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Protecting Penang's Marine Biodiversity: Establishing the Middle Bank Marine Sanctuary (MBMS)

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Protecting Penang's Marine Biodiversity: Establishing the Middle Bank Marine Sanctuary (MBMS)

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1. INTRODUCTION: ASKING THE RIGHT QUESTIONS

Lying at the northern end of the Strait of Penang just off the eastern coast of George Town, the Middle Bank is a ridge that plays a key role in the environmental and ecological health and sustainability of the seas surrounding the state of Penang.[1]

In 2021, Centre for Marine and Coastal Studies at Universiti Sains Malaysia (CEMACS, USM) and Penang Institute were tasked by the Penang State Government to undertake studies and prepare the groundwork for the gazettement of the Middle Bank area as a marine sanctuary to be named the Middle Bank Marine Sanctuary (MBMS).

This report is the first of several done in line with that mandate. It presents in detail key ecosystems and biological species found in the Middle Bank, and describes the crucial ecological functions provided by them. Apart from being an area rich in fisheries resources, the Middle Bank is acknowledged to house unique ecosystems such as seagrass beds, fish nursery areas, and marine feeding grounds for resident and pelagic species.

2. STUDY PHASES

Studies relevant to the gazettement of the Middle Bank Marine Sanctuary (MBMS) project are herewith divided into three phases, as listed below.

a) First Phase – An investigation into the natural components of the Middle Bank (This report)

This phase provides a detailed description of the natural conditions found in the MBMS area. Multiple field surveys were done between October 2021 to March 2022. These include:

i. Mapping of the natural areas of the Middle Bank and Pulau Gazumbo using satellite imageries, aerial drones, and ground truthing to determine the extent and distribution of these natural ecosystems.
ii. Determining the diversity of these natural ecosystems and taxonomic investigation of their biological components.

The results of this phase provide a baseline on the type and distribution of the ecosystems and their components. This report will be essential to understanding and promoting the MBMS establishment, and also provides information required for the future management of the sanctuary.

b) Second Phase – An investigation into the human impact on the Middle Bank and the restoration of its ecosystems

The project's second phase focuses on the human impact on the MBMS. The large human population centres on the fringes of the MBMS and the varied land uses there carry significant impact for the MBMS. It is, therefore, necessary to determine the type and degree of such activities on the health and sustainability of the proposed park.

This phase will determine the areas affected and what follow-up steps needed to be taken to restore and improve the MBMS area.

[1] A series of articles on the Middle Bank can be accessed in the June issue of *Penang Monthly*. See https://penangmonthly.com/issue/20379

c) Third Phase – An investigation into the blue carbon value and potential of the Middle Bank

The project's third phase investigates the blue carbon value and potential of the MBMS and how this may be improved. Such a framework will guide the MBMS' establishment and its subsequent development and maintenance.

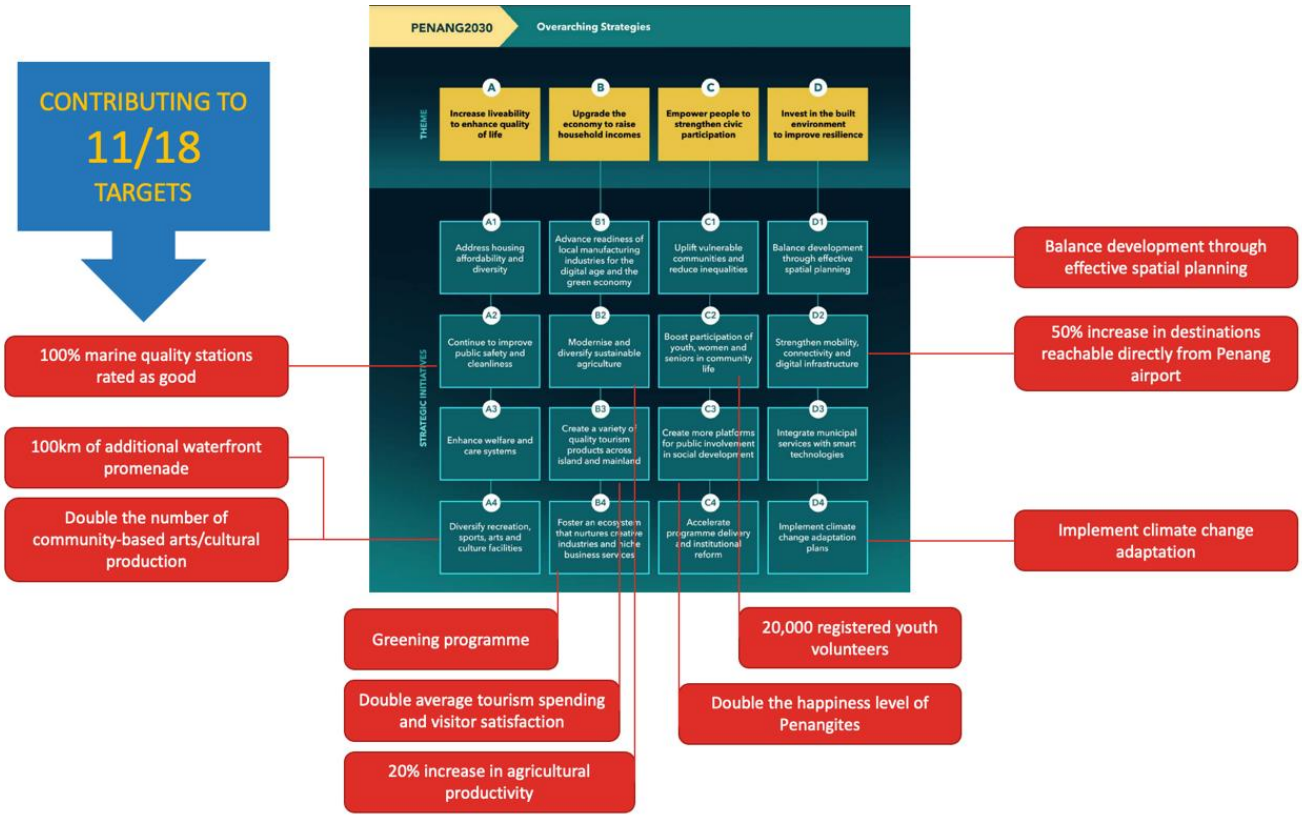
Pulau Gazumbo, Middle Bank, overlooking the eastern foreshore of Penang

3. SUSTAINABILITY AND THE MIDDLE BANK

The establishment of the Middle Bank Marine Sanctuary will be the first of its kind in Malaysia—a marine sanctuary sandwiched between urban settlements. MBMS is expected to improve the sustainability of Penang by meeting 10 of the 17 Sustainable Development Goals (SDGs) set by the United Nations (Figure 2-1). It will also help to substantiate the Penang Green Agenda 2030 (Figure 2-2) and address 11 of the 18 targets set by the State government.

Figure 2-1. Achievable SDGs (denoted by the circle) following the establishment of Middle Bank Marine Sanctuary (MBMS).

Figure 2-1. Prospective contribution of Middle Bank Marine Sanctuary (MBMS) to the Penang 2030 Agenda.



4. LOCATION OF THE MIDDLE BANK AND THE PROPOSED MARINE SANCTUARY

The Middle Bank Marine Sanctuary is located in the Strait of Penang, on the foreshore of Jelutong and Gelugor to the north of the first Penang Bridge (Figure 3-1). It is delineated by the boundary whose nodes are given in Table 3-1 below. The area covers approximately 10 square kilometres, of which less than 0.2% is land composed of the uninhabited island of Pulau Gazumbo Besar.

Figure 3-1. Map of the Middle Bank and the proposed Middle Bank Marine Sanctuary (MBMS).

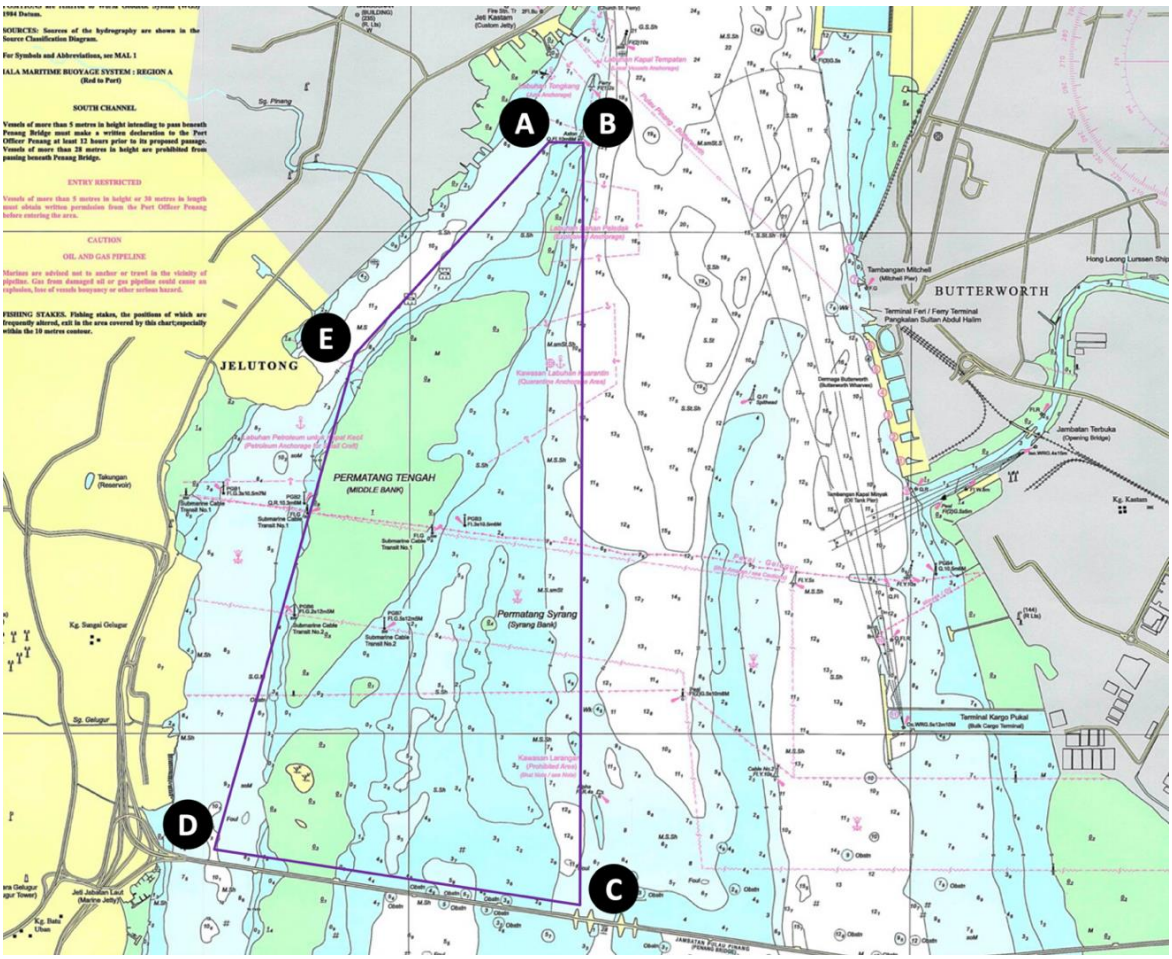


Table 3-1. GPS coordinates of the nodes on the borders of the Middle Bank Marine Sanctuary.

Nodes	Latitude	Longitude
A	5°24'20.97 "N	100°20'33.06 "E
B	5°24'20.36 "N	100°20'41.99 "E
C	5°21'19.32 "N	100°20'40.49 "E
D	5°21'32.48 "N	100°19'13.91 "E
E	5°23'30.15 "N	100°19'46.71 "E

5. HUMAN USE OF THE MIDDLE BANK

Middle Bank is one of a few traditional fishing grounds for artisanal fisherfolks residing in Batu Uban, Gelugor, Jelutong and Sungai Pinang, and who employ gill and drift nets, long lines (rawai) and crab pots (bubu).

Other inhabitants of Penang frequent the place to collect edible shellfish at the lowest tides, sometimes for sale at the local markets. The Middle Bank is also fast gaining popularity among sports fishermen.

Much of Penang's port activities occur in the Strait of Penang, especially at the North Butterworth Container Terminal (NBCT), Butterworth Deep Water Wharves (BW), Prai Bulk Cargo Terminal (PBCT) and Swettenham Pier Cruise Terminal (SPCT). The major infrastructures for these are located on the eastern bank of the Strait at Butterworth and do not coincide with the proposed park boundaries. Exceptions to these are the berthing sites for hazardous wastes (opposite the Jelutong landfill area) and the quarantine area (northeast of the proposed MBMS). Some dredging is carried out by the port authorities.

Three main projects had, before the MBMS project took off, been proposed by various actors for areas adjacent to the western boundaries of the proposed MBMS. The proposed boundaries of the MBMS took these developments into consideration, which are:

i. The coastal reclamation of the Light Development Project (Phases 3 and 4) just north of the bridge towards the Jelutong landfill.
ii. The development at the Jelutong landfill
iii. Realignment of the Jelutong waterfront

The list below summarises the major human use of the Middle Bank. The area is now used for:

i. Artisanal fisheries and fishermen jetties
ii. Sportfishing by local anglers
iii. Aquaculture cages
iv. Scientific research and monitoring
v. Food foraging by locals at low tide
vi. Conservation activities of seagrass beds and islands
vii. Marine traffic in the Penang Strait
viii. Port activities by the various port authorities
ix. Effluent discharge from drains and rivers of east Penang
x. Landfill at Jelutong and its activities
xi. Activities carried out by the Penang Bridge authorities

6. PHYSICAL SETTING, WATER DEPTH AND COASTAL GEOMORPHOLOGY

The Middle Bank is located south of the cape where George Town is located, and has over time naturally formed itself parallel to the eastern coastline of Penang Island. The sea to the north of it is narrow, but widens towards the south. Figure 5-1 shows the position and extent of the physical geography of the Middle Bank and illustrates the geomorphological profile of the area. Table 5-1 shows the percentage covered by different water depths. Much of the area (78%) is less than 5m in depth, with a significant portion being in the intertidal and shallow zones (less than 2m deep). Deeper areas are located in the eastern channel adjacent to the Gelugor-Jelutong waterfront. The deepest area of the MBMS lies close to the eastern edge of the proposed sanctuary, close to the mid-section of the Strait of Penang.

Figure 5-1. The geomorphological profile and main ecosystems of the Middle Bank.

Table 5-1. The area and percentage covered by different water depths.

Water depths (Bathymetry)	Area (m^2)	Percentage (%)
0m-2m	4,414,447.00	42.20
2m-5m	3,806,366.99	36.39
5m-10m	1,839,973.80	17.59
10m-15m	400,350.78	3.83
TOTAL	**10,461,138.57**	**100.00**

6.1. Shallow intertidal areas

These are the areas that cover and uncover with the spring tides and are designated in green. The main area is an inverted tear-shaped bank that runs alongside the Jelutong-Gelugor shoreline. Much of the seagrass beds and associated ecosystems are found here. The shallow intertidal areas form a continuous bank that provides vital protection to the Penang coastline, as observed during the Indian Ocean Tsunami of 2004.

6.2. Subtidal seas

The subtidal areas below the water line that are deeper and lie beyond the intertidal zones are designated in light blue. This is the largest category of sea areas within the MBMS, and forms a vital fishing ground for local fishermen. The subtidal areas are important for the maintenance and survival of the MBMS ecosystems.

6.3. The coastal island of Pulau Gazumbo

Pulau Gazumbo is a man-made island located just north of the Penang Bridge. Dredged materials had once been left to form two islands – Pulau Gazumbo Besar and Pulau Gazumbo Kecil (Figure 5-2). The latter submerged since 2017 and can be seen as a shallow intertidal bank south of the main island. Pulau Gazumbo Besar is therefore the only island within the MBMS and forms a vegetated island with large casuarina trees. The centre of the island is a low-lying depression that is filled during high tide. Several important ecosystems are found at Pulau Gazumbo, including a stand of mangrove trees south of the island. The island is surrounded by sand beaches on the upper shore, which are replaced by mudflats and extensive seagrass beds on the lower shore.

Figure 5-2. Satellite imagery (taken in February 2021) of Pulau Gazumbo Besar and Pulau Gazumbo Kecil.

7. BIOLOGICAL COMMUNITIES AND ECOSYSTEMS

The extent and distribution of the main ecosystems on the Middle Bank are described below. This covers the land, the intertidal areas and the shallow seas found in the area.

7.1. Types of ecosystems

There are seven (7) main types of ecosystem found inthe Middle Bank area, as presented below:

7.1.1. The seagrass ecosystems

Categorically, these vegetated ecosystems are dominated by seagrasses and are unique in their component communities. Several types of seagrass areas are found on the Middle Bank and are named after the dominant seagrass species:

- **The *Halophila* communities** – These are dominated by the very short and creeping *Halophila ovalis*, commonly known as 'spoon grass' or 'Dugong grass', found at the mid-tide mark of Pulau Gazumbo and to the south of the Middle Bank. They can be seen as a large expanse of turf at low tide and are then frequented by wading birds and very small juvenile fishes. A high diversity of bivalves and gastropod snails forage on the substrate here. Photo 6-1 shows the *Halophila* communities found around Pulau Gazumbo at low tide.

Photo 6-1. The *Halophila* communities (green forefront) around Pulau Gazumbo at low tide.

- **The Enhalus communities** – Also known as 'tape seagrass' or 'eelgrass', these can be found from the middle section to the northern section of the Middle Bank. They are known locally as 'Jerangau Laut' or 'Setul'. Tape seagrass is the largest species of seagrass in the world, and the leaf blades can extend to more than a metre under water at high tide. This unique ecosystem provides food, shade and substrate in the vicinity of their stands. Their roots can extend more than 1.5m into the mud, binding the substrate and, together with other vegetative parts, providing food to the ecosystem.

- **The mixed seagrass communities** – In many areas of the Middle Bank, several co-dominant species exist together in one community and form a mixed seagrass community. Structurally they are the intermediate communities that lie beyond the dominant stands and allow for the migration of small invertebrates and juvenile fishes to extend their range on the bank. Co-dominant species include seagrass species such as *Thalassia hemprichii* and the uncommon *Halophila beccarii*. Seagrass stands are seen to be significantly deteriorating in many parts of the Middle Bank. This may be due to coastal erosion and changes in the substrate of the bank. A detailed study of this will be carried out in a following phase.

7.1.2. The mudflats

The open mudflats are the most extensive ecosystem of the Middle Bank and can be seen as vast areas of intertidal land exposed at the lowest tides. They run as a long wedge from north to south. The northern end is located south of the Aston navigational buoy near the foreshore of Weld Quay, and extends to the south of the Penang Bridge at Pulau Jerejak.

7.1.3. The sandy beaches

Large sand banks are found at the centre section of the Middle Bank near the Sungai Pinang foreshore/Jelutong foreshore. Other dominant areas where this ecosystem surfaces are at the upper shores of Pulau Gazumbo and an intertidal sandbank just south of the Penang Bridge at the Batu Uban foreshore. These are composed of highly porous sand that drains at low tide. Sandbanks support unique communities typified by several common shellfish species. They provide special nursery habitats for many marine animals, such as the horseshoe crab that is now critically endangered here. At high tide, several types of commercial fish predominate in this area.

7.1.4. Molluscs beds

The Middle Bank is rich in molluscan fauna. In subtidal and intertidal locations, significant tracks of the bank are covered by these animal communities. They modify the sea floor and support a unique habitat consisting of both living molluscs and their remnant shells. These are cemented by other microbiota to form the seabed. Dead snail shells are home to large populations of hermit crabs. Mollusc beds are rich in invertebrate diversity and form the basis of important marine food chains.

7.1.5. Subtidal ecosystems

These are areas of the Middle Bank that permanently lies beneath the sea, even at the lowest tides. The plant and animal communities here include the marine species we commonly associate with the sea. We have included both the pelagic and planktonic components of the Middle Bank in this category. Subtidal ecosystems are fluid by nature and, together with the benthic ecosystems mentioned above, form the main ecological components of the Middle Bank. They connect the bank to the seas adjacent to the Strait of Penang. Several marine mammal species, such as the bottlenose dolphin and the sea turtles, frequent these areas.

7.1.6. Mangrove ecosystem

A small stand of mangroves is found on the southern shore of Pulau Gazumbo. These are composed of several trees consisting mainly of *Avicennia*, *Brugierra* and *Rhizophora* species, and are sadly found to be in decline.

7.1.7. Island ecosystems

We have classified the plant and animal communities that reside on the only island of the Middle Bank – Pulau Gazumbo, as an important island ecosystem. These comprise true terrestrial plants, of which the casuarina or 'rhu' is the largest tree. They are complemented by smaller shrubs such as the wild jasmine and sea almond. Grasses and morning glory can also be found on the beaches

The interior of the island is a tidal depression that has been colonised by small halophytic salt-tolerant plants. The size of the island has been maintained since its creation during the construction of the Penang Bridge in the late 1980s, but recently there has been serious beach erosion on the southeast portion of the island. Several large casuarina trees rooted there have fallen into the water.

Pulau Gazumbo is home to several mammals and reptile species that have rafted from the mainland. These include several species of rodents and terrestrial snakes. One species of the coastal marine otter has also been recorded. There have been turtle landings in the past, most probably of the green turtle, Chelonia mydas and in the late 1990s, one large specimen of the endangered river terrapin, *Batagur baska* or 'tuntung', was encountered on the island during a

field trip by Universiti Sains Malaysia - although this would probably be a specimen that could have floated from the peninsular mainland.

It should be noted that there was another large island just south of Pulau Gazumbo known as Pulau Gazumbo Kecil. This less-vegetated island disappeared in 2017 but can still be seen at the lowest tides. This now forms an important subtidal bed with a rich invertebrate population. The recent disappearance of Pulau Gazumbo Kecil and the serious erosion now seen on the southern beaches of Pulau Gazumbo Besar are a serious concern.

The beaches of Pulau Gazumbo indicate a high degree of plastic waste pollution. This has certainly been coming from the island and mainland since the island was constructed in the late 1980s. In some areas of high deposition, these have formed layers beneath the sand and are a concern for the health of the ecosystem.

7.1.8. Human-introduced ecosystems

The Middle Bank is adjacent to the highly populated areas of Jelutong, Gelugor and Georgetown. The area is an important fishing ground and port. Human-introduced structures are found widely distributed in the vicinity of the bank. These include landing jetties and berthing for fishermen at Sungai Pinang, Jelutong and Gelugor. There are also aquaculture cages and their mooring. Some of these structures have sunk below the water line and formed artificial reefs. Others, like fish cages, have been moved to Pulau Jerejak. There is a small shipwreck recorded at the Syriang Bank (just west of Pulau Gazumbo) at a depth of about 3m. Two wooden wrecks are found along the Jelutong foreshore. Although these structures are not natural ecosystems, they are important in modifying the sea bed and act as home to many marine flora and fauna.

Navigation buoys are another artificial feature at the Middle Bank. These are maintained by the Marine Department and serve to delineate the shallow marine areas of the bank. The bases of some of these buoys are protected by rock piles that have formed special habitats for the marine benthos.

Photo 6-2. Aquaculture cages near the Jelutong coastline.

7.2. Areal coverage of the Middle Bank ecosystems

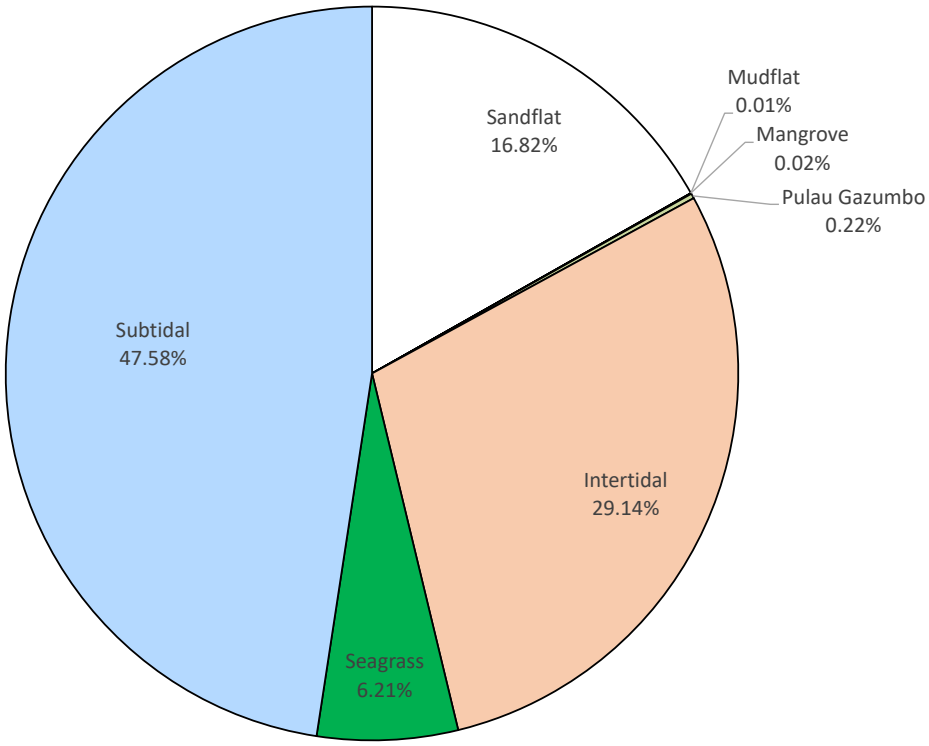
The total area coverage of the Middle Bank Marine Sanctuary (MBMS) is about 10.5 km^2. Of this, the most significant component are the shallow subtidal seas (47.6%), followed by the intertidal areas (land that is continually covered and uncovered by the tide (29.1%). The seagrass beds of the Middle Bank are located within the intertidal zone.

The small island of Pulau Gazumbo to the south is only 0.2 km^2 or 0.2% of the proposed sanctuary. However, apart from being the only portion of the sanctuary that is terrestrial, it is also home to the terrestrial island ecosystem. Figure 6-1 below summarises the area coverage of each coastal marine feature at MBMS.

Figure 6-1. The area and percentage of the coastal marine features in the Middle Bank Marine Sanctuary (MBMS).

Coastal-Marine Features	Area (m^2)
Sandflat	1,759,608.00
Mudflat	3,279.00
Intertidal	3,698,344.00
Subtidal	4,977,079.57
Pulau Gazumbo	22,828.00
TOTAL AREA (m^2)	**10,461,138.57**

	Area (m^2)
Mangrove area on the mudflat	2,610.00
Seagrass on intertidal	649,532.60



8. CONNECTIVITY OF ECOSYSTEMS

Although the Middle Bank is composed of different types of ecosystems, these are connected and are integral to the sustainable conservation of the whole Middle Bank. Each ecosystem supports adjacent ecosystems in the area. The diversity of ecosystems stimulates higher total biodiversity in the area. The component ecosystems reinforce each other through two main processes.

8.1. Physical and chemical connectivity

Water and its physicochemical components connect the ecosystems of the Middle Bank. The flow of marine waters in the Strait of Penang affects the physical stability of the area by controlling the transfer of sediment and nutrients to and from the Middle Bank. Similarly, the effluent waters from discharge points, especially at Sungai Pinang and Jelutong, introduce significant nutrients and pollution into the system. The effluent discharge also introduces solid wastes, which are more visible in the form of plastic debris that accumulates here.

Water flow affects both the depository and erosional forces that operate in the Middle Bank and influence the sediment budget of the area. The shallow intertidal banks stabilised by seagrass and molluscs beds offer coastal protection to Weld Quay, Jelutong and Gelugor. This was evident in the abatement of the tsunami surges in December 2004, which protected the coasts here.

8.2. Biological connectivity of the Middle Bank

Many critical biological processes connect the ecosystems of the Middle Bank. Through the marine food chain, a large number of fish populations are supported throughout the bank. The shallow banks generate food through benthic photosynthesis, which supports the animal populations of the Middle Bank. Material recycling, such as the carbon cycle, operates through the food chain and passes material from the sediment to the plants and marine animals. Such processes make the Middle Bank one of the world's carbon-rich ecosystems and are important in climate change mitigation.

9. BIODIVERSITY OF THE MIDDLE BANK

The biodiversity of the Middle Bank is high due to the ecosystems found here. This section of the report discusses the diversity found here and summarises the long-term research at the Middle Bank and current surveys in the area. Much of this research was done at CEMACS (Universiti Sains Malaysia) over the last 40 years.

The diversity is described through the categories of flora and fauna, which are further ascribed to the component ecosystems. Animal diversity is represented according to their taxonomic groups. These studies are continually growing, and the species list is not exhaustive but illustrates the ongoing findings of the research at Middle Bank.

9.1. Plant species of the Middle Bank

This section describes the plant species found on the Middle Bank, which include the terrestrial plants found at Pulau Gazumbo Besar, the intertidal ecosystems and plants found in the rest of the Middle Bank.

9.1.1. Seagrass species

Seagrass are the dominant flora of the Middle Bank. This is found in intertidal areas, which are its natural habitat. The species found on the Middle Bank are given in Table 8-1. The largest of these species, *Enhalus acoroides* or eelgrass, extends to more than one metre in height at high tide and forms an important microhabitat on the bank. The eelgrass is found in abundant patches north of the Middle Bank. Altogether seven species of seagrass are found on the Middle Bank. The diversity of the spoon grass (three species of *Halophila*) is the highest.

Table 8-1. List of seagrass species, with their scientific and common names, found on the Middle Bank.

Scientific name	Local name
1. *Enhalus acoroides*	Tape seagrass, Eel grass, Setul, Jerangau laut
2. *Halophila beccarii*	Spoon grass, Dugong grass, Rumput senduk
3. *Halophila ovalis*	Spoon grass, Dugong grass, Rumput senduk
4. *Halophila decipiens*	Spoon grass, Dugong grass, Rumput senduk
5. *Thalassia hemprichii*	Turtle grass, Sickle seagrass
6. *Halodule pinifolia*	Needle seagrass
7. *Halodule uninervis*	Needle seagrass

9.1.2. Macroalgae species

Fourteen (14) species of benthic macroalgae species have been discovered on the Middle Bank (Table 8-2). These include representatives of the red, green and brown algae. Some of these, such as the sea grapes (*Caulerpa* species), are commercial species. Both *Caulerpa* and *Gracilaria* are used in the local cuisine.

Table 8-2. Common species of benthic macroalgae, with their scientific and common names, found on the Middle Bank.

Scientific name	Local name
1. *Acanthophora spicifera*	Bulu tombong
2. *Avrainvillea erecta*	Elephant's Ear
3. *Caulerpa racemosa*	Sea grapes, Latok
4. *Caulerpa sertularioides*	Sea grapes, Latok
5. *Caulerpa taxifolia*	Sea grapes, Latok
6. *Gracilaria changii*	Sare
7. *Gracilaria edulis*	Sare
8. *Gracilaria manilaensis*	Sare
9. *Gracilariopsis bailiniae*	Red seaweed, Agar merah
10. *Halimeda discoidea*	Watercress, Coral algae
11. *Halimeda macroloba*	Sea cactus, coralline algae
12. *Halimeda tuna*	Sea cactus, calcareous green seaweed
13. *Sargassum plagiophyllum*	Brown algae
14. *Ulva reticulata*	Ribbon sea lettuce

9.1.3. Mangrove species

A small patch of mangrove is found in the southern part of Pulau Gazumbo, and the common species are well represented here (Table 8-3). However, there are few large trees, and the coverage of this habitat is dwindling.

Table 8-3. List of mangrove species, with their scientific and common names, found on the Middle Bank.

Scientific name	Local name
1. *Bruguiera cylindrica*	Bakau Berus, Bakau putih
2. *Avicennia marina*	Api-api jambu, Grey mangrove
3. *Sonneratia alba*	Mangrove apple, Perepat
4. *Rhizophora apiculata*	Bakau minyak
5. *Rhizophora stylosa*	Bakau pasir

9.1.4. Other coastal vegetation

Terrestrial vegetation is found on Pulau Gazumbo. They range from large trees to grasses on the island (Table 8-4). Some halophytic plants are found in the lagoon area at the centre of the island. These stabilise the soil and protect the island from coastal erosion (Photo 8-1).

Table 8-4. Coastal vegetation at Pulau Gazumbo (trees, shrubs and grass).

Scientific name	Local name
1. *Casuarina equisetifolia*	Casuarina, Horsetail Tree, Pokok Rhu
2. *Terminalia catappa*	Sea almond, Tropical almond, Ketapang
3. *Ximenia americana*	Sea lemon, Yellow plum, Tallow wood, Bidara laut
4. *Clerodendrum inerme*	Gambir laut, Wild jasmine
5. *Cordia subcordata*	Sea trumpet
6. *Cuscuta* sp.	Hairweed, Strangle tare, Wizard's net
7. *Ipomoea pes-caprae*	Sea morning glory, Tapak kuda
8. *Scaevola taccada*	Ambung ambung, Beach naupaka
9. *Taliparitiliaceum*	Sea hibiscus
10. *Sesuvium portulacastrum*	Gelang Laut

Photo 8-1. Aerial view of the coastal vegetation found to the north of Pulau Gazumbo Besar.

9.2. Animal species of the Middle Bank

These are the fauna found on the Middle Bank and comprise terrestrial, marine and bird species. Terrestrial species can be found on Pulau Gazumbo or may swim from the nearby island of Penang. This is true of the bird species with the additional migratory species that feed on the Banks. Marine species found here include macrofauna (marine mammals and fish) and smaller invertebrate groups.

9.2.1. Resident species and Transient/migratory species

The seasons influence the populations of animals found on the Middle Bank. They can therewith be grouped as resident species (those found here throughout the year) or migratory species (those found seasonally). Others, such as the fish species, can be pelagic and move into the areas following their prey or migrate to special sites to mate and breed. Marine mammals such as dolphins and reptiles (turtles) migrate to the Middle Bank and are commonly spotted at specific times of the year.

9.2.1.1. Commercial fish species of the Middle Bank

The Middle Bank area has been the main fishing ground for the artisanal fishermen from villages located within the Penang Strait. About 139 commercial fish species have recorded here (Table 8-5). These range from highly commercial and pelagic species such as *Rastrelliger* spp. (Temenong) and *Pampus* spp. (Bawal) to minor commercial species such as *Johnius* spp. (Gelama). Major commercial species caught in this area are the demersal species, which live and feed on or near the bottom of the sea, such as *Anodontostoma chacunda* (Kebasi), *Arius* spp. (Duri), *Trichiurus* spp. (Timah), *Himantura* spp. and *Gymnura* spp. (Pari).

Table 8-5. Commercial fishes of the Middle Bank.

Scientific name		Local name
1.	*Abalistes stellatus*	Leather jacket, jebong, triggerfish
2.	*Aetomylaeus maculatus*	Mottled eagle ray, pari lang tompok putih
3.	*Aetomylaeus nichofii*	Banded eagle ray, Pari lang jalur
4.	*Alectis indica*	Indian threadfish, cermin, rambai
5.	*Alepes djedaba*	Yellowtail Scad, Pelata
6.	*Aluterus monoceros*	Unicorn leatherjacket filefish, barat-barat
7.	*Ambassis interrupta*	Long-spined glass, petek, pridin
8.	*Amblygaster sirm*	Spotted sardinella, tamban sisek
9.	*Stolephorus commersonii*	Commerson's anchovy, bilis
10.	*Anodontostoma chacunda*	Chacunda gizzard Shad, Kebasi, Selangat
11.	*Ariomma indica*	Butterfish, ikan jepun
12.	*Arius jella*	Blackfin sea catfish, duri, pulutan, utek
13.	*Arius maculatus*	Spotted catfish, Duri tompok, Seludu
14.	*Arius venosus*	Veined catfish, duri, pulutan, utek
15.	*Atropus atropus*	Kuweh, Rambai, cleftbelly trevally
16.	*Atule mate*	Yellowtail scad, Selar gelek, Pelata
17.	*Auxis thazard*	Frigate tuna, aya kurik
18.	*Carangoides armatus*	Longfin trevally, demudok putih
19.	*Carangoides coeruleopinnatus*	Coastal trevally, demudok cupak

20.	*Carangoides dinema*	Shadow trevally, demudok
21.	*Carangoides malabaricus*	Malabar trevally, Rambai, chupak
22.	*Caranx sexfasciatus*	Bigeye trevally, kerepoh
23.	*Cephalopholis boenak*	Brown-banded grouper, kerapu tenggarong
24.	*Chiloscyllium griseum*	Grey bambooshark, yu bodoh
25.	*Chiloscyllium indicum*	Ridge-back bamboo shark, Yu Cicak, yu tokeh
26.	*Chirocentrus dorab*	Wolf herring, Parang Parang
27.	*Congresox talabonoides*	Indian pike conger, malong
28.	*Cynoglossus arel*	Largescale tonguesole, lidah sisik besar
29.	*Cynoglossus lingua*	Long tongue sole, lidah pasir
30.	*Cynoglossus macrostomus*	Malabar tonguesole, lidah sawa
31.	*Cynoglossus puncticeps*	Speckled tonguesole, lidah
32.	*Decapterus russelli*	Indian scad, selayang, curut
33.	*Dendrophysa russelii*	Goatee croaker, gelama janggut tanda
34.	*Deveximentum insidiator*	Pugnose ponyfish, kikek
35.	*Drepane punctata*	Spotted batfish, sickle fish, daun baharu
36.	*Dussumieria elopsoides*	Slender rainbow sardine, Round herring, tamban bulat, tamban buloh
37.	*Elates ransonnettii*	Dwarf flathead, Baji-baji
38.	*Eleutheronema tetradactylum*	Fourfinger threadfin, senangin
39.	*Ephippus orbis*	Spadefish, pluru
40.	*Epinephelus amblycephalus*	Banded grouper, anak pertang
41.	*Epinephelus areolatus*	Areolate grouper, kerapu bintik bulat
42.	*Epinephelus bruneus*	Longtooth grouper, pertang
43.	*Epinephelus chlorostigma*	Brownspotted grouper, kerapu
44.	*Epinephelus latifasciatus*	Striped grouper, kerapu garis
45.	*Epinephelus malabaricus*	Malabar grouper, kerapu, kertang
46.	*Epinephelus sexfasciatus*	Sixbar grouper, kerapu
47.	*Eubleekeria splendens*	Splendid ponyfish, kekek
48.	*Euthynnus affinis*	Kawakawa, aya kurik
49.	*Fistularia petimba*	Rough flutemouth, jenjulong
50.	*Gazza minuta*	Toothed ponyfish, kekek labu
51.	*Gerres erythrourus*	Silver biddy, kapas laut
52.	*Gerres filamentosus*	Long-rayed silver biddy, kapas laut, senohong
53.	*Grammoplites scaber*	Rough flathead, Baji kasar
54.	*Gymnura poecilura*	Long-tailed butterfly ray, Pari tembikar
55.	*Harpodon nehereus*	Bombay duck, lumi-lumi
56.	*Hexanematichthys sagor*	Sagor catfish, duri pedukang
57.	*Himantura uarnak*	Honeycomb sting ray, Pari rimau
58.	*Ilisha elongata*	Slender shad, beliak mata, puput
59.	*Johnius amblycephalus*	Bearded croaker, gelama janggut
60.	*Johnius belangerii*	Belanger's croaker, gelama, tengkerong
61.	*Johnius carutta*	Purple jewfish, gelama batu, gelama kling, gelama hitam
62.	*Johnius dussumieri*	Sin croaker, Gelama Keling
63.	*Katsuwonus pelamis*	Skipjack tuna, aya jalur

64.	*Kumococius rodericensis*	Spiny flathead, Baji duri
65.	*Lates calcarifer*	Barramundi, siakap
66.	*Leiognathus brevirostris*	Shortnose ponyfish, Kikek
67.	*Leiognathus equula*	Greater ponyfish, kekek gedabang
68.	*Lobotes surinamensis*	Tripletail, pelayak, patipok
69.	*Lutjanus argentimaculatus*	Mangrove red snapper, ikan merah, jenahak
70.	*Lutjanus johnii*	John's snapper, jenahak tanda
71.	*Lutjanus malabaricus*	Malabar blood snapper, Ikan merah
72.	*Lutjanus russellii*	Russell's on-spot snapper, ikan tanda
73.	*Megalaspis cordyla*	Torpedo scad, trevally, Cencaru
74.	*Megalops cyprinoides*	Indo-Pacific tarpon, bulan-bulan
75.	*Muraenesox cinereus*	Silver conger eel, malong
76.	*Nemapteryx caelata*	Engraved catfish, mayong
77.	*Nemipterus japonicus*	Japanese Threadfin bream, kerisi jepun
78.	*Nemipterus nematophorus*	Doublewhip threadfin bream, kerisi, aji-aji
79.	*Nemipterus nemurus*	Redspine threadfin bream, kerisi birat
80.	*Nemipterus peronii*	Notchedfin threadfin bream, kerisi
81.	*Netuma thalassina*	Saw-edged catfish, Giant catfish, Jahan, Goh
82.	*Nibea soldado*	Green-backed jewfish, croaker, gelama papan, gelama bongkok
83.	*Nuchequula blochii*	Twoblotch ponyfish, kikek
84.	*Opisthopterus tardoore*	Long-finned herring, nipis
85.	*Osteogeneiosus militaris*	Soldier catfish, duri muncung
86.	*Otolithes ruber*	Tigertooth croaker, tengkerong, gelama jarang gigi
87.	*Otolithoides biauritus*	Bronze croaker, tengkerong, gelama selampai
88.	*Pampus argenteus*	Silver pomfret, bawal putih
89.	*Pampus chinensis*	Chinese silver pomfret, bawal tambak
90.	*Parastromateus niger*	Black pomfret, bawal hitam
91.	*Pellona ditchela*	Herring, puput, beliak mata
92.	*Pennahia aneus*	Grey-fin jewfish, croaker, gelama pisang, gelama cherua
93.	*Pentaprion longaminus*	Long-finned silver biddy, kapas laut
94.	*Planiliza melinoptera*	Mullet, belanak perak
95.	*Platycephalus indicus*	Bartail flathead, baji ekor jalur
96.	*Plicofollis platystomus*	Flatmouth sea catfish, duri goh
97.	*Plicofollis platystomus*	Flatmouth Sea Catfish, duri, utik
98.	*Plotosus lineatus*	Striped eel catfish, sembilang karang
99.	*Polydactylus sexfilis*	Sixfinger threadfin, senangin buis rambu enam
100.	*Polydactylus sextarius*	Blackspot threadfin, senangin buis tanda
101.	*Pomadasys argenteus*	Lined silver grunter, gerut-gerut perak
102.	*Pomadasys argyreus*	Bluecheek silver grunt, gerut-gerut kepala batu
103.	*Pomadasys kaakan*	Javelin grunter, gerut-gerut
104.	*Pomadasys maculatus*	Spotted grunter, gerut-gerut sebokoh
105.	*Priacanthus tayenus*	Spot-finned bull's eye, Temenggong
106.	*Psettodes erumei*	Indian halibut, togok, sebelah
107.	*Pseudorhombus malayanus*	Malayan flounder, sebelah, sisa nabi

108.	*Pseudotriacanthus strigilifer*	Long-spined tripod fish, ikan lembu, barat-barat
109.	*Pterois russelli*	Lionfish, Gedempu, Lepu, Depu
110.	*Rachycentron canadum*	Cobia, aruan tasek
111.	*Rastrelliger brachysoma*	Short mackerel, kembong, temenong
112.	*Rastrelliger kanagurta*	Indian mackerel, Kembong, Temenong
113.	*Rhizoprionodon acutus*	Milk shark,Yu Pasir
114.	*Rhynchobatus djiddensis*	Shovel-nose ray, Yu Kemejan
115.	*Sardinella fimbriata*	Fringescale sardinella, tamban sisik tajam
116.	*Saurida tumbil*	Greater lizard fish, Mengkarong, Ubi, Chonor
117.	*Saurida undosquamis*	Brushtooth lizardfish, Mengkarong, Ubi, Chonor
118.	*Scatophagus argus*	Spotted scat, kitang, ketang
119.	*Scomberoides lysan*	Leatherskin, Talang
120.	*Scomberomorus guttatus*	Spotted spanish Mackerel, Tenggiri papan
121.	*Selaroides leptolepsis*	Yellowstripe scad, Selar kuning, lolong
122.	*Setipinna taty*	Scaly hairfin anchovy, kasai janggut
123.	*Siganus fuscescens*	Mottled spinefoot, kitang lada
124.	*Sillago aeolus*	Oriental sillago, puntung damar ubi
125.	*Sillago sihama*	Silver sillago, puntung damar perak, bulus-bulus
126.	*Sphyraena jello*	Giant sea pike, Barracuda, Alu-alu
127.	*Sphyraena obtusata*	Blunt-jawed sea-pike, Barracuda, Kacang lopek
128.	*Escualosa thoracata*	White sardine, bilis bunga air
129.	*Strongylura strongylura*	Spottail needlefish, todak, julung julung
130.	*Suggrundus macracanthus*	Large-spined flathead, baji duri besar
131.	*Telatrygon zugei*	Pale edged sting ray, Pari nyiru, Ketuka
132.	*Terapon theraps*	Large-scaled banded grunter, kerong-kerong, gendang
133.	*Thryssa hamiltonii*	Anchovy, jemedi, bakok daun
134.	*Thunnus tonggol*	Longtail tuna, Aya, kayu, tongkol hitam
135.	*Triacanthus biaculeatus*	Short-nosed tripodfish, cagak langit
136.	*Triacanthus nieuhofii*	Silver tripodfish, lembu
137.	*Trichiurus lepturus*	Large-headed ribbon fish, timah
138.	*Tylosurus crocodilus*	Hound needlefish, todak buaya, banang
139.	*Upeneus sulphureus*	Yellow goatfish, biji nangka

9.2.1.2. The bird species of the Middle Bank

The bird species found on the Middle Bank can be divided into resident species (continuously resident here) and the migratory species (found here seasonally). The Middle Bank shares its bird fauna with the nearby Important Bird Area (IBA) which is the Teluk Air Tawar-Kuala Muda IBA. Waders or shorebirds here do fly frequently to the south towards Kuala Juru-Sungai Sembilang-Batu Kawan mudflats, using the seagrass beds of Middle Bank to feed during low tide. These include the endangered *Numenius madagascariensis* (Far Eastern Curlew), *Tringa guttifer* (Nordmann's Greenshank) and *Calidris tenuirostris* (Great Knot).

The Middle Bank is the hunting ground for raptors such as *Haliastur indus* (Brahminy Kite) and the endemic *Haliaeetus leucogaster* (white-bellied Sea Eagle). Tall casuarina trees (*Casuarina equisetifolia*) at Pulau Gazumbo serve as its roosting and perching site. Although both species are listed as being of 'Least Concern' by the IUCN, the numbers seem to be in decline in certain parts of Southeast Asia, including Malaysia. Table 8-6 lists the birds that can be found on the Middle Bank and the adjacent coastal areas.

The diversity of bird species found here reflect its close proximity to the bird fauna found on the island of Penang.

Table 8-6. List of bird species found on the Middle Bank and the surrounding coastal areas.

	Scientific name	Local name
1.	*Acridotheres cristatellus*	Crested Myna
2.	*Acridotheres fuscus*	Jungle Myna
3.	*Acridotheres javanicus*	Javan myna
4.	*Acridotheres tristis*	Common myna
5.	*Actitis hypoleucos*	Common Sandpiper
6.	*Aegithina tiphia*	Common Iora
7.	*Aerodramus germani*	Germain's swiftlet
8.	*Agropsar sturninus*	Daurian Starling
9.	*Alophoixus phaeocephalus*	Yellow-bellied Bulbul
10.	*Anastomus oscitans*	Asian Openbill
11.	*Anthreptes malacensis*	Brown-throated Sunbird
12.	*Aplonis panayensis*	Asian glossy starling
13.	*Apus cooki*	Cook's swift
14.	*Ardea alba*	Great egret
15.	*Ardea cinerea*	Gray heron
16.	*Ardea intermedia*	Intermediate Egret
17.	*Ardea purpurea*	Purple heron
18.	*Ardeola bacchus*	Chinese Pond-Heron
19.	*Ardeola speciosa*	Javan Pond-heron
20.	*Arenaria interpres*	Ruddy turnstone
21.	*Aviceda leuphotes*	Black Baza
22.	*Bubulcus ibis*	Cattle egret

23.	*Butorides striata*	Striated heron
24.	*Cacomantis merulinus*	Plaintive Cuckoo
25.	*Calidris canutus*	Red knot
26.	*Calidris falcinellus*	Broad-billed Sandpiper
27.	*Calidris ferruginea*	Curlew Sandpiper
28.	*Calidris minuta*	Little stint
29.	*Calidris ruficollis*	Red-necked Stin
30.	*Calidris subminuta*	Long-toed Stint
31.	*Calidris tenuirostris*	Great Knot
32.	*Caprimulgus macrurus*	Large-tailed Nightjar
33.	*Charadrius alexandrinus*	Kentish Plover
34.	*Charadrius leschenaultii*	Greater sand-plover
35.	*Charadrius mongulus*	Lesser Sand-plover
36.	*Chlidonias hybrida*	Whiskered tern
37.	*Chlidonias leucopterus*	White-winged Tern
38.	*Chrysococcyx minutillus*	Little Bronze-Cuckoo
39.	*Cinnyris jugularis*	Olive-backed sunbird
40.	*Columbia livia*	Rock pigeon
41.	*Corvus macrorhynchos*	Large-billed Crow
42.	*Corvus splendens*	House crow
43.	*Cypsiurus balasiensis*	Asian Palm Swift
44.	*Dicaeum cruentatum*	Scarlet-backed flowerpecker
45.	*Dicrurus leucophaeus*	Ashy Drongo
46.	*Ducula aenea*	Green Imperial-Pigeon
47.	*Egretta garzetta*	Little egret
48.	*Eudynamys scolopaceus*	Asian Koel
49.	*Gelochelidon nilotica*	Gull-billed Tern
50.	*Geopelia striata*	Zebra dove
51.	*Gerygone sulphurea*	Golden-bellied Gerygone/Flyeater
52.	*Halcyon smyrnensis*	White-throated kingfisher
53.	*Haliaeetus leucogaster*	White-bellied sea eagle
54.	*Haliastur indus*	Brahminy kite
55.	*Hirundo rustica*	Barn swallow
56.	*Hirundo tahitica*	Pacific swallow
57.	*Lanius cristatus*	Brown shrike
58.	*Leptoptilos javanicus*	Lesser Adjutant
59.	*Limnodromus semipalmatus*	Asian Dowitche
60.	*Limosa limosa*	Black-tailed Godwit
61.	*Lonchura maja*	White-headed munia
62.	*Lonchura punctulata*	Scaly-breasted Munia
63.	*Lonchura striata*	White-rumped munia
64.	*Merops philippinus*	Blue-tailed Bee-eater
65.	*Merops viridis*	Blue-throated Bee-eater
66.	*Microcarbo niger*	Little Cormorant

67.	*Motacilla alba*	White wagtail
68.	*Numenius arquata*	Eurasian curlew
69.	*Numenius madagascariensis*	Far Eastern Curlew
70.	*Numenius phaeopus*	Whimbrel
71.	*Nycticorax nycticorax*	Black-crowned night heron
72.	*Oriolus chinensis*	Black-naped Oriole
73.	*Orthotomus ruficeps*	Ashy tailorbird
74.	*Orthotomus sutorius*	Common tailorbird
75.	*Passer montanus*	Eurasian Tree Sparrow
76.	*Pericrocotus divaricatus*	Ashy Minivet
77.	*Phylloscopus borealis*	Arctic Warbler
78.	*Ploceus philippinus*	Baya weaver
79.	*Pluvialis fulva*	Pacific Golden-Plover
80.	*Pluvialis squatarola*	Black-bellied Plover
81.	*Pycnonotus conradi*	Streak-eared Bulbul
82.	*Pycnonotus goiavier*	Yellow-vented bulbul
83.	*Pycnonotus jocosus*	Red-whiskered Bulbul
84.	*Pycnonotus plumosus*	Olive-winged Bulbul
85.	*Rallus striatus*	Slaty-breasted rail
86.	*Rhipidura javanica*	Malaysian Pied Fantail
87.	*Spilopelia chinensis*	Spotted dove
88.	*Sterna hirundo*	Common tern
89.	*Sterna sumatrana*	Black-naped tern
90.	*Sternula albifrons*	Little tern
91.	*Thalasseus bengalensis*	Lesser Crested Tern
92.	*Thalasseus bergii*	Great Crested Tern
93.	*Todiramphus chloris*	Collared kingfisher
94.	*Treron vernans*	Pink-necked Green-Pigeon
95.	*Tringa glareola*	Wood Sandpiper
96.	*Tringa guttifer*	Nordmann's Greenshank
97.	*Tringa nebularia*	Common greenshank
98.	*Tringa stagnatilis*	Marsh Sandpiper
99.	*Tringa totanus*	Common Redshank
100.	*Xenus cinereus*	Terek sandpiper
101.	*Zosterops palpebrosus*	Oriental White-eye
102.	*Zosterops simplex*	Swinhoe's White-eye

9.2.1.3. The marine mammals and reptiles of the Middle Bank

At least seven (7) species of marine mammals and two (2) species of turtles have been recorded in Penang waters (Table 8-7). While the sighting of whales and turtles may be uncommon in the Penang Strait, they have been observed in the open waters off Penang Island, from Teluk Bahang in the north to Pulau Kendi in the south. A stranded loggerhead turtle (*Caretta caretta*) was found in 2021 – the first record in the Straits of Malacca; previous sightings have been mainly made on the east coast of Peninsular Malaysia. The turtle was found with its head and front flippers entangled in a discarded trawler net at Teluk Kumbar, south of Penang Islands. At the same time, the vulnerable Indo-Pacific hump-backed dolphin (*Sousa chinensis*) have been spotted in the Penang Strait near the Middle Bank area. They generally feed close to the shallow ocean floor. The Middle Bank provides a suitable feeding ground since demersal fishes are found in abundance here.

Table 8-7. List of marine mammals and reptiles found on the Middle Bank.

Scientific name	Local name
1. *Neophocaena asiaeorientalis*	Finless porpoise
2. *Orcaella brevirostris*	Irrawady dolphin
3. *Peponocephala electra*	Melon headed whale
4. *Pseudorca crassidens*	False killer whale
5. *Sousa chinensis*	Indo-Pacific hump-backed dolphin
6. *Stenella longirostris*	Spinner dolphin
7. *Tursiops truncatus*	Bottlenose dolphin
8. *Chelonia mydas*	Green turtle
9. *Lepidochelys olivacea*	Olive ridley turtle

9.2.2. Marine invertebrate species

The Middle Bank is rich in invertebrate fauna. The main groups studied here are the mollusc (groups comprising snails, shellfish and squids), crustaceans (groups of crabs and shrimps) and echinoderms (groups of sea cucumbers and starfishes). These are described below. The microfauna is not listed here.

9.2.2.1. Marine molluscs of the Middle Bank

Research conducted CEMACS have shown that shellfish and snails are the dominant mollusc group found on the Middle Bank, with around 100 species having been recorded so far (Table 8-8). Several commercial species of molluscs are present here such as *Anadara* spp. (Kerang), *Atrina* spp. (Peha Ayam), *Perna viridis* (Siput Sudu), *Meretrix meretrix* (Kepah) as well as *Loligo edulis* (Cumi-cumi) and *Sepia esculenta* (Sotong Katak).

Table 8-8. List of marine molluscs found on the Middle Bank.

Scientific name	Local name
1. *Anadara antiquata*	Antique ark, cockle, kerang
2. *Anadara indica*	Rudder ark, cockle, kerang
3. *Arcuatula senhousia*	Asian date mussel
4. *Atrina pectinata*	Pen shell, siput kemudi, peha ayam, hai chiau
5. *Atrina serrata*	Saw-toothed pen shell
6. *Barbatia foliata*	Decussate ark
7. *Bathytormus radiatus*	Radiated crassatella
8. *Bractechlamys vexillum*	Distant scallop
9. *Callista planatella*	Venus clam, siput gayam, kepah nangka
10. *Cardiolucina* sp.	Lucinid bivalve
11. *Chlamys* sp.	Scallop
12. *Circe scripta*	Script venus clam, kepah
13. *Corbula* sp.	Basket clam
14. *Diplodonta* sp.	Venus clam
15. *Dosinia* sp.	Venus clam
16. *Macrocallista* sp.	Venus clam
17. *Mactridae* sp.	Trough shell, duck clam
18. *Meretrix lusoria*	Asian hard clam, common orient clam
19. *Meretrix meretrix*	Asian hard clam, kepah minyak, kunau, dalus
20. *Modiolus auriculatus*	Eared horse mussel
21. *Modiolus modulaides*	Horse mussel
22. *Modiolus nitidus*	Horse mussel
23. *Modiolus philippinarum*	Horse mussel
24. *Paphia crassisulca*	Venus clam
25. *Paphia philippiana*	Venus clam
26. *Paphia rotundata*	Venus clam
27. *Perna viridis*	Siput sudu, kupang, green mussel
28. *Pinna pectinata*	Siput kemudi, siput kipas, peha yam, hai chiau
29. *Protapes gallus*	Venus clam
30. *Semele* sp.	Cockle, clam
31. *Solen strictus*	Razor shell, siput buluh
32. *Sunetta menstrualis*	Venus clam
33. *Tegillarca* sp.	Cockle, kerang

34.	*Tellina* sp.	Tellins shell
35.	*Timoclea* sp.	Venus clam
36.	*Architectonica perdix*	Partridge sundial snail
37.	*Brunneifusus ternatanus*	Ternate false fusus
38.	*Cerithium atratum*	Dark cerith
39.	*Cerithium coralium*	Coral cerith
40.	*Clathrodillia jeffreysii*	Drills
41.	*Clypeomorus batillariaeformis*	Necklace or channelled cerith
42.	*Clypeomorus bifasciata*	Morus cerith
43.	*Conotalopia musiva*	Trochid, top shell
44.	*Cryptospira ventricosa*	Broad marginella
45.	*Desmaulus extinctorium*	Conical slipper snail, Chinese hat snail limpet
46.	*Drupa* sp.	Rock snails
47.	*Drupella margariticola*	Shouldered castor bean
48.	*Epitonium* sp.	Wentletrap snail
49.	*Ergaea walshi*	Eastern white slipper limpet
50.	*Euchelus asper*	Four-keeled margarite
51.	*Gibborissoia virgata*	Litiopids snail
52.	*Haminoea* sp.	Bubble snail
53.	*Indothais gradata*	Rock snails
54.	*Indothais javanica*	Rock snails
55.	*Indothais lacera*	Rock snails
56.	*Indothais rufotincta*	Rock snails
57.	*Monilea callifera*	Shrewd trochid
58.	*Morula* sp.	Rock snails
59.	*Murex occa*	Harrowed murex
60.	*Murex trapa*	Siput duri, siput gasi, rarespined murex, chi lay
61.	*Nassarius crematus*	Whelks
62.	*Nassarius dorsatus*	Whelks
63.	*Nassarius gaudiosus*	Whelks
64.	*Nassarius glans*	Whelks
65.	*Nassarius jacksonianus*	Mud Whelks
66.	*Nassarius leptospira*	Whelks
67.	*Nassarius limnaeiformis*	Whelks
68.	*Nassarius livescens*	Whelks
69.	*Nassarius pullus*	Whelks
70.	*Nassarius stolatus*	Whelks
71.	*Nassarius sufflatus*	Whelks
72.	*Nassarius teretiusculus*	Whelks
73.	*Natica* sp.	Moon snail
74.	*Nerita polita*	Siput timba, tekuyung timba, sihik
75.	*Neverita lewisii*	Lewis’s moon snail
76.	*Notocochlis gualteriana*	Comma necklace shell
77.	*Oliva* sp.	Olive snails
78.	*Paratectonatica tigrina*	Tiger moon snail
79.	*Pictocolumbella fulgurans*	Dove snails
80.	*Pirenella cingulata*	Siput tanduk hitam, girdled horn snail
81.	*Pirenella conica*	Horn snail
82.	*Pleuroploca trapezium*	Trapezium horse conch
83.	*Polinices mammilla*	Oval moon snail
84.	*Pseudanachis basedowi*	Dove shell
85.	*Ptychobela nodulosa*	Turrid snail

86.	*Pugilina cochlidium*	Spiral melongena
87.	*Scalptia scalariformis*	Nutmeg snails
88.	*Smaragdia souverbiana*	Nerite snail
89.	*Strombus* sp.	Siput gong-gong, siput tarik
90.	*Terebralia sulcata*	Siput belitong
91.	*Tricolia* sp.	Pheasant shell
92.	*Trochus nilotica*	Siput tudung saji, olak
93.	*Turbo argyrostomus*	Silver-mouthed turban
94.	*Turbo petholatus*	Tapestry turban
95.	*Turricula javana*	Java turrid
96.	*Turritella terebra*	Screw turret, siput kon, siput skru, teng lo
97.	*Volegalea cochlidium*	Siput unam, melon conch
98.	*Zafra atrata*	Dove shell
99.	*Loligo edulis*	Swordtip squid, cumi-cumi
100.	*Sepia esculenta*	Golden cuttlefish, sotong katak

Photo 8-2. The mud whelk (*Nassarius jacksonianus*) grazing on emergent seagrass during the low tide.

9.2.2.2. Marine arthropods of the Middle Bank

Sixteen (16) species of shrimp and five (5) species of crabs have been recorded here on the Middle Bank (Table 8-9). *Penaeus merguiensis* (udang putih) and *Portunus pelagicus* (ketam bunga) have been the dominant commercial crustaceans caught in this area. Penang is also the second highest contributor for landings of *P. merguiensis* in western Peninsular Malaysia.

Two species of horseshoe crabs are found on the Middle Bank. These are the larger and edible horseshoe crab *Tachypleus gigas* and the rounded tail but smaller species of *Carcinoscorpius rotundicauda*. Both were common until about 2010 and have since become infrequent. Now the only specimens found are the occasional carcasses washed on shore.

Table 8-9. List of marine arthropods found on the Middle Bank.

Scientific name	Local name
1. *Acetes* sp.	Udang Baring, Acetes shrimp
2. *Harpiosquilla* sp.	Udang Lipan, Mantis Shrimp
3. *Metapenaeus affinis*	Udang Merah Ros, Gingja Shrimp
4. *Metapenaeus brevicornis*	Udang Kuning, Yellow Prawn
5. *Metapenaeus ensis*	Prawn, Udang kaki merah, Udang kulit keras
6. *Metapenaeus lysianassa*	Udang Putih Kecil, Bird Shrimp
7. *Metapeneopsis berbeensis*	Udang Pasir, Sand Prawn
8. *Metapeneopsis stridulans*	Udang Pasir, Sand Prawn
9. *Parapenaeopsis coromandelica*	Coromandel shrimp
10. *Parapenaeopsis hungerfordi*	Udang Cendana Rotan, Sharp Rostrum Prawn
11. *Parapenaeopsis sculptilis*	Udang Kulit Keras, Rainbow Prawn
12. *Penaeus indicus*	Udang Putih, Banana Prawn
13. *Penaeus merguensis*	Udang Putih, Banana Prawn
14. *Penaeus monodon*	Prawn, Udang rimau
15. *Solenecera subnuda*	Udang Kaki Merah, Sua Lor, Red Prawn
16. *Trachypenaeus fulvus*	Udang Pasir, Sand Prawn
17. *Charybdis helleri*	Indo-Pacific swimming crab, spiny hands
18. *Clibanarius infraspinatus*	Orange-striped hermit crab
19. *Macrophthalmus* sp.	Sentinel crab
20. *Ocypode* sp.	Ghost crab
21. *Portunus pelagicus*	Flower crab, blue crab, ketam bunga, ketam renjung
22. *Carcinoscorpius rotundicauda*	Mangrove horseshoe crab
23. *Tachypleus gigas*	Coastal horseshoe crab, Indo-Pacific horseshoe crab

9.2.2.3. Marine echinoderms of the Middle Bank

Twenty (20) species of echinoderms have been found on the Middle Bank, ten (10) are sea cucumbers including the two (2) newly discovered species - *Acaudina spinifera* and *Euthyonidiella zulfigaris*. Other echinoderms found here are sea urchins, brittle stars, sand starfish and the sand dollar.

Table 8-10. List of marine echinoderms found on the Middle Bank.

Scientific name		Local name
1.	*Acaudina spinifera*	Sea cucumber
2.	*Actinocucumis longipedes*	Sea cucumber
3.	*Amphioplus* sp.	Brittle star
4.	*Astropecten vappa*	Painted sand star
5.	*Diadema setosum*	Landak laut, long-spined sea urchin
6.	*Echinodiscus truncatus*	Deduit laut, sand dollar
7.	*Euthyonidiella zulfigaris*	Sea cucumber
8.	*Globosita* sp.	Sea cucumber
9.	*Holothuria leucospilota*	Black sea cucumber
10.	*Holothuria martensii*	Sea cucumber
11.	*Luidia hardwicki*	Starfish, tapak sulaiman
12.	*Macrophiothrix speciosa*	Brittle star
13.	*Ophiactis carnea*	Brittle star
14.	*Ophiactis fuscolineata*	Brittle star
15.	*Ophiothela venusta*	Brittle star
16.	*Ophiothrix spinosissima*	Brittle star
17.	*Phyrella thyonoides*	Sea cucumber
18.	*Phyllophorella spiculata*	Sea cucumber
19.	*Pseudocnus echinatus*	Sea cucumber
20.	*Stolus buccalis*	Sea cucumber

9.2.3. Discovery of new species on the Middle Bank

The discovery of species new to science in 2022 accentuates the high biodiversity and importance of establishing the Middle Bank Marine Sanctuary. Two new sea cucumber species found here are *Euthyonidiella zulfigaris* and *Acaudina spinifera*, both on the intertidal mudflats.

Scientists from CEMACS researching the Middle Bank in 2022 discovered these species during their biological survey of the area. It is quite remarkable that these species new to science can still be found in an environment influenced heavily by the highly populated areas of the Penang waterfront. Other new species may be expected to be discovered here.

Photo 8-3. *Euthyonidiella zulfigaris* on the sandy substrate of Middle Bank.

10. THE IMPORTANCE OF THE MIDDLE BANK AS A BIODIVERSITY NEXUS

The Middle Bank is an area of high biodiversity. The large range of ecosystems is sustained by interacting living communities that reside or visit the area. This led to the development of a unique range of marine diversity, as illustrated above.

An important function of biodiversity is the ecosystem functions it provides. These include:

- The supply of food such as seen from the fisheries sector of the Middle Bank.
- Provision of a healthy coastal environment through biological processes.
- Coastal protection for the Gelugor-Jelutong foreshore, as the substrate is stabilised by these communities.
- The maintenance of an overall stable biological system in the Strait of Penang.
- Providing coastal habitats for the animals and plants that live here and the sustenance of the ecosystem services provided by these habitats.
- Purifying the marine waters from coastal pollution, by retaining organic matter and suspended solids.
- The sequestration of carbon by the ecosystems, such as the seagrass beds of the Middle Bank. This service is particularly important in a rising CO^2 world.

Seagrass ecosystems of the Middle Bank have the ability to store carbon in a process known as carbon sequestration. These ecosystems found on the Middle Bank are able to sequestrate large amounts of carbon and are therefore important for mitigating climate change. Since the Middle Bank is rich in seagrass, their conservation and sustenance are critical in the changing climate future that challenges Penang.

Migratory species visit the Middle Bank to forage for food. These include the avian groups seen in the Strait of Penang and North Perak which congregate in large numbers to forage for food at low tide.

Aquatic species such as dolphins have been spotted foraging here as well. The pods search the area for fish and are more common in the early months of the year.

There are records of turtles discovered on the Banks, with some nesting at Pulau Gazumbo. These events have become increasingly rare as the populations of sea turtles decrease.

10.1. The environmental degradation of the Middle Bank

Currently, the Middle Bank is exposed to anthropogenic pressures such as the influx of polluted waters from the nearby hinterland of Penang with its high human population. This includes the introduction of sewage and solid wastes (such as plastics and debris). The following phase of this study will look into this aspect in more detail. At this stage, it is evident that the pollution here will adversely impact the ecosystems of the Middle Bank. The establishment of the MBMS will highlight the value of this area and emphasise the importance of habitat restoration and conservation and the reduction of pollution here.

11. CONCLUSION TO THE STUDY

The study has revealed the high habitat and species diversity found on the Middle Bank. Altogether a total of 429 species were identified to frequent or settle on the Middle Bank. These include:

- 7 species of seagrass
- 14 species of macroalgae
- 5 species of mangrove trees
- 10 species of coastal vegetation
- 139 species of commercial fishes
- 102 species of birds
- 7 species of marine mammals (dolphins, whales)
- 2 species of turtles
- 100 species of molluscs (shellfishes, snails, squid)
- 23 species of arthropods (prawns, crabs)
- 20 species of echinoderms (sea cucumber, starfishes, brittle stars)

MBMS is a unique home to many important species, including species new to science. It underlines the importance of the Middle Bank to the health and economic value of the Penang seas and ultimately to the well-being of Penang and north Malaysia.

The sustenance and promotion of ecosystem services are dependent on conservation of the areas. Such ecosystem services include the maintenance of food security, the protection of coastal erosion, readiness for climate change and the maintenance of ecosystem processes. The Middle Bank is an important feeding ground and nursery area for marine animals. This service is provided not only for resident species but also for the migratory fish and avian species that visit the area.

Conservation and improvement of the areas must be done soon, especially given the importance of the Middle Bank to the health and services of the marine environment and the benefit it brings to the state. MBMS also supplements general efforts taken to improve the future of Penang through the Green Agenda 2030.

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