naturally regenerated areas as well in the older plantations carried out as per the prescribed silvicultural practices. This system was followed till the end of B.P. Sinha's Working Plan in 1980. Thereafter the park area was placed under Protection Working Circles in the subsequent working plans.

### 3.3.2 Mangrove, Small Wood and other Non-Wood Forest Products Harvest

Until its creation in 1983, mangrove forest resources from MGMNP areas were exploited by the local settlers for their bonafide use. However a complete ban on exploitation of mangrove forest resources was imposed in whole of the Andaman and Nicobar Islands since 1988. All mangrove forests in the South Andaman Forest Division including those within the MGMNP are placed under the Mangrove and Littoral Swamp Coastal Belt Conservation Working Circle and Wildlife Protection Working Circle, in the current Working Plan of South Andaman Division.

Similarly, non-timber forest produce was exploited as per the prescription given under Minor Forest Produce Working Circle. This working circle overlapped the Conversion Working Circle in earlier plan. Cane, Dhup resin, hutment materials, small wood, firewood and other NTFPs were being harvested by locals before declaring the area as Marine National Park in 1983.

### 3.4 LEASES

No area is under lease in the M. G. Marine National Park.

### 3.5 Other Programmes and Activities

Department has conducted various programmes and activities in association with various premier institutions, NGOs etc. for the general public, school and college students for inculcating love and affection towards nature and its creation. The idea behind conducting such programme was to make people aware about the rich biodiversity of MGMNP and its conservation through people's participation. These programmes were mainly conducted during important days like Wildlife Week, International Biodiversity day, International Wetland days etc. Following are the programmes which were conducted by MGMNP Range:

1. Nature camp for school and college students, women and PRIs.
2. Awareness programme on crocodile.
3. Birth watching for students.
4. Awareness programme for fishermen.
5. Cleanliness drive.

#### 3.5.1 Tourism

MGMNP is quite popular among the tourists coming to Andamans, both Indian as well as foreign. Increased spending power, leisure time and interest in diving, snorkeling and other adventurous forms of recreation have created an increasing use of coral reef areas as tourist destinations. Many small islands have few natural resources other than sunshine, sea and marine products, and thus tourism has

been viewed as a major source of economic development in Andaman and Nicobar Islands. Since the time this Marine National Park was established, only two islands namely Jolly Buoy and Red Skin are open for tourism. Mainly during summer i.e., fair season, Jolly Buoy and during monsoon Red Skin is open for tourism. The statistical data clearly shows that the tourist flow to these islands is drastically increasing. While tourism is providing employment opportunities to the local people, the increased tourism activity is adversely impacting the health of the coral reef community.

During summer, tourism is mainly dominated by tourists from mainland and in monsoon it is by local tourists. The Forest Department regulates the tourist traffic and generally tourist guides accompany the tourists and tell them the code to be followed, for eco-friendly viewing of coral reef. The main reason of destruction of corals is damage by tourists standing on them. The majority of the tourists, who are unable to do snorkeling, spend their time swimming in shallow water, which results in disturbance to sand which settles on corals and damages them. In the peak season when tourist flow increases, the magnitude of disturbance increases resulting in death of corals (Table No. 12 & 13).

Table No. 12 : Details of Tourists visitation at Jolly Bouy and Red Skin

| Year        | Indian |       |          | Foreigners |       |          | Total |
|-------------|--------|-------|----------|------------|-------|----------|-------|
|             | Adult  | Child | Students | Adult      | Child | Students |       |
| 2010        | 221    | 2     | 0        | 2          | 0     | 0        | 225   |
| 2011        | 394    | 0     | 0        | 0          | 0     | 0        | 394   |
| 2012        | 306    | 2     | 0        | 8          | 0     | 0        | 316   |
| 2013        | 489    | 1     | 0        | 3          | 0     | 0        | 493   |
| 2014        | 997    | 30    | 0        | 5          | 0     | 0        | 1032  |
| 2015        | 1284   | 61    | 0        | 5          | 0     | 0        | 1350  |
| 2016        | 1583   | 13    | 0        | 2          | 0     | 0        | 1598  |
| 2017        | 1871   | 43    | 0        | 1          | 0     | 0        | 1915  |
| 2018        | 2450   | 20    | 0        | 5          | 0     | 0        | 2475  |
| 2019        | 1745   | 0     | 0        | 0          | 0     | 0        | 1745  |
| 2020*       | 607    | 0     | 0        | 0          | 0     | 0        | 607   |
| Grand Total | 11947  | 172   | 0        | 31         | 0     | 0        | 12150 |

\* as on October, 2020.

Table No. 13: Details of tourists visitation at Phongy Balu

| Year  | Indian |       |         | Foreigner |       |         | Total  |
|-------|--------|-------|---------|-----------|-------|---------|--------|
|       | Adult  | Child | Student | Adult     | Child | Student |        |
| 2010  | 34009  | 2309  | 94      | 200       | --    | 20      | 36632  |
| 2011  | 33890  | 2025  | 112     | 496       | 13    | 15      | 36551  |
| 2012  | 36932  | 2262  | 286     | 264       | 04    | 02      | 39750  |
| 2013  | 44479  | 2771  | 79      | 310       | --    | 22      | 47661  |
| 2014  | 34401  | 2410  | --      | 252       | --    | --      | 37054  |
| 2015  | 34011  | 2423  | 40      | 432       | 01    | --      | 36907  |
| 2016  | 39239  | 2885  | 55      | 383       | --    | --      | 42562  |
| 2017  | 42862  | 3183  | 17      | 963       | --    | --      | 47025  |
| 2018  | 38509  | 3067  | 12      | 297       | 05    | --      | 41890  |
| 2019  | 18871  | 1931  | 140     | 196       | 11    | --      | 21149  |
| Total | 357203 | 2526  | 835     | 3793      | 34    | 59      | 387181 |

### 3.6 Forest Protection

The area being vast and remotely accessible, mostly by waterways, coupled with non-accessibility during the South West Monsoon season and the turbulent NE Monsoon season, protection of the area becomes an uphill task for the Management. Regular patrolling is done by the executive staff using speedboats and dinghies mostly. Further, presently there are two remote camps with adequate basic amenities that serve as round the year protection bases on various strategic locations within the Park to monitor the day to day happenings. Patrolling is also carried out by vehicle in main South Andaman Island. There is one Protection Camp under MGMNP Range headed by one Deputy Ranger with adequate executive staffs responsible for overall protection of the park jurisdiction. However, due to the geographical remoteness and difficulty in accessibility, movement being influenced to a great extent by the prevailing weather, extreme undue biotic stress exists on the natural resources within the Park, many a time foiling the conservation efforts. Illegal entry, hunting without permit, poaching and illegal lumbering are the most common illegal activities observed.

Human resource becomes a limiting factor in effective protection strategies. The fringing villages, mostly being of a settled origin, are unaware of the conservation importance of these reefs for their own sustenance. Even though regular patrolling is being done and various communication systems have been put in place, the recent unbridled promotion of tourism has propelled the situation to a grave

position where, the population venturing into the Park areas illegally in search of adventure has risen.

To deal with poaching related issues a state level coordination committee exists under the Chairmanship of Chief Secretary, Andaman and Nicobar Administration. There is a District Coordination Committee under the chairmanship of the Superintendent of Police, Andaman District in which the Deputy Conservator of Forests (Wildlife) is a member along with representatives from Coast Guard, Andaman and Nicobar Command, Port Management Board, Fisheries and Intelligence Bureau. The Assistant Conservator of Forests (Wildlife) of CWLW's office is the Member Secretary of the said Committee. Besides, UT-level intelligence coordination meeting is held on monthly basis by the Indian Coast Guard which is represented by the Andaman and Nicobar Command, Police, Forest, Intelligence Bureau, Customs and Port Management Board. The issues related to poaching including poaching by foreigners are discussed and action taken to apprehend them by joint operation by Police, Forest and Coast Guard.

### 3.6.1 Legal Status

Presently all the 15 Islands under the jurisdiction of MGMNP comprise as National Park. All the islands in MGMNP were declared as Reserved Forest under the Indian Forest Act, 1927 (Act XVI of 1927) vide Notification No. 59/G/635 of 1962 dated 17.4.1963. The intention to declare the area as Marine National Park was notified vide notification No. 314/83/CF/WL/43-Vol.1 dated 24.5.1983 under sub-section 1 of section 35 of the wildlife (Protection) Act 1972 and the final notification was issued vide notification No. 192/99/F. No. CWLW/WL/61 dated 18.10.1999.

### 3.6.2 Hunting, Poaching and other Illegal Activities

Hunting in any form, collection of shell, coral and sea cucumber, fishing, sand mining and removal of NTFP are prohibited in the Park areas and are the major illegal activities. Being very near to the international border, Burmese poachers too take advantage of the remoteness within the Park area and have been intercepted at times. They have also been known to collude with the local populace. Most of the illegally harvested resources are consumed locally. No organized illegal harvesting of resources from the jurisdiction of MGMNP with international ramification has been noticed.

### 3.6.2.1 Hunting and Poaching

#### Spotted deer:

The introduction of spotted deer (*Axis axis*) in Andaman and Nicobar islands is a major concern among the ecologists. There is no natural predator of spotted deer except human beings. Although there is scarcity of fresh water in some islands this mammal has adapted to the system very well. They mainly feed on seedlings of some plants and prevent their growth. In MGMNP spotted deer are present in almost all islands except Grub and Rifleman. Due to its abundance it is vulnerable to hunting.

#### Wild pig:

Wild pig that is endemic to this island is present in Red Skin, Tarmugli and Rutland islands. It has not been noticed on other islands. It is hunted occasionally.

#### Turtle:

The MGMNP provides the nesting sites and feeding grounds for Leatherback, Green Sea, Olive Ridley and Hawksbill turtles. The green turtle and Hawksbill turtle feed in reef area. The turtles are killed predominantly as incidental catch. They get entangled in the net or sometimes feed on bait released by fishermen and they get caught.

#### Water monitor lizard:

The water monitor lizard functions as scavenger of the ecosystem. These lizards are caught by laying trap and are generally eaten by local settlers.

#### Fishing:

Fishing by country boats, dinghy, with hook and cast net is done by local people residing in fringing villages of MGMNP. Fishes and other resources like Groupers, Sharks, Prawns, Shrimps, Crabs, etc. are mostly fished out illegally. Fishes like Angel fish, damsel fish, Butterfly fishes, Banner fishes, Chromis, etc. have a high demand in the pet industry. The threat to conservation efforts is mainly due to coral damage by anchoring and depletion of resources. Details of fishing dinghies in villages situated in the vicinity of MGMNP are given in table No. 14.

Table No. 14: Details of Fishing Dinghies

| SL No | Name of Village | No of Dinghy (Motorized) | No of Dinghy (Non-Motorized) |
|-------|-----------------|--------------------------|------------------------------|
| 1.    | Guptapara       | 70                       | 09                           |
| 2.    | Manjery         | 11                       | 06                           |
| 3.    | Naya shaher     | 02                       | --                           |
| 4.    | Manglutan       | 01                       | --                           |

|    |             |    |    |
|----|-------------|----|----|
| 5. | Wandoor     | 91 | 01 |
| 6. | Lohabarrack | 02 | 06 |
| 7. | Hasmatabad  | 01 | -- |
| 8. | Indranagar  | -- | 04 |

Source: Fisheries Department, 2020

#### Shell/Coral Collection:

Collection and sale of corals is now banned in these islands. Also the Mollusc such as *Cassis cornuta*, *Charonia tritonis*, *Conus milneedwardsi*, *Cypraeassis rufa*, *Hippopus hippopus*, *Nautilus pompilius*, *Tridacna maxima*, *Tridacna squamosa* and *Tudicla spirillus* have been brought under Schedule I and other molluscs such as *Cypraea lamacina*, *Cypraea mappa*, *Cypraea talpa*, *Fasciolaria trapezium*, *Harpulina arausica*, *Lambis Chiragra*, *Lambis chiragraathitica*, *Lambis crocea*, *Lambis millipede*, *Lambis scorpius*, *Lambis truncate*, *Placenta placenta*, *Strombus plicatus siboldi*, *Trochus niloticus* and *Turbo marmopratus* were brought under schedule IV of Wildlife (Protection) Act, 1972 and accorded protection. The collection of the above species is totally banned. However, sale of the shell items under Schedule IV is being permitted by issuing proper licence by the Chief Wildlife Warden as per the provisions of the said Act till such time the existing stock is liquidated.

#### Sea Cucumber Collection:

The sea cucumber (beche de mer) has very high commercial value in South East Asian countries. These sluggish animals play a very important role in removing algae and preventing stratification of bottom and also preventing algal attack on corals. These sea cucumber resources faces serious threats from foreign as well as local poachers in the Marine National Park. The important species are *Holothuria nobilis*, *Holothuria scabra*, *Holothuria atra*, *Actinopyga lecanora* and *Actinopyga mauritiana*. Sea cucumbers serve a vitally important ecological role filtering ocean sediments and recycling nutrients back into the food web. Their eggs are also necessary as a food source for many other marine species. Since sea cucumber populations grow very slowly, they may take decades to recover from exploitations. Collection and trade of sea cucumbers is banned, it being listed in Schedule I of the Wildlife (Protection) Act, 1972.

#### 3.6.2.2 Sand Mining

Sand from coastal areas is collected for construction work in Wandoor, Port Blair and other areas. This not only affects the mangrove and coastal ecosystem, but also encourages further soil erosion and sedimentation in the coastal and offshore

areas. Before the declaration of Park, sand mining was permitted in Wandoor that resulted in erosion of coast and fall of coastal trees, mainly bullet wood (*Mimusops littoralis*). Since the declaration of MGMNP in 1983, the activity of sand mining has been stopped.

#### 3.6.2.3 Illegal Entry

Tourism has found a great fillip in these Islands in the past one decade. With the increasing spending powers, propelled by the escalating social media interface that caters to the innate urge of recognition to the human psyche, adventurous ventures into the Park areas without valid permits has also been observed. Game fishing/scuba/snorkeling companies, operating from outside promote their adventure sport amongst the adventure seekers, without notifying their customers about the sanctity of the place or the legal embargoes involved therein. Fringe village populace too enter the Park illegally for seeking adventure and recreation in areas that have been kept specifically off-limit looking into the conservation importance of the place, more often for the shallow and sensitive reef. As they mostly use engine-fitted dinghies with low drag, their activities lead to damage of the shallow reef and corals beds.

#### 3.6.2.4 Illegal Lumbering

Areas prone to illegal lumbering and tree felling are Hobday Island, Tarmugli Island, Alexandra Island and Rutland Island. However, no large scale illegal felling of trees have been reported.

#### 3.6.2.5 Setting Traps

Wire traps are regularly recovered from almost all the islands and particularly from Tarmugli, Rutland, Hobday, Boat Island, and Alexandra. The traps are laid for hunting Wild pig and spotted deer. Regular patrolling in the said islands have resulted in reduction in the incidences, however, a complete stoppage of this illegal activity is yet to be achieved.

#### 3.6.3 Domestic and Livestock Grazing

The Park is free from grazing pressure by livestock since all the islands are remote and there are no habitations. Villagers around the Marine National Park are seasonally dependent on the forests for the fodder requirement of their livestock.

Poultry is kept near the house itself. The cows, bulls, buffaloes and goats are tied at the fringe of the forest or left to forage by themselves. During and after the harvest the cows and bulls are stall-fed, with agricultural residue. For the rest of the year, the cattle are either tied near the forest or left to graze freely in the forest. Thus, livestock are primarily dependent on the forests for the green fodder. The period after harvest, when grazing is rampant, coincides with the period of germination of seedlings of most of the forestry species, after the rains and therefore, free grazing by cattle adversely affects the natural regeneration of the forests. The effect is more pronounced in the adjoining forest areas of MGMNP.

### 3.6.4 Wild Fires

No major or minor forest fire incidences have been reported from MGMNP in the past decade.

### 3.6.5 Wildlife Health

#### 3.6.5.1 Insect Attack

The forests of the Park area are healthy and no incidence of insect attack has been reported. The terrestrial wildlife are also healthy and there have been no reports of any known disease afflicting the flora or the fauna of MGMNP. No major epidemic attack of insects, threatening the survival of any tree or marine species has been reported in MGMNP so far. However, the coral reefs have suffered from attacks of crown of thorn starfish, as discussed below, as well as in Chapter 2.

#### 3.6.5.1 Disease

No serious pathogenic disease threatening the survival of any terrestrial tree, animal or marine species has been reported in MGMNP. The live coral reef in MGMNP is by and large healthy. However, a prime cause of degradation seems to be sedimentation from the land area adjoining the Park and proliferation of 'crown of thorn'. Due to the cumulative effect of storms, feeding by *Acanthaster planci*, rise in sea surface temperature and sedimentation coral reefs are degrading. Corals are weakened and more or less unable to cope up with fungal/algal attack on both branching and massive corals. Among diseases of corals, white pox, white plaque, white band and dark spot disease are reported in coral reefs of Tarmugli, Boat and Red Skin Island.

### 3.6.6 Inter agency Programme and Problems

Different government and government funded agencies are functioning in Mahatma Gandhi Marine National Park. During performance of their duties clashes of ideologies are inevitable. Following are the inter-agency programmes and their related issues:

- a) Conflict of interests amongst the major stake holders in MGMNP areas- The major stakeholders here are the Department of Environment and Forests, the adjoining Panchayats, the Revenue Department, the Department of Tourism, the Department of Police, Tourist/Boat Operators and the Indian Coast Guards. Jurisdiction though is vested with the Department of Environment and Forests, the area functions as a prime area of tourism that poses as a huge opportunity to the surrounding villages for their economic development.
- b) Resistance to formation of Eco-development Committees amongst the locals. The remuneration that can be achieved through community mediated activities is way lesser than the individual efforts of running tourism boats or fisheries in and around MGMNP. Even though efforts have been made on and off by the Department for initiating community based activities, the eco-development committee, even after being registered in 2015, failed to take up on ground.
- c) Issues of notified Port : Ministry of Shipping, GoI vide its notification No. G.S.R. 617 (E) dated 24<sup>th</sup> August, 2001 declared the extent of limits of ports in the Union territory of Andaman and Nicobar Islands. In the said notification major chunk of area of MGMNP has been brought under the port limit (Annexure: XXI) as a result of this jurisdictional dispute exist between the Port Management Board and Department of Environment and Forest.
- d) Issues of Fisheries Jetty: A Fish Landing Jetty has been created just 250 m away from the Park boundary. The engine-fitted fishing dinghies anchor themselves at the jetty. Even though awareness programmes have been done amongst the stakeholders, most of the non-saleable fishes and by-catches are disposed off unscientifically in the waters nearby by the fisher folk, thereby triggering the resident crocodiles of the Park area to get attracted to the fish landing jetties, as easy food is available always for the largest predator in MGMNP. This leads to an increase in man-animal conflict.
- e) Cooperation with District Administration and Police Department: To ensure safety and security of the visitors at Wandoor jetty and beach area of Red

Skin and Jolly Bouy, Administration appoints life guards and these life guards are deputed under the control of Range Officer, MGMNP. Further to check whether the tourist boats plying in MGMNP are following the safety protocol or not, Administration constituted Tourist Safety Enforcement Team (TSET) and Camp Officer, Tourism, MGMNP Range is appointed as In-charge. Police personnel and staff of Port Management Board are also deputed at Wandoor jetty to ensure safety of tourists.

- f) Sharing of intelligence: Protection of terrestrial and marine resources is the prime responsibility of In-charge of MGMNP for which a strong intelligence network is required. Intelligence sharing, joint planning with other stakeholders like Police, PMF, Coast Guard, IB etc. is also required for effective control on curbing the illegality in MGMNP.

### 3.7 Research, Monitoring and Training

#### 3.7.1 Research

Researches inside the Park area have been focusing largely on the assessment of biodiversity and its monitoring, especially of the terrestrial flora and fauna. Of late, studies have been initiated on the marine flora and fauna. The past work is summarized below.

C.G. Rogers in 1903 did the first floristic survey in the Labyrinth group of Islands and thereafter Parkinson (1921) studied the flora and enumerated them in his pioneering work, "The Forest flora of Andamans". Champion and Seth (1968) described the forest types of the Andaman and Nicobar Islands, including the Park area. The forest types found in ten islands of the Park were again discussed by Davidar et al. (1994). Balchandran (1997) has given the checklist of plants from MGMNP.

Till date there were six numbers of floristic studies, twenty numbers of faunal studies and three other studies being conducted by individual researchers on the various components of MGMNP. Detailed list of researches being conducted as on date is provided in Table No. 15

Table No. 15: List of researchers conducted scientific research at MGMNP

| SN | Name of the Researcher | Name of the Institute   | Duration   | Topic   |
|----|------------------------|---|--|---|
| 1  | V. B. Mathur           | WII, Dehradun   | April, 2010 to March, 2014<br><br><u>Extension:</u><br>Jan., 2014 to March, 2014 | Survey on herpetofauna in Protected Area of ANI   |
| 2  | Dr. Jayshree Ratnam    | Wildlife Biology and Conservation, National Center for Biological Science Bangalore | Dec., 2011 to Nov., 2016<br><br><u>Extension:</u><br>October, 2017 to Sept. 2018 | Long term monitoring of Forest Tree Community Biomass and Vegetation dynamics in South Andaman    |
| 3  | K.N. Ganeshiah         | University of Agricultural Science, Bengaluru                                       | Jan., 2013 to Dec., 2013   | The DBT Project on Mapping Plant Resources of ANI   |
| 4  | N. V. Vinith Kumar     | A&N Center for Ocean Science and Technology, Port Blair                             | July, 2013 to March, 2014  | Analysis for COMAPS programme from the coastal areas of MGMNP, Wandoor                            |
| 5  | Kamala Devi            | ZSI, Port Blair   | Sept., 2013 to Oct., 2013<br><br><u>Extension:</u><br>Jan., 2014                 | Faunal Survey of MGMNP, Wandoor   |
| 6  | Ajith Kumar            | National Centre for Biological Sciences, Bengaluru                                  | Nov., 2013 to May, 2014  | Study on early life history of coral in the MGMNP, Wandoor  |
| 7  | Ajith Kumar            | National Centre for Biological Sciences, Bengaluru                                  | Nov., 2013 to May, 2014  | Study of effect of sedimentation on coral reef system of MGMNP, Wandoor                           |
| 8  | Ajith Kumar            | NCBS, Bengaluru   | Nov., 2013 to May, 2014  | Study on gene flow of different species of Bats in ANI  |
| 9  | P. M. Mohan            | Pondicherry University, Port Blair  | Feb., 2014 to Aug., 2017   | Monitoring of marine Benthos along Andaman Coast in and around Tarmugli and Boat Island in MGMNP. |
| 10 | Elrika D Souza         | Nature Conservation Foundation,   | March, 2014 to Dec., 2014  | Research on Dungog and its habitat around Protected Islands                                       |

|    |                        |  |  |  |
|----|------------------------|--|--|--|
|    |                        | Mysore   | Extension :<br>January, 2016<br>to Dec., 2016  |  |
| 11 | C. Murugan             | BSI, Port Blair  | April, 2014 to<br>March, 2015  | Collection of Lichen<br>sample for<br>morphological,<br>anatomical, chemical<br>and molecular<br>characterization and<br>identification in the<br>laboratory |
| 12 | Deepak Apte            | BNHS, Mumbai   | April, 2014 to<br>March, 2015<br>Extension :<br>April 2015 to<br>March, 2016                                       | Collection of Molluscs<br>species for `Population<br>estimation and status of<br>giant clam in<br>Andaman_   |
| 13 | Tasneem Khan           | ANET, Wandoor  | Sept., 2014 to<br>Aug., 2015   | The effect of Cheetal<br>(Axis axis) disturbance<br>on the composition and<br>functional traits of<br>understory vegetation<br>in the forest of ANI          |
| 14 | C. Srinivasulu         | Osmania<br>University,<br>Hydrabad                         | Oct., 2014 to<br>March, 2016   | Study and collection of<br>specimen of bats.   |
| 15 | KirubaSankar<br>R.     | CIARI, Port<br>Blair                                       | Oct., 2014 to<br>Nov., 2014  | Radiometry survey in<br>Jolly Bouy and<br>surrounding Islands  |
| 16 | Kunal Satyam           | Pondicherry<br>University                                  | Mid Oct.2014<br>to Mid Nov,<br>2014  | Sediment collection<br>from PhongyBalu for<br>research on<br>sedimentation   |
| 17 | Dr.Vardhan<br>Patankar | National Centre<br>for Biological<br>Science,<br>Bengaluru | Feb., 2015 to<br>Dec., 2015<br><br>Extension :<br>April, 2016 to<br>March, 2017<br><br>July, 2017 to<br>June, 2018 | Coral reef resilience<br>study in Andaman<br>Archipelago   |
| 18 | Lalji Singh            | BSI, Port Blair  | January, 2016<br>to March, 2016  | Survey the RET plants<br>and collect the<br>representative sample<br>in the reserve forest and<br>Protected Area   |
| 19 | The Director           | National Centre<br>for Sustainable                         | April, 2017 to<br>March, 2018  | Blue Carbon offsetting<br>carbon emission by   |

|    |                       |   |  |   |
|----|-----------------------|---|--|---|
|    |                       | Coastal Management, Chennai   |  | conserving coastal vegetative ecosystem in Andaman Group of Islands.  |
| 20 | Dr. V. B. Mathur      | WII, Dehradun   | July 2017 to June, 2018<br><u>Extension:</u><br>July, 2019 to June, 2020           | CAMPA- Dugong Recovery Programme  |
| 21 | P. M. Mohan           | Pondicherry University  | July, 2017 to August, 2020   | Climate change and its biodiversity significance on life larger foraminiferan in a selective coral reef environment |
| 22 | Dr. Jayshree Ratnam   | Wildlife Biology and Conservation, National Center for Biological Science Bangalore | Oct, 2017 to May, 2018   | Tropical Forest responses to historic logging and assisted regeneration in Andaman                                  |
| 23 | N. V. Vinith Kumar    | NIOT, Dollygunj   | 2017 to 2018   | Sea water quality monitoring at Wandoor creek   |
| 24 | Dr. Manchi Shrish S.  | SACON, Coimbatore   | January 2018 to December, 2018<br><u>Extension:</u><br>July, 2018 to October, 2020 | In-situ and Ex-situ conservation of Endemic Andaman Edible nest Swiftlet in Andaman and Nicobar Islands             |
| 25 | Mahi Mankeshwar       | Inlaks Foundation, Maharashtra  | March, 2018 to March, 2019   | Study on boat based visual survey for cetaceans in MGMNP  |
| 26 | Dr. Shweta Yadav      | Dr. HS Gour Central University  | August, 2018 to October, 2018  | Study and collection of different species of earthworm  |
| 27 | Dr. P. Laxminarasimha | BSI, Port Blair   | January, 2019 to February, 2019  | Survey on genus Luisia species (Orchid) and collection of representative sample from the Forest of ANI              |
| 28 | Dr. Sabyasachi Maiti  | IIT, Kharagpur  | February, 2019 to Dec. 2021  | Shoreline change Analysis along A & N Islands : Implication for Coral Conservation                                  |
| 29 | Dr. Ruchi Badola      | WWI, Dehradun   | February, 2020 to 2021   | Mangrove response to sea level change along a gradient of tectonic subduction- A multi-disciplinary approach        |

### 3.7.2 Monitoring

Monitoring is the basic component of control function. Effective management strategies require day-to-day monitoring of the various biotic and abiotic components of the Park. With the changing times, the status of many species change, and therefore the objectives too change to accommodate other allied requirements leading to greater conservation efforts.

#### Census:

Census of wildlife, particularly the Spotted Deer and Wild Pig, was carried out for the first time in MGMNP in 2005 - 2006 to monitor the population. Crocodile census was again carried out during 2016 and 2017.

#### Coral reef monitoring:

To know the status of health of coral reef, monitoring of corals is essential by employing standard methods namely Line Intercept Transect and Manta tow survey. This is done by various agencies like CARI, ZSI, Reef Watch and ICMAM in MGMNP. The Scuba and Coral Monitoring Unit, MGMNP has been mandated with monitoring of coral reef in and around MGMNP.

#### Turtle nesting monitoring:

Monitoring of turtle nesting is being carried out by the Department at Jahaji beach, Rutland from 2017. Every year temporary camp at jahaji beach is being established and turtle monitoring is done from the month of November each year. Details of turtle monitoring and conservation done by MGMNP Range is given in Table No. 16.

Table No. 16: Turtle Report from 2017-18 to 2019-20

| Sl No. | SPECIES      | 2017-18 | 2018-19 | 2019-20 |
|--------|--------------|---------|---------|---------|
| 1.     | Olive Ridely | 49      | 22      | 08      |
| 2.     | Hawks Bill   | 26      | 19      | 07      |
| 3.     | Green Sea    | 31      | 05      | -       |
| 4.     | Leatherback  | 10      | 03      | -       |

Scuba Diving and Reef Monitoring Unit:

Scuba Diving and Reef monitoring Unit is established at Wandoor under Research and Survey Range in the year 2019 with following mandate:

1. Mapping of Coral Reef of MGMNP.
2. Mapping of Sea Grass bed of MGMNP.
3. Mapping and monitoring of Coral Reef of selected areas under different forest division.
4. Monitoring and conservation of corals through artificial regeneration techniques.
5. Training and Capacity building of Executive Staff.
6. Conducting outreach programme on conservation of corals.

The Unit has trained staff on techniques of creation of artificial coral reef and has already started the work of coral restoration through artificial techniques at Tarmugli island. The Unit has mapped the considerable part corals and sea grass meadow of MGMNP.

Apart from conservation programme, the Unit had successfully conducted training programme on open water diving and refresher course for executive staff. Details of training programmes conducted by R&S Range, Wandoor given Table No. 17.

Table No. 17: Open water diving and refresher courses

| Sl. No. | Name of the course                    | Number of courses | No. of staff attended training |
|---------|---------------------------------------|-------------------|--------------------------------|
| 1       | Open Water Diving Course              | 02                | 13                             |
| 2       | Refresher Course on open Water Diving | 02                | 13                             |

### 3.7.3 Training

In the past few years efforts have been taken to train and create work specific teams for addressing wildlife management issues specifically. Trainings have been rendered and teams of Animal Handlers, Dog Squad, Scuba Dive Unit have been established who attend to specific Wildlife Management Issues not just in and around Port Blair, but also the entire of Andaman and Nicobar Islands in times of exigencies. Though basic training and knowledge of wildlife is imparted to the inducted executive staff here in the Forest Training Institute, Wimberlygunj, however, they are not specialized in aquatic ecosystem which is very important for management of the Marine Parks. The requirement of having dedicated units for handling wildlife related cases and regular monitoring of wildlife areas is highly felt in today's world as we strive to create awareness amongst not just the staff of our Department in general and the Wildlife Wing in particular, but also amongst the other stakeholders including other department of the Administration and the public to bring down the reaction time in attending to human- wildlife conflicts, which anyhow is on the rise all across the world. At present, the specialized training imparted to staff of the Department per se is very limited.

Table No. 18: Trainings imparted on management of wildlife by this Division

| S.No. | Particular of training                                  | Year | Number of participants |
|-------|---|------|------------------------|
| 1     | Training on snake capturing and handling                | 2016 | 24                     |
| 2     | Training on stress management                           | 2016 | 48                     |
| 3     | Training on crocodile capturing and handling techniques | 2017 | 47                     |
| 4     | Training on snake capturing and handling                | 2018 | 18                     |
| 5     | Training on crocodile capturing and handling technique  | 2018 | 67                     |
| 6     | Training on snake capturing and handling                | 2019 | 37                     |
| 7     | Training on crocodile capturing and handling techniques | 2019 | 47                     |

Table No. 19: Training imparted by other agencies

| S.No. | Particular of raining   | Name of Agency   | Y ear |
|-------|---|--|-------|
| 1     | Training on implementation of EDC   | Periyar Tiger reserve, Kerala  | 2012  |
| 2     | Training on wildlife crime and forensic science   | Loknayak Jayprakash Narayan National Institute of Criminology and Forensic Science, Delhi. | 2012  |
| 3     | Training on Green India Mission and its implementation  | IGNFA, Dehradun  | 2012  |
| 4     | Legal implications in wildlife crime  | Wildlife Crime Control Bureau, Chennai   | 2015  |
| 5     | Stress management   | Sixth Sense Resource Pvt., Bangalore   | 2016  |
| 6     | Training on Web portal for online submission and monitoring of Forests, WL and Environment clearance to the user agency & departmental staff. | Forest Academy, Coimbatore   | 2018  |

### 3.8 Wildlife Conservation Strategies and Their Evaluation

MGMNP is home to not only the aquatic animals but also terrestrial animals. MGMNP has diverse ecosystems such as forests, coral reef ecosystem, sea grass beds, mangroves, etc., and is home for wild pig, water monitor lizards, several amphibians, birds, butterflies, bats, rodents, crocodiles, and feeding and is also breeding ground for turtles.

The Directory of National Parks and Sanctuaries in Andaman and Nicobar Islands (Pande et al., 1991) recommended for zonation of National Park for proper protection and management and underlined the importance of interaction of the wildlife authorities with the local people for building up a relationship of harmony and mutual support suggested to have a separate budget expand the MGMNP to include the adjacent Lohabarrack Crocodile Sanctuary, entire Rutland, Twin and the two Cinque Islands.

Rodgers and Panwar (1988) while evaluating the adequacy of the existing network of Wildlife Protected Areas divided the entire country in 10 different biogeographic zones and placed Andaman and Nicobar Islands under the biogeographic zone 9 i.e. Islands. The Zone was further divided into provinces 9A-

Andaman Islands and 9B-Nicobar Islands and the MGMNP is placed under region South Andaman, Baratang and Rutland of Province Andaman Islands.

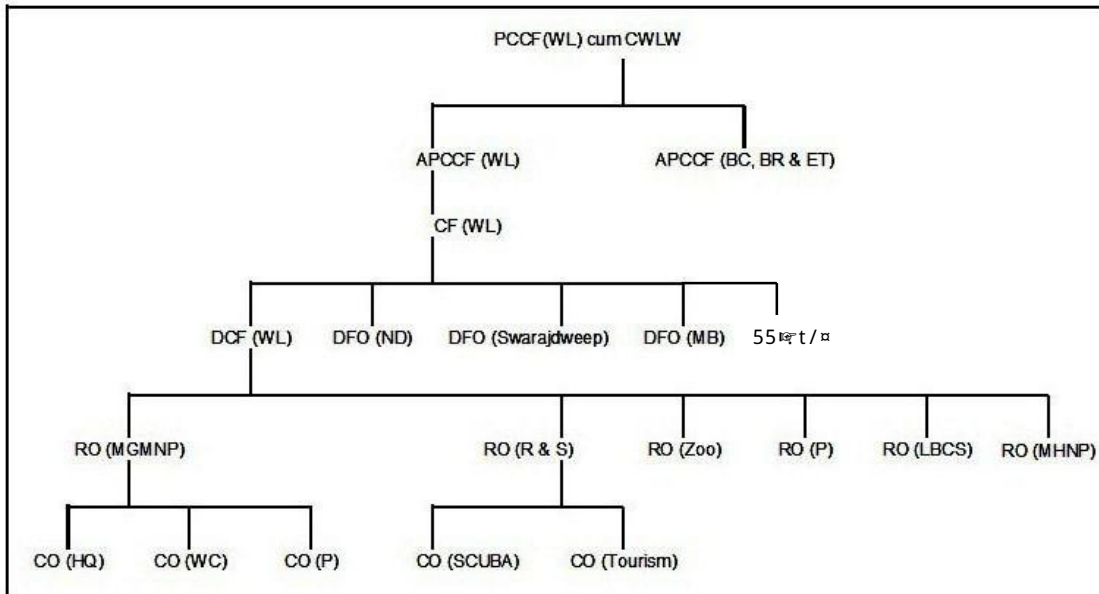
The UNDP - GEF study on coral reef ecosystems of Andaman Islands recommended that future surveys on coral reefs in the Andaman & Nicobar Islands continue to use Landsat TM data to map the shallow tropical marine habitat and the biotypes which is an efficient tool for mapping and monitoring large areas. The survey predicted many more species of corals to be discovered in Andamans when further studies are undertaken over a wider geographical range encompassing a greater diversity of habitats. It also recommended to examine all coral samples collected previously from Andamans and held in museums and recommended to photograph coral species and publish a review of Andaman coral species similar to those published by Veron and Hodgson (1989) for Philippines or Wallace and Wolstenholme (1998) for Indonesia.

The Andaman & Nicobar Islands Union Territory Biodiversity Strategy and Action Plan (Jayaraj and Andrews, 2005) recommended to do analysis of pesticide residues in birds in various areas and determine pesticide use and bird community composition. It also recommended to increase awareness of tourists in Protected Areas and Education of students and teachers in Protected Areas, carry out impact assessment of tourism in Wandoor, study ecology and breeding biology of common Mynah, carry out survey on little known mammals, establish an effective communication network, procure arms, boats and vehicles for effective communication and protection, training of forest executive staff in anti-poaching and implementation of legislations, and survey and demarcation of forest boundaries. The strategy also recommended identification and establishment of new Protected Areas, consolidation of existing PAs, strengthening of infrastructure with wildlife wing, survey of mangroves to identify degraded locations and planting of mangroves and survey and delineation of coral reefs. It was also suggested to procure camping equipments, boats and glass-bottom boats for development of eco-tourism.

### 3.9 Administrative Setup

Since the creation of Park the Deputy Conservator of Forests, Wildlife-I, with its Head Quarters at Port Blair is vested with the control and responsibilities of MGMNP. DCF (WL) is also the designate Wildlife Warden of the Park. DCF is

assisted by two ACFs, one in charge of the headquarters and the other in charge of the field. MGMNP has two ranges namely MGMNP Range and Research & Survey Range and each is headed by a Range Officer. DCF (WL-I) reports to the Conservator of Forests (Wildlife) who in turn reports to the Additional Principal Chief Conservator of Forests (Wildlife). The overall jurisdiction is vested with the Chief Wildlife Warden/the Principal Chief Conservator of Forests (Wildlife). Workflow is as detailed below:



### 3.10 Communication

The Park is comprised of 15 uninhabited islands and the only means to reach the islands is by boat. Within these islands there is no road. Patrolling is done on foot and on dirt path. Very High Frequency system is being used for communication and four numbers of VHF Masts and with sufficient number of mobile/fixed and handsets are presently available and functional in the Range which connects DCF- WL office at Port Blair with the remote islands. Details is given in table No. 20

Table No. 20 : Details of VHF Sets

| SL. No. | DETAILS OF VHF SETS | NUMBER |
|---------|---------------------|--------|
| 1       | Fixed Set           | 07     |
| 2       | Mobile Set          | 03     |
| 3       | Handheld Set        | 16     |
| 4       | Marine Mobile Set   | 02     |
| 5       | Marine Handheld Set | 05     |

## CHAPTER - 4

### THE INTERFACE BETWEEN THE PROTECTED AREA AND THE ZONE OF INFLUENCE

#### 4.1 The Zone of Influence

The Zone of Influence around MGMNP comprises of the habitation areas covering the Gram Panchayats- Wandoor, Humpherrygunj, Guptapara and Beodnabad. It is depicted through a map and elaborated under 4.1.1. In the zone of influence there are thirteen villages, having 2100 households with a population of more than 8395 as per 2011 census (Table No. : 21).

Table No. 21 : Village wise population as per 2011 census

| Village                                | Household | Population |
|--|-----------|------------|
| Wandoor                                | 364       | 1437       |
| Mamyo                                  | 187       | 825        |
| Hasmatabad                             | 208       | 872        |
| Humpherrygunj                          | 103       | 424        |
| Manglutan                              | 631       | 2430       |
| Guptapara                              | 225       | 936        |
| Manjeri                                | 137       | 613        |
| Pongi Balu/Bala Dera                   | 3         | 12         |
| Chidiyatapu                            | 123       | 499        |
| R. M. Point                            | 4         | 6          |
| Bamboo nallah including Kitchad nallah | 32        | 96         |
| Rutland (revenue village)              | 26        | 76         |
| Badakhari                              | 57        | 169        |
| TOTAL                                  | 2100      | 8395       |

Manglutan village has the maximum population with 2430, followed by Wandoor village with 1437. These villages and the hilly slope adjoining the villages have profound impact on the management of MGMNP. 77.5% of the population is literate. Most of the forests on the hilly slopes in the adjoining village areas are

replaced by arecanut and banana plantation. There are no major industries in these villages. About 1/5<sup>th</sup> of the population is dependent on livelihood options of agriculture and horticulture. The residents of the area mainly engage in fishing, daily labour, government services and job in private firms. In recent times, tourism related ancillary businesses too have come up in a big way wherein, home stays and travel and tours operation services have attained a huge fillip. 5081 people out of the total population are reported to be unemployed with 3/5<sup>th</sup> of the number being women.

#### 4.1.1 The location, extent, boundaries and natural attributes of the ZI

The area of MGMNP attached with the eight revenue villages and encroachment pockets at Rutland are the area falls in zone of influence. The zone of influence is not clearly demarcated as it varies from place to place (Fig. No. 19). Dependency of the villagers on the biological resources of MGMNP is low but due proximity to park, villagers frequently venture to creek or shore for fishing, for their subsistence. The zone of influence is mainly flat and every activity in Revenue Villages have direct or indirect affect on the coastal stretch of MGMNP attached with these villages.

#### 4.1.2 Settlements inside and outside PA

The area of MGMNP and adjoining western South Andaman Island were originally inhabited by Aka-bea-da tribe of the Great Andamanese. The sub-tribe Termuga- da-sept of the Aka-bea-da inhabited the now called Tarmugli Island. During the years of colonisation and establishment of the penal settlement, it was proposed to settle 421 convicts between Port Mout on the West coast and Port Blair in the East in 32 villages to act as a frontier to the aborigines. After independence, the first batch of refugees from East Pakistan arrived in Port Blair by 1949. Seven of these families were allotted land in Wandoor where they cleared and settled down in the area now called North Wandoor. Tarmugli and Alexandra islands were also targeted for settlement, but these plans never came into being. The settlers are predominantly Bengalis from (Bengal, East Pakistan) many of whom came as refugees in 1949. Another set of refugees arrived in 70's as a result of the independence of Bangladesh and was allotted some lands for their settlement.

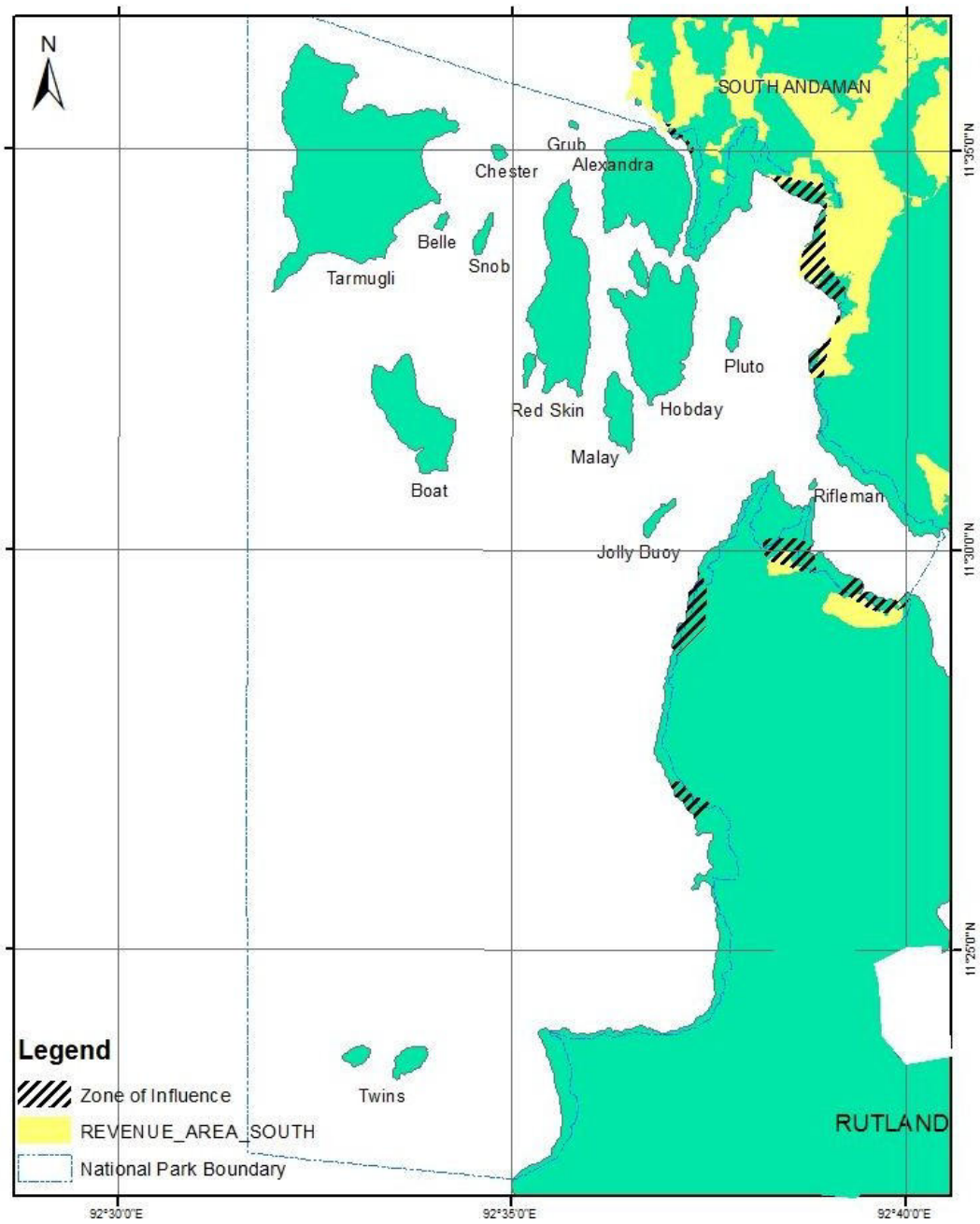


Fig. 19 Location, extent, boundaries and natural attributes of zone of influence

A part from Bengalis, tribal from areas of Chotta Nagpur were also brought in at various times, primarily to work in forest production. These immigrants were not allotted any land. However it was not difficult for them to clear a small patch of the forest and collect construction materials from the forest to put up a house. Due to continued immigration the population has continually increased resulting in strain on natural resources and equitable development.

After the rehabilitation and colonization operations were over, the Islands attracted a steady flow of unauthorized settlers from all over the country.

The total population of the villages around MGMNP is 8395 as per 2011 Census. Out of the 8395 total population, 4459 are males and 3936 are females. Majority of the population belongs to General caste and OBC. Minuscule population is scheduled tribe. Caste is not given importance even though ethnic identity within the social sphere and the basic tenet of culture is maintained at home and outside (Kulkarni, 2000).

#### 4.1.3 Land-use Pattern in Zone of Influence

The maximum land i.e. hilly slopes and encroached forest is used to cultivate crops like arecanut, coconut and banana which has replaced the forest and is a common picture in the adjacent hilly slope of revenue land around the park. The flat land is used for paddy in monsoon and in summer a few villagers use it for vegetable cultivation. Small portion of land is used for fishpond, which are generally active in monsoon period. The cultivation of horticulture and vegetable crops is a source of income for the household. Though paddy cultivation sustains the household, but now in most of the locations paddy fields are converted to grow plantation of arecanut and coconut which earn income and is less labour intensive. Instead of paddy fields, hilly slopes and forest areas are usually encroached upon to cultivate crop like arecanut and banana. Landless migrants and settlers have used deemed forest land to establish and extend their land holdings, thus reducing natural forest area. Rutland Island and Wandoor have maximum encroachments. Action under the Public Premises (Eviction of Unauthorized Occupants) Act, 1971 has not deterred the encroachers. Now the Supreme Court in 2002 has ordered the eviction of all post-1978 encroachments, but the order is still in the process of being implemented.

Encroachments, being widespread and uncontrolled are a serious threat not only to the forest ecosystem but also to coral reefs, sea grass beds and mangroves.

As per the annual report of the Agriculture Department, A & N Administration for the year 2016-17 (documenting year of 2013-14), most of the land under the mentioned villages is habitation areas, coupled with agriculture lands, horticulture lands, and animal husbandry. Arecanut, Banana, Tapioca, Coconut, seasonal crops like tuber crops, vegetables, pulses, etc are majorly grown in the vicinity of the Park. The farms are both irrigated as well as rainfed. For irrigation, open wells and ponds are primarily used. High value fruit crops like pineapple, banana are mostly irrigated. Rest of the seasonal vegetables/pulses and perennial cash crops like areca and coconut are mostly rainfed. The cropping intensity reported in the South Andaman District overall is 103.6%.

Poultry like ducks, hens, turkey, quails, etc are raised commercially. Alongwith poultry farming, animals like cattle, buffalo, goat, pig, and sheep are also reared.

Fishery is widely practiced in South Andaman District, including in the Zone of Influence. The fisheries practices adopted by the surrounding population in the Zone of Influence and MGMNP management strategies are interlinked and inter-dependent. Mangrove creeks, marine fisheries form the bulk of fishing activities. Fishing in any form is restricted inside the Park boundary. However, registered fishermen folk are entitled for innocent passage across the Park. The fishermen go to the high seas for fishing, however, many a times breach has been also seen. They are also permitted to bring their fish catch to the Wandoor jetty and other areas along the Park boundary, such as North Wandoor, Guptapara and Manjeri. From here the fish catch is transported to Port Blair by road. In summer, pre-summer and post monsoon season fishermen get the maximum catch.

Both mechanized and non-mechanized boats are used, though percentage of mechanized boats is lesser than country made boats. Nets used are both Shore Seines, Stake & trap nets on one hand and on the other hand Trawl nets and Gill nets. The fish catches mainly consist of mackerel, Carangids, Seer-fish, Sea bass, Sardines, Groupers, Shark, Rayfish, Lethranids, Snappers and mullet; fish catch decreases as monsoon progresses due to the high wind speed. Due to high fishery returns, reefs always attract fishermen and shell & sea cucumber collectors. Inland fishing is also

prevalent in the Zone of Influence, where mostly it is practiced in the farmer's own pond. No common village tanks are reported in the Zone of Influence.

Exploitative fishing and poaching activities create imbalances in the ecosystem. The top predators on coral reefs, such as sharks and barracuda, help to control the number of omnivorous and herbivorous organisms. If sharks and barracuda were to disappear from reef ecosystems, herbivore populations would increase. A decrease in large predatory and herbivorous fishes often leads to a spurt in echinoderms (Jackson et al, 2001). The mass removal of grazers and predators leave marine ecosystems vulnerable to disease. Macro algae overgrowth on corals has been identified as one of the factors responsible for the demise of coral reefs in the Caribbean since the ecological extinction of *D. antillarum*. From this one example, we can see the inherent, unknown, and fragile complexities that exist in coral reef ecosystems, thus, making their future existence extremely susceptible to disturbance events.

#### 4.1.4 Economics of Livelihood

People residing in the fringe area of MGMNP predominantly belong to service class- more than 4/5<sup>th</sup> of the working population has been categorized under 'other works' during 2011 census, indicating service in either Government or in private sector. Out of the total population only 39 percent constitute workers of various categories, including those who are working in their own farms, etc. There are no major/minor industries around the fringe area. Agriculture, fishing, labour, government services and job in private firms are the main occupation. Variations in the legal status of land lead naturally to the various sources of income and further stratification in the society.

Occupations vary according to ability and the needs to be met for the family. In 2000, Kulkarni had reported cultivation to be the dominant profession (23.31%) followed by labour (13.35%), Government job (13.18%), fishing (11.04%), job in private firms (10.32%), trading (7.29%) and owning hotels (0.57%). However, the Census of 2011 shows that 68% of the population is engaged in other works, primarily service sector, 26 % is engaged in direct farming and allied practices. 11 % of the population is engaged as marginal workers of varying seasonality (0-12 months), of which again, 78% is in service sector, both Government and private.

The unemployment within these villages is considerably high (20.95%) (Kulkarni, 2000). As per the census of 2011 about 61% of the population is not contributing to the economics of the zone. About 2/3<sup>rd</sup> of this population is females.

A good number of tourists visit MGMNP every year. The tourism industry has made significant impact on these villages. However, since the tourists stay at Port Blair and visit MGMNP during day time only, direct benefits accrued by the population in the Zone of Influence is not substantial. More often than not, only a few key players are benefited in the market, who ply their own tourist boats to and fro the areas of tourism within the Park. Only a handful of persons are employed as part of the boat crew of private boats/lifeguards, etc.

#### 4.1.5 Forest/PA Management Practices and their Implications on the Local Communities

Many steps are being regularly taken to strengthen the management aspect of the Park area. Mostly are regulatory in nature and is aimed towards protection and preservation of the natural resources within the confines of the National Park. Given the fact that the conservation of the biodiversity contained within the Park area is the ultimate aim and objective to be attained by the Department of Environment and Forests, most often than not, the regulatory steps being taken paints a negative image of the Department. However, with the increasing awareness creation programs and the involvement of the local communities in the day to day activities of the Park, there is a paradigm shift in understanding the dynamics of the Nature amongst a handful of people, which is likely to increase if we keep continuing with our Awareness Creation amongst the local communities.

#### 4.2 Implication of Land Use and Resource Dependency for the Conservation of PA

People of these villages are predominantly from the plains of southern Bengal, who have been settled in this hilly, undulating area. Thus the settlers here, like those in several other such areas in the islands, lack the traditional wisdom to optimally utilize the terrain and its living resources. Added to it is the lack of knowledge of the biodiversity surrounding them and its importance towards their own sustenance. The Ranchi (tribal people from Bihar) are more conversant with living near the forest but

they are not at all used to living in coastal area. Unable to rely on the wisdom of the older generation, people are unknowingly causing massive damage to the land as well as marine resources of the area, which sustain them. Increasing immigrant population and exploitative land-use system, particularly for house site, hotels and arecanut/banana plantation is a common trend in these villages nowadays. Many a times, the geo-morphology of the land has been changed leading to unwarranted loss of topsoil, blockage of waterways/natural drains and water-channels, modification of creek morphology, etc. Presently a trend has started wherein all low-lying areas are being filled and plotted for further sale as housing/commercial sites. The increasing immigration has also triggered clearing the vegetated lands which till now were not cleared. This is for asserting ownership. The early or registered settlers too have joined the race to acquire more land by clearing and encroaching lands and their further conversion. These activities are thus leading to loss of green cover, thereby impacting the micro-climate of the place. This also has a profound impact on the availability of water in and around the Park as the depth of obtaining clear water usable for domestic use has been increasing. The clearing of existing green cover on the hills, the abundance of secondary growth in terms of creepers shrubs etc., apparent in the forests, the increasing vulnerability of the coasts due to clearing of mangrove, are some indicators of the adverse effects of unbridled development leading ultimately to the denigration of the whole ecosystem. The demographic growth is considered the fundamental factor for straining the island's fragile ecosystems, impinging on the general economic health of the territory (Sirur 1999).

## CHAPTER 05

### PROPOSED MANAGEMENT - VISION AND OBJECTIVES

#### 5.1 Vision

The Mahatma Gandhi Marine National Park, as has already been discussed (Chapter 1, Part I), is an integral part of the Indo-Burma Region biodiversity hotspot having immense geo-morphological importance giving rise to an impressive biodiversity that makes it significant at not just local or state or regional levels, but also National and Global scale. It maintains an important connecting link in the region of South East Asia and that is the breeding ground for an abundance of marine RET species. MGMNP landscape has a great potential for generation of employment opportunities for the local people for improving their socio-economic conditions.

Let us all return to the soil  
That lays the corners of its garment  
And waits for us.  
Life rears itself from her breasts,  
Flowers bloom from her smiles  
Her call is the sweetest music;  
Her lap stretches from one corner to the other  
Her warbling waters bring  
The murmur of life from all eternity.

Taking cue from the Palliprakiti by Gurudev Tagore, the vision for the Mahatma Gandhi Marine National Park marinescape is to see it in its fullest primeval glory wherein it serves like an assortment of biodiversity on the one hand and on the other the people of the Zone of Influence landscape become the true custodians and perpetrators of the conservation of the rich flora and fauna of this unique

ensemble and maintain the ecological integrity of this pristine natural resource through generations to come.

## 5.2 Management Goals

To materialize the Vision, the Management Goal that would help in setting the objectives of management is to 'Economically, culturally, socially and ecologically empower the dependent local communities residing in and around the Zone of Influence of the Mahatma Gandhi Marine National Park towards maintaining a conducive terrestrial and marine ecosystem having viable population of flagship and umbrella species for attaining the greater goal of conserving the associated species of flora and fauna, specifically the very RET species using scientific tenets of habitat and population management as tools\_.

Protection and conservation of the diverse and rich biodiversity, while involving the public in general shall be the prime management goal. It is worth mentioning here that 'conservation\_ does not necessarily mean 'preservation\_ and has an element of 'utilization\_ ingrained in it. 'Utilization\_ is important here, because it is human nature that unless something pays, we hardly care to conserve it. Given the immensely high biodiversity in terms of flora and fauna, judicious utilization of the resources will help in attaining the greater goals of conservation. By 'sustainable', it means an economy of use is to be worked out so that the utilization is optimized through the greatest possible period of time, spanning over multiple generations of human population resident in this landscape. Involving the local communities is of utmost importance here as this is the sole way of maintaining the ecological integrity of any given place and a place as important and valuable as the Marine National Park.

## 5.3 Objectives

The primary objective of MGMNP is the conservation of the natural and cultural resources and their ecological relationship. The dynamic ecological processes must be kept going in the same way as they have been going on since time immemorial, devoid of human interferences and influences. This can only be

achieved through strict protection measures and sustainable use of all natural resources to ensure overall economic growth.

The major general objectives envisaged are as follows:

- a) To maintain biological diversity at the ecosystem, habitat, species, population, community and genetic levels.
- b) To allow species to evolve and function naturally while maintaining the ecological processes and support system within their specific and associated communities
- c) To safeguard the breeding and feeding grounds of rare, endangered and threatened species of fauna and flora.
- d) To provide solid ecological base from which threatened species or habitats can recover themselves through restoration of their critical habitats.

The specific objectives are:

- a) To provide for preservation of habitat of MGMNP in their natural state with minimum human interference in the Preservation Zone.
- b) To provide for the protection of the areas of MGMNP, particularly the critical habitats of the rare endangered and threatened species so as to allow them to proliferate in a natural and unhindered way.
- c) To provide for and strengthen the conservation efforts within the Park area as well as in the Zone of Influence of MGMNP through scientific management and interventions for habitat improvement.
- d) To provide employment opportunities for the local people by promoting their participation in tourism related activities.
- e) To create awareness and provide opportunities for nature education to students and local communities about marine conservation and ecologically sustainable development so as to make them understand the value and benefits of conservation of biodiversity.
- f) To strengthen capacity of the staff in conservation and protection of the biodiversity of the Park.
- g) To promote the Park as a destination for low impact and responsible eco-tourism.
- h) To collaborate with various Academic and Research Institutions / Scientist / Researchers in undertaking scientific studies in the Park.

## CHAPTER 06

### PROPOSED MANAGEMENT - ZONATION AND STRATEGIES

As discussed in Part I the importance and values of Mahatma Gandhi Marine National Park are manifold. To maintain the landscape and the marinescape for its vast ecosystem services and having far reaching socio-politico and economical implications, a holistic approach is required. In the Management Plan of the period 2006-2016, the strategies involved various measures to ensure that the conservation practices are put in place with the direct and indirect involvement of the local communities. Once a system is in place, now it is required to fine tune the existing practices and to maintain a state of absolute dynamism while conserving this beautiful landscape. As the economics and social fibre of the communities inhabiting the Zone of Influence changes rapidly with the changing times, stressing more on commercial furtherance of their selves, it becomes pre-requisite to strengthen protection measures. For the major critical habitat areas, intensive protection strategies in lines with the previous management plan are to be continued with. For the adjoining areas, mostly in the Zone of Influence but outside the protected boundaries, conservation efforts have to be strengthened, promoting well-defined and sustainable utilization of the resources. Newer avenues may be opened for furthering the eco-development activities, however with utmost protection measures. Focus has to be also on streamlining the activities of various line Departments and adjoining Forest Divisions to jointly tackle issues related to human wildlife conflicts vis-à-vis the rising pressure on the sustenance of endangered species propelled due to unbridled human interference.

#### 6.1 Zonation

The purpose of zoning the Mahatma Gandhi Marine National Park area is to protect and preserve sensitive components of the ecosystems while facilitating compatible activities. Zoning ensures that areas of high ecological importance evolve

naturally with minimal human interference. It also promotes sustainable use, protects diverse habitats and preserves important natural resources and ecosystems. It is suggested to have both Zonal Plans and Azonal/Theme Plans for a two pronged approach towards the protection and preservation of this Marine National Park.

## 6.2 Zonal Plans

There are three zones proposed in MGMNP for the current Management Plan period, viz., 1. Preservation Zone, 2. Multiple use Zone and 3. and Tourism Zone. The Zoning Plan describes specific strategies to implement vis-a-vis objectives set (Fig. No. : 20).

### 6.2.1 The Preservation Zone

The Preservation Zone shall protect shallow reefs and shall encompass discrete, biologically important areas to reduce conflicts and sustain critical marine species and habitats. Regulation for preservation zones are designed to limit all activities except research to a limited extent that do not threaten resource integrity.

#### 6.2.1.1 Objectives:

- a) Preservation of the natural reef areas
- b) Preservation of Benthic zone on sea floor
- c) Preservation of the Mangroves around the islands
- d) Preservation of the Island ecosystems

#### 6.2.1.2 Area and Extent

There are four sub-preservation zones totaling approximately more than two third of MGMNP area. The Islands namely Grub, Tarmugli, Chester, Belle, Snob, Boat and Twins Island have been included in the Preservation Zone.

- a) Preservation Sub-zone-I : The largest among the three is the sub-zone comprising the islands of Grub, Chester, Belle, Snob, Tarmugli and Boat

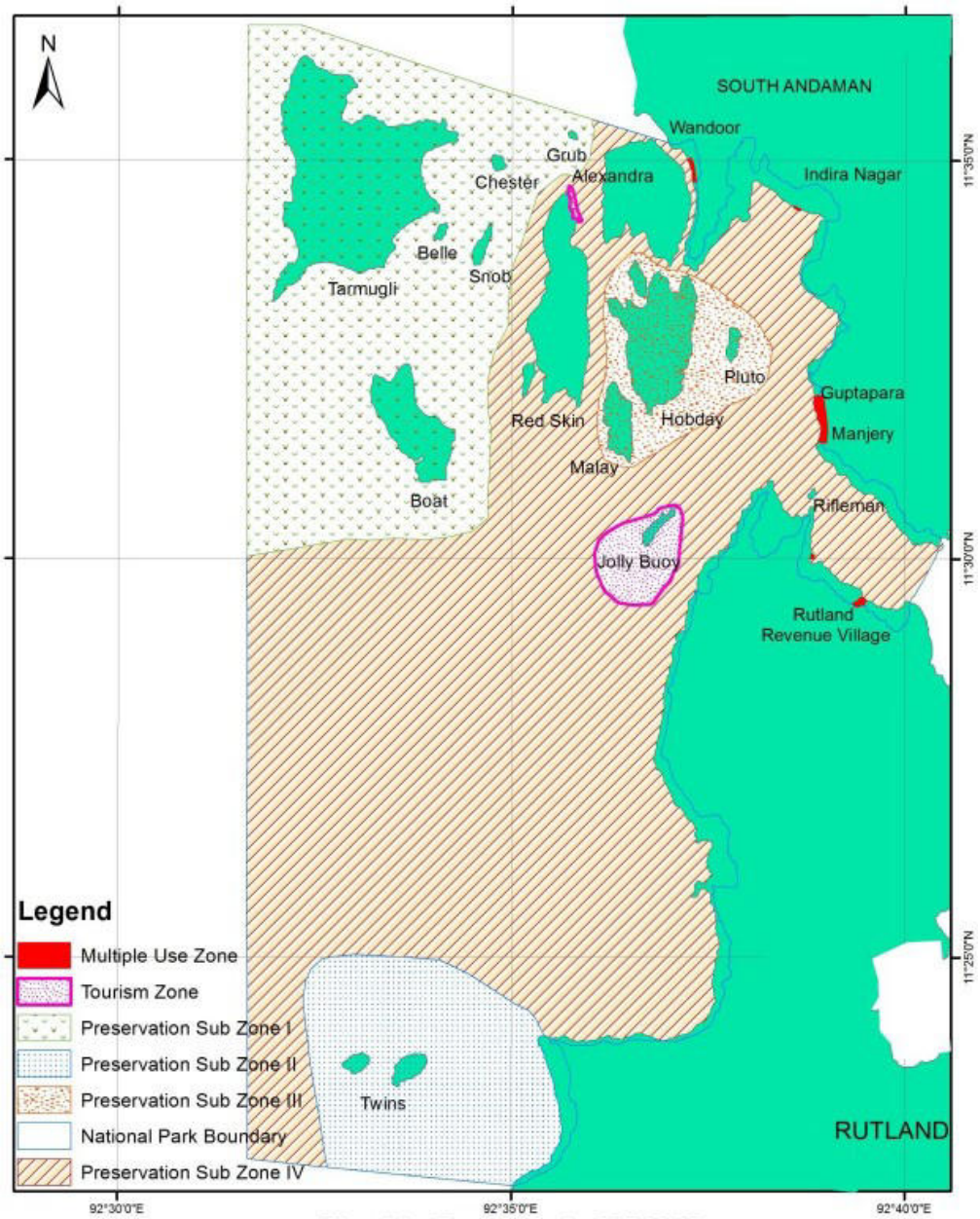


Fig: 20 Zonation in MGMNP

along with the rocky out crops and the reef areas including the sea surrounding them.

- b) Preservation Sub-zone-II : The second sub-zone comprises of the Twin islands, the reef areas surrounding the islands and the Jhajji beach area of Rutland, which is a critical turtle nesting habitat for all the four turtles nesting in the Indian Coast. The zone also includes the Rutland nallah which is a habitat for the Saltwater Crocodile. The sea surrounding the Twin islands is the habitat for Manta rays and Dolphins.
- c) Preservation Sub-zone-III : The third preservation sub-zone shall include the islands of Hobday, Pluto and Malay and the surrounding sea water including the reefs around the islands. The Islands have good cover of Mangroves.
- d) Preservation Sub-zone-IV : The Benthic area preservation zone shall include the sea areas around Alexandra, Red Skin, the McPherson Strait, the shallow reef areas along the western coast of Rutland, the marine area between Boat and Twins Islands and the area between Jolly Buoy and Twins islands. The Benthic area serves as a diverse habitat for fishes, dolphins, dugongs, crocodiles, turtles and all marine life-forms on which these species are dependent upon.

Further, the islands so mentioned all have varied terrestrial ecosystems. They have coastal and littoral forests, evergreen-to-semi-evergreen- to deciduous forest types, freshwater ecosystems, etc. which abounds in unique assemblages of flora and fauna, different on each island. The details and extent of various preservation sub-zones in MGMNP are shown in Fig. No. : 21.

### 6.2.1.3 Strategies

- a) Securing the boundary of the preservation sub-zones to avert breach by innocent passage of fishing boats. This can be achieved by deploying buoys along the outer boundaries and strict regulation of movement/passage of fishing dinghies plying to and fro across these areas to the outer seas. Boundary buoys with stickers for transit line within MGMNP may be placed to facilitate innocent passage of fishing boats.



- b) Eco-profiling of sub-zones to monitor and evaluate decadal changes.
- c) Habitat Management and improvement by coral transplantation in degraded reef areas, plantations / enrichment of mangroves and littoral forests, conservation of sea-grass beds and sea-algae beds and coral reefs.
- d) Undertaking scientific survey of population of Dolphins, Manta Rays, and Dugongs and preservation of their habitats.
- e) Conservation and protection of turtle nesting sites and scientific documentation of nesting.

## 6.2.2 Multiple Use Zone

Multiple Use Zone shall be for management of the interface of the wildlife and the human habitations on the fringe areas.

### 6.2.2.1 Objectives

- a) To strengthen conservation efforts within the Park area as well as in the Zone of Influence of MGMNP so as to make the local people residing near the Park to understand the value and benefits of conservation of biodiversity.
- b) To provide livelihood opportunities amongst the dependent local communities.
- c) To minimise conflict between the human and the wildlife in the fringe areas of the Park.

### 6.2.2.2 Area and Extent

These zone shall include the inter tidal areas and the land area above the high tide lines along the outer boundary of MGMNP bordering human habitation viz., Wandoor, Hasmatabad, Manglutan, Pongibalu, Guptapara, Manjeri and Revenue village of Rutland.

### 6.2.2.3 Strategies

- a) Establishment of regulatory checkpoints with strengthened communication facilities at the jetties, embarkation/disembarkation points for quick dispatch of teams in case of emergencies like Human-Wildlife Conflict situations.
- b) To promote engagement of local youths as tour guides / nature interpreters and in protection / management activities of the Park.
- c) Strengthening of eco-development committee activities.
- d) To create awareness among local people regarding importance of maintenance of biodiversity through awareness camps and distribution of publicity materials.

### 6.2.3 Tourism Zone

The eco-tourism has been defined as responsible travel to natural areas that conserves the environment and sustains the wellbeing of local people. The Ministry of Environment, Forest & Climate Change in the year 2019 circulated a draft policy for eco-tourism in forest and wildlife areas. In the draft policy, it has been inter-alia provided that eco-tourism facilitation within the forest and wildlife areas will be a part of the management plan/working plan of the unit. It has also been provided in the draft policy that sensitive sites like wildlife breeding areas, tribal areas of Particularly Vulnerable Tribal Groups (PVTG) etc. should be excluded from the eco-tourism activities to maintain the sanctity of the forest rights of such tribal people and for maintenance of ecological integrity. The draft policy also stipulates that eco-tourism activities will be eco-friendly in nature and no permanent structure will be established in violation of the Forest (Conservation) Act, 1980 and Forest Rights Act, 2006 and that construction works like permanent buildings for camps, camping complexes with lodging/boarding structures, helipads, new roads, tourist bungalows/commercial lodges etc. for eco-tourism purpose shall not be allowed without clearance under Forest (Conservation) Act, 1980.

The Andaman & Nicobar Administration has also approved a eco-tourism policy guidelines for Andaman & Nicobar Islands in the year 2015. The policy guideline prescribes that for the purpose of eco-tourism in these Islands activities like bird watching, turtle watching, trekking, nature trails, cruising in the creeks/water ways, surfing, snorkelling and more importantly mere watching of scenic beauty of Islands, water bodies etc. shall be promoted. One of the key principles enunciated in the policy is to adopt low impact tourism that protects ecological integrity of the wilderness areas and secures conservation values of the destination and its surrounding areas. The policy also stipulates inter-alia, making appropriate prescription to incorporate low impact eco-tourism in the working plans for the forest areas and in the wildlife management plans of the National Parks and Sanctuaries. The policy also prescribes that only eco-friendly materials and locally available ones will be used for development of eco-tourism infrastructure and such infrastructure will be kept at bare minimum. The policy specifically prohibits construction of concrete infrastructure and buildings for eco-tourism purpose.

On the orders of Supreme Court of India, the Ministry of Environment & Forest appointed Shri Shekhar Singh of Indian Institute of Public Administration, New Delhi as Commissioner to give a report on the state of forest and other allied matters in the Andaman & Nicobar Islands. The commission submitted the report on January, 2002 in which several

recommendations were made. The recommendation No. 40 of the said report state as follows:

“No concrete or permanent infrastructure for tourism should be built on any forest area in the Islands. Tourist activities in forest areas should be restricted to tented accommodation or temporary wooden/prefabricated structures that can be dismantled easily and moved to another site. These areas should remain under the control of the forest department who should be responsible for ensuring that the quantum and type of tourism is such that it does not in any way degrade the forests or other ecosystems.”

The Andaman & Nicobar Administration has accepted the above recommendation.

Tourism shall be carried out in the specifically marked tourism zones only. Regulation of activities such as operation of tourist boats, mooring, plying of glass bottom boats, swimming, snorkelling and diving shall be done by the Park management authority in conformity with the international and national standards and the SOP issued by UT Administration in this regard. Access shall be restricted to permitted entry only. The tourism zone also includes islands which are areas for bird roosting and nesting, habitat for wild animals such as spotted deer, reptiles, amphibians, etc. Therefore all tourism activities that are non-intrusive and non-invasive to the safety and security of the flora and fauna in the tourism zone shall be allowed.

#### 6.2.3.1 Objectives

- a) To further the cause of conservation amongst the local population dependent directly or indirectly on MGMNP
- b) To showcase the significance of MGMNP at national and international arena
- c) Revenue generation

#### 6.2.3.2 Area and Extent

The Tourism Zone within MGMNP shall be confined to the islands of Jolly Buoy, Red Skin including the adjoining reef areas and beach area of Phongy Balu (Fig. No. : 22). However, as the waters around these islands have strong eddies and under-currents, restricting the activities within well demarcated areas by the park authorities shall continue to be done.

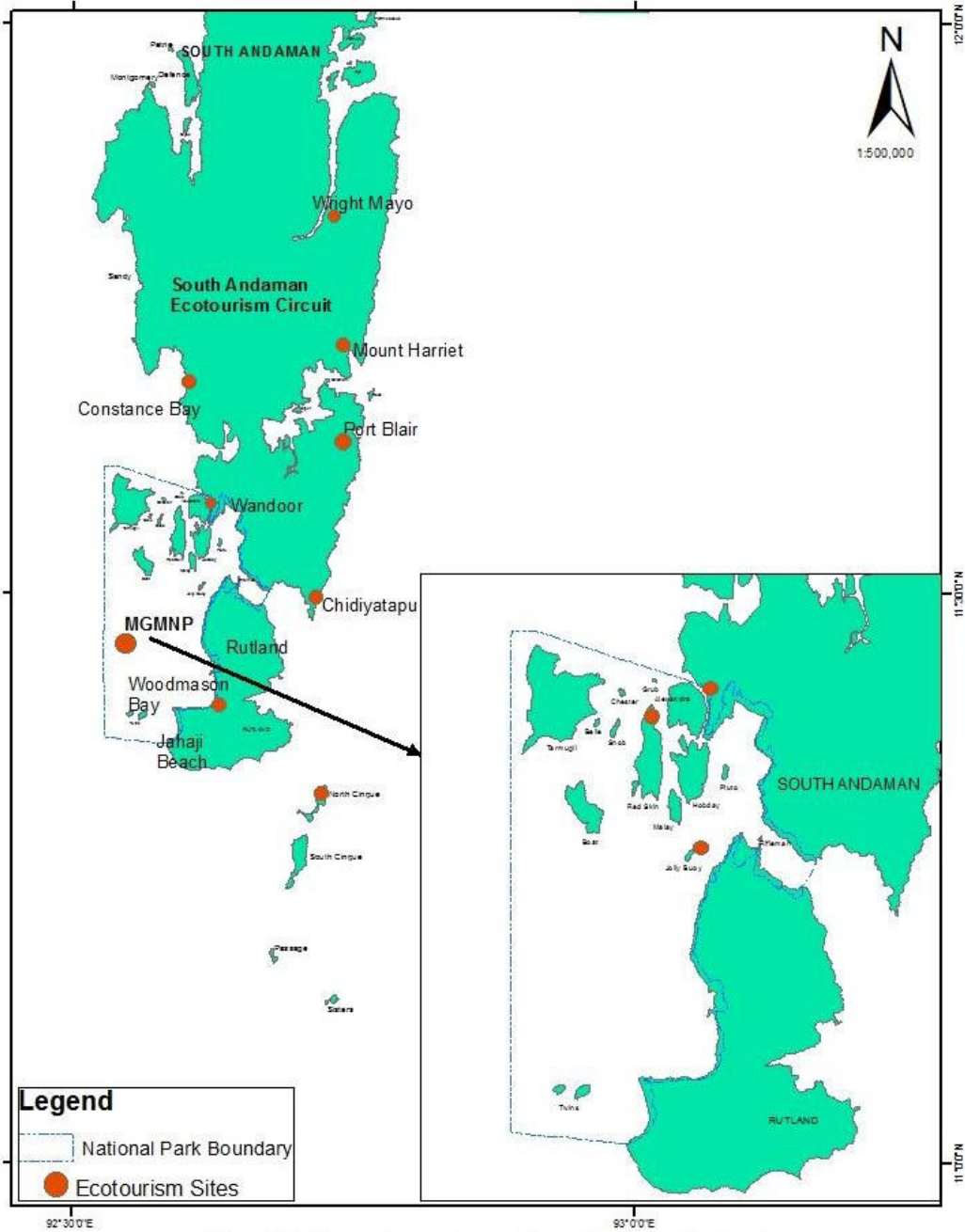


Fig: 22 Eco - Tourism Sites in South Andaman

### 6.2.3.3 Strategies

- a) Development of tourist amenities in the Zone of Influence like at Pongibalu, Wandoor and Guptapara shall be done. The tourists will be allowed as per the carrying capacity fixed for Jollybouy and Red-skin islands in the Tourism Zone within MGMNP. Tourists are to be allowed in by 7 am and by 3 pm the tourism activity shall cease in the Park area. One day in a week shall be kept free of visitation to Park Area during the tourism season for repair and maintenance works within the visitation areas. In the visitation areas eco-friendly tourist amenities will be developed / maintained in consonance with the eco-tourism guidelines issued by the Ministry, Eco-tourism Policy guidelines of UT Administration and the recommendation of Shekhar Singh Committee in this regard.
- b) Demarcation of the tourism areas within the National Park by placing buoys. Glass bottom boats, Tourist boats are to operate with its notified capacity only. Tourist boats shall anchor in designated mooring point, without damaging coral reefs.
- c) Swimming, Glass bottom boat and Snorkelling shall be permitted in the Park in designated zones at tourist sites under supervision of TSET team and as per the SOP approved in this regard. Snorkelling be allowed only under protocol of donning Lifejacket and fins by both guide and tourist. Being a plastic free zone - no plastic items are allowed inside the park while entry.
- d) Impact assessment of tourism activities on the biodiversity of the areas open for tourism, will be done.
- e) Strengthening of the eco-tourism facilities through maintenance and creation of better public amenities and regulation of all allowable activities shall be done. However, all facilities so provided shall be made of eco-friendly materials only. To attract the visiting tourists, a view point near the sunset point at Manjeri is proposed to be developed. Cycle tracks at suitable locations within the Park are also proposed to be developed to provide better facilities to the visiting tourists.
- f) The anchors and chains damage the coral environments. The Marine National Park area is to be designated as no anchoring areas once the mooring buoys are placed at Red Skin Island. Mooring buoys have already been placed at Jolly Buoy, for anchoring and mooring the boats which are permitted to ply in MGMNP. It is prescribed that they should carry enough chain or chain line for

required depth, check out area before anchoring, anchor in sand or mud away from corals, and motor towards the anchor when hauling in.

- g) Strengthening of communication and related infrastructure, including vehicles for immediate rescue operations.
- h) Promotion of alternate livelihood options by developing soft skills like in handicrafts making, processed food making, etc., guide training as naturalists, nature interpreters, glass bottom boat drivers, etc, so that the rural areas surrounding the Park can benefit. Priority shall be given to the local and fringe dwelling population.
- i) Emphasis on use of alternative sources of energy should be made while minimising dependence on fossil fuels.
- j) Undertaking extensive education and awareness campaign amongst the dependent local communities and the visitors. Displays and publicity materials projecting the importance of MGMNP, the ecosystem components and functions, major species like mangroves, coral reefs, sea-grass beds, resident and migratory birds, sea turtles, dugongs, etc., their habit and habitat and similar wayside exhibits and signage will be made available in visitation areas as well as in the zone of influence. Do's and Don'ts should be displayed for the tourists in the tourism area. Updated publicity materials will be available at the entry/exit gate. Suggestion box will be made available for tourists. The trees present in the visitor use area at Jolly Buoy and Red Skin are to be fixed with proper name plates containing the scientific name, family, the local name, use, etc.
- k) Additional area may be considered for inclusion in the tourism zone if need arises in future after carefully considering the carrying capacity of the area and the impact of tourism on flora / fauna.

### 6.3 Azonal Plans/Theme Plans

Azonal Plans/Theme Plans shall be the plans targeted towards obtaining specific outcome while being implemented in the entire stretch of the area of the National Park. These plans are to be utilised all across the landscape and marinescape of MGMNP on day-to-day regular basis.

There shall be four azonal plans, namely, 1. Protection Plan, 2. Habitat Management Plan, 3. Disaster Management Plan, and 4. Research, Survey & Monitoring Plan.

### 6.3.1 Protection Plan

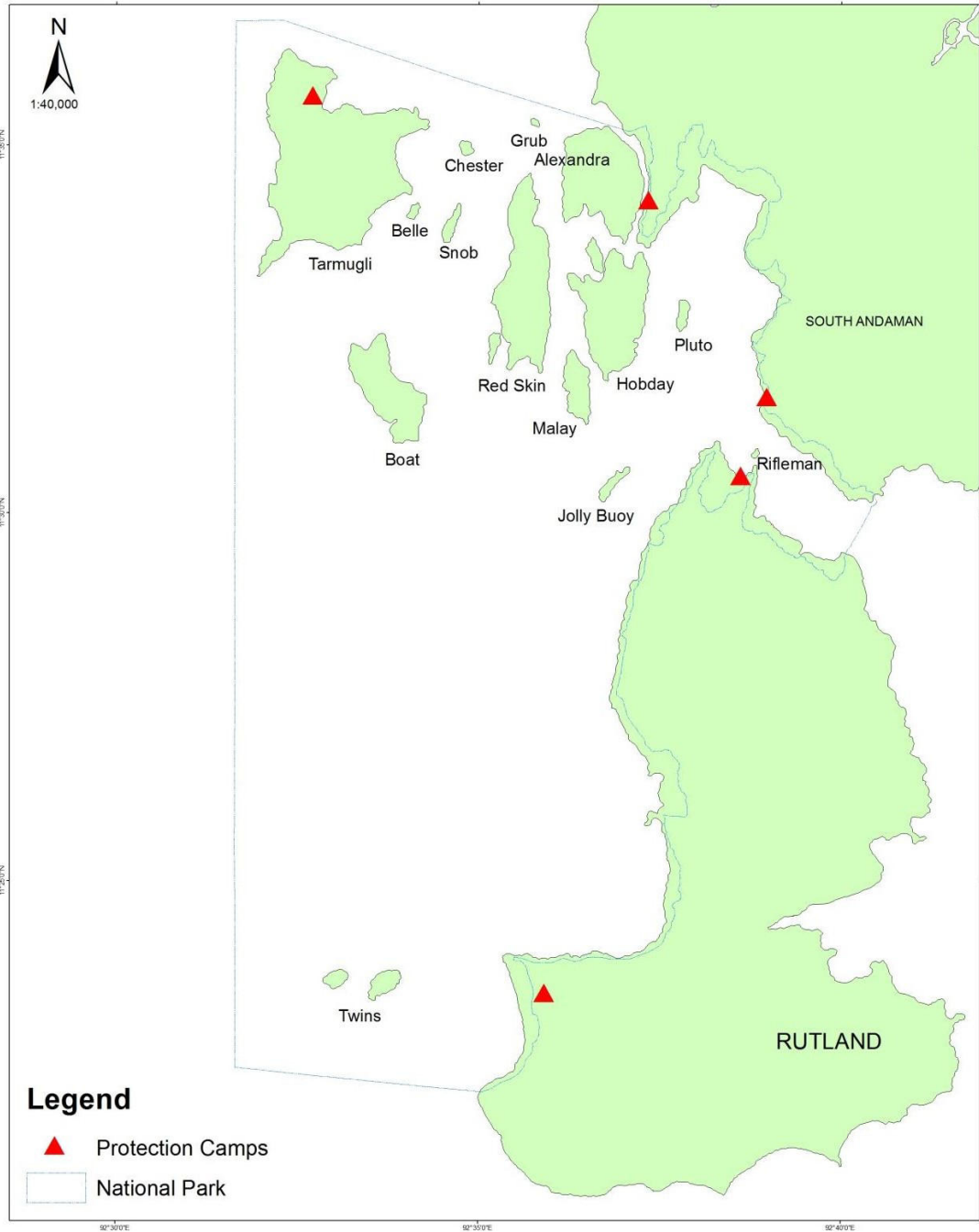
This plan is to ensure that utmost protection is provided to the flora, fauna, and the geo-morphological features within the Mahatma Gandhi Marine National Park, so that the future generations are not left bereft of the marvels of this unique area. Protection camps established for protection of natural resources in MGMNP is shown in Fig. No. : 23.

#### 6.3.1.1 Objectives

- a) To accord complete protection to the breeding and feeding ground of flora and fauna.
- b) To safeguard against the unscrupulous elements indulging in illegalities within the notified areas of MGMNP through clandestine collection and/or destruction of flora and fauna, fishing, poaching of wild animals and breach of any applicable legal provisions in force in MGMNP.
- c) To improve the infrastructure and augment the capacity of staff for better protection of the Park.

#### 6.3.1.2 Strategies

- a) Regular awareness generation through extensive outreach programmes shall be carried out, specifically across the Zone of Influence, regarding the wildlife crimes in general and activities that are prohibited/regulated within the National Park in particular.
- b) Maintenance and further strengthening of the existent camps at Cinque Island, Tarmugli Island and Jhajji beach, with the deployment and operationalization of the central unit at Wandoor Range HQs. Free ration is to be provided to all camping staff in addition to their allowances. Provision shall be made of a Secret Fund, in line with that available with the Police Department, at the disposal of the Wildlife Warden to collect intelligence regarding wildlife crime.
- c) Rotational and temporary/seasonal camping may be put up in other islands like the Twin Islands and Boat Island which are extremely sensitive in regards to poaching and related illegal activities.
- d) Capacity building of staff in detection of wildlife and forest crimes and prosecution procedures, usage of arms and ammunition, etc. will be undertaken.



**Fig: 23 Protection Camp in MGMNP**

- e) Augmentation of infrastructure. Presently the infrastructure is in nascent stage and an effective protection of the National Park can be brought about by augmentation of existent infrastructure by bringing in state of art equipments and all weather sea-worthy vessels and field vehicles for fast and safe movement of men and materials. It is proposed to construct a small inspection hut near the jetty at Pongibalu for the inspecting officials. Unmanned tower mounted Remote camera Surveillance system may be installed at North Eastern side of Boat island/ and other suitable locations to keep 360 degree check over entire area. Use of Drone for effective monitoring and interception inside the National Park will be encouraged. To ensure safety of the frontline staff, arms and ammunition shall be provided to them. Constructions and maintenance of barriers, watchtowers, checkposts, camps, fair-weather roads and all such related paraphernalia will be undertaken as and when necessary with due approval of CWLW. Additional Sea worthy vessels of suitable specifications will be procured so that remote areas of Cinque Islands, Twin Islands, Brother-Sister Island, North Sentinel Island, etc. can be monitored on regular basis. Obsolete watercrafts are to be condemned / replaced. Sea-scooters, high speed boats as per necessity shall be procured to be deployed for patrolling.
- f) Inter-departmental and intra-departmental liaison to be strengthened and joint patrolling & combing operations with adjoining Divisions like South Andaman, Havelock and Baratang divisions and with Police shall be done.
- g) Generation of intelligence at local and regional level is of utmost importance and capacity building is required at the field level. Creation of informer network by way of incentivising them through secret fund on case to case basis will be undertaken.
- h) Use of dog squad for wildlife crime prevention and detection.
- i) Wildlife/Forest crime dossier of each person apprehended / accused / convicted will be maintained in both hard and soft copy version to refer, make history sheet and for surveillance purposes. This should be in addition to Offence Register which otherwise contains offence reports, details of court cases attended month-wise to facilitate follow-up of all detected crimes within the given jurisdiction and monitoring based on season and area. Such crime data will be shared on regular basis with the

nodal agencies like Wildlife Crime Control Bureau(WCCB) New Delhi.

### 6.3.2 Habitat Management Plan

A large number of varied species inhabit the waters & islands within the Mahatma Gandhi Marine National Park. Broadly, it can be divided into terrestrial & marine habitats.

#### 6.3.2.1 Objectives :

The main objective of the Habitat Management Plan shall be as follows:

- a) To ensure that ecosystems within MGMNP and adjoining areas retain their ecological integrity and functioning.
- b) To ensure viability, sustenance and continuance of a healthy mix of flora and fauna within the National Park and adjoining areas.
- c) To protect and conserve the present; rehabilitate & improve the degraded areas by making scientifically informed & time-tested interventions & thereby, transmit to future generations the outstanding universal values of the MGMNP Area.

#### 6.3.2.2 Strategies

- a) Eco-profiling of the existing of eco-systems vis-a-vis historical studies and documentations require to be done. Based on the eco-profiling, restocking of RET plants at appropriate site shall be taken up.
- b) In order to restore the areas affected by the onslaught of the Tsunami, intensive planting with native suitable species shall be taken up for bringing back the islands vegetation to near normalcy.
- c) Re-introduction programmes based on the historical studies and present documentations shall be carried out, e.g., Andaman wild pig re- stocking, sea-grass replanting, mangrove re-planting and artificial coral planting.
- d) Fresh water is available only at Tarmugli and Redskin Islands. Augmentation of existing fresh water sources with suitable Soil Water Moisture Conservation structures will benefit terrestrial re-introduction programmes not just for the large bodied animals, but also for birds, reptiles and amphibians.
- e) To monitor the extent and health of coral reef, a reef monitoring unit has been formed. The unit shall be equipped with suitable driving gear, protection gears, a fibre boat with diving facility etc. Staff posted at the unit shall be trained in diving.
- f) Artificial reef building exercise shall be undertaken through sinking of suitable structure & attaching part of live coral on it, in the areas where coral reef has been damaged.

- g) Scientific management interventions shall be undertaken to protect the habitat of Dugong and Manta Ray.

The Conservation Plans, including the habitat management aspect, for the keystone, umbrella and cornerstone species like the turtles, birds, dugong, and corals are discussed in details in the following chapters.

### 6.3.3 Disaster Management Plan

The nature is unpredictable and ominous. Natural calamities are very frequent in this part of India, as has been discussed in Part I. Added to it is the activity of the human beings that may give rise to disasters endangering all including the frontline staff engaged on field for the protection and conservation efforts. It is pre-requisite to have a disaster management plan to attend to and combat disasters so as to prevent loss of men and material.

#### 6.3.3.1 Strategies for Fire Protection

- a) Clearing fire line and construction of watch towers to monitor the area for the purpose of fire control.
- b) Assessment of adjoining villages (coastal belt of South Andaman main islands) in Zone of Influence, as well as in bigger islands and fire protection measures should be taken well in advance of the winter season when some areas become prone to fire due to dry conditions and increased human presence particularly in tourism zone.
- c) Installation of fire-fighting equipments, tools. Infrastructure maintenance and augmentation w.r.t. communication, easy and fast movement of staff and rescue team.
- d) Capacity building of the staff in dealing with wild-fires and man-made fires.
- e) Involvement of local youth in fighting fire in the zone of influence and tourism areas within MGMNP by capacity building of the local communities. A suitable team maybe created in all the nearby villages dedicated for such work with all necessary equipments and tools. One Honorary wildlife warden maybe appointed from the local civil society to further strengthen the sense of belonging of villagers with the park management.

#### 6.3.3.2 Strategies for Animal Disease/ Insect attacks/Pathogen spread

- a) Regular monitoring and strict vigil within the Zone of Influence is requisite to keep the management of park abreast with any and every change seen in livestock, including poultry and inland fish health. Any sudden change, mass mortality, deformity is to be immediately taken up with the concerned authority for containing the spread into the national park.
- b) Care should be taken that no spillover of exotic fishes or other aquatic organism is not let loose into the natural environment. Sampling of all creeks should be done periodically for assessing the biodiversity and ingress of exotics.
- c) Diseased animals should be handled with utmost care. All personnel should take precautions to minimize the risk of disease transmission to protect themselves, their families and wildlife populations. Proper clothing with footwear, gloves are a must. People with severe allergies associated with animals, with immune-deficiency diseases or on immunosuppressant therapy should not engaged in the rescue operations.
- d) In case of alerts of diseases like Bird Flu, etc., strict vigil will be maintained on all migratory birds visiting the Park and action will be taken in consultation with Animal Husbandry Department.

#### 6.3.3.3 Strategies against chemical poisoning

- a) Strict vigilance should be kept in the Zone of influence particularly in the creeks and other natural/man-made water channels.
- b) Use of heavy chemicals for agriculture, livestock farming, fisheries, etc. should be discouraged by involving and orienting the habitants of the villages through their local PRIs, District Administration and concerned line departments, NGOs, etc.
- c) Promotion of Solid and Liquid Waste Management in the Zone of Influence by involving line departments, NGOs, district authority, etc.
- d) Addressing animosities arising out of wildlife-human conflict immediately so that retaliatory poisoning of wild animals could be avoided.
- e) Retrieval of poisoned animals should be done with proper care of self-hygiene, wearing gloves, overall, face-masks, boots, etc. Post mortem confirmation should be taken and due care should be taken in disposal of

the chemical-laced carcass. Care should be taken that it doesn't spill onto the natural environment further.

#### 6.3.3.4 Strategies against Oil Spill

- a) Liaison with Nodal Agency notified for the Islands, capacity building of the staff and infrastructure augmentation as per the protocol.
- b) Following the standard protocol developed by the Coast Guard in this regard.
- c) Live birds and large bodied marine animals affected by oil spill should be handled with utmost care and the laid down standard protocol should be followed for relieving the animal of stress. Rescued birds, be kept in captivity till they are treated and thereafter released back safely.

#### 6.3.3.5 Strategies for stranded marine animals

- a) Capacity building amongst staff for first response. Only staff of the Division/ Department shall engage in whale and dolphin stranding incident responses.
- b) Wildlife Control Unit should be manned 24X7 and infrastructure augmentation should be taken to ensure quick response, particularly in case stranding incident occurs in habitation areas.
- c) Awareness creation of incidences amongst the public is necessary and the guidelines for contacting the Wildlife Control Unit without delay on occurrence of such incidence should be put in place. Involvement of public in whale or dolphin stranding incident responses should necessarily be under the supervision of the authorized staff of the Division/Department.
- d) Human safety should be of highest priority. The second priority for incident response shall be animal welfare.
- e) Use of appropriate personal protective clothing is a must. None should touch the animals with bare hands.

- f) Area of incidence, if on a beach area accessible to public, should be cordoned off immediately, preferably at a distance of minimum 30 metres.
- g) The animal, if live should be handled with utmost care and in case of entanglement, the nets/plastics/noose, etc. should be swiftly removed, as far as practicable to lessen the distress to the animal. Primarily, the objective would be to facilitate the animal to swim back into the sea.
- h) In case the stranded animal is dead, the carcass should be disposed off sensitively after post mortem and documentation. Self-hygiene and safety of local communities, if habituating nearby, should be of utmost priority. In such cases investigations be also made to ascertain the reason for death of animal.
- i) Unanticipated and known risks should be assessed alongside while being on the operation and appropriate mitigation measures implemented during the response. This may require suspension of the response act altogether, for example, due to turbulent weather etc.
- j) Reporting of the incidence to the Chief Wildlife Warden immediately with copies of Post Mortem Report etc.

#### 6.3.4 Research and Monitoring Plan

Research and monitoring are imperative to attain the objectives & to help ensure scientific management of resources. Research & monitoring is necessary to provide the knowledge which is important to make decisions concerning the protection of the biological diversity & natural ecosystem processes of MGMNP and its resources, to encourage and provide support for research and monitoring that lead to better understanding of important ecological processes and understand ecological change. The specific purpose of monitoring is to establish the baseline information on natural resources and other components of the ecosystems and to measure changes over time. As monitoring studies gather data, they have the potential to detect significant changes and the source/cause of such in natural resources. Monitoring can also measure whether a system is recovering from damage. In MGMNP monitoring protocols are necessary to get information on the critical habitats such as coral reefs, mangroves and sea grass beds. It is also necessary to know the population trend of important species such as reef fishes, dugongs, sea turtles, crocodiles and other terrestrial mammals namely spotted deer and wild pig. The results of research

and monitoring shall be used to evaluate management actions and improve them accordingly in upcoming management plans.

#### 6.3.4.1 Objectives

- a) To assess the biodiversity and the change in their composition in spatial and temporal realms.
- b) To improve the understanding of the interaction of the components of the terrestrial and marine ecological processes.
- c) To establish an information and knowledge base for MGMNP and for its ecologically sustainable multiple use
- d) Sharing and accessing data and information and coordinating the research efforts amongst various stakeholders at local, regional, national and international levels.
- e) To address the developmental and socio-economic issues vis-a-vis the conservation requirement based on robust scientific information and analyses.
- f) Prioritising the areas within the national park for management interventions.
- g) To improve the capacity to determine the ecologically sustainable fishing practices in the adjoining areas.

#### 6.3.4.2 Strategies

- a) Capacity building and orientation of staff of the Research and Survey Range in research tools and methods to identify and generate basic data through close monitoring over a period of time. A Reef Monitoring Unit has been established and the same should be kept functional and strengthened further by regular training of staff of the Department in attaining proficiency in diving, including certification and carrying out the regular monitoring works required periodically. These services are to be necessarily employed in the survey and monitoring of the coral and sea-grass beds of MGMNP. A Research Associate shall have to be appointed with R&S Range whose services are to be utilised for collation and analysis of all scientific data generated. All necessary diving equipments / gears and a suitable boat having diving facilities is to be provided to the unit. Remote Monitoring of Reefs through suitable equipments shall also be explored.

- b) Advanced monitoring equipments like camera traps, drones, Radio Frequency Identification tags, acoustic devices, etc shall be used for intensive monitoring of wildlife populations. Infrastructure likewise requires to be augmented further for easy movement of the staff without having to share the resources with the other Ranges.
- c) Prioritising the research and monitoring requirements based on local requirements shall be done. Regular census are to be done biennially to monitor the important populations like that of crocodiles, birds, wildpigs, dugongs, turtles, etc. Impact assessment of various socio-economic interventions on the ecological processes and their health should be of topmost priority.
- d) Collaboration with similarly placed research and monitoring agencies at regional, national and international levels carrying out studies in marine national parks, like Zoological Survey of India, Centre for Advanced Studies in Marine Biology, Annamalai University, National Institute of Oceanography, Central Inland Agriculture Research Institute, Wildlife Institute of India, Forest Survey of India, Geological Survey of India, National Remote Sensing Agency, Indian Council for Forestry Research and Education, Salim Ali Centre for Ornithology and Nature conservation, Botanical Survey of India, Central and Regional universities, etc.
- e) The agency interested in taking up research activities within MGMNP shall submit a detailed proposal including the background, the objectives, the methodology, the study area, literature on past research on the field, the time schedule, the source of funding and the collaborators, if any. The proposal should be submitted to the Chief Wildlife Warden for prior review and approval.
- f) Foreign institutes / agencies / collaborators or entities utilizing foreign funding for their research, survey or monitoring shall

have to obtain all statutory clearances before undertaking research work in the Park.

- g) Establishing a library of recent advancements in marine and terrestrial studies, ecological processes, impact assessments, etc. alongwith storage, retrieval and dissemination of existing and newly acquired scientific information on MGMNP.
- h) Monitoring for establishing baseline information should be got done and then periodically monitored for assessing the changes thereby, viz., seasonal physiochemical and biological properties of the water in creeks, creek-mouth and at various depths of the marine environment, soil surveys of all the islands, plankton growth and dispersal, trends in coral reef health, sea-grass bed extent and spread, algal bloom spread, mangrove regeneration, sea turtle nesting monitoring clutch release, census of crocodiles, terrestrial animals, birds, etc. Survey, census and data generation suited to the local environment should be as per the procedure mentioned in part I and formats.
- i) Monitoring the adaptive responses and the natural recovery and / or restoration of injured or degraded ecosystems, including the reefs, mangroves, sea-grass beds and information on the location of potentially harmful activities, generating baseline survey data for assessing catastrophic damage from natural or man-made events such as storms, diseases, vessel groundings, and toxic spills and serves as an early warning system for identifying declines in coral reef health.
- j) Assessment of the effectiveness of various zones namely the preservation zone, tourism zone and multiple use zone as a management action for the conservation and sustainable use of marine resources.
- k) Designing of species based recovery programmes based on the assessment of the life histories and population dynamics, while monitoring and evaluating trends in their population parameters. For Corals, artificial implantation techniques will be tried at different areas within MGMNP, in the areas where corals have faced damage due to natural/artificial means. Other scientific techniques for reef building including Bio-Rock Technique shall also be undertaken.

- I) The research programme should have minimal impact on the physical environment and aesthetics of the area. While conducting research, monitoring or surveys, utmost care is to be taken to not violate any provision of the Wildlife (Protection) Act, 1972. No specimen shall be collected from the marine national park area, without the explicit permission obtained from the Competent Authority. It is also to be ensured that the research activities do not interfere with those of other users in the MGMNP or pose as potential danger to others.

#### 6.3.4.3 Monitoring of important ecosystems and the methods to be employed

##### A. Coral reefs

The health of the coral reefs shall be monitored for measuring the extent of coral cover, species assemblage, extent of coral reef degradation, sewage influx, sedimentation, fish prevalence and assemblage, water quality, nutrient status, extent of deprecating indicators like the crown of thorns, algae formation, etc. The area has been divided into major and minor grids. Coral reef monitoring in MGMNP is to be done based on both line intercept transect method and manta tow survey method within the mapped grids. Permanent transects with GPS locators shall be laid for this purpose and periodical evaluation shall be carried out. Data should be collected in the format as per Annexure-XXII.

##### B. Sea-grass beds

Sea grass beds are highly productive for fisheries by providing food and shelter for grazing fish and a place to grow for algae and invertebrates that the fish feed on. Sea grasses are nursery grounds for young prawns and fishes. So monitoring the extent of these sea grasses, alongwith the dominant species give important information on the number of foraging animals it can cater to. The surveys should be repeated at different times of the year, preferably in different seasons, since the sea grass beds are naturally variable and some species have annual periods of die back. It is proposed to monitor the sea grass area twice a year to see whether they are declining or enlarging. This has to be done using natural landmarks and marking the

outlines of the sea grass beds on a map at a very low tide. Doing this biennially at the same time of year will give a good idea of change in sea grass beds.

### C. Mangrove forests

The mangrove forests area may change either as a result of natural factors or as a result of human activities such as pollution, etc. There may be large or small areas where trees have been removed or damaged and trees may have branches cut off, Branches and trunks may have bark with cracks or crevices, The uppermost branches in the sun may be dying at their tips, leaves may be fewer, smaller, show twisting and curling, and have dead parts or spotting, the distance between leaf pairs on shoots may be very much shorter than in a healthy tree, There may be no flowers, Fruits may fall off before they have matured, the seeds may be deformed - have abnormal growth., established seedlings may begin to grow abnormally, Seedlings may be browsed upon or die, the small upright aerial roots (pneumatophores) coming up from the mud may be branched, twisted or curled, and aerial roots may develop on the tree's trunk and young trees may grow at an angle.

Counting the number / size of trees will provide quantitative information about mangrove forests. It is proposed to have transect line from the sea ward edge of the mangrove forests to its inland edge and it is proposed to establish three transects in each island. It is also proposed to mark five permanent sample plots of 10 m x 10 m. All trees larger than 40 cm girth should be identified and the girth at breast height from ground level in low tide (above the knee roots and stilt roots) should be recorded and marked with dendrobands. For seedling count, 5m X 5m sub plots may be taken within the main plots and all the seedlings in the sub-sample plots be counted. The recordings should be as per the format at Annexure-XXIII.

### D. Sea Turtle

The beaches of MGMNP provide breeding grounds for sea turtles namely Leather Back, Hawks Bill, Green and Olive Ridges. The knowledge of sea turtles biology is crucial to the conservation efforts. The information such as the frequency of a turtle nest within a season, whether the nesting takes place every year, seasonal accretion of sand, the extent of its migration within and between nesting seasons, the information on nests, nest depth, the clutch size and hatching success rate are needed to get information about the migration and reproductive biology for its conservation It

is also essential to understand the factors that affect egg and hatchling survival. The turtles are to be measured to relate body size to reproductive output, to determine minimum size at reproduction and to monitor nesting female size. Changes in nesting female size can be an indicator of either declining population or in some cases an expanding population. The sea turtles emerge frequently on nesting beaches and return without laying eggs, sometimes after constructing several nests. Further, the assessment and monitoring of sea turtle feeding grounds is felt important at this juncture to know more about the frequenting population. Turtle Hatcheries shall be developed if needed at the nesting sites.

Sea turtle monitoring during nesting season from October to April every year during the plan period at Jahaji beach in Rutland and Tarmugli shall be done on a daily basis. The beaches at Twin islands, Boat Island and Grub island may be monitored periodically once in a fortnight during the nesting season. It is imperative to clear the beaches of debris to aid nesting by turtles. The direct counting of turtles is proposed for counting of turtles instead of track count since the beach length is comparatively small and the intensity of turtle nesting is not high. The nest counts are to be done throughout the nesting season. Sea turtles shall be monitored and surveyed using strip transects. Wide strips are to be laid perpendicular to the coastline of the beach. The data should be collected as per the format prescribed in Annexure-XXIV.

#### E. Crocodile Census

The crocodiles being amphibious in nature can be counted directly both on land and water. Crocodiles basking on land during day time are easier to count and their size can be determined by ocular estimation. At night crocodiles floating on water or resting on land can be counted by using a hand held spotlight and catching the reflected 'ruby red' glow from their eyes. Presence, absence and relative abundance of crocodiles in MGMNP can also be assessed from indirect evidences such as footprints and faecal droppings on the shoreline. An estimation of number of breeding females can be made by counting the number of active nest each year. The air temperature and day length should be recorded. Winter months are good for counting crocodiles during day time. It is prescribed to carry out day count during September to December in MGMNP. During summer the crocodiles avoid high temperature and spend much of their time submerged (Rodgers, 1991). During night they surface or rest on land and night counts are ideal during summer. Since the MGMNP area is influenced by tidal fluctuations conditions at low tide are easier to

spot the basking crocodiles and therefore the counting should always be carried out during low tide. The location of each crocodile spotted and the estimated size is to be recorded including the details such as time, activity of the sighted animal, weather condition, moon stage, habitat condition, water stage, etc as per the format prescribed in Annexure-XXV.

#### F. Dugong Survey

The best way to conduct dugong survey is through aerial surveys using drones when they surface. The survey should be conducted round the year alongwith the sea-grass bed surveys. It is also important to have the line departments and other agencies aware of such sightings, the places of such sightings so that any information is notified to the Department without delay. Data has to be recorded as per format provided at Annexure-XXVI.

#### G. Wild Pig and Spotted deer

To monitor the wild animal population particularly the wild pig and spotted deer in the islands of MGMNP regular census programme is to be organized in all the islands of marine national park. The census shall be carried out in 10% forest area of each island and for this fixed transects with GPS locators be laid in MGMNP on islands having fresh water sources primarily. The distance between two transect lines should be atleast 50 m. The width of the transect is decided keeping in view the visibility inside forest. Two recorders should be on one transect as per protocol, one for sighting and the other for recording on datasheet. The transect walk should as far as possible be straight for which a compass with pre-decided bearing may be used and the team should move up along the pre-decided bearing. The observation should be recorded on the prescribed data sheet. Different sheets are to be used for spotted deer and wild pig. The data sheets for spotted deer and wild pig census and analysis of data are enclosed in Annexure-XXVII and XXVIII respectively.

#### H. Census of Birds

The birds census is necessary to get an idea about their diversity, the habitat status and level of abundance. Total count for birds is difficult due to high density. The Sampling based index may be done in case of forest birds by encounter rate

survey method. This will provide the index of abundance. The survey on birds should be started a little after sunrise on pre-decided and identified transect lines of known length. The observations may be recorded in the data sheet which is enclosed in Annexure-XXIX.

## CHAPTER 07

### CONSERVATION AND MANAGEMENT PROGRAMME FOR IMPORTANT SPECIES

The primary objective of setting up the Mahatma Gandhi Marine National Park has been to conserve of the unique natural and cultural resources and their ecological relationship. The dynamic ecological processes must be kept going in the same way as they have been going on since time immemorial, devoid of human interferences and influences. To maintain biological diversity at the ecosystem, habitat, species, population, community and genetic levels, it is necessary to identify and draw Conservation Plans for the species that are the keystone and umbrella species.

The keystone is the topmost stone in an arch that holds the entire structure together' keystone species are therefore defined as those species that have a disproportionately large effect on the communities in which they occur. Such species help to maintain local biodiversity within a community either by controlling populations of other species that would otherwise dominate the community or by providing critical resources for a wide range of species. The name keystone species was coined by American zoologist Robert T. Paine in 1969, and is derived from the practice of using a wedge-shaped stone to support the top of an arch in a bridge or other construction. Just as other stones in the construction depend on the keystone for support, other species in a biological community depend on the presence of a keystone species to maintain the community's structure. Key-stone species help maintain biodiversity and there are no other species in the ecosystem that can serve their same function. Without them, their ecosystem would change dramatically or could even cease to exist.

Though for the want of ecology-based scientific studies here, it is difficult to ascertain the keystone species in the vast realm of the marine and adjoining ecosystems, for the sake of management based on the available documentations, corals can be termed as the keystone species that requires utmost protection, as upon it thrives a substantial large number of marine species of flora and fauna. Similarly, the turtles are an important species that require to be conserved. Sea-turtles

are scavengers and keep the seas free of organic debris, therefore, it would be imperative to have the turtles thrive is a good number. In the context of the Park, the Dugongs, Sea-grass which sustains different animals and birds also can be considered as important species which requires to be conserved.

## 7.1 Sea-Grass Beds Conservation Plan

The values of sea-grass beds and the animals that use them are described in chapter 2. Sea-grass beds occur in shallow inshore waters that are used by fishing boats for passage. This disturbs the herbivorous marine animals such as dugong and turtles and there is risk of collisions and injuries to the animals and the boats too. Movement of fishing boats with high speed poses a threat to these species in the narrow channels and shallow waterways in MGMNP. Seagrass beds are also under threat from runoff from agriculture, aquaculture and land-based tourist activities.

With increasing human population in the adjoining villages in coastal areas the marine ecosystems and species are showing adverse signs potentially related to some adjacent land uses (for example, declining water quality), and improved fishing methods has the potential to be a serious threat to populations of animals dependent on the sea- grass beds.

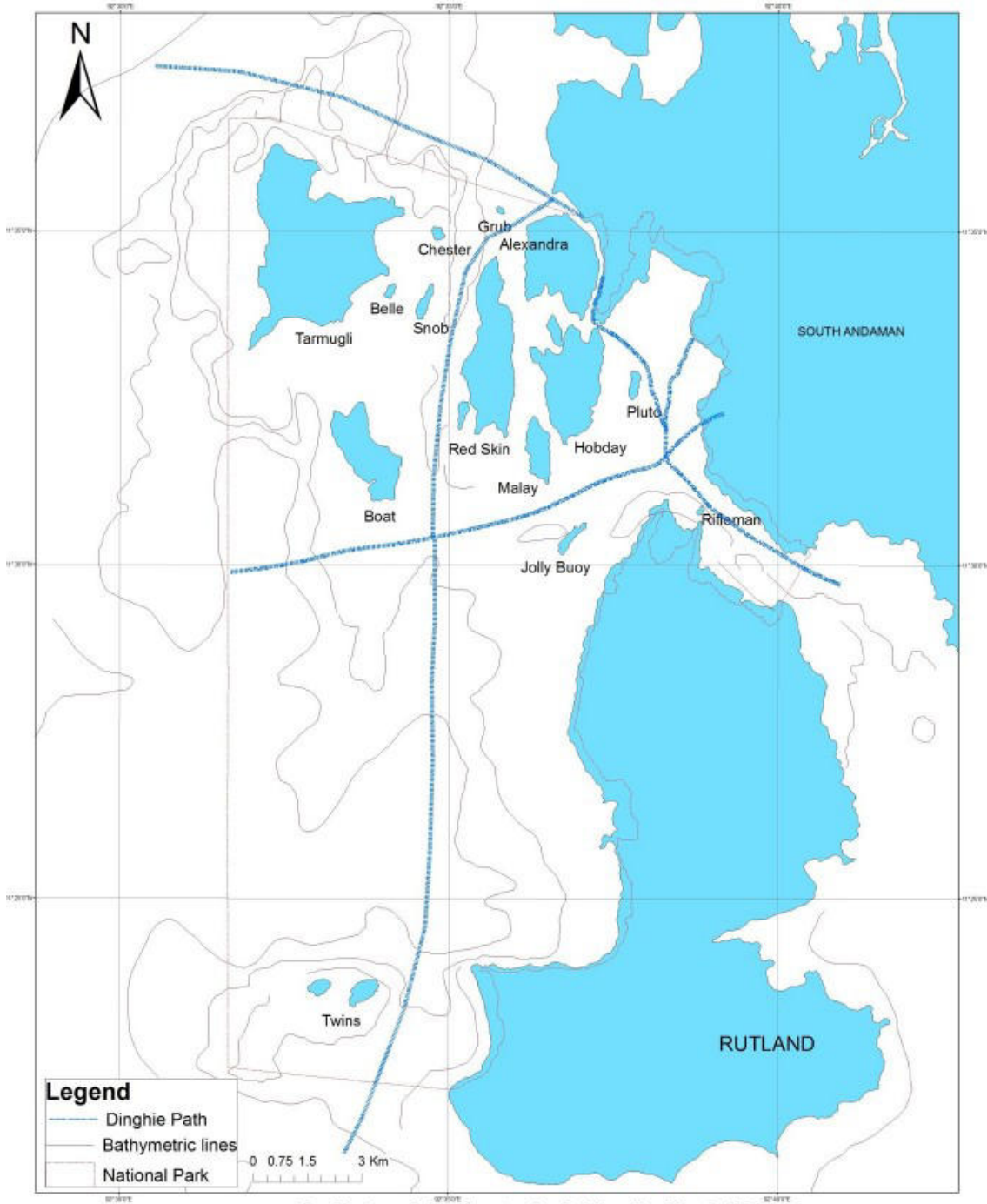
### 7.1.1 Objectives

- a) To ensure that the natural distribution, extent and biological diversity of seagrass beds are kept intact.
- b) To protect and conserve the fauna dependent on the sea-grass beds
- c) To restore such areas that once had sea-grass beds, however have depleted over time.
- d) Mapping of availability of Sea-grass beds in the Park.

### 7.1.2 Strategies

- a) Mapping of all existent sea-grass beds with GPS locations and display of such maps at jetties and fish landing sites for awareness creation. Eco-Development Committees will also be involved in creating awareness in this regard.

- b) Regular monitoring of the Sea-grass beds to ascertain their health and other factors.
- c) A strong network involving the local communities, line departments, researchers and NGOs should be put in place to report all sightings of new Sea-grass beds for effective documentation.
- d) Build a common consensus on conservation and orient all stakeholders about the importance of saving the sea-grass beds, its ecological and economic importance at local, regional and international levels.
- e) To prevent damage to Sea-grass beds, the local fishermen shall be encouraged not to anchor their boats on Sea-grass beds. Tourist boats shall be allowed to anchor on designated areas only.
- f) Transit lanes or routes are to be strictly marked with buoys for the outgoing and incoming fishermen dinghies to prevent habitat degradation. The boats are to be plied at recommended speed limit of 10 knots on transit lanes (Fig. No. : 24).



**Fig: 24 Transit lane/routes for fishing dinghies in MGMNP**

- g) Soil and water conservation measures including Check Dams, Gully plugging, etc. may be made in areas adjoining the MGMNP to reduce the runoff and sedimentation load in MGMNP to protect Sea-grass beds.
- h) The installation of facilities such as moorings and pontoons should be avoided in shallow waters to protect the beds.
- i) Research and monitoring programs aimed at obtaining more information on the distribution and ecology of seagrass, dependence of the large marine mammals and turtles on Sea-grass shall be taken up. Periodical monitoring of the water quality in the sea grass areas shall be carried out to ascertain changes.
- j) Signage and educational materials will be developed to explain Sea-grass conservation measures and placed at strategic locations such as jetties, interpretation centre, etc. They will be distributed to local villagers, schools, hotels, etc. for creating awareness.

## 7.2 Corals and associated biota Conservation Plan

A viable, functioning and healthy coral reef ecosystem is a major critical component of the marine ecosystem and a major basis for the management and protection of MGMNP. The value and importance of coral reefs has been explained in Part I.

All the coral reef areas within the National Park has been categorised under the Preservation Plan, except for the limited use of the reefs in the Tourism area.

### 7.2.1 Objective

- a) To keep intact the functional reef ecosystem upon which Corals and associated biota are afforded high levels of protection.
- b) Coral reefs are protected from identified threats, such as anchoring, snorkeling and scuba diving.
- c) To scientifically manage the habitat.
- d) To conduct survey to ascertain the grid-wise and species-wise availability of corals in the Park.
- e) To prepare a Reef Restoration / Reef Creation Plan where coral reefs are found damaged.

### 7.2.2 Strategies

- a) Damage to corals shall be avoided at all cost. The entire MGMNP area is a no anchor zone except the designated areas at Wandoor Jetty, Jolly Bouy and Red Skin.
- b) Entry into MGMNP shall be subject to explicit permission from CWLW. Collection of coral in any form is prohibited, unless permitted by CWLW.
- c) The habitation areas around the National Park should be monitored regularly to ensure no organic or inorganic sewage is let into the creeks that find way into the Park areas to avoid damage to the coral colony. Regular monitoring of the water quality should be taken to monitor change that might impact on the coral colony.
- d) Areas open for tourist visitation to be regularly monitored closely to prevent any damage to coral reefs.
- e) Areas of coral reef that are most susceptible to damage, or that are known sites for rare species of biota, shall be identified and marked as no-anchoring areas. Anchoring, including the use of diver descent lines and other facilities, shall not be allowed within these no-anchoring areas.
- f) Grid survey to ascertain availability of corals is to be conducted and the information so generated based on the grid surveys shall be put to use to strengthen the protection strategies. Efforts will be made for establishing a Protocol for restoration of degraded coral reefs affected due to cyclic El-Nino and rising sea-surface temperature. For this purpose, artificial reef building techniques and creation of coral nurseries shall be undertaken.
- g) Research on the Coral habitat, the changes through the spatial and temporal realms will be prioritized and taken up through the institutes identified for this purpose. Restoration and rehabilitation works should be supported by prior scientific studies.

- h) Simultaneously, capacity of the staff in such research works has to be upgraded over the period of time, alongwith infrastructure augmentation for better and faster movement, effective communication, compilation and collation of the data generated for efficient utilisation of the information.
- i) Survey and monitoring of coral reefs shall be done as per Annexure-XXII.

### 7.3 Bird Conservation Plan

MGMNP is a haven for birds. As mentioned in Part I, most of the endangered and endemic birds found in Andaman group of islands have been sighted in MGMNP. Species like the Nicobar pigeon and Andaman wood pigeon that are relatively obscure in Andaman Islands are encountered commonly in MGMNP area. MGMNP is an important roosting and breeding site for the endangered and endemic species like the Andaman Serpent eagle, Andaman Crake, Andaman cuckoo dove, Andaman Coucal, Andaman Scops Owl, Andaman Black Woodpecker, Andaman Nightjar, Andaman Drongo, Beach Thick knee, etc. Being confined to the islands of this Union Territory, it is pre-requisite that these birds and their habitats are conserved.

Apart from the endemics, MGMNP forms the stop over site for many migratory species like the Rosy Terns, Noody terns, Boobies, Curlews, Sandpipers, etc., making the National Park immensely rich.

#### 7.3.1 Objective

- a) To keep the habitat vibrant so that the indigenous bird populations having restricted range remain viable
- b) To ensure that the visiting migratory birds population utilising the habitat within MGMNP for roosting and breeding, thrives.
- c) To identify the breeding sites of indigenous birds and migratory birds.

#### 7.3.2 Strategies

- a) Strict regulation of tourism activities within areas of Tourism Zone that have viable bird population of resident/ migratory birds. No horns, loud speakers, stereo-players to be allowed in such Zone and the tourism activities to be conducted in such areas in such a way that the birds do not get disturbed and their habitats are not destroyed.

- b) Awareness generation and orientation of the local populace in adopting ways of life that is in tune with the sustenance of the birds within and outside the National Park.
- c) Banning of use of Air-rifles/Air guns within the Park by the tourists.
- d) Periodical monitoring of the resident and the migratory populations within MGMNP. Habitat augmentation shall be done by creating artificial perches, water bodies, protection of roosting and breeding sites, etc.
- e) Demarcating roosting areas of birds in adjoining areas outside the National Park and monitoring of such areas. Preparation of maps of such areas for management purpose.
- f) Motivating the local populace towards conservation of such habitats outside the National Park by emphasizing on the significance of such habitats.
- g) Taking up of behavioural studies of the bird populations including their migratory patterns.
- h) Conducting periodical bird census in the Park with the help of NGO / Scientific Institutions. The data will be collected as per Annexure-XXIX.

#### 7.4 Sea Turtle Conservation

Sea turtles are the scavengers of the high seas. They feed on debris in the sea waters and keep it clean. Sea turtles namely Olive Ridley, Hawksbill, Green and Leather back turtles use the beaches of MGMNP particularly Jhajji in Rutland, Tarmugli, Twins, Boat Islands for nesting. Park area is also a known feeding ground for the Olive Ridley and the Green Sea Turtles. The population of sea turtles are susceptible to fishing activities in the open seas. They often get caught as by-catch or get entangled in nets. Ingestion of plastic refuse floating the sea is also common place. The sea turtle populations are in need of urgent conservation.

##### 7.4.1 Objectives

- a) To provide for a safe habitat to the sea turtles within the Park.
- b) Ensuring a disturbance free feeding ground for them in the Park.
- c) To protect their nesting sites within the Park from biotic interference.
- d) To maintain record of turtle nesting in the Park.

##### 7.4.2 Strategies

- a) Strict implementation of the protection measures within and in the fringing areas of MGMNP.

- b) Ensuring heightened protection during the seasonal migration for nesting.
- c) Ensuring the feeding grounds are protected and augmented.
- d) There shall be no disturbances to the nesting beaches within MGMNP.
- e) To monitor and ensure that the anthropogenic activities in adjoining coastal areas, particularly in beaches and creeks are not detrimental to the ecology of the sea.
- f) Sand mining, beach armouring, exotic plantation activities in beaches of MGMNP shall continue to be strictly prohibited.
- g) Close monitoring of the turtle population, their habitat, nesting beaches, habits, etc.
- h) Awareness creation about the importance of sea turtles, laws governing them, etc. amongst the locals, particularly the fishermen. Dumping of nets, sewage, human wastes are to be avoided strictly and awareness created against the act. Use of technology, like, acoustic devices, Turtle Excluder Devices (TED), will be promoted amongst the fishermen.
- i) Temporary camps will be established in nesting sites like Jhaji Beach, Twin and Boat Island during nesting season to protect the nesting areas from biotic interferences.
- j) Data on the nesting turtles shall be maintained as per the format given at Annexure-XXIV.

## 7.5 Dugong Conservation

The word `dugong\_ is derived from the Tagalog term dugong which was in turn adopted from the Malay duyung, both meaning `lady of the sea\_. Other common local names include `sea cow\_, `sea pig\_ and `sea camel\_. The global distribution of this endangered species is limited to the warm temperate and tropical coastal waters of Indo-Pacific region between the east coast of Africa and Red Sea to the west coast of Australia. In India Dugongs occur along the coast of Gulf of Kutch, Gulf of Mannar and Palk Bay and in the Andaman and Nicobar Islands. Herds of hundreds of dugongs were reported to have once occurred in Palk Strait between India and Sri Lanka while dugongs are believed to be extinct in the Maldives and the Lakshadweep Islands.

Dugongs have an important ecological role as the gardeners of the Sea-grass habitats. With their feeding style, they help in nutrient re-cycling which in turn allow the Sea-grass beds to flourish. This in turn help many species of invertebrates and fishes to

survive and flourish as the Sea-grass beds act and serve as a foraging and nursery grounds for such species.

Dugongs are one of the two marine- mammals found in Andaman and Nicobar Islands, making it a most charismatic species. However, being a mammal and having specific dietary requirement, the animal is found in quite less in number. ZSI reported 44 individuals in the year 2012. Breeding occurs throughout the year and peak months for birth vary geographically. The length of gestation is about 374 days. Single calf is the norm and twins are quite rare. The dugong is classified as vulnerable to extinction by the World Conservation Union on the basis of decline in area of extent of occupancy, habitat quality, and actual or potential levels of exploitation.

In the Mahatma Gandhi Marine National Park, the Dugongs have been sighted around Chester, Grub, Tarmugli, Boat, Malay, Hobday and Pluto Islands. The Dugongs have also been sighted in the adjoining areas like Constance Bay inside the Jarawa Tribal Reserve and in the seawaters around the fishing villages like Wandoor, Manjeri, Guptapara, Chidiyatapu, Rutland, Rangachang and Burmanallah.

#### 7.5.1 Objectives

- a) To provide for a safe habitat to the dugongs.
- b) Ensuring a disturbance free feeding ground.
- c) Ensuring disturbance free and protected nesting and to conserve a thriving population having global implication.
- d) To create awareness among the local people and sensitize them regarding the importance of conserving the Dugongs for protecting their livelihoods particularly of that of local fishermen.
- e) To build the capacity of the staff and veterinary personnel in Dugong identification, handling of Dugong stranding and Dugong rescue.
- f) To establish an emergency stranding response team for rescue of stranded animals.
- g) To take various measures to conserve the Dugong habitats outside the boundaries of the Park.

### 7.5.2 Strategies

- a) Strict implementation of the protection measures within and in the fringing areas of MGMNP. Boat patrols and beach patrols intensity to be increased, by increasing staff strength and boat infrastructure, as delineated under Protection Plan especially in Dugong habitats.
- b) Ensuring the feeding grounds are identified, demarcated, protected and augmented.
- c) To monitor and ensure that the anthropogenic activities in adjoining coastal areas, particularly in beaches and creeks are not detrimental to the ecology of the sea. Localised pollution loads impact the sea-grass beds, which in turn will negatively impact the presence of dugongs. Regular monitoring and assessment of the water quality and both qualitative and quantitative surveys of the sea-grass beds is necessary. As Department might not be fully equipped for such rigorous scientific monitoring, institutes/agencies of repute like ZSI, WII, NCBS, state/central universities, etc. may be roped in.
- d) Monitoring dugong distribution and relative abundance using regular aerial surveys every year. Mapping of potential feeding habitats will be done and habitat use pattern by the animal shall be ascertained.
- e) Understanding the ecological behaviour of Dugongs, their migratory, territorial, breeding and parturition behaviours by satellite /remote monitoring.
- f) All vessels/boats operating in Andaman and Nicobar Islands should have a dugong sighting log which will enable to understand the distribution of dugong in all over these islands as well as effective management.
- g) Development of a chart detailing the distribution of sea-grass beds in Andaman and Nicobar Islands to allow fishermen to identify potential dugong areas so that they can avoid fishing in such areas.
- h) Awareness creation about the importance of dugongs, laws governing them, etc. amongst the locals, particularly the fishermen folks. Dumping of nets, sewage, human wastes are to be avoided strictly and awareness created against the act. Use of technology, like, acoustic devices, animal exclusion devices, etc. should be promoted amongst the fishermen.

- i) Capacity building of staff and veterinary personnel through regular training on Dugong identification, reporting of Dugong sightings, handling of Dugong stranding, rescue of entangled Dugong in nets, etc.
- j) An emergency stranding response team comprising of forest staff and local fishermen will be constituted to provide first aid to the stranded animal.
- k) Efforts will be made to regulate the speed of fishing boats passing through the Park in consultation with Fisheries Department. The boat owners will be encouraged to fix propeller guards on boats to prevent injury to Dugongs.
- l) The local committees will be engaged for long term conservation of Dugong habitats falling outside the Park boundary, in collaboration with the Fisheries Department. The local fishermen community will be suitably sensitized and encouraged to rescue and release entangled Dugongs, not to anchor their boats on Sea-grass habitats and not to undertake fishing in Dugong habitats.

## CHAPTER 08

### ECO- DEVELOPMENT

No environmental conservation or management strategy is sound unless the needs, aspirations and livelihoods of people who depend on ecosystem resources and benefits are recognised and fully integrated. The effective management of ecosystem requires consideration not only of the biological and ecological parameters of the system but also the social and economic factors that condition their utilization by human societies.

Coastal zones are particularly susceptible to conflicts between various user interests. The coasts represent a sequential series of ecosystems that constitute the interface between the aquatic and terrestrial realms. The coasts comprise a set of diverse habitats on land and in water that provide a multitude of social benefits and economic resources on which the majority of the population directly or indirectly depends. The coastal populations residing around MGMNP are not deprived of economic resources by constituting the MGMNP since vast stretches of coasts are available outside the MGMNP for exploitation. The Andaman & Nicobar Islands has a coast line of approximately 1962 km and 600 thousand km<sup>2</sup> under Exclusive Economic Zone. However, the linkages between human activities and impact on land and in the sea are intimate and immediate since the population in the adjoining villages of MGMNP lives on or near the coast. The threats to the MGMNP are sedimentation of near shore coastal ecosystem- Coral Reefs, Sea Grass beds and Mangroves by terrestrial run off and dredged sediment, discharge of solid and liquid waste into near shore waters, unsustainable and illicit harvesting of living marine resources and denudation and erosion of littoral habitats in the adjoining areas of MGMNP.

To minimize the threats to the natural ecosystems of MGMNP and to protect its resource integrity it is essential to integrate the multiple use nature of coastal zone and prevent human over exploitation. Assessment, evaluation and integration of socio economic factors governing the use and abuse of coastal resources become critical for this purpose. The same has to be addressed through eco - development activities in the villages adjoining the MGMNP area.

## 8.1 Objectives

- a) To identify the socio-economic factors influencing the territorial ecosystem and marine ecosystem.
- b) To improve the capacity of the MGMNP Management to conserve biodiversity and increase the opportunities for local people's participation in PA management, through providing employment opportunities.
- c) To promote collaboration of local people in conservation efforts.
- d) To make the community residing around the Park aware regarding the importance of conservation of flora and fauna.

## 8.2 Components of Eco - Development

The Eco-Development programme of MGMNP should include components such as Improved PA management, Education and awareness, Impact monitoring and research.

More than 8000 people are living in villages adjoining MGMNP as per Census 2011. The Eco - development projects aims to reduce the biotic pressure by addressing the social and economic needs employing sustainable approaches by creating Eco - development committee in the villages adjoining the Marine National Park and various user groups.

The Eco - development activities can create a positive impact on the overall development and provide diverse employment opportunities to local people, improved benefit sharing in tourism management, reduction in the negative dependency, greater dissemination of MGMNP values and improve relations between MGMNP and the fringe villagers.

## 8.3 Eco Development Committees (EDC)

Efforts will be made to form Eco-development Committees (EDC) in the villages located around the Park. The provisions of the Resolution dated 8.8.2011 of the Andaman and Nicobar Administration regarding the formation and working of the EDC shall be followed in this regard. Through these EDC's, efforts will be made to promote participation of local people in the management of the Park and to improve their livelihood opportunities by employing the villagers as tour guides, boat operators, nature interpreters, etc.

## 8.4 Microplan

For each EDC a Microplan will be prepared based on the need assessment of the villagers. The Microplan will be prepared in a participatory manner and will contain the list of the activities to be carried out within the framework of the Management Plan. The Microplan should aim to make the EDC self-sustainable and free from dependencies on the Park.

## CHAPTER 09

### ORGANIZATION AND ADMINISTRATION

The Chief Wildlife Warden heads the wildlife wing of the Department of Environment and Forests, Andaman & Nicobar Islands who is assisted by Addl. PCCF(WL), CF(WL) and ACF(WL-HQ). There are five divisions under wildlife wing namely Wildlife Division - I, Wildlife Division - Mayabundar, Swarajdweep (erstwhile Havelock) Division, Nicobar Forest Division and Biological Park, Chidiyatapu. All the Divisional Forest Officers and Deputy Conservator of Forests in-charge of territorial divisions and wildlife are ex - officio Wildlife Wardens. The Assistant Conservator of Forests and the Forest Rangers working in territorial and wildlife divisions are ex - officio Assistant Wildlife Wardens. The Mahatma Gandhi Marine National Park, Wandoor is one of the Protected Areas falling under Wildlife Division - I and the overall administration and management of the park is the responsibility of the Deputy Conservator of Forests, Wildlife Division-I. The Deputy Conservator of Forests is assisted by Assistant Conservator of Forests (Wildlife) and Assistant Conservator of Forests (Head Quarters). The Deputy Conservator of Forests is responsible for achieving the management objectives by judicious use of resources, both men and material, placed at his/her disposal.

All the activities of MGMNP is managed by two Ranges namely Wandoor Range and Research and Survey Range and Wandoor is the Headquarter of both the Ranges. The territorial functions are carried out through Wandoor Range. The Range Officer, Wandoor is in charge for the protection and management issues related to the park. He is also responsible to enforce various provisions of the Indian Forest Act, 1927, the Wildlife (Protection) Act, 1972, the Forest Conservation Act, 1980, the Environment Protection Act, 1986 and the Coastal Zone Regulation, 1991 in the entire Marine National Park area. He is also accountable for the protection, upkeep and maintenance of all resources namely boats, buildings, VHF network, equipments, jetty at Wandoor, mooring buoys, patrolling camps and boundary pillars, etc. He is also responsible for organizing wild animal census in MGMNP.

To perform the above functions, the Range Officer, Wandoor is provided with Camp Officers and there are three camps in Wandoor Range namely Headquarters, Watercraft and Protection. Deputy Rangers and Foresters are the incharge of the camps (Table No. : 22).

Table No. 22 : Staff position at MGMNP, Wandoor

| S.No.            | Staff Details     | Number |
|------------------|-------------------|--------|
| Executive Staff  |                   |        |
| 1                | Forest Ranger     | 01     |
| 2                | Deputy Ranger     | 01     |
| 3                | Forester          | 04     |
| 4                | Head Forest Guard | 02     |
| 5                | Forest Guard      | 04     |
| Afloat Staff     |                   |        |
| 1                | M. B. Driver      | 01     |
| 2                | Oiler             | 01     |
| 3                | Lascar            | 01     |
| Industrial Staff |                   |        |
| 1                | Assistant Fitter  | 01     |
| 2                | Regular Mazdoor   | 17     |

The Range Officer, Research and Survey Range is responsible for survey, monitoring, tourism and visitor management. He is responsible for conservation education, organizing nature camps and maintaining the Interpretation Center. He is also responsible for the upkeep and maintenance of Wandoor Forest Rest House. To perform the above functions the Range Officer is provided with two Camp officers at the level of Deputy Rangers for Tourism and Forest Rest House (Table No. : 23).

Table No. 23 : Staff position at Research & Survey Range, Wandoor

| S.No.           | Staff Details                | Number |
|-----------------|------------------------------|--------|
| Executive Staff |                              |        |
| 1               | Forester                     | 02     |
| 2               | Forest Guard                 | 04     |
| Afloat Staff    |                              |        |
| 1               | 1 <sup>st</sup> Class Master | 01     |
| 2               | Sarang                       | 01     |
| 3               | Seacunny                     | 01     |
| 4               | Oiler                        | 01     |

|                  |                                     |    |
|------------------|-------------------------------------|----|
| 5                | Lascar                              | 04 |
| Industrial Staff |                                     |    |
| 1                | Regular Mazdoor                     | 20 |
| 2                | Daily Rated Mazdoor<br>(Continuous) | 02 |
| Other            |                                     |    |
| 1                | Projector Operator                  | 01 |

### Wandoor Range :

The Range Officer, Wandoor is responsible for the issues related to the Protection, Conservation and Management of MGMNP. He is also responsible to enforce various provisions of the Indian Forest Act, 1927, the Wildlife (Protection) Act, 1972, the Forest Conservation Act, 1980, the Environment Protection Act, 1986 and the Coastal Zone Regulation, 1991 in MGMNP. He is accountable for the protection, upkeep and maintenance of resources namely the Range Office, Camp Offices, Residential accommodations, VHF network, patrolling camps and boundary pillars, etc.

It is prescribed to have a maintenance regime for the boundary pillars of MGMNP once in two years. The Range Officer, Wandoor alongwith the Camp officer incharge of that area should inspect all the pillars in MGMNP to ascertain their status. The damaged pillars if any should be re- erected. The Range Officer should also maintain a boundary pillar register for MGMNP. It is also prescribed the status of boundary pillars in MGMNP should also be reflected in the charge handing over and taking over note of Range Officers. Similarly, the Camp Officer / Beat Officer Incharge should also have a register with details of boundary pillars in his area and frequently check the status of the same while conducting patrolling / combing activities. All construction activities within and for MGMNP including maintenance shall be the responsibility of this Range.

### Research and Survey Range:

Though research within the Marine National park in the areas prescribed would be carried out by various organizations, institutes and universities, it is imperative to have a Range exclusively for survey and monitoring purposes. The Range Officer, Survey and Monitoring shall carry out the survey and monitoring in MGMNP as per

the prescriptions made on various subjects in the Management Plan and shall also coordinate with all agencies involved in research activities at MGMNP. Periodic monitoring and surveys are to be carried out as prescribed and the same compiled, collated and analysed and report submitted to the Deputy Conservator of Forests in a time bound manner. He is also accountable with regard to regulation of researchers entry and operation into and within MGMNP based on approvals received from CWLW. The scuba diving unit with the Range should be put to good use by being involved in all water based monitoring and surveys as well as for capacity building of the workforce of the Department. Necessary infrastructure augmentation shall be necessary.

The Range shall also be responsible for conservation education, interpretation programmes and accountable for development and maintenance of main visitor center and information center of Interpretation including upkeep and maintenance of boats, the Forest Rest House at Wandoor.

It is proposed to continue with the present administrative set-up. However, in near future, the staff strength requires being increased along with infrastructure; number of protection camps within the park may be increased by defining beats and making beat incharges.

#### Staff requirement :

To perform the various functions and the execution of works prescribed in the plan additional manpower is essential and the plan proposes to provide additional staff, both industrial as well as executive staff of the level till forester. Presently most of the industrial and afloat staff are beyond fifty years. 60% of the executives strength is above fifty, which ultimately compromises the protection front. The requirement of staff is presented in Table No. 24.

Table No. 24 : Table showing additional requirement of staff

| S.No.           | Staff Details           | Number | Remarks                                    |
|-----------------|-------------------------|--------|--|
| MGMNP Range     |                         |        |  |
| Executive Staff |                         |        |  |
| 1               | Head Forest Guard       | 02     | For conservation and protection            |
| 2               | Forest Guard            | 02     |  |
| 3               | LMV Driver              | 01     | For LMV of MGMNP Range                     |
| 4               | Industrial Mazdoors     | 10     | For overall management of MGMNP Range      |
| R & S Range     |                         |        |  |
| 1               | Head Forest Guard       | 01     | For Tourism camp                           |
| 2               | Forest Guard            | 02     | For Coral Monitoring and Scuba Unit        |
| 3               | Industrial Mazdoor      | 08     | For overall management of R & S Range      |
| 4               | Marine Biologist        | 01     | For undertaking Research in Marine Biology |
| 5               | Asstt. Marine Biologist | 01     |  |

Staff posting :

Presently 18 executive staff are posted. The Marine National Park requires frontline Staff who are experienced in conservation and protection measures and have inclination towards enforcement activities. Since the nature of job involves frequent patrolling in sea areas, camping in islands, survey and monitoring of terrestrial and marine fauna, management of tourism, diving and snorkelling, camping at remote islands, etc., it is imperative to post suitably healthy staff. Regular screening of their health and monitoring of their welfare is necessary. Regular capacity building programmes for the frontline staff in self defence, laws and implementation, personality development, etc. is imperative to keep them motivated all along to serve in the tough waters. It is pre-requisite that staff posted in wildlife units should be trained by reputed institutes having experience of PA management at Andaman itself like WII.

R&S Range shall offer one week regular course for new recruits of the Department and refresher course on wildlife management techniques like census & survey of wildlife animal and SCUBA diving (Certification) for the existent Departmental Staff at Tarmugli island of MGMNP by integrating it in curriculum of Forest Guard and

Foresters at FTI. Postings of staff to Wildlife Division should be as per the capacity so developed over time in the service of such staff.

The marine water is habitat for various endemic and endangered species of wildlife and almost 80% of the area in this park is water. In order to manage such a large area of marine habitat regular research back up is needed and for this purpose provision for one Marine Biologist and A sst. Marine Biologist is made in the plan to undertake such activities.

Amenities available for Staff :

Most often, wildlife staff are posted in remote and tough areas. Working in the marine environment particularly in mangroves, creeks, reefs etc. is a difficult proposition and the staff should therefore be provided with the required facilities so as to get the best out of them. Camping at the Range/Camps thus should be ensured in a staggered manner so that presence of staff is always there for immediate and unforeseen works/necessary activities.

Housing:

A total of 37 residential units are available at Wandoor, Mamyo and Pongibalu for accommodation of staff and employees of MGMNP, in addition to the Forest Rest House and other office buildings. The list of buildings at Wandoor, Mamyo and Pongibalu is presented in table No. 25 and 26 .

Table No. 25 : Details of buildings (Other than Quarters)

| Sl. No. | Details of Buildings         | Location        |
|---------|------------------------------|-----------------|
| 1       | Marine Interpretation Centre | Wandoor         |
| 2       | Auditorium                   | Wandoor         |
| 3       | Reef Forest Rest House       | Wandoor         |
| 4       | Ticket Counter               | Wandoor         |
| 5       | Check Post                   | Pongi Balu      |
| 6       | Protection Camp              | Tarmugli Island |
| 7       | Protection Camp              | Cinque Island   |

Table No. 26 : Details of Quarters

| S.No. | Type of Quarters        | Location   | Number |
|-------|-------------------------|------------|--------|
| 1     | Type-IV                 | WANDOO R   | 1      |
| 2     | Type-III                | WANDOO R   | 1      |
| 3     | Type- III               | Mamyo      | 1      |
| 4     | Type-II                 | WANDOO R   | 4      |
| 5     | Type-II                 | Mamyo      | 4      |
| 6     | Type-II                 | Pongi Balu | 2      |
| 7     | Type-I                  | Wandoor    | 2      |
| 8     | Type I                  | Mamyo      | 2      |
| 9     | 4 Family Labour Barrack | Mamyo      | 3      |
| 10    | 4 Family Labour Barrack | Pongi Balu | 2      |

Any construction of accommodations/amenities for the welfare of the staff and for conservation purposes at MGMNP shall be carried out on required basis after taking due approval of the CWLW or any authority as authorized by CWLW.

Vehicles/Watercrafts:

Mobility is of prime importance since Protection is the paramount activity in marine National Park. Surveillance and monitoring is required both on land and sea. Presently, the following vehicles/watercrafts are available with MGMNP:

**Table No. 27 : Details of Vehicles and Marine craft at MGMNP**

| Sl/ No.    | Details of Vehicles and Marine craft | Number |
|------------|--------------------------------------|--------|
| Vehicles   |                                      |        |
| 1          | Tata Xenon pickup Van                | 01     |
| 2          | Motor Cycle                          | 01     |
| Watercraft |                                      |        |
| 1          | Dug Out Engine Dinghy                | 03     |
| 2          | Glass Bottom Boat                    | 03     |
| 3          | Fibre Boat                           | 02     |
| 4          | Yamaha 40 HP Engine                  | 01     |
| 5          | Yamaha 25HP Engine                   | 01     |
| 6          | Hondex 40 HP Engine                  | 01     |

**Table No. 28 : Details of Vehicles and Marine craft at R & S Range**

| Sl. No. | Details of Marine craft  | Number |
|---------|--------------------------|--------|
| 1.      | Wooden Boat (Sea Spirit) | 01     |
| 2.      | Boat (M.V. Lalram)       | 01     |
| 3.      | Boat (M.V. Van Sevak)    | 01     |
| 4.      | RIB Yamaha 115 HP        | 01     |
| 5.      | RIB Tohatshu 115 HP      | 01     |
| 6.      | Yamaha 15 HP             | 01     |
| 7.      | OBM Hondex               | 02     |
| 8.      | Tohatshu 40 HP           | 02     |
| 9.      | Yamaha 25 HP             | 01     |
| 10.     | Yamaha 8 HP              | 01     |
| 11.     | Yamaha 75 HP             | 01     |

Sea-worthy fibre- boats with cabin facilities are necessary in the recent times with technological changes and advancements observed. Protection strategies are to be furthered with development of infrastructure which is pre-requisite for effective implementation of protection. Advancements in technology for remote monitoring techniques are to be employed. Further, the executive staff shall be trained in handling of the vehicles and watercrafts as well for meeting exigent situations.

CHAPTER 10

BUDGET AND FINANCIAL OUTLAY

In the past Management Plan it has been observed that many times, even though provisions were made under the Management Plan, many prescriptions could not be implemented due to either paucity of funds or for Administrative delays.

Funds are to be projected every year as per the norm of the State and necessary provisions for meeting the requirement of the management of the Park shall be made every year. Augmentation shall be done under the available Central funds. If admissible fund available with CAMPA shall also be used for this purpose.

The financial outlay projected for the upcoming 10 years is as follows:

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| t ㄱIXI t ㄱIXI IX<br>a ㄱIXI t ㄱIXI IX                                | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ |
| t ㄱIXI t ㄱIXI IX<br>- ㄱIXI t ㄱIXI IX                                | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ |
| t ㄱIXI t ㄱIXI IX<br>IXI t ㄱIXI IX<br>IXI t ㄱIXI IX<br>IXI t ㄱIXI IX | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ |
| t ㄱIXI t ㄱIXI IX<br>IXI t ㄱIXI IX                                   | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ |
| t ㄱIXI t ㄱIXI IX<br>! ㄱIXI t ㄱIXI IX<br>! I I ㄱIXI IX               | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ |
| t ㄱIXI t ㄱIXI IX<br>IXI t ㄱIXI IX<br>t ㄱIXI t ㄱIXI IX               | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ | ㄱ |







The implementation timeline of the present Management Plan shall be for a period of ten years, with a scope of review at 5<sup>th</sup> year of implementation, based on the date of approval of the Management Plan by the Competent Authority.