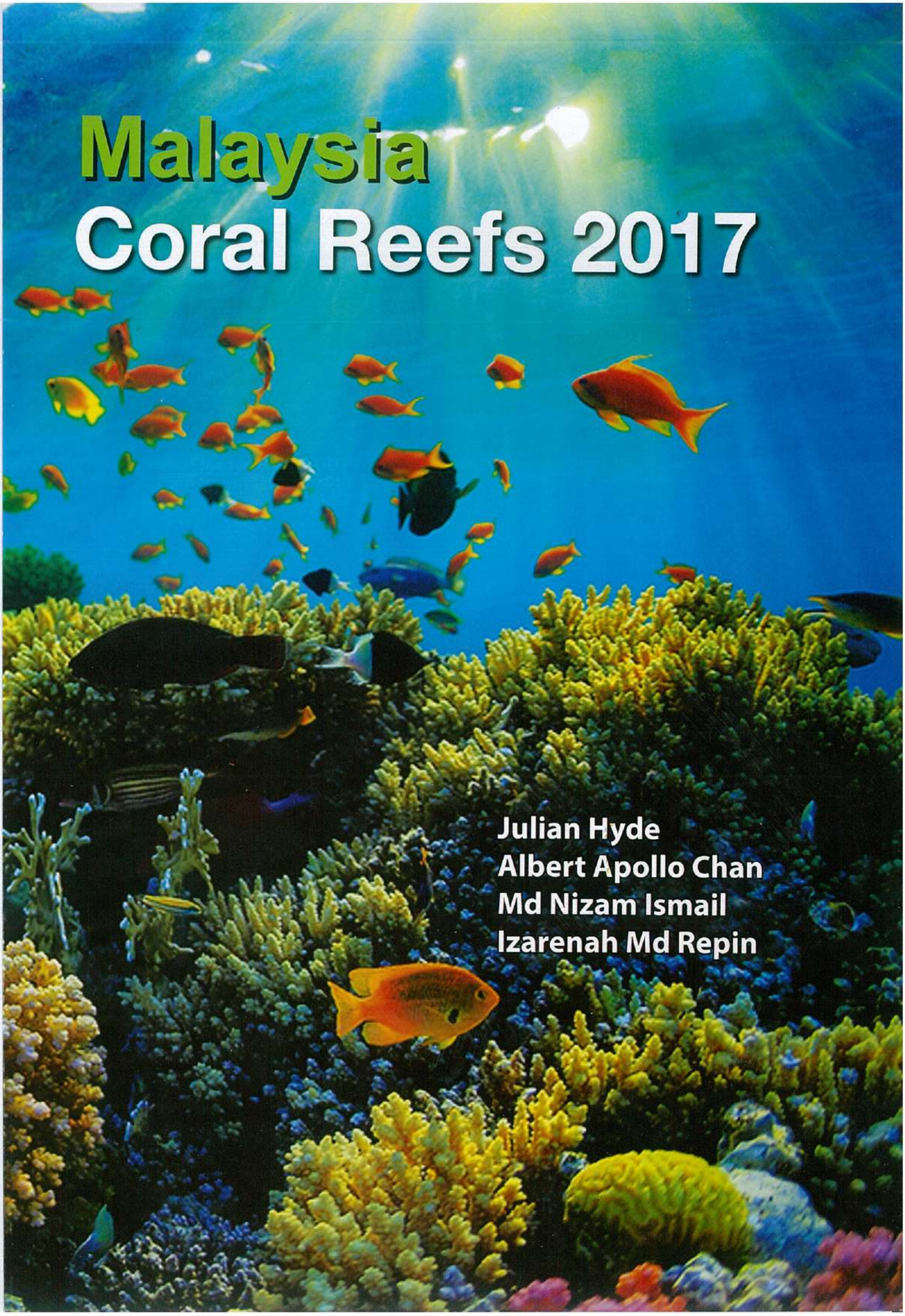
Malaysia Coral Reefs 2017



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Malaysia Coral Reefs 2017

IYOR 2018
INTERNATIONAL YEAR OF THE REEF

Malaysia Coral Reefs 2017

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Executive Summary

1. A total of 227 sites were surveyed in 2017 (2016: 209), 89 in Peninsular Malaysia and 138 in East Malaysia. The surveys are a continuation of a successful National Reef Check Survey Programme that has now run for more than ten years.

2. The surveys were carried out by trained volunteers as well as government officials from the Department of Marine Parks Malaysia and Sabah Parks, reflecting commitment from the Government in further improving management of Malaysia's coral reefs. Surveys were carried out on several islands off Peninsular Malaysia's East and West coast, covering both established Marine Protected Areas and non-protected areas, and in various parts of East Malaysia, both Sabah and Sarawak.

3. The results indicate that Malaysian reefs surveyed have a relatively high level of living coral, at 42.53% (2016: 43.71%). However, this has been declining for four years, and over that period it has fallen over five percentage points. Moreover, for Peninsular Malaysia there has been a reduction in living coral cover of nearly 5%, which is a major cause for concern.

4. Most indicator species of both fish and invertebrates are present in low numbers or completely absent from many surveys. Although this could indicate low natural population levels, this is particularly worrying where survey sites are in protected areas, where populations would be expected to grow over time. This is suggestive of continuing problems with poaching inside Marine Protected Areas.

5. Some coral reefs show increasing amounts of algae, This suggests that they are suffering from an ecosystem imbalance due to elevated nutrient inputs (possibly from sewage and agriculture activities), coupled with low herbivory by fish and sea urchins. Algae dominated reefs are less productive than coral dominated reefs and this "phase shift", if it continues, could have significant impacts on reef-related tourism and jobs.

6. A series of recommendations is provided with a focus on improving management to reduce impacts. Key to this is participation by local stakeholders, and co-management is the favoured management model for the future.

7. Of particular importance is the need to build resilience of coral reefs, in the face of growing global threats from climate change (bleaching and ocean acidification). Managing local threats will ensure coral reefs are in the best possible condition to resist these growing external threats.

8. The government is asked to support further survey programmes, to take steps to build resilience of coral reefs and to establish a comprehensive Bleaching Response Plan as well as Reef Resilience Surveys to enable it to better respond to future mass coral bleaching events.

9. While tourism is a valuable source of income, the government is asked to require hotels and dive facilities to follow best practices including careful attention to sewage treatment and discharge, and education of clients so as to avoid damage to reefs.

10. Coral reefs are a valuable economic and biological resource in Malaysia, where they are a major attraction for the tourism industry, serve as a protein source for millions of people and are a major source of biodiversity. One estimate puts the economic value of well-managed coral reefs in Malaysia at RM150 billion per annum. Coral reefs are threatened by global warming, overfishing, pollution and sedimentation.

11. Reef Check is a coral reef monitoring methodology used worldwide to assess the health of coral reefs in over 95 countries and territories worldwide, and in Malaysia since 2001. The non-profit Reef Check Malaysia (RCM) is available to oversee training and surveys in Malaysia.

This report is available for download at:

http://www.reefcheck.org.my/reports-downloads/annual-survey-reports

For further information, please contact Reef Check Malaysia at: ecoaction@reefcheck.org.my

1. Introduction

Coral reefs are an important ecological and economic resource in many countries around the world, providing a range of valuable ecosystem services to millions of people. Coral reefs provide jobs, food and coastal protection, among other benefits, to over 100 million people in South East Asia. They are the most diverse marine ecosystems on earth.

Despite being recognised for their economic and aesthetic value, coral reefs are being damaged by a variety of both local and global threats:

- The 2008 "Status of Coral Reefs of the World" report stated that the world has effectively lost 19% of the original area of coral reefs and that 15% are seriously threatened with loss within the next 10-20 years, with a further 20% under threat of loss in the next 20-40 years.
- In 2011, "Reefs at Risk Revisited" stated that more than 60% of the world's reefs are under immediate and direct threat from one or more local sources.

These threats arise largely as a result of human activities and land use changes along coastlines adjacent to coral reefs. Local threats to coral reefs are many, and are reasonably well understood. They include:

- Over-fishing, which can result in detrimental changes to reef ecology
- Destructive fishing(such as dynamite and cyanide fishing), which destroy the reef structure
- Coastal development, releasing silt and sediment that can smother reefs and altering hydrological flows
- Pollution, from industrial and agricultural activities as well as sewage pollution
- Physical impacts from tourism, including divers, snorkelers and boats.

In Malaysia, the Department of Marine Parks (Federal), Sabah Parks and Sarawak Forestry are tasked with managing these local threats to their protected reef areas.

However, against these *local* threats, mass coral reef bleaching has emerged over recent years as a *global* threat that is difficult to manage locally and which can have potentially devastating effects. The first significant mass coral reef bleaching event reported in Malaysia was in 1998, as a result of which an estimated 40% of corals in reefs around Peninsular Malaysia died. Reefs had barely recovered before the 2010 mass coral reef bleaching event occurred, which fortunately saw lower coral death rates.

Scientists agree that mass coral reef bleaching is likely to occur with increasing frequency in the coming decades, and there is an urgent need to put in place plans to:

- Respond effectively to mass coral reef bleaching events with management interventions to protect reefs during bleaching events
- Build the "survivability" of coral reefs to better withstand future bleaching events.

Reef Check Malaysia (RCM) works with various stakeholders to conserve coral reefs. Since it was registered in 2007, RCM has established an annual, national coral reef monitoring programme. This report presents the results of coral reef surveys conducted in Malaysia during 2017, the eleventh year of surveys.

2. Reef Check

2.1 Background

Reef Check Malaysia is part of the world wide Reef Check network. Established in 1997 in the USA, Reef Check now has Coordinators in over 95 countries worldwide. Reef Check was established by a group of scientists who developed a simple, rapid method of surveying coral reefs. It is the name both of the organisation and the survey methodology.

Reef Check Malaysia (RCM) was registered in Malaysia as a non-profit company in 2007, and since then has established an annual survey programme to assess the health of coral reefs around Malaysia (reports are available for download from the website: www.reefcheck.org.my). In the last eleven years RCM has trained over 800 divers to conduct reef surveys at over 150 permanent monitoring sites on coral reefs off the East coast of Peninsular Malaysia and at sites around East Malaysia. RCM is also active in education and awareness programmes, and has a long term education programme for schools.

In 2010, RCM established its first coral reef rehabilitation programme in Pangkor, to assist local snorkelling guides to improve sites. In 2011 and 2012, the programme was replicated, on a larger scale, in Tioman, Perhentian and Redang. These rehabilitation programmes were continued in 2014 and have contributed to our understanding of coral reef ecology, and provide an ideal vehicle to educate local populations, businesses and tourists on the benefits and value of coral reefs and how human activities are damaging them.

In 2014, RCM initiated its first community programme, the Cintai Tioman Campaign in Tioman, with funding from Yayasan Sime Darby. The goal of the programme is to build ecological and social resilience on the island, with particular emphasis on involving the local community in managing the islands' reefs. In 2015, EcoKnights joined RCM in the programme, with funding support from the Small Grants Programme to implement a number of economic and social development programmes.

In 2016, RCM started two new community-based projects. A project in Mantanani Island brings all the stakeholders together to establish a community-led marine managed area, leading to sustainable economic development on the island. We also joined Department of Marine Parks Malaysia (DMPM) as a project partner in The Mohamed bin Zayed Species Conservation Fund and UNEP-GEF grant to operationalise the Malaysian National Plan of Action for Dugong in Pulau Sibu and Pulau Tinggi, Johor. This is a part of a bigger national project which involves 4 other sub-projects.

This report is the eleventh annual Malaysia coral reef survey report and details the results of Reef Check surveys carried out during 2017. It represents a continuation of the reef monitoring effort started by RCM in 2007. The information shown highlights key concerns and identifies steps that need to be taken to contribute to the conservation of Malaysia's coral reefs.

2.2 Survey Methodology

Reef Check surveys are based on the philosophy of "Indicator Species". These are marine organisms that:

- are widely distributed on coral reefs
- are easy for non-scientists to identify
- provide information about the health of a coral reef

Using a standardized methodology, data from surveys in different sites can be compared, whether it be on an island, regional, national or international basis (see www.reefcheck.orgfor more details).

The Reef Check monitoring methodology allows scientists and managers to track changes to coral reefs over time. By surveying reefs on a regular basis, deleterious changes can be highlighted early, before they become problems. This gives managers the opportunity to intervene, carry out additional more detailed studies and/or initiate management actions to try to reverse the change before permanent damage is done to the reef.

Reef Check surveys are conducted along two depth contours (3 m to 6 m and 6 m to 12 m depth). A 100 m transect line is deployed and along it four 20 m transects are surveyed, each separated by 5m, which provides four replicates per transect (8 per complete survey) for statistical analysis (see Figure 1).
Four types of data are collected:

- Fish abundance: the fish survey is carried out by swimming slowly along the transect line counting the indicator fish within each of the four 20 m long x 5 m wide x 5 m high corridors
- Invertebrate abundance: divers count the indicator invertebrates along the same four 20 m x 5 m belts
- Substrate cover: collected by the Point Intercept method whereby the substrate category such as live coral is noted every 0.5 m.
- Impact: the impact survey involves the assessment of damage to coral from bleaching, anchoring, destructive fishing, corallivores such as *Drupella* snails or crown-of-thorns starfish, and trash.

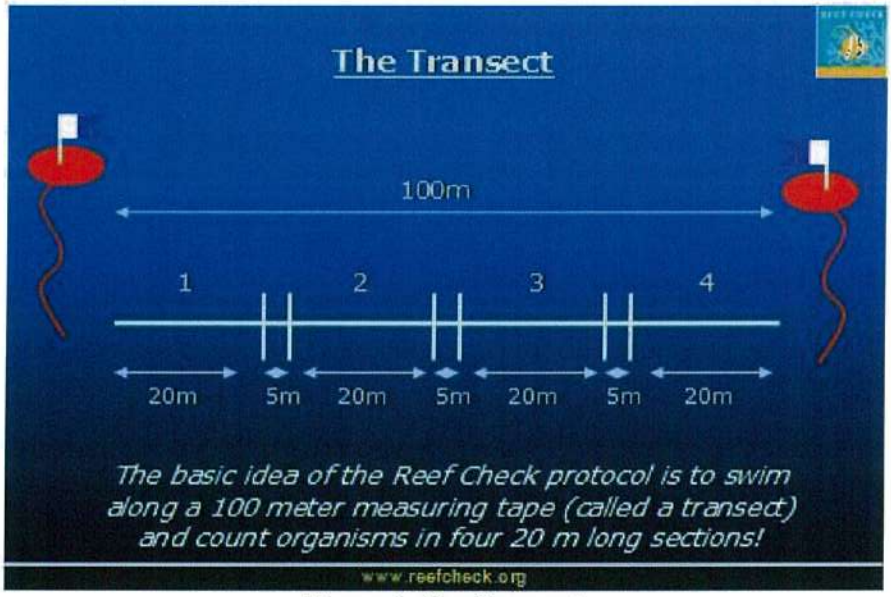


Figure 1: The Transect

2.3 Survey Sites

In 2017, a total of 227 sites were surveyed, 89 of which were in Peninsular Malaysia and the remaining 138 in East Malaysia. As far as possible, the same sites are visited each year to provide consistent data over time.

In Peninsular Malaysia, surveys were conducted at sites around several islands off the East coast (Bidong, Yu, Kapas, Pemanggil, Perhentian, Redang, Sibu, Tinggi, Tenggol, Tioman, Rawa and Tengah). Numerous sites were also surveyed around islands off the West coast (Sembilan, Pangkor Laut and Payar). In East Malaysia, a large percentage of the surveys were conducted by a number of dive operators, notably in Lankayan and Mataking in Sabah and Miri in Sarawak, and by Sabah Parks, in Pulau Tiga, Pulau Penyu, Tun Sakaran Marine Park, Tunku Abdul Rahman Park and Sipadan in Sabah. This is one of the success stories of getting local stakeholders, especially governments, dive operators and local community, to be involved in monitoring and management of their own local reefs.

The list of sites surveyed is shown in appendix 1.

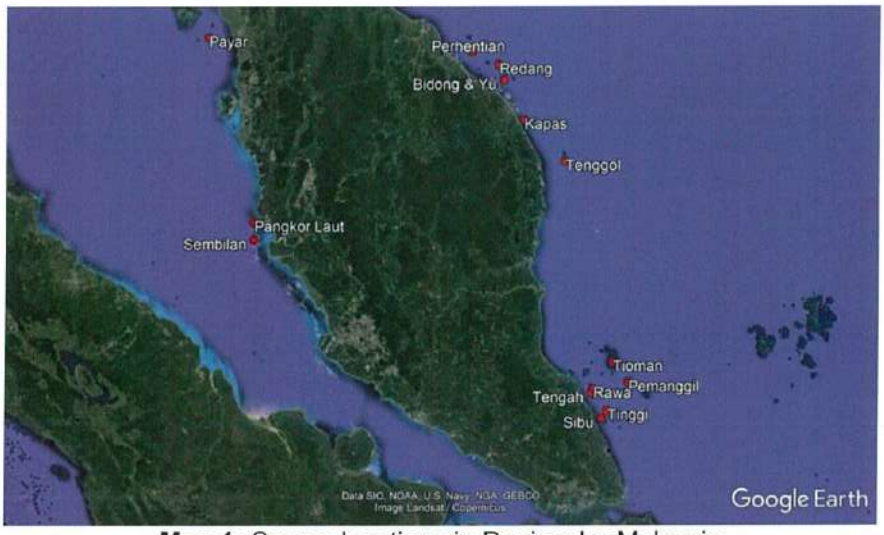
3. 2017 Survey Results and Analysis

This section presents the results from surveys conducted in 2017, providing an overview of the condition of coral reefs in Malaysia as a whole, and a detailed analysis of the health of reefs in surveyed reef areas.

3.1 Status of Coral Reefs in Malaysia 2017

The results from all 220 surveys were compiled to provide an overview of the status of coral reefs around Malaysia. In Peninsular Malaysia, most sites are on islands that are gazetted as Marine Parks and are important tourism destinations, many with high visitor numbers (e.g. Tioman, Redang, Payar). In Sabah and Sarawak, the impact of tourism is more varied, with some areas (e.g. Semporna) having high numbers of visitors and others (e.g. Lahad Datu) having none. The condition of reefs and the impacts noted reflect these variations in the local economy:

- Where tourist numbers are high, impacts are often related to physical damage by divers, snorkelers and boats and the result of pollution from sources such as sewage
- Where tourist numbers are low, impacts are often related to fishing pressures, particularly fish bombing, which is still commonplace in Sabah.



Map 1: Survey locations in Peninsular Malaysia

Map 2: Survey locations in Sabah
(Note: TSMP= Tun Sakaran Marine Park; TARP= Tunku Abdul Rahman Park)

Map 3: Survey locations in Sarawak

3.1.1 Substrate

One widely-used measure of coral reef health was developed by Chou *et al*, 1994. The table below shows the Coral Reef Health Criteria they developed and that are used in this report.

Table 1: Coral Reef Health Criteria

Percentage of live coral cover	Rating
0-25	Poor
26-50	Fair
51-75	Good
76-100	Excellent

According to these ratings Malaysian reefs are considered to be in "fair" condition, with average live coral cover (Hard Coral + Soft Coral – see Chart 1) of 42.53% (43.71% in 2016).

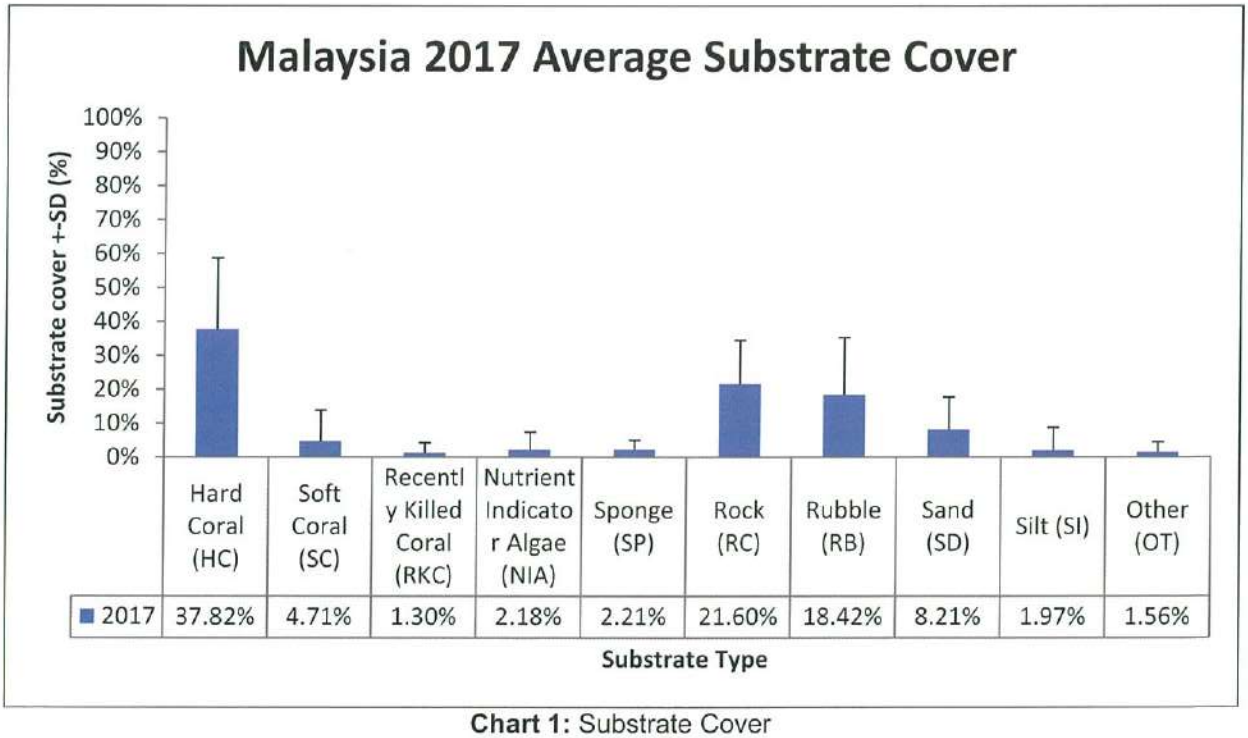


Chart 1: Substrate Cover

Recently Killed Coral (RKC) shows the amount of coral killed within the last 12 months due to a variety of impacts, including bleaching, predation (e.g. by Crown of Thorns starfish, Drupella snails) and other local stressors (e.g. sedimentation, disease). The low level of RKC, at only 1.3% (2016: 1.73%) indicates that there are few local impacts in most places. However, at some sites, the level of RKC was significantly higher such as 21.25% at Pulau Tengkorak (Bidong), 20.63 at Lok Liak (Usukan Cove) and 15.00% at Pulau Nanga (Sibu) and reasons for this need to be investigated.

Nutrient Indicator Algae (NIA) is a measure of the amount of algae growing on reefs, and can provide an indication of the health of herbivorous fish and invertebrate populations on reefs and of the level of nutrient input to reefs. Algae are a natural and essential part of the coral reef ecosystem, but if allowed to grow un-checked algae can shade corals from the sunlight they need for photosynthesis, smothering and eventually killing them. This can lead eventually to a phase shift from coral- to algae-dominated reefs, which are much less productive than coral-dominated reefs. NIA level in 2017 was low at 2.18% (2016: 3.92%), suggesting that algae does not appear to be a threat in most places. However, it should be noted that this average figure masks a wide range and there are some sites where the proliferation of algae is becoming an issue that needs more attention. 9 sites recorded NIA above 10% and the highest were 49.38% (Tukas Laut, Perhentian) and 37.50% (Adal, North Semporna). Further investigation should be undertaken to understand why these sites have such high levels of NIA, and remedial measures identified.

Sponges (SP) are another normal component of coral reefs that, under the right conditions, can proliferate in the presence of high levels of nutrients. At 2.21% (2016: 2.25%), the level of SP does not appear to be a threat.

Rock (RC) comprises both natural rock and dead coral. Bare RC can be re-colonised by coral recruits and is critical for reef recovery, regeneration and extension. In 2017 the average cover of RC on Malaysian reefs was 21.60% (2016: 21.29%). It should be noted that new coral recruits cannot settle onto RC that has significant algae or silt cover; and under these conditions settlement of new recruits will be reduced. This demonstrates the importance of healthy herbivore populations, which graze on algae and keep it under control, providing clean surfaces for coral recruits, and the need to manage release of silt from, for example, construction sites and dredging operations.

Rubble (RB) comprises small pieces of rock, coral fragments, dead shells and other small pieces of substrate. RB is created by a number of factors, some natural such as wave action and storms, while others result from human activities, including fish bombing, anchoring and SCUBA diving. On reefs with high levels of RB, coral regeneration is slow due to the difficulty of corals recruiting onto a mobile substrate: recruits are easily damaged or displaced from mobile substrate moving around on the seabed. The average cover of RB on reefs around Malaysia in 2017 was 18.42% (2016: 14.36%). Although this has not changed much over the last few years, it has been increasing slowly, and the level of RB recorded in 2017 was the highest since the start of Reef Check surveys in 2007. Nearly 43% of reefs in Malaysia had RB in the range 10-29% of RB (2016: 40%) and 22% of reefs recorded RB above 30% (2016: 8.6%). At some sites, RB level was even higher, such as 80.63% at South Rim (TSMP), 69.38% at Senanggol (Pulau Tiga), 67.50% at Base Camp (TARP) and 66.25% at Coral Garden (Mataking). Some of this damage is likely to be natural, for example cause by storms; but some is likely to be the result of destructive fishing methods; further investigation needs to be undertaken to assess how this damage occurs in each site, and what can be done to reduce incidences of damage and rehabilitate reefs.

Sand (SD) is a natural component of reefs, and can be expected to be found on any survey. Increasing amounts of SD in a given coral reef can be an indication of disturbance as dead coral breaks off and is eroded into fine particles (sand) by wave action. The average (5.09% in 2017) has not differed much since 2007 and is considered normal.

Silt (SI) arises from a variety of natural sources (e.g. mangroves and mud flats) as well as from land use changes, including agriculture, forestry and construction. Silt can smother corals, depriving them of sunlight and causing coral death. The average level of SI for Malaysia is low at 1.97% (2016: 1.21%). It appears that corals in some areas (e.g. West coast of Peninsular Malaysia) have adapted to high natural levels of SI, so average levels of SI are not necessarily a good indicator of reef health. However, changing level of SI in a specific area can indicate a local impact and it is this change that should be monitored.

The category Other (OT) includes all other sessile organisms that do not indicate any impacts, but are natural components of coral reefs. The average level of OT in Malaysia in 2017 was 1.56% in (2016: 1.65%).

3.1.2 Fish

Reef Check indicator fish species were chosen on the basis of targeted demand for:

- Aquarium trade: Butterflyfish
- Food fish: Sweetlips, Snapper, Barramundi Cod, Parrotfish, Moray Eel, Grouper
- Live-food fish trade: Humphead Wrasse, Bumphead Parrotfish.

The average abundances of indicator fish counted during the 2017 surveys are shown below (Chart 2).

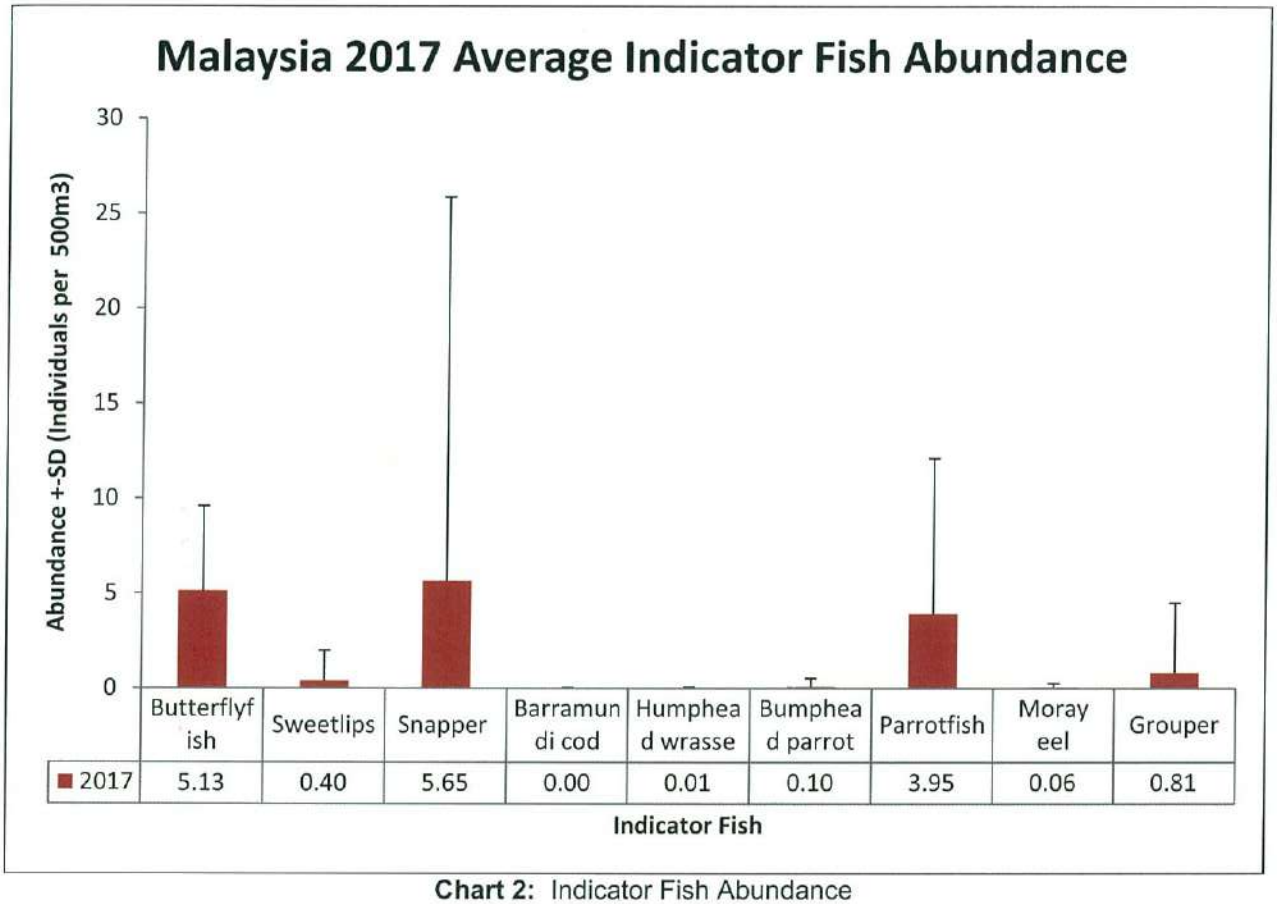


Chart 2: Indicator Fish Abundance

Barramundi cod, Humphead wrasse, Bumphead parrotfish, Groupers, Sweetlips, and Moray eels recorded an average abundance of less than 1 individual per 500m^3 survey transect. High value fish such as these, which are specially targeted for the international live food trade, recorded the lowest average abundance and were absent from most surveys.

With restaurants willing to pay up to US$ 10,000 for a single adult Humphead wrasse, it is not surprising that poachers target these fish, even inside marine protected areas. Greater protection (including enforcement of Marine Park regulations and trade restrictions) will be necessary to aid recovery of populations of these iconic species, and on-going monitoring will help to track recovery in populations.

Butterflyfish recorded a national average of 5.13 individuals per 500m^3 in 2017 (2016: 5.40), showing a slight decrease from previous years. Butterflyfish is used as an indicator of fishing pressure for the aquarium trade as well as an indicator of reef health as they feed on coral polyps, and only healthy reefs can sustain a large population of these fish.

Parrotfish are important herbivores, controlling algal growth on reefs thus avoiding competition with corals. The national average in 2017was 3.95 individuals per 500m^3, a slight increase from last year (2016: 3.24).

3.1.3 Invertebrates

The invertebrate indicators are targeted for different reasons:

- Collected for Curio trade: Banded Coral Shrimp, Pencil Urchin, Triton Shell
- Collected for Food: Collector Urchin, Sea Cucumber, Lobster, Giant Clam
- Ecological Imbalance/predator outbreaks: *Diadema* Urchin, Crown of Thorns

The abundance of indicator invertebrates documented during the 2016 surveys is shown in Chart 3 below.

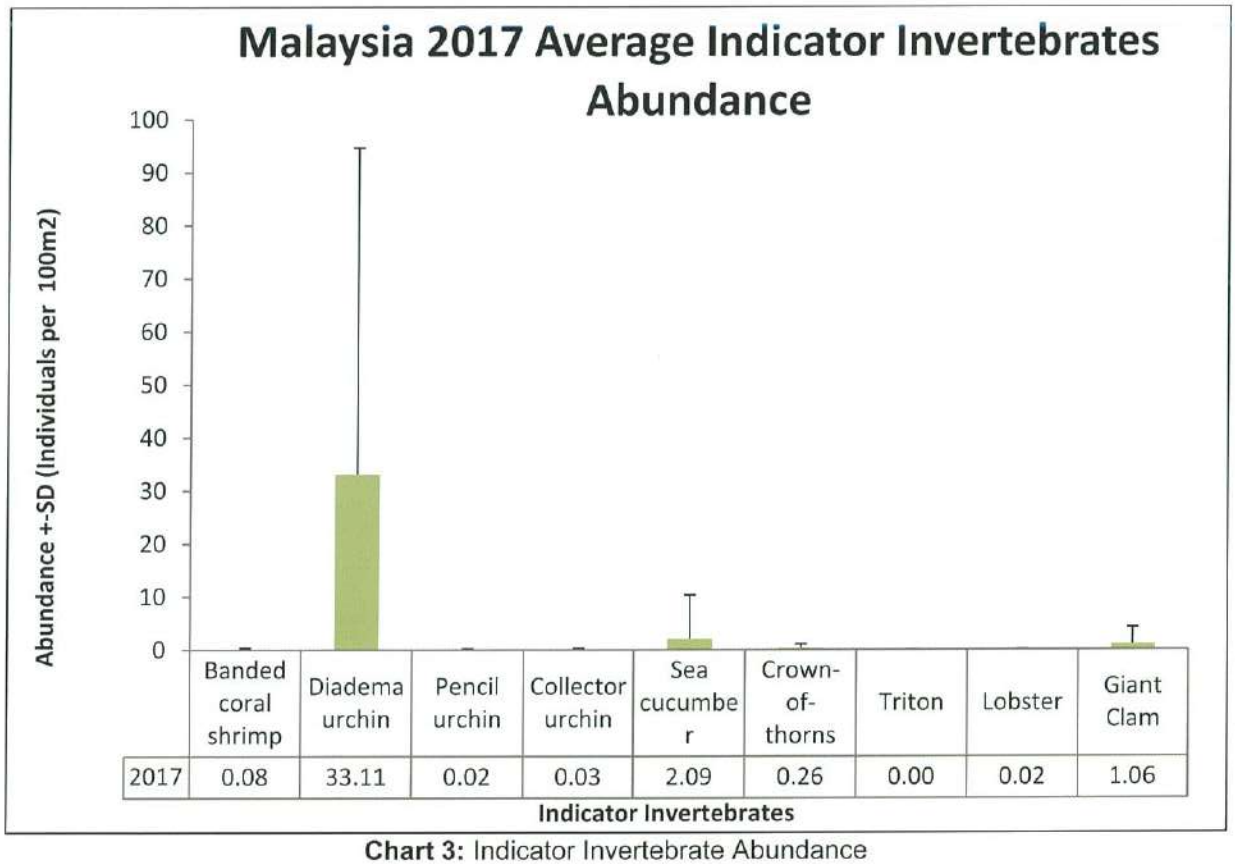


Chart 3: Indicator Invertebrate Abundance

The average abundance of invertebrates targeted for the aquarium and curio trade was less than one individual per 100m^2. While this may be partly explained by low natural abundance and cryptic behaviour, historical overexploitation of invertebrates such as Triton and Pencil Urchin may have had a significant impact on their populations.

Similarly, several species targeted for the food trade are at or near zero (Lobster 0.02 individuals per 100m^2 survey transect; Collector Urchin – 0.03). The abundance of Sea Cucumber is low at 2.09 (2016: 1.85) individuals per 100m^2. Giant Clam recorded an average of 1.06 individuals per 100m^2 (2016: 1.02). This includes both mature breeding adults as well as juveniles. The low numbers of giant clams within 100m^2 is something to take note of as the sessile nature of these organisms would make breeding difficult if distances between breeding adults are too large.

The abundance of long-spine sea urchin *(Diadema sp.)* varies widely between survey sites, and in some sites they are present in unusually high numbers. In a balanced reef ecosystem, the numbers of *Diadema* Urchin, in combination with herbivorous fish, keep algal growth in check. However, these urchins can reproduce rapidly in conditions in which their main food source (micro- and macro- algae, which proliferate in nutrient rich water) is abundant. Thus, high numbers of *Diadema* could indicate eutrophication or overfishing of herbivores.

While grazing algae on coral reefs, *Diadema* cause some damage to reefs, scraping the top layer of the coral skeleton. However, in high numbers, *Diadema* can have two further negative impacts. First, if algae are scarce, their feeding preference can change to coral tissue, and large numbers actively grazing can cause a weakening of the hard coral structure. Secondly, their spines scrape corals as they move over the surface of the reef, potentially damaging the reef structure if the rate of bio-erosion exceeds the rate of coral growth. Controlling nutrient pollution as well as maintaining a healthy population of herbivores fish can contribute to reducing the scale of this problem.

Crown-of-thorns starfish (COT) feed on corals and can cause significant damage to coral reefs, destroying large areas in a short period of time. According to CRC Reef Research Centre (Australia), a healthy coral reef can support a population of 20-30 COTs per hectare (10,000m^2), or 0.2-0.3 individuals per 100m^2 (Harriott et al., 2003) The average abundance of COTs found during surveys, 0.26 per 100m^2 (which is the same as 2016) suggests that COT numbers are not a threat to the reefs in most places. However, 15% of sites have numbers of COT higher than the upper limit of 0.3 individuals per 100m^2 quoted above, and the highest numbers are a magnitude greater, suggesting that urgent action is needed in some sites to control COT numbers (Pulau Tengkorak, Bidong – 6 per 100m^2; Kerengga Besar, Redang – 4 per per 100m^2; Adams Point and Fish Eye, Lahad Datu – 4 per 100m^2).

3.2 Status of Coral Reefs in Key Eco-regions in Malaysia

The data below provide an overview of the health of coral reefs surveyed in three Eco-regions in Malaysia, using Live Coral Cover as a key indicator. An Eco-region is defined as an area of relatively identical species composition, clearly distinct from adjacent regions (Spalding et al, 2007).

The marine eco-regions relevant to Malaysia are based on the "Marine Eco-regions of the World" system (Spalding et al, 2007). They are:

- Malacca Strait (West coast of Peninsular Malaysia, Eco-region 118)
- Sunda Shelf (East coast of Peninsular Malaysia and Sarawak, Eco-region 117)
- North Borneo (Sabah, Eco-region 126)

Focusing management efforts at an eco-region level can provide benefits as reefs in a given region are similar; therefore the results of this report have been delineated into these three eco-regions.

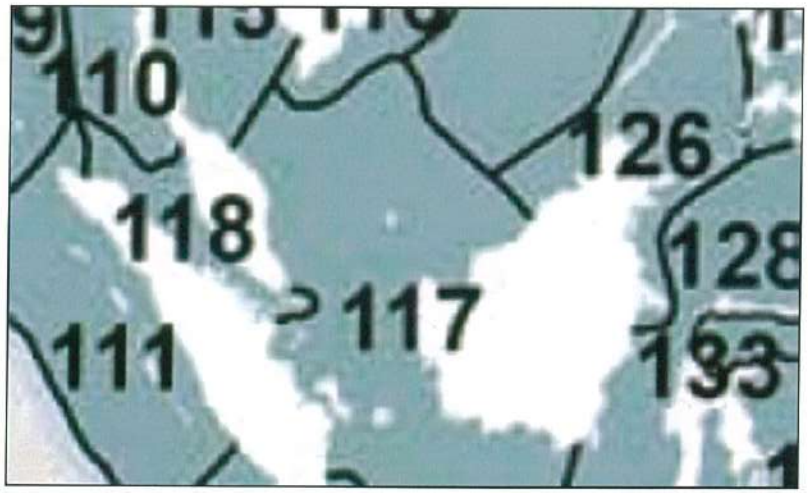


Figure 2: Eco-regions of Malaysia; 118 = Malacca Strait, 117 = Sunda Shelf and 126 = North Borneo

The results highlight the different problems each island/area is facing. Islands/regions covered in each Ecoregion are shown in Table 2 below.

Data on LCC indicate that in general sites in Peninsular Malaysia have higher LCC than in East Malaysia. Furthermore, sites in protected areas (e.g., Marine Parks, SIMCA, TARP, TSMP) have higher LCC than sites outside protected areas (e.g., Sembilan, Kapalai, Mabul), suggesting that protected areas are having some beneficial impacts on coral reefs in Malaysia.

Table 2: Site Coverage by Ecoregion

Islands/Areas	No. of sites	Protection Status	LCC (%)
Sunda Shelf			
Perhentian	10	Marine Park	42.31
Redang	12	Marine Park	49.95
Tioman	17	Marine Park	66.36
Kapas	5	Marine Park	50.00
Bidong and Yu	6	Marine Park	48.33
Tenggol	6	Marine Park	52.92
Pemanggil	4	Marine Park	51.41
Tinggi	4	Marine Park	64.53
Sibu	6	Marine Park	58.85
Pulau Tengah	3	Marine Park	46.25
Pulau Rawa	1	Marine Park	43.75
Miri	6	Miri-Sibuti Coral Reefs National Park	54.90
Malacca Strait			
Sembilan	9	No protection	23.54
Pangkor Laut	1	No protection	66.25
Payar	5	Marine Park	51.38
North Borneo			
Lankayan	15	SIMCA	37.08
Mataking	6	No protection	27.29
Mabul	5	No protection	30.42
Kapalai	4	No protection	12.81
Mantanani	12	No protection	40.21
Usukan Cove	3	No protection	25.83
Lahad Datu	15	No protection	31.00
Tunku Abdul Rahman Park	6	Tunku Abdul Rahman Park	37.81
Tun Sakaran Marine Park	12	Tun Sakaran Marine Park	50.68
Sipadan Island	12	Sipadan Island Park	49.95
Pulau Tiga	6	Pulau Tiga Park	35.63
Pulau Penyu	9	Turtle Islands Park	42.85
Northern Semporna	14	No protection	28.79
Southern Semporna	13	No protection	33.61
Total	**227**	**Average**	**42.53**

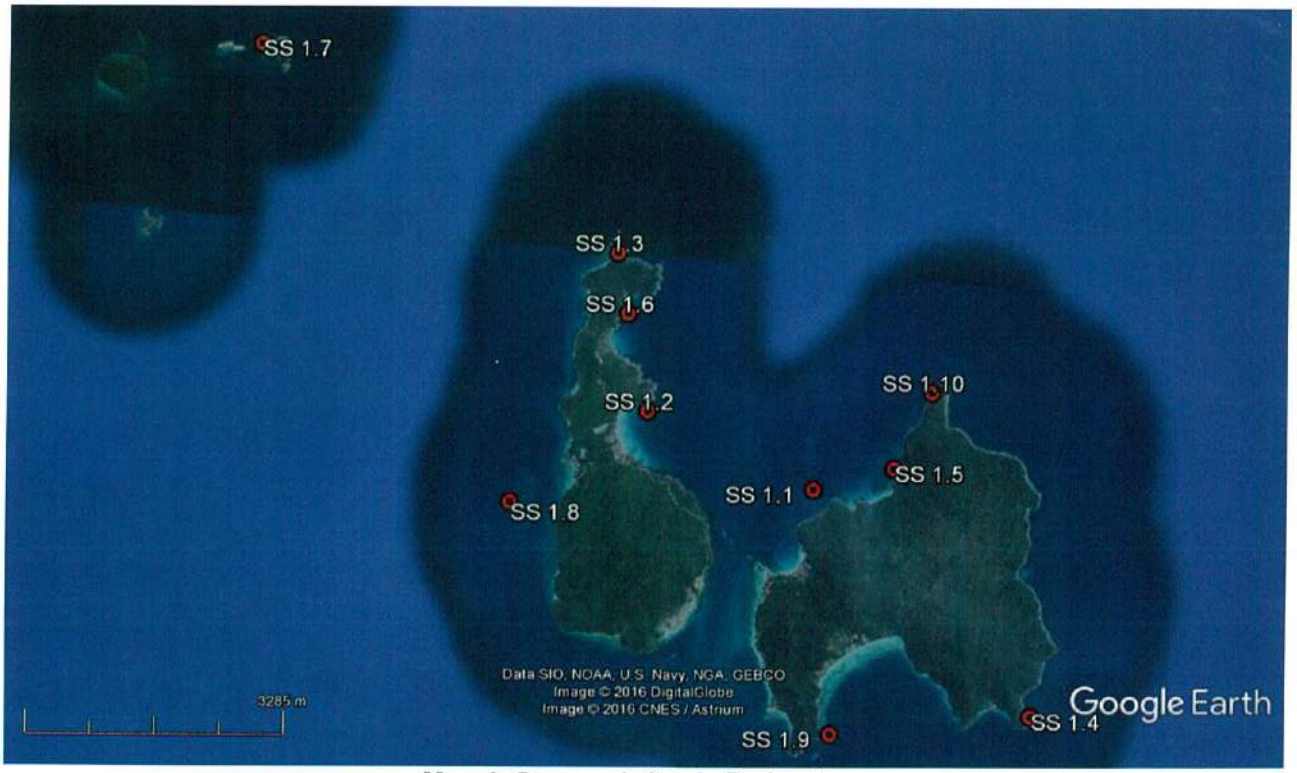
Sunda Shelf Region

3.2.1 Perhentian

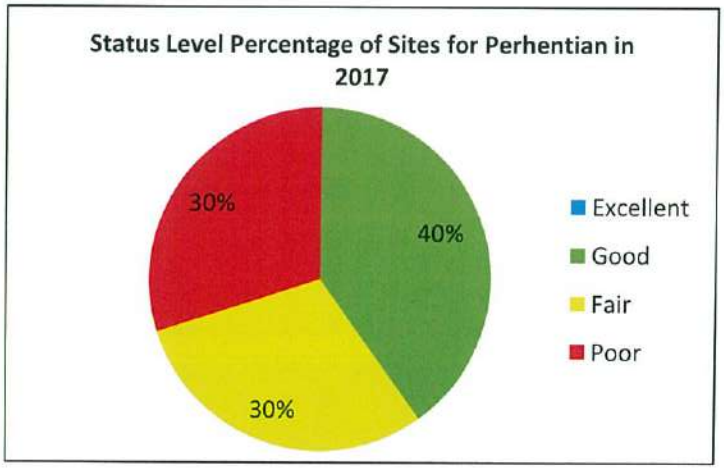
The Perhentian islands are located some 20km from Kuala Besut off the East coast of Terengganu, Malaysia. The islands have one village with a population of approximately 2,300, most of who work in tourism, the main industry on the islands. The islands are gazetted as a Marine Park (since 1994).

A popular tourist destination, particularly among backpackers, there are over 40 resorts, mainly small, family run chalets with a couple of large resorts, and over 20 dive operators, spread around the two main islands. Diving and snorkelling are the main tourist activities. Growth in tourism has been rapid on the islands, and resort development continues. There is no grid-supplied electricity, nor centralised sewage treatment; groundwater supplies are limited in Perhentian and fresh water is supplied from the mainland.

Reefs are mainly fringing off-shore reefs, with some submerged reefs.

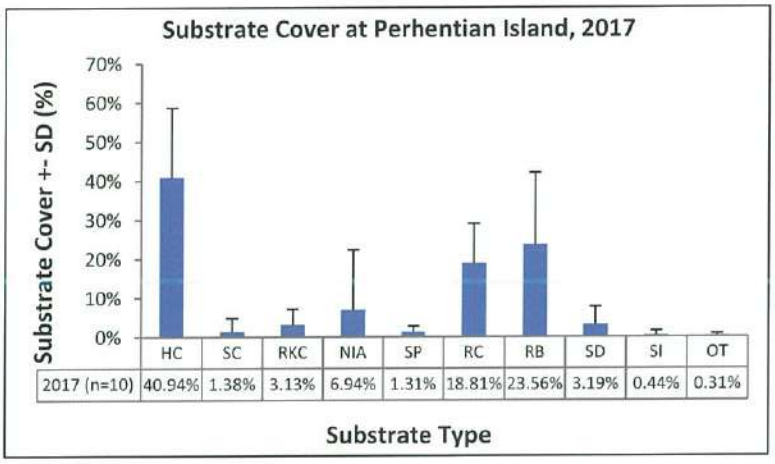


Map 4: Surveyed sites in Perhentian



A total of 10 coral reef sites were surveyed in Perhentian and 40% of the reefs were in good condition. 30% were in fair condition and the remaining 30% were in poor condition. No reefs were in excellent condition.

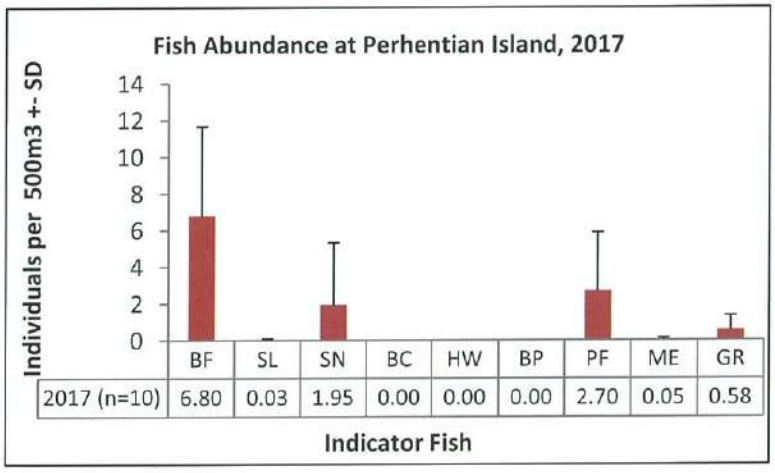
Substrate



Coral reefs around the Perhentian islands are considered to be in 'Fair' condition, with 42.31% live coral cover, below the average (54.21%) for reefs within the Sunda Shelf region.

HC cover has decreased significantly compared to last year and this is due to the significant increase in RB level. The level of RB has increased from 9.94% in 2016 to 23.56% in 2017. RKC and NIA level has also increased a lot; RKC has increased from 0.38% in 2016 to 3.13% in 2017 while NIA has increased from 1% in 2016 to 6.94% in 2017.

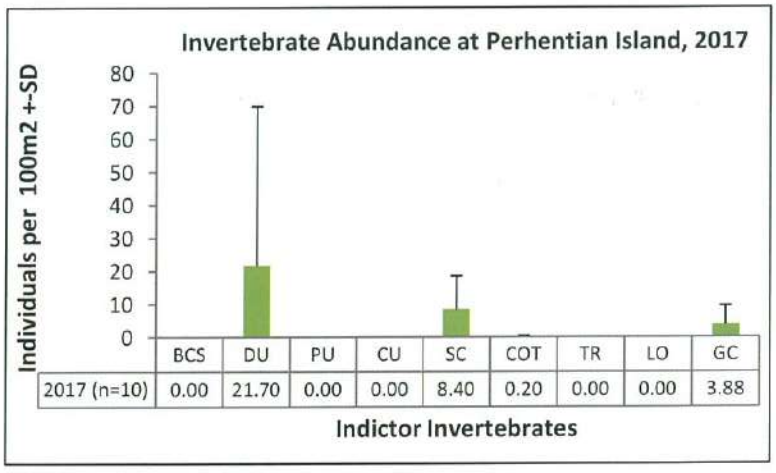
Fish



Six indicator fish were recorded during surveys. The most abundant fish recorded was Butterflyfish, followed by Parrotfish and Snapper. Sweetlips, Moray Eel and Grouper were present in low number.

High value fish such as Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish were completely absent from surveys.

Invertebrates



None of the indicator invertebrate targeted for curio trade (Banded Coral Shrimp, Pencil Urchin and Triton) was recorded during surveys. Collector Urchin and Lobster which are targeted for food also absent from the surveys.

Diadema Urchin, Sea Cucumber and Giant Clam were common on most reefs. Perhentian recorded the second highest number of Sea Cucumber in the Sunda Shelf region.

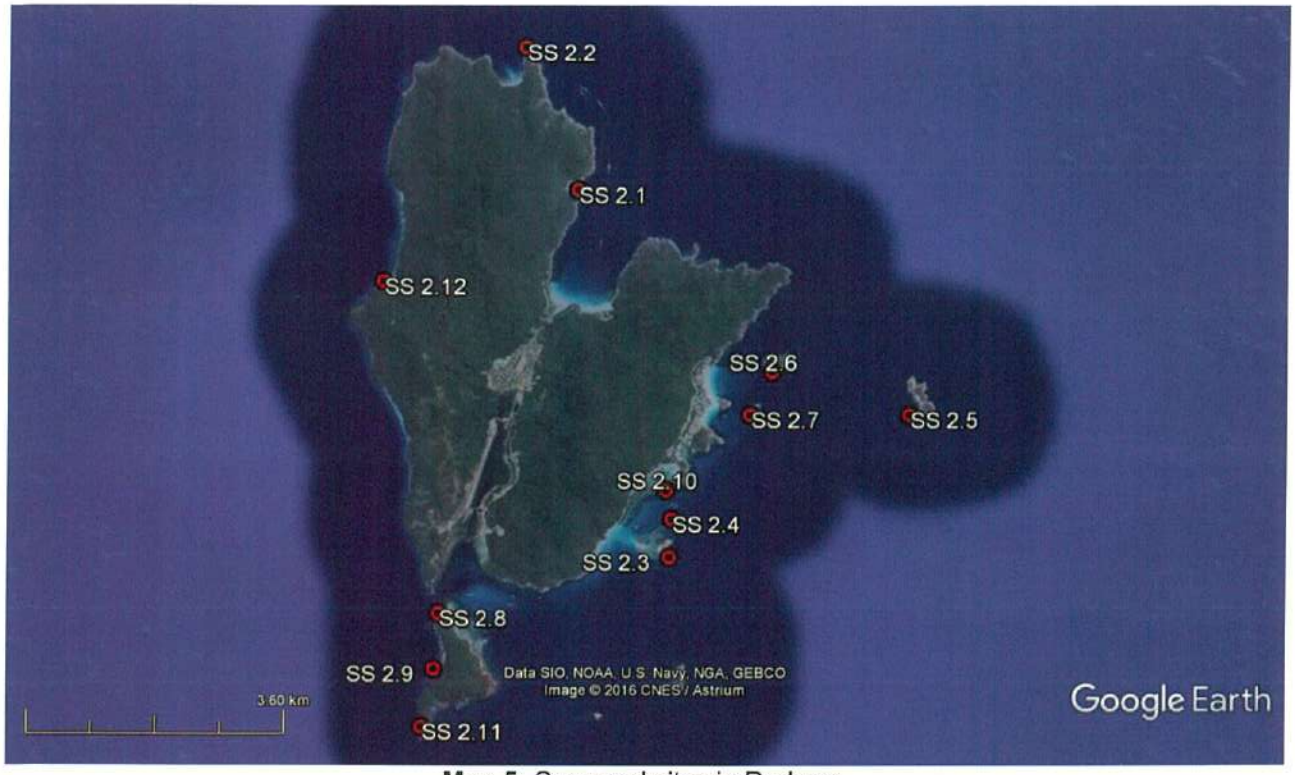
Boat anchor damage was observed during surveys. Discarded fishing nets and trash were also found during surveys. On a positive note, sharks and turtles were recorded during surveys. Within the Sunda Shelf region, Perhentian recorded the highest number of turtles.

3.2.2 Redang

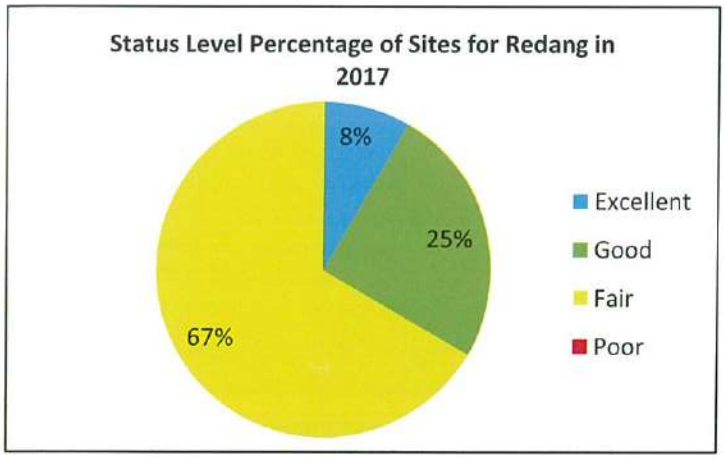
Redang Island is located some 25km from Merang, off the East coast of Terengganu, Malaysia. The island has a population of approximately 1,500, only a small proportion of who work in tourism, the main industry on the islands. The islands are gazetted as a Marine Park (since 1994).

The island is a popular resort destination, with a more upmarket image than nearby Perhentian. Diving and snorkelling are the main tourist activities. There are 10 medium-large size resorts, mainly on Pasir Panjang. Most resorts have an in-house dive operator. There is no mains electricity, water is supplied by pipeline from the mainland and each resort has its own sewage treatment facilities. The island is served by an airport as well as boat services.

Both fringing off-shore reefs and submerged reefs can be found in the area.

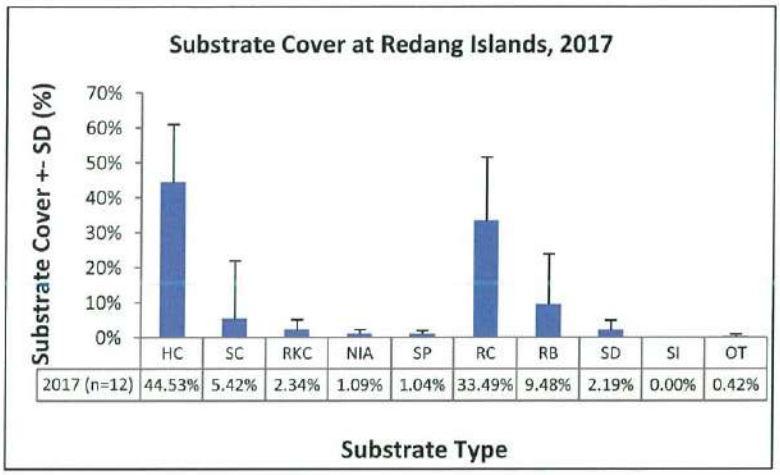


Map 5: Surveyed sites in Redang



A total of 12 coral reef sites were surveyed in Redang and 8% of the sites were in excellent condition. 67% were in fair condition and the remaining 25% were in good condition. No reefs were in poor condition.

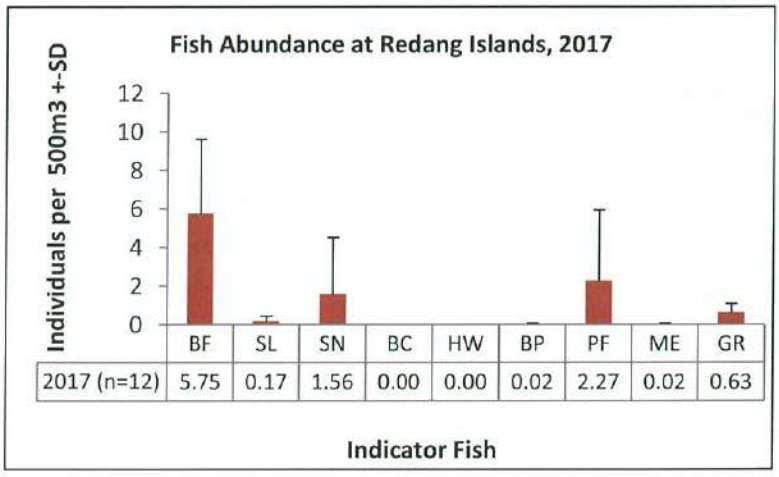
Substrate



The reefs around Redang islands are considered to be in 'Fair' condition, with live coral cover of 49.95% and below the average (54.21%) for reefs within the Sunda Shelf region.

While the average level of RB in Redang has decreased compared to last year, the level is still very high at some sites; 51.88% at SS2.4 Kerengga Kecil and 20% at SS2.3 Kerengga Besar. RB level at SS2.4 Kerengga Kecil has in fact increased from 27.50% in 2016 to 51.88% in 2017.

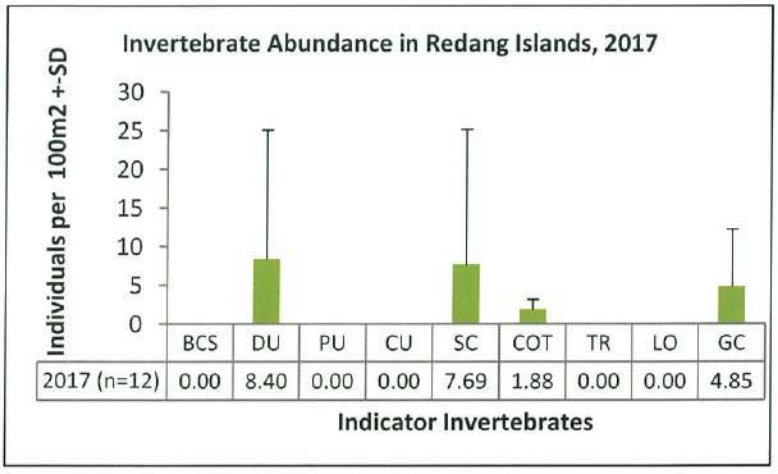
Fish



Highly prized fish such as Barramundi Cod and Humphead Wrasse were absent during surveys.

Butterflyfish recorded the highest number, followed by Parrotfish and Snapper. Sweetlips, Moray Eel and Grouper recorded low abundance. Bumphead Parrotfish also recorded in low abundance.

Invertebrates



Numerous targeted species were absent, including Banded Coral Shrimp, Pencil and Collector Urchin, Triton and Lobster.

Although DMPM conducts annual COT cleanups around the island, COT abundance has increased from 0.77 ind./100m^2 in 2016 to 1.88 in 2017. The number is way above what a healthy reef can sustain (0.2-0.3 ind./100m^2). Within the Sunda Shelf region, Redang recorded the highest number of COT and action must be taken to control the increasing COT population in Redang.

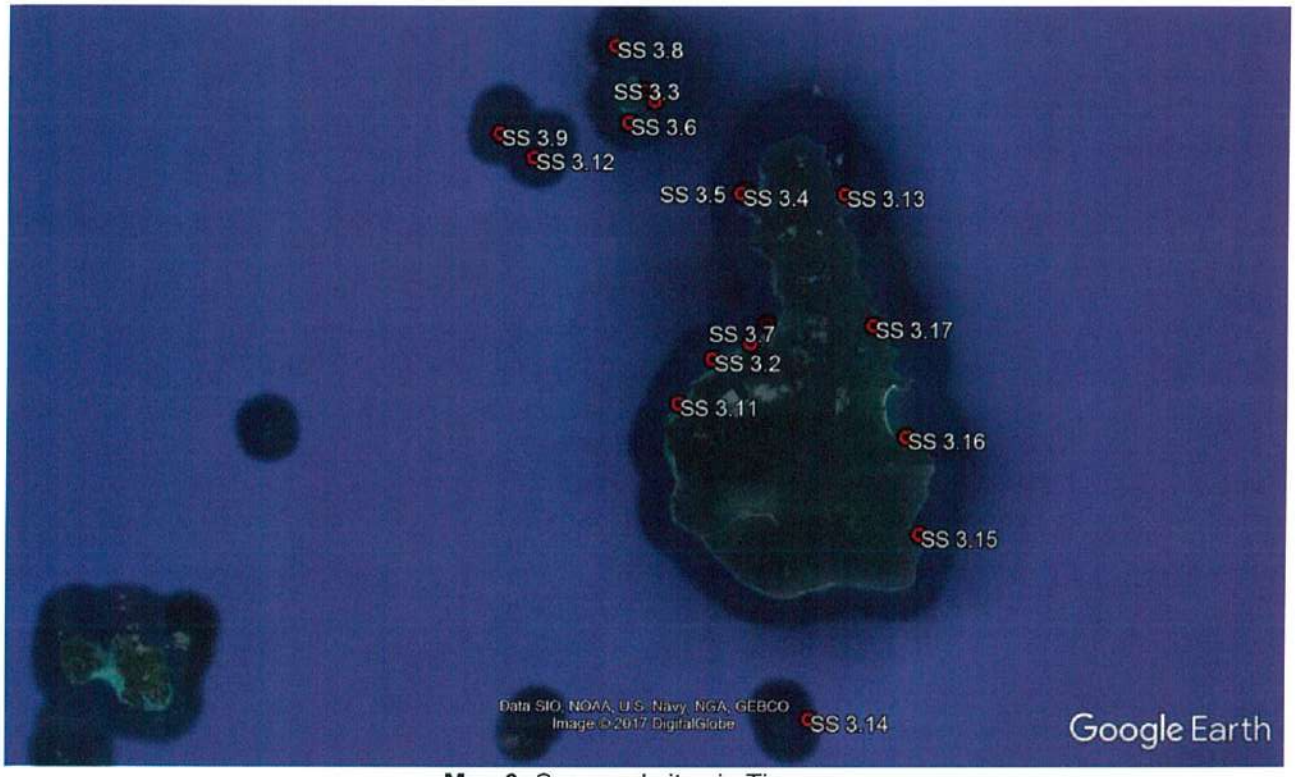
Boat anchor damage was observed during surveys. Discarded fishing nets and trash were also found during surveys. On a positive note, turtles were recorded during surveys.

3.2.3 Tioman

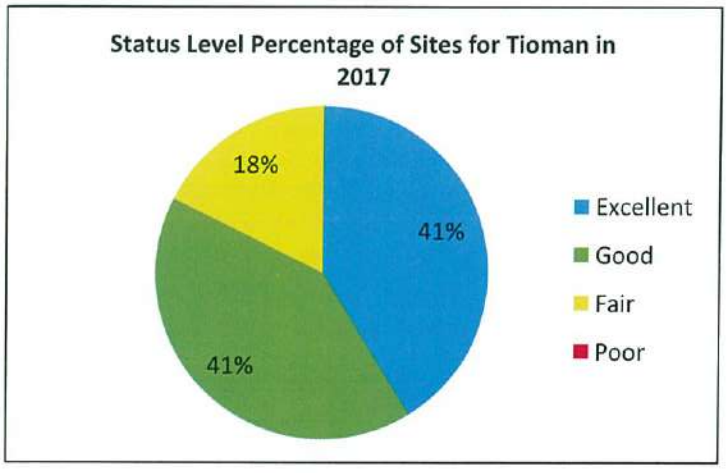
Tioman Island is located some 50km from Mersing, off the East coast of Pahang. It is the largest island off the East coast of Peninsular Malaysia. The island has five villages, with a total population of approximately 3,700 most of whom work in the tourism industry, the main industry on the islands. The island has been gazetted as a Marine Park since 1994. Reefs are mainly fringing off-shore reefs with some submerged reefs.

Diving and snorkelling are the main tourist activities. The island has long been a popular tourist destination, though at one point it has been eclipsed by other destinations (particularly Redang and Perhentian). However, in recent years, tourism on Tioman Island has picked up again and now there are some 72 resorts on the island and 34 dive operators.

There is a small power generation station on the island, supplying electricity to all areas. Freshwater on the island depends mainly on several river systems coming from the hilly forested areas. A municipal incinerator was constructed some years ago. The island is served by an airport as well as ferry services.

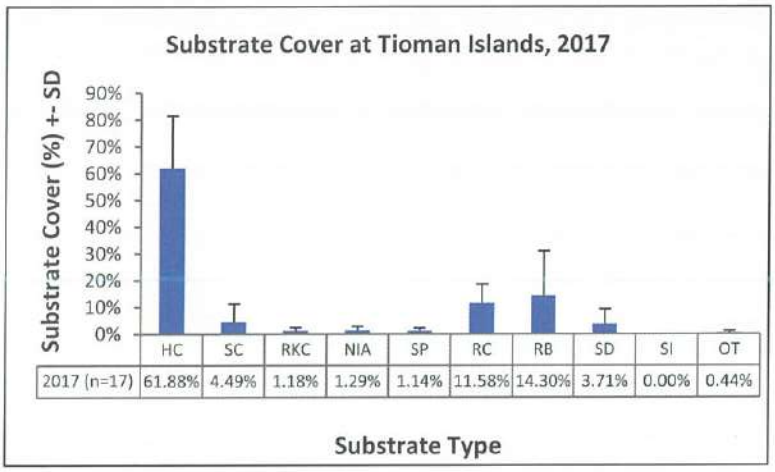


Map 6: Surveyed sites in Tioman



A total of 17 coral reef sites were surveyed in Tioman and 41% of the reefs were in excellent condition. 41% were in good condition, while 18% were in fair condition. No reefs were in poor condition.

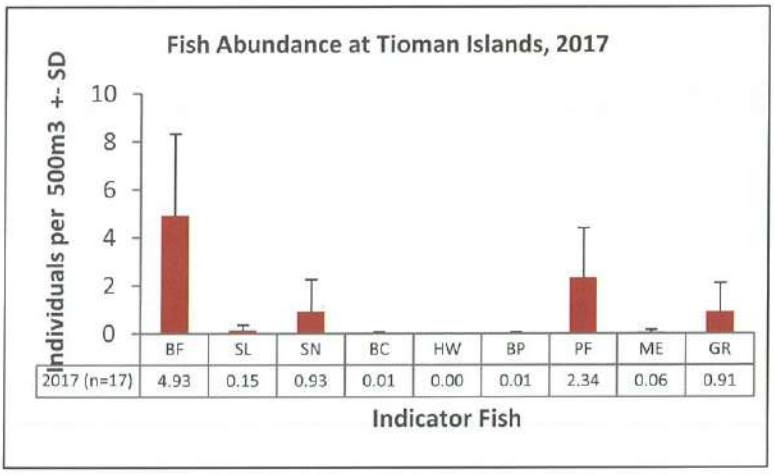
Substrate



The reefs in Tioman are considered to be in 'Good' condition, with 66.36% live coral cover, above the average for reefs of the Sunda Shelf region (54.21%).

Level of RB was high and has increased compared to last year. Five of the survey sites recorded more than 20% of RB and the level was exceptionally high at SS3.4 Soyak South, recording as much as 56.88% (36.88% in 2016). RB level is still high at SS3.12 Labas, recording 50.63% (56.88% in 2016).

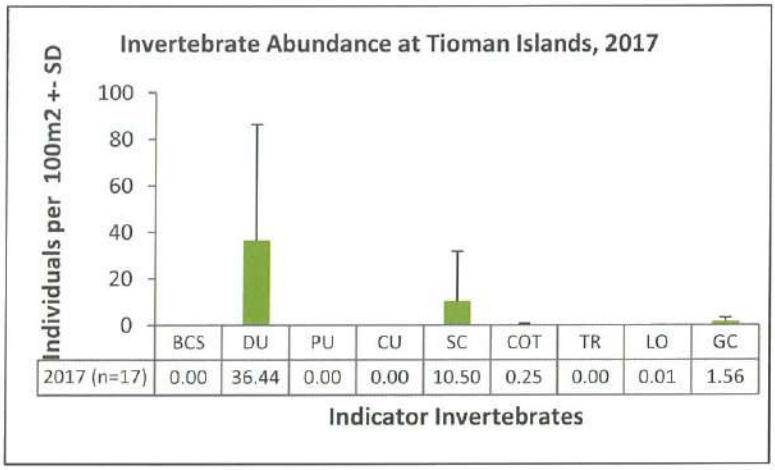
Fish



Only Humphead Wrasse was not recorded during surveys.

Butterflyfish recorded the highest number, followed Parrotfish. Other indicators were present in low number, less than 1 ind./500m^3.

Invertebrates



None of the indicator invertebrate targeted for curio trade (Banded Coral Shrimp, Pencil Urchin and Triton) was recorded during surveys. Collector Urchin which is targeted for food also absent from the surveys.

The number of Diadema was the highest, followed by Sea Cucumber. Tioman recorded the highest number of Sea Cucumber in the Sunda Shelf region. The number of COT is within what a healthy reef can sustain (0.2-0.3 ind./100m^2).

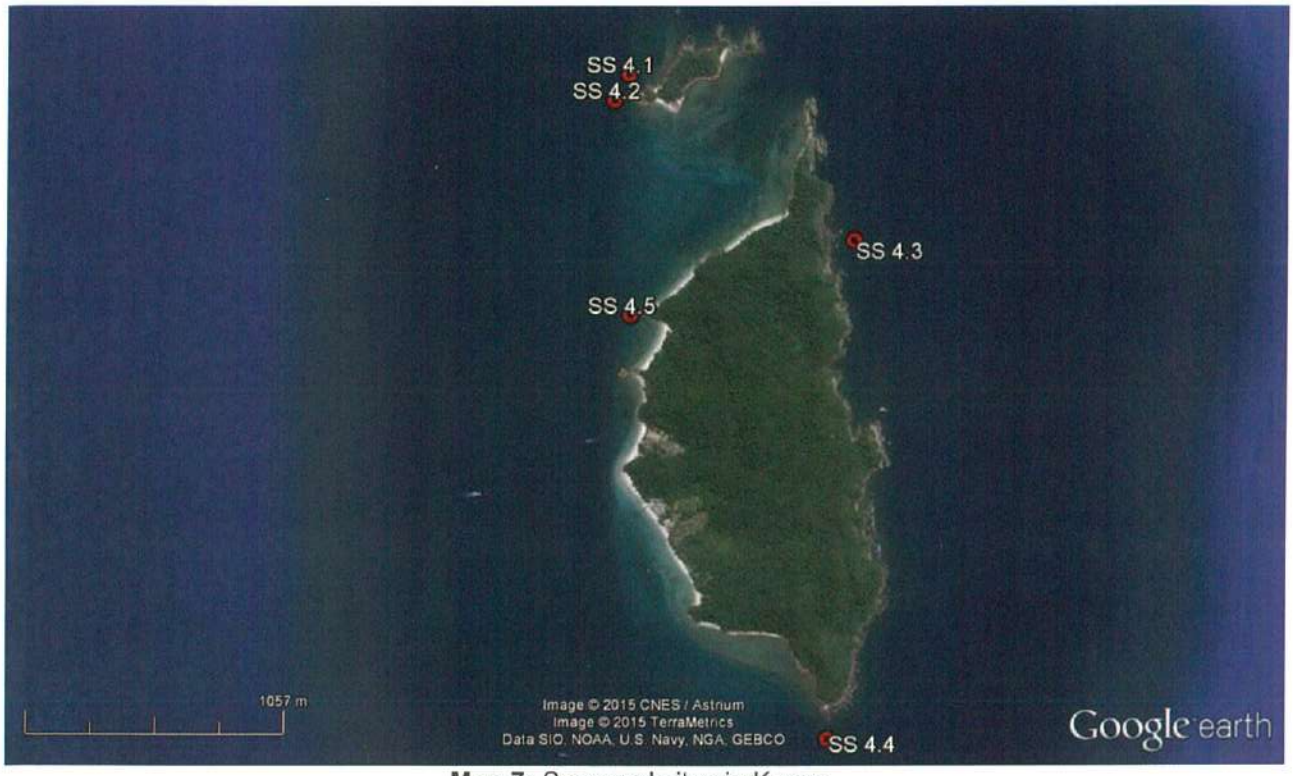
Boat anchor damage, discarded fishing nets and trash were recorded during surveys. Within the Sunda Shelf region, Tioman recorded the second highest for severity of damage due to discarded fishing nets. Some of the reefs were also impacted by warm water bleaching and disease. On a positive note, shark and turtle were observed at a number of survey sites.

3.2.4 Kapas

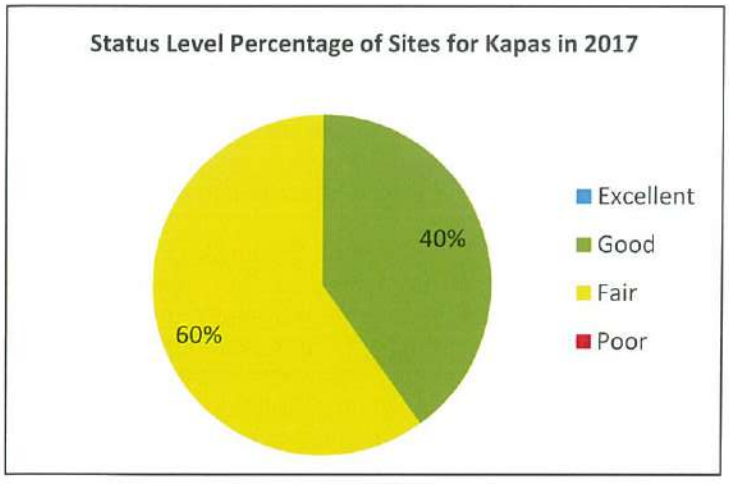
Kapas Island is located just 6km from Marang, off the East coast of Terengganu, Malaysia. This small island has no local population. The islands are gazetted as a Marine Park (since 1994).

The island is not a major tourist destination due to its small size, but does have an established tourist market, with less than ten resorts and one dive operator. Diving and snorkelling are the main tourist activities. There is no mains electricity, groundwater supplies are limited and there is no centralised sewage treatment.

Reefs are mainly fringing off-shore reefs, with some submerged reefs.

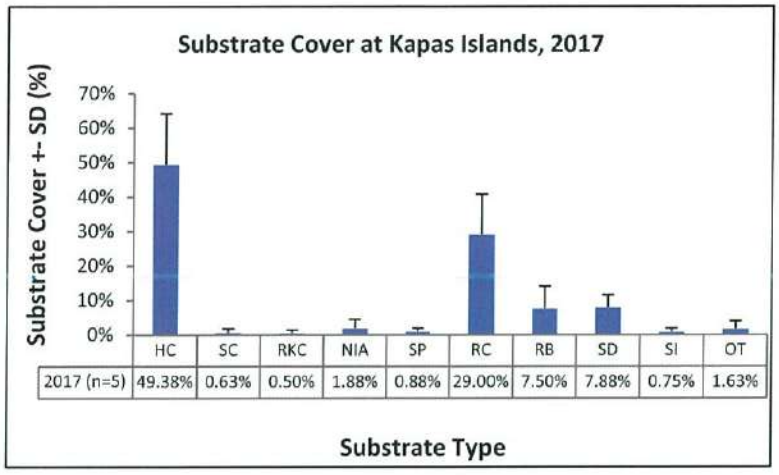


Map 7: Surveyed sites in Kapas



A total of 5 coral reef sites were surveyed in Kapas. 40% of the sites were in good condition, while 60% were in fair condition.

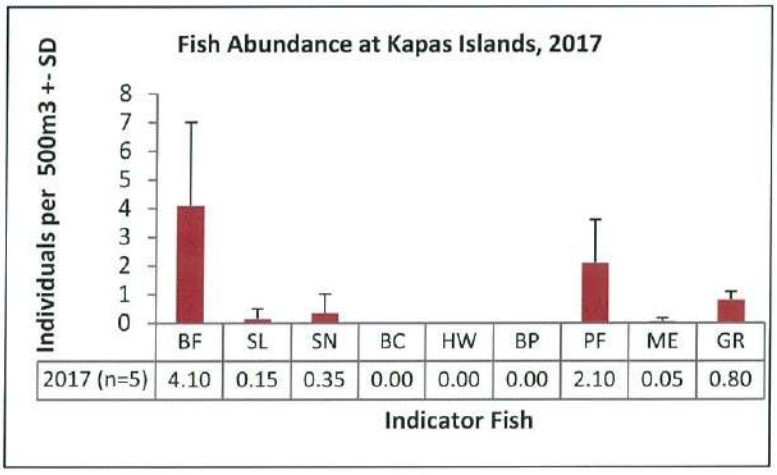
Substrate



Coral reefs around Kapas islands are considered to be in 'Good' condition, with 50% live coral cover, below the average (54.21%) for all islands surveyed in the Sunda Shelf region.

The level of NIA has decreased considerably from 15.13% in 2016 to 1.88% in 2017. However RB level at SS4.1 Coral Garden 1 still remain high although it has decreased slightly from 24.38% in 2016 to 18.13% in 2017.

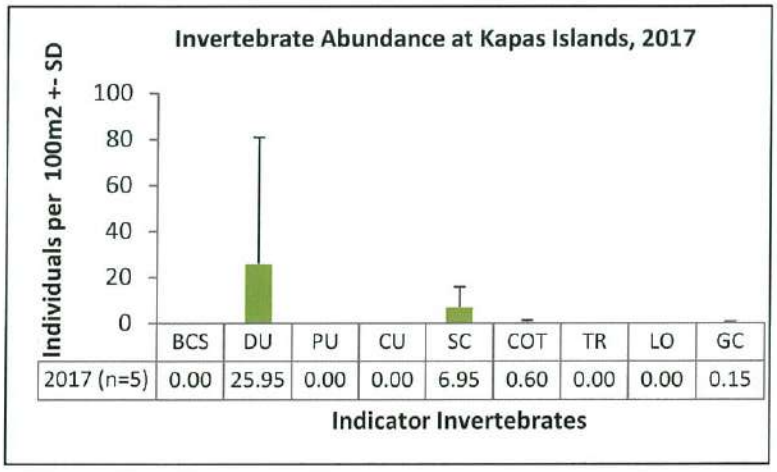
Fish



The most abundant fish were Butterflyfish, followed by Parrotfish. Sweetlips, Snapper, Moray Eel and Grouper were present in low number.

High value fish such as Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish were completely absent from surveys.

Invertebrates



None of the indicator invertebrate targeted for curio trade (Banded Coral Shrimp, Pencil Urchin and Triton) was recorded during surveys. Collector Urchin and Lobster which are targeted for food also absent from the surveys

Abundance of Diadema Urchin was the highest, followed by Sea Cucumber. Giant Clam was present in low number. Although COT abundance has decreased from last year, the number is still way above what a healthy reef can sustain (0.2-0.3 ind./100m^2).

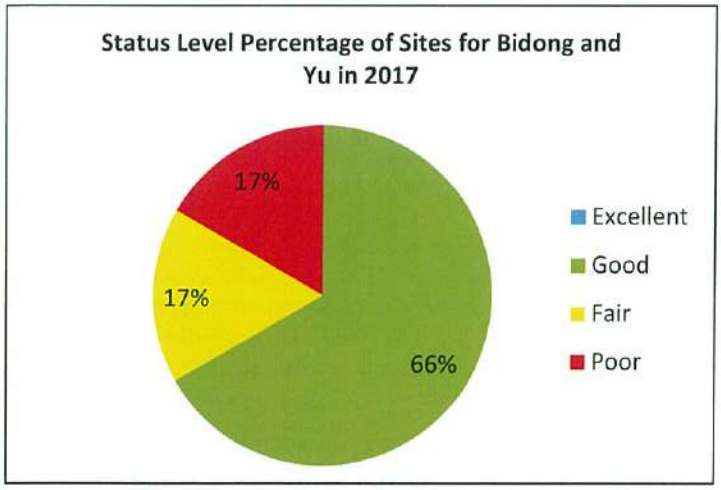
Discarded fishing nets and trash were recorded during surveys. A blacktip shark of approximately 2m was also seen during surveys at SS4.2 Coral Garden 3.

3.2.5 Bidong and Yu

The Bidong and Yu archipelago comprises several small islands, located 15-25km from Marang, off the East coast of Terengganu, Malaysia. The islands are unpopulated, though from 1978 to 1991 Bidong was a centre for Vietnamese refugees. The islands are now gazetted as a Marine Park.

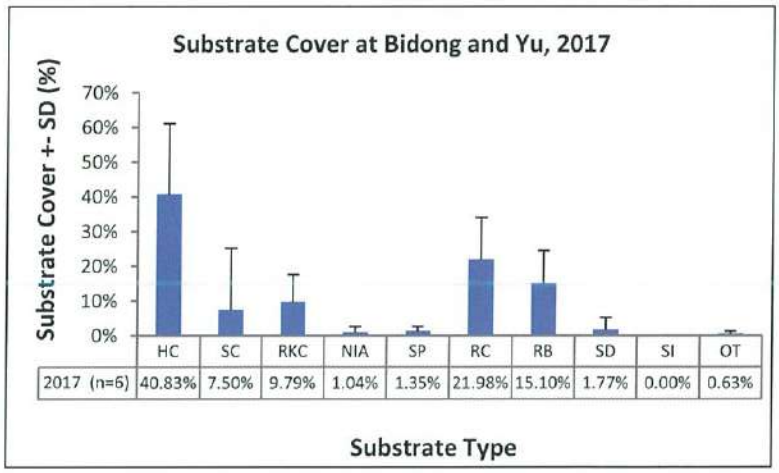
Bidong has mainly been a research base for University Malaysia Terengganu but has recently grown in popularity as a diving destination. Bidong has some sandy beaches and fringing reefs while Pulau Yu Besar and Kecil are mainly small rocky islands, with boulder slopes dropping to 25-30m, with some coral reef areas.

Map 8: Surveyed sites in Bidong and Yu



A total of 6 coral reef sites were surveyed in Bidong and Yu. 66% of the reefs were in good condition. 17% were in fair condition and the remaining 17% were in poor condition.

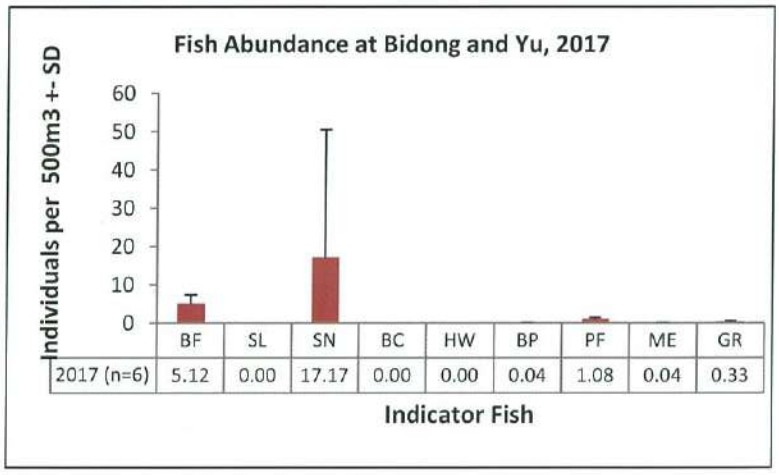
Substrate



Coral reefs around Bidong and Yu islands are considered to be in 'Fair' condition, with 48.33% live coral cover, lower than the average (54.21%) for reefs in Sunda Shelf region.

RKC level remain high at 9.79%. This is highly likely due to COT predation as high number of COT was recorded during surveys. RB level has increased considerably from 8.96% in 2016 to 15.10% in 2017.

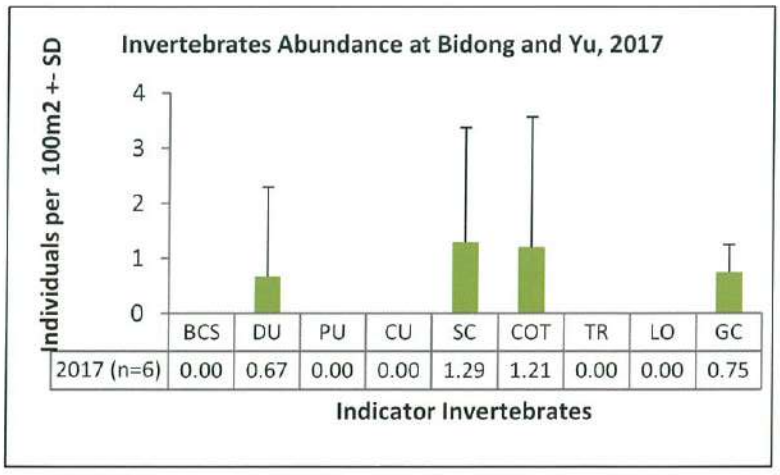
Fish



Highly prized fish such as Barramundi Cod and Humphead Wrasse were absent from surveys. Sweetlips was also not recorded during surveys.

Abundance of Snapper is the highest, followed by Butterflyfish. Abundance of Bumphead Parrotfish, Moray Eel and Grouper was low.

Invertebrates



As in most sites, none of the indicator invertebrate targeted for curio trade (Banded Coral Shrimp, Pencil Urchin and Triton) was recorded during surveys. Collector Urchin and Lobster which are targeted for food also absent from the surveys

Although the abundance of COT has decreased slightly, the level is still way above acceptable limits (0.2-0.3 ind./100m^2). COT population in Bidong and Yu is the second highest of all islands surveyed in Sunda Shelf region and this is a cause for concern.

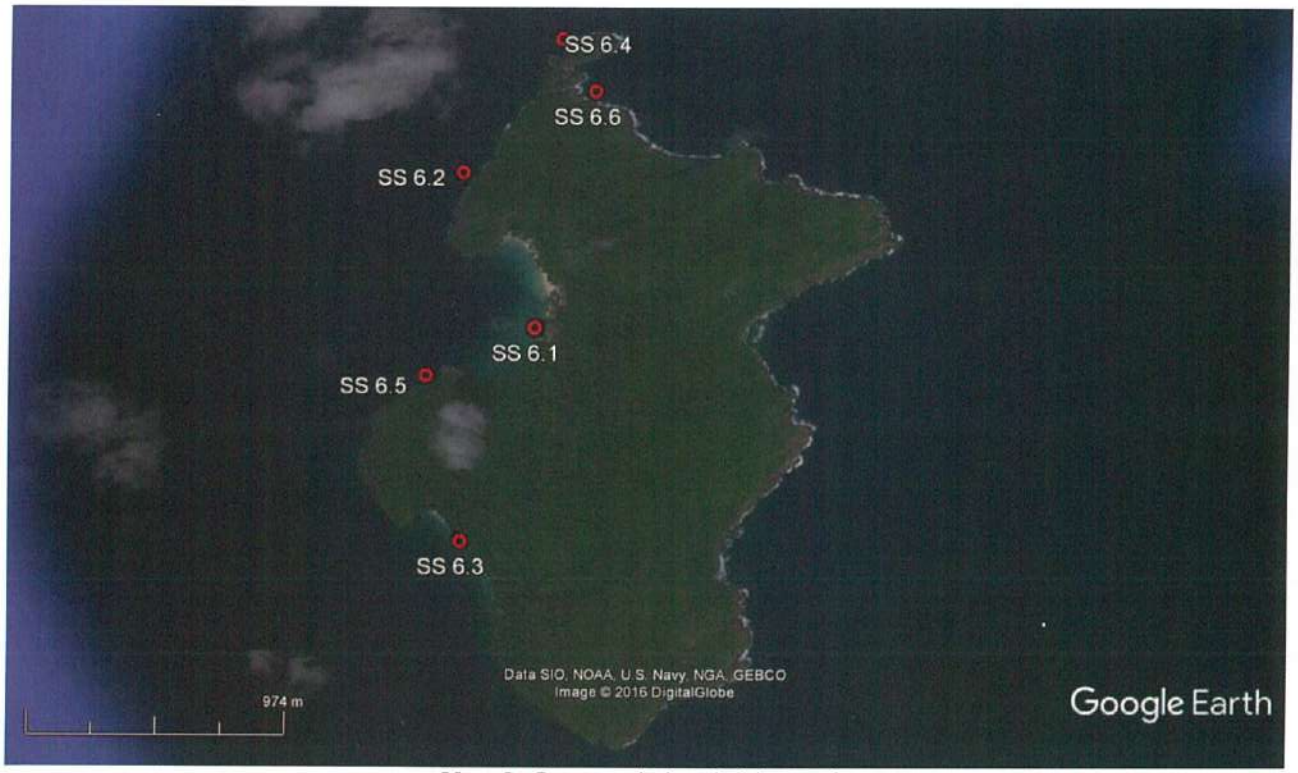
Boat anchor damage, discarded fishing nets and trash were recorded at many survey sites. Within the Sunda Shelf region, the severity of damage cause by discarded fishing nets was the highest in Bidong & Yu. On a positive note, turtles were observed at two sites.

3.2.6 Tenggol

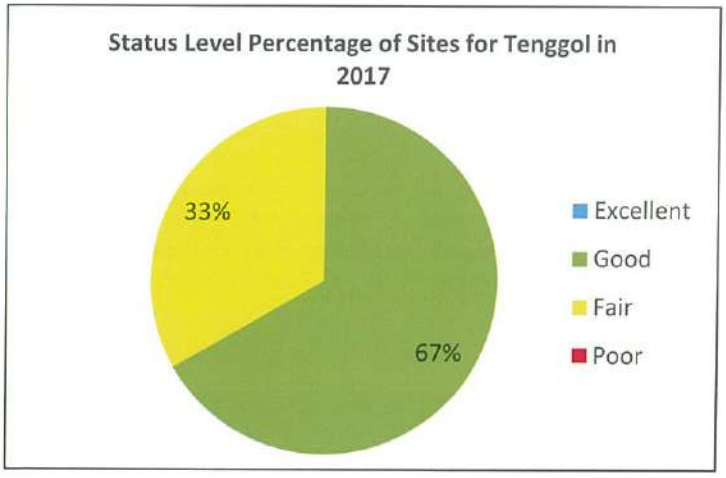
Tenggol Island is located approximately 30km from Dungun, off the East coast of Terengganu, Malaysia. This small island has no local population. The island is gazetted as a Marine Park (since 1994).

The island is a popular diving destination due to the surrounding deep water which attracts more mega fauna than other islands (whale sharks are common around the island). There are four resorts on the island, each with its own dive operator. There is no mains electricity, groundwater supplies are limited and there is no centralised sewage treatment. Tenggol Island gains popularity in the last few years and many dive and snorkel operators has started to operate from Dungun mainland, offering day trip packages to divers and snorkelers alike.

Much of the islands' coastline is rocky, besides a couple of sandy beaches. The reefs are mainly fringing reefs and rocky reefs.

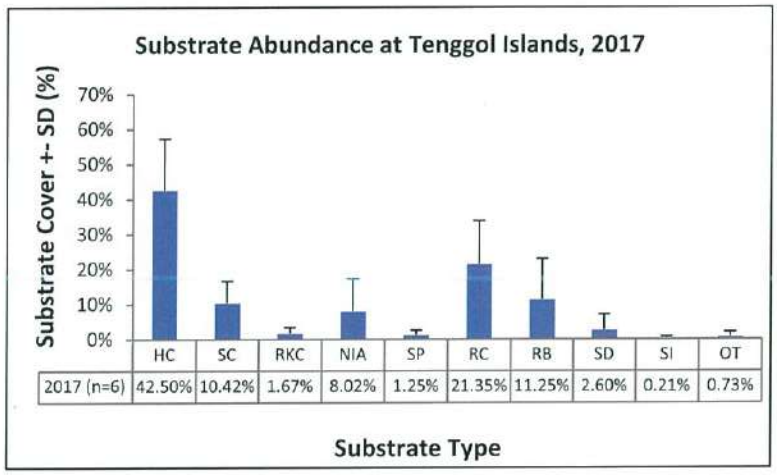


Map 9: Surveyed sites in Tenggol



A total of 6 coral reef sites were surveyed in Tenggol. 67% of the sites were in good condition, while the remaining 33% were in fair condition.

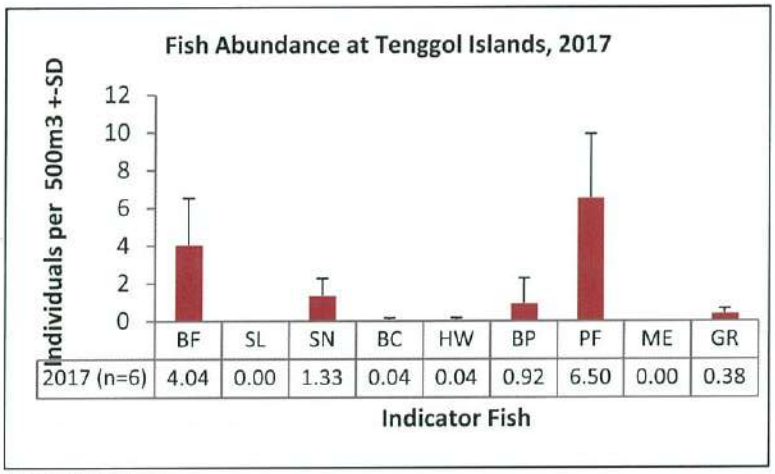
Substrate



The reefs in Tenggol were considered to be in 'Good' condition, with 52.92% live coral cover, below the average (54.21%) for reefs of the Sunda Shelf region.

Both the level of NIA and SP has increased from 3.23% in 2016 to 8.02% in 2017 and 0.94% in 2016 to 1.25% in 2017, respectively. This indicates raised level of nutrient runoff. The level of NIA at SS6.1 Freshwater Bay has increased from 16.88% in 2016 to 25.63% in 2017 and this need to be monitored closely.

Fish



Abundance of Parrotfish was the highest, followed by Butterflyfish and Snapper. Other indicators such as Barramundi Cod and Grouper were present in low number.

Bumphead Parrotfish was recorded at almost all surveyed sites and is the highest of all islands surveyed in Sunda Shelf region. Humphead Wrasse was also recorded and Tenggol is the only island within the Sunda Shelf region that recorded Humphead Wrasse during surveys.

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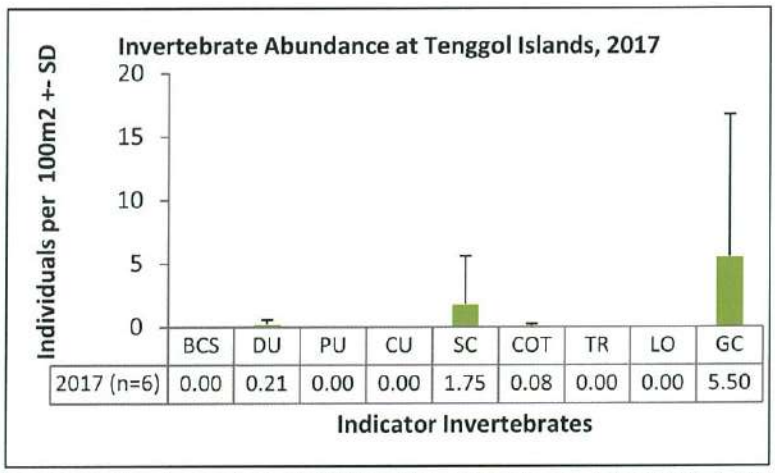
Invertebrates



None of the indicator invertebrate targeted for curio trade (Banded Coral Shrimp, Pencil Urchin and Triton) was recorded during surveys. Collector Urchin and Lobster which are targeted for food also absent from the surveys.

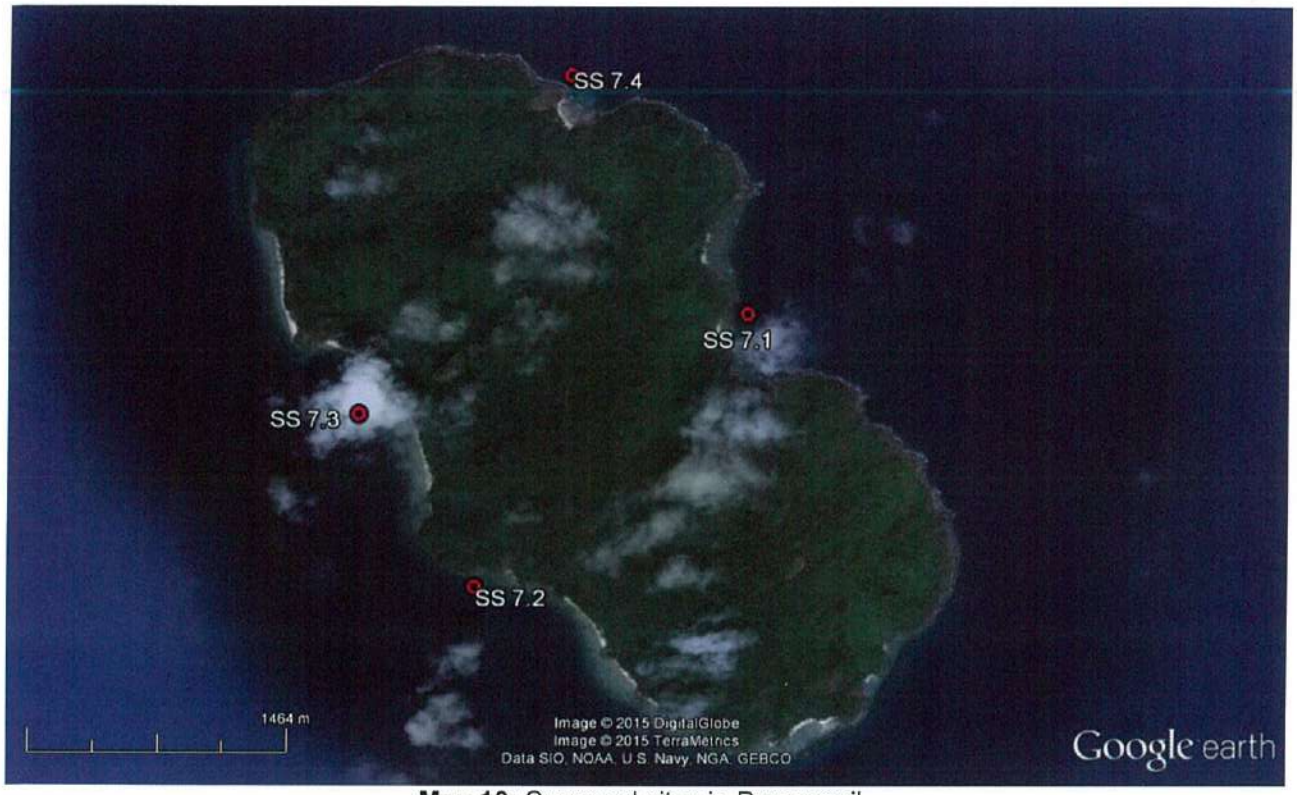
Giant Clam recorded the highest abundance (highest within the Sunda Shelf region), followed by Sea Cucumber. Abundance of other indicator species was very low. The abundance of COT remains within the range which a healthy reef can support (0.2-0.3 ind./100m^2).

Damage due to warm water bleaching was observed at SS6.1 Freshwater Bay and SS6.5 Turtle Point. Within the Sunda Shelf region, the severity of damages due to warm water bleaching was the highest in Tenggol. Boat anchor damage, discarded fishing nets and trash were also recorded during surveys. Drupella predation was observed at SS6.2 Gua Rajawali. On a positive note, sharks (the highest within the Sunda Shelf region) and turtles were observed at few surveyed sites.

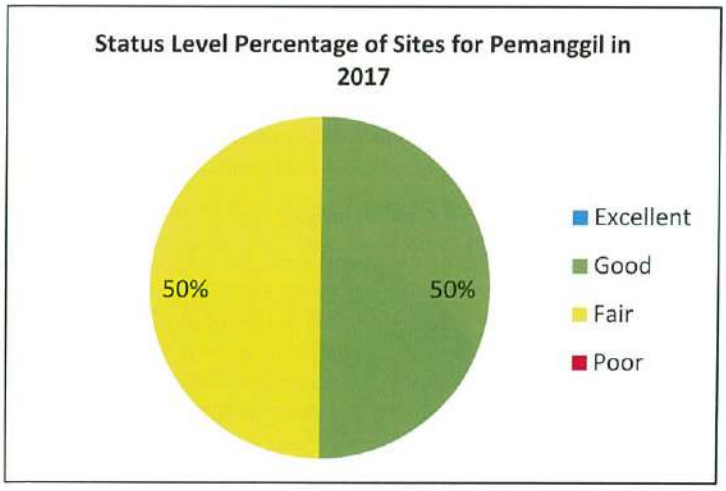
3.2.7 Pemanggil

Pemanggil Island is approximately 45km east of Mersing off the East coast of Peninsular Malaysia. The island and its surrounding waters were gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1993).

The island is sparsely populated and has for many years been a frequent stopover point for fishermen.

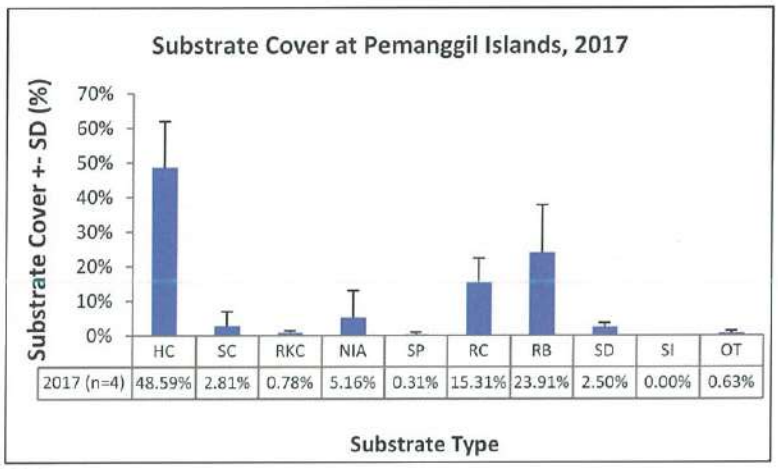


Map 10: Surveyed sites in Pemanggil



A total of 4 coral reef sites were surveyed in Pemanggil and 50% of the sites were in good condition. The remaining 50% were in fair condition.

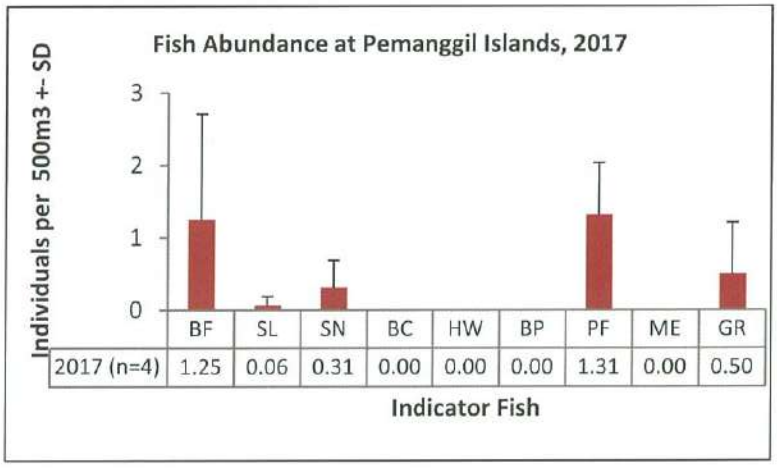
Substrate



The reefs in Pemanggil are considered to be in 'Good' condition, with 51.41% live coral cover, below the average (54.34%) for reefs of the Sunda Shelf region.

Although the level of RKC and NIA has decreased slightly from last year, the level of RB has increased significantly (15.94% in 2016). All sites surveyed in Pemanggil showed a significant increase. This is a cause for concern and need to be monitored closely.

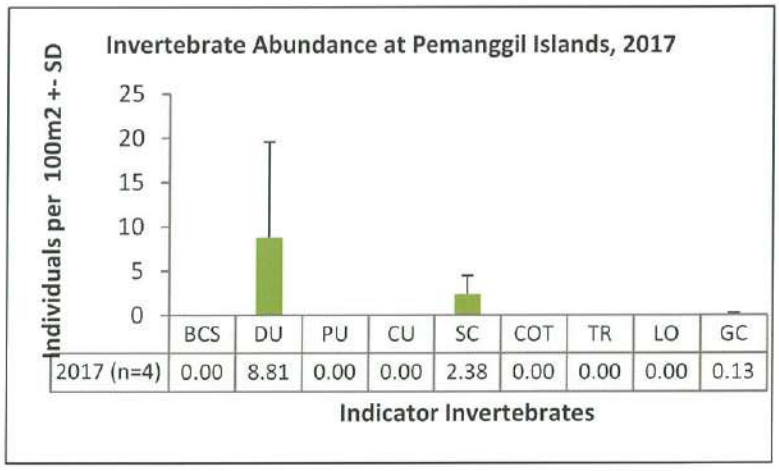
Fish



Highly prized fish were absent during surveys (Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish).

All indicator species were present in low number.

Invertebrates



Similar to other islands, several targeted species were absent, including Banded Coral Shrimp, Pencil and Collector Urchin, Triton and Lobster.

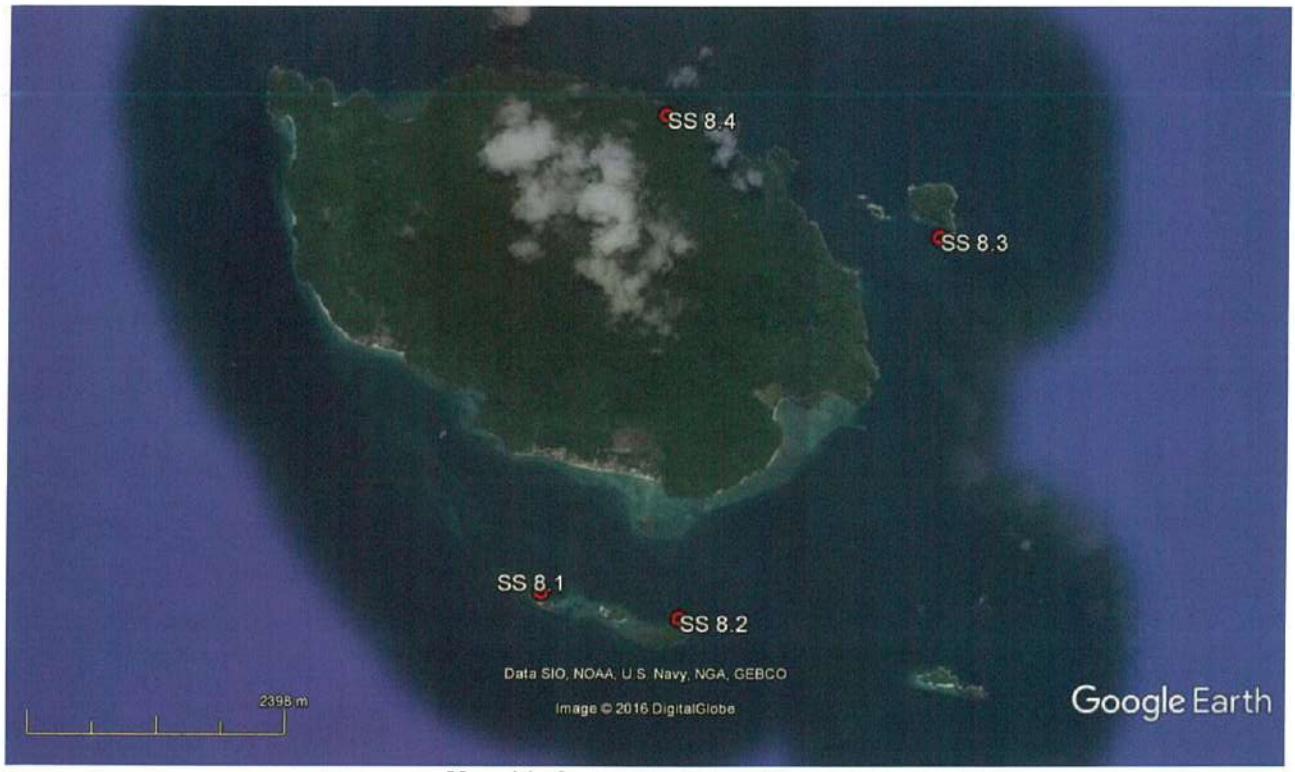
Diadema Urchin recorded the highest number, followed by Sea Cucumber. COT abundance which recorded above what a healthy reef can sustain last year does not seems to pose any dangers this year as the abundance has dropped back to within the healthy range.

Boat anchor damage (the highest severity of all islands surveyed within the Sunda Shelf region), discarded fishing nets and trash were recorded during surveys. Hawksbill turtle was also observed.

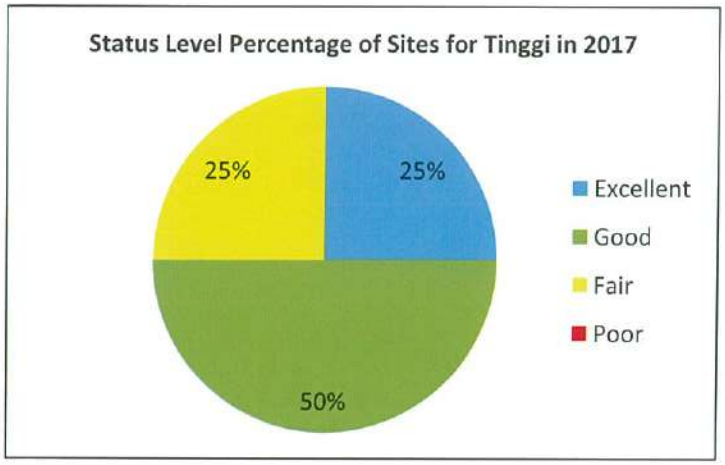
3.2.8 Tinggi

Tinggi Island is located less than 15km off the East coast of mainland Peninsular Malaysia. The island and its surrounding waters were gazetted as Marine Parks in 1994 under the Fisheries Act 1985 (Amended 1993).

The island is not as popular among tourists as other islands off the East coast, but the tourism industry here is growing. There is no dive operator on Tinggi Island.

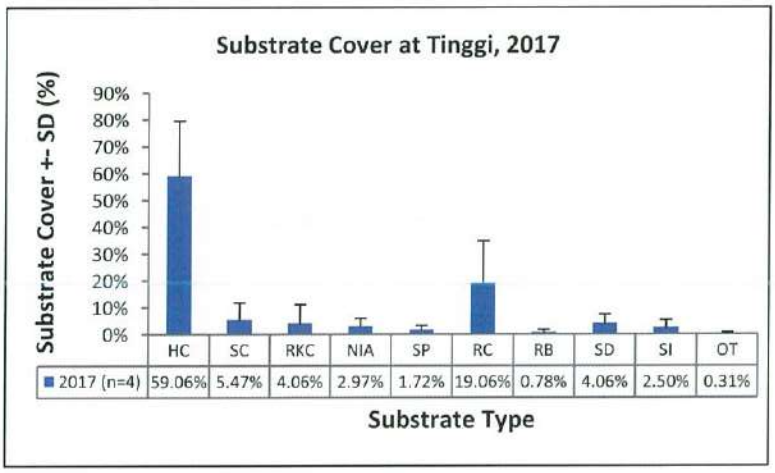


Map 11: Surveyed sites in Tinggi



A total of 4 coral reef sites were surveyed in Tinggi and 25% of the sites were in excellent condition. 50% were in good condition and 25% were in fair condition. No reefs were in poor condition.

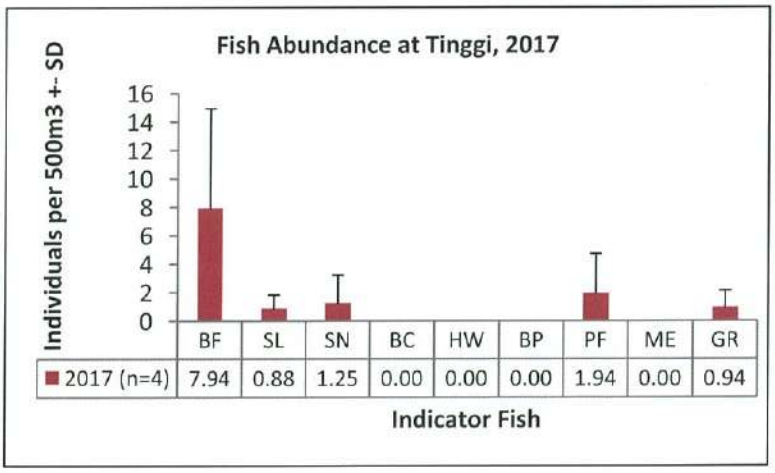
Substrate



Coral reefs around Tinggi Island were in 'Good' condition, with 64.53% live coral cover, above the average (54.21%) for reefs in the Sunda Shelf region.

The level of RKC has increased from 0.47% in 2016 to 4.06% in 2017. The increase was attributed to high level of RKC at SS8.2 Nanga. Both NIA and RB level has dropped slightly compared to last year.

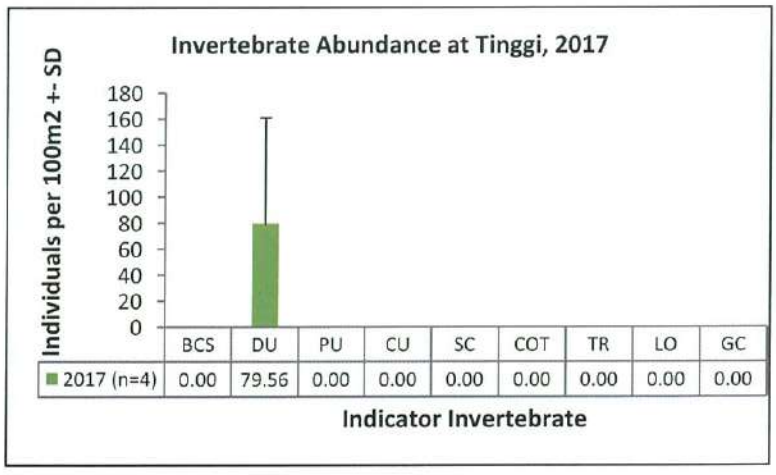
Fish



Highly prized fish such as Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish were not recorded during surveys. Moray Eel was absent too.

Butterflyfish was the most abundant targeted fish, followed by Parrotfish and Snapper. The abundance of Sweetlips and Grouper was low, less than 1 ind./500m^3.

Invertebrates



Only Diadema Urchin was recorded during surveys and the abundance was high at 79.56 ind./100m^2.

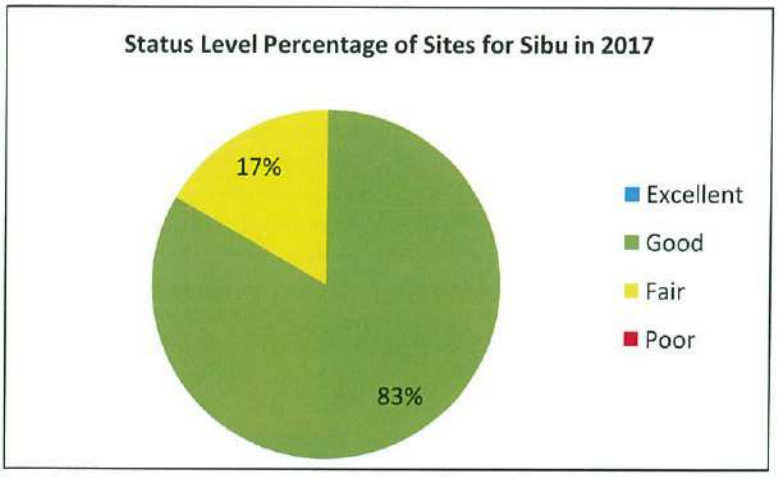
Only trash was seen during surveys and mild warm water bleaching was observed at SS8.2 Nanga.

3.2.9 Sibu

Sibu Island is located less than 10km off the East coast of mainland Peninsular Malaysia. The island and its surrounding waters were gazetted as Marine Parks in 1994 under the Fisheries Act 1985 (Amended 1993).

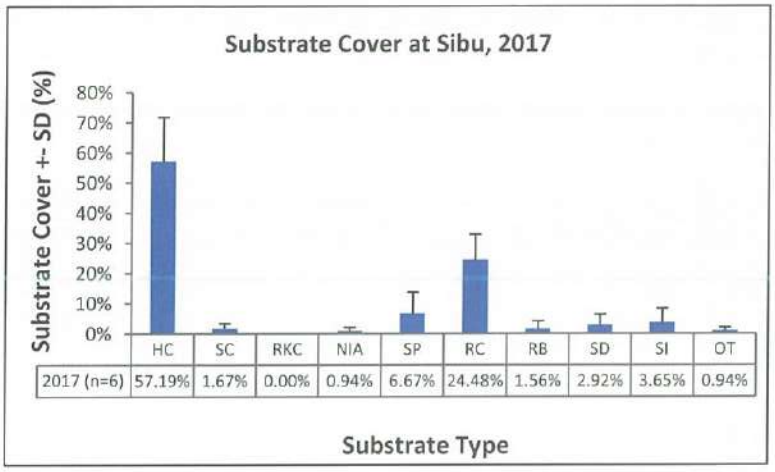
The islands are not as popular among tourists as other islands off the East coast, but the tourism industry here is growing. The islands are sparsely populated with few villages and a number of small resorts.

Map 12: Surveyed sites in Sibu



A total of 6 coral reef sites were surveyed in Sibu Islands. 83% of the reefs were in good condition and 17% were in fair condition.

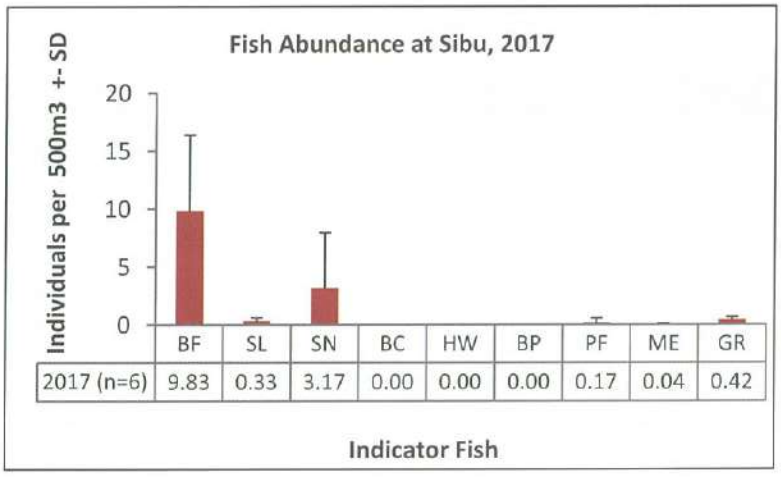
Substrate



Coral reefs around Sibu Islands were in 'Good' condition, with 58.85% live coral cover, above the average (54.21%) for reefs in the Sunda Shelf region.

The level of NIA and SI has decreased with only a slight increase in RB level. This shows that there are fewer disturbances on reefs in Sibu Islands.

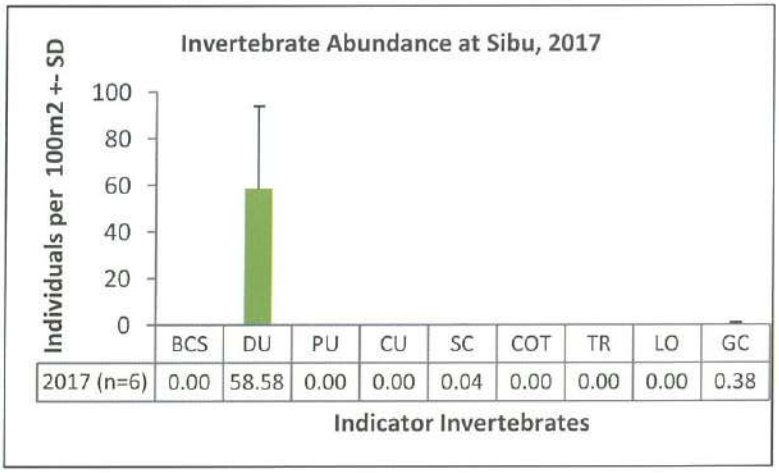
Fish



Highly prized fish such as Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish were not recorded during surveys.

Butterflyfish was the most abundant targeted fish recorded, followed by Snapper. Abundance of other indicators was very low, including Sweetlips, Parrotfish, Moray Eel and Grouper, less than 1 ind./500m^3.

Invertebrates



None of the indicator invertebrate targeted for curio trade (Banded Coral Shrimp, Pencil Urchin and Triton) was recorded during surveys. Collector Urchin and Lobster which are targeted for food also absent from the surveys

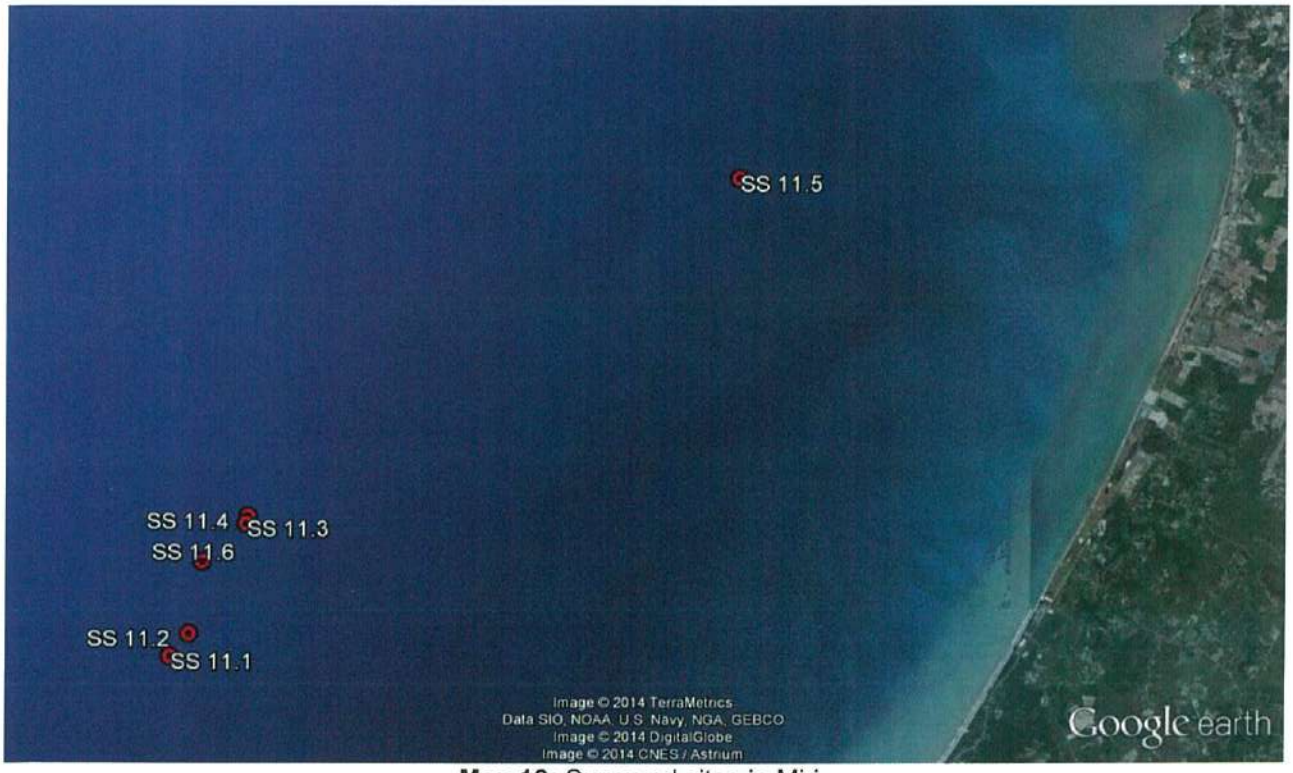
The abundance of Diadema Urchin was high while the abundance of Sea Cucumber and Giant Clam was very low. The abundance of COT remains within the range which a healthy reef can support (0.2-0.3 ind./100m^2).

Human impacts such as boat anchor damage and trash were observed. Natural impact such as warm water bleaching was observed at SS9.6 The Coconut.

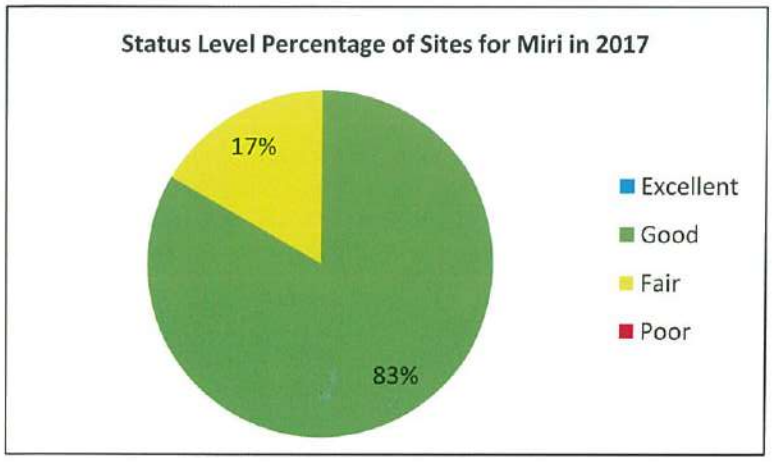
3.2.10 Miri

Miri is located at the northern end of Sarawak and is the State's second largest city. Miri is the birthplace of Malaysia's petroleum industry, which remains the major industry in the city, alongside timber and oil palm production and a growing tourism sector.

Miri has extensive submerged offshore reefs, generally flat in profile, in depths ranging from 7 to 30m. The reefs and its surrounding water, 186930 hectares areas that covers the Miri and Sibuti districts, were gazetted as Miri-Sibuti Coral Reefs National Park in 2007 under the National Parks and Nature Reserves Ordinance. The national park is located in the maritime boundary between Bintulu town and Miri City and is the largest offshore national park created in this state. Petroleum and gas mining, archaeological excavations, fishing and waste dumping are among the activities prohibited in the area. Those that do not threaten the undersea environment, like diving, boating and snorkelling, are allowed.

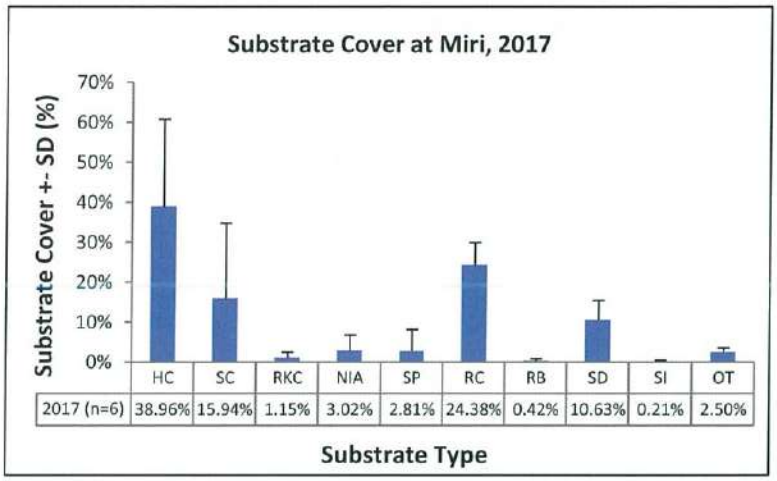


Map 13: Surveyed sites in Miri



A total of 6 coral reef sites were surveyed in Miri and 83% of the sites were in good condition. The remaining 17% were in fair condition.

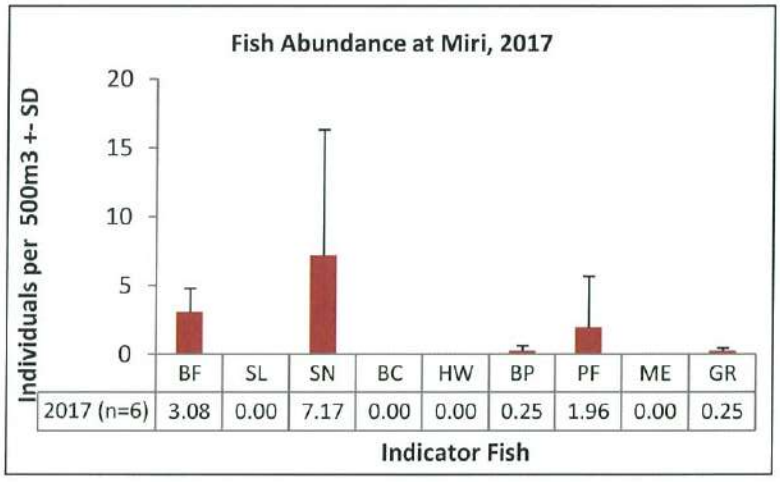
Substrate



Coral reefs around Miri were in 'Good' condition with 54.90% of live coral cover, slightly above the average (54.21%) for Sunda Shelf region.

The level for NIA, RB and SI has decreased from last year. Miri reefs have the highest level of SD of all islands surveyed in Sunda Shelf region.

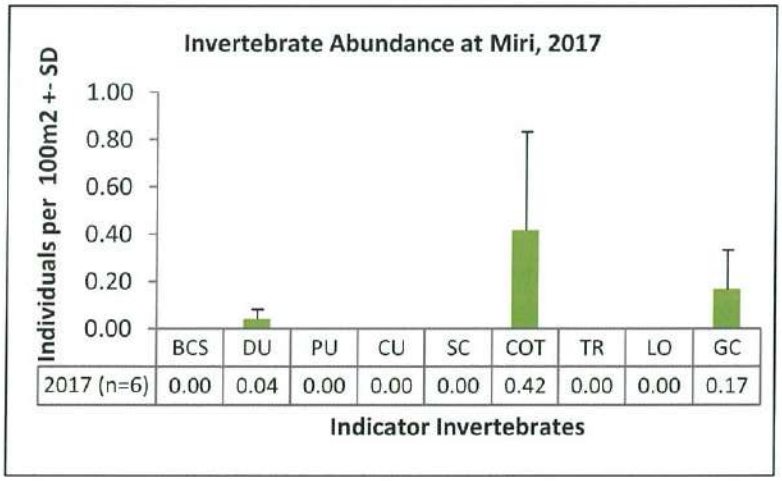
Fish



Highly prized fish such as Barramundi Cod and Humphead Wrasse were not recorded during surveys. Sweetlips and Moray Eel were absent too.

The abundance of Snapper was the highest, followed by Butterflyfish and Parrotfish. Bumphead Parrotfish and Grouper were recorded in low abundance.

Invertebrates



Only three indicators were observed during surveys, including Diadema Urchin, Crown-of-Thorns and Giant Clam.

The abundance of Diadema Urchin and Giant Clam was very low, however the abundance of COT was above the range which a healthy reef can support (0.2-0.3 ind./100m^2).

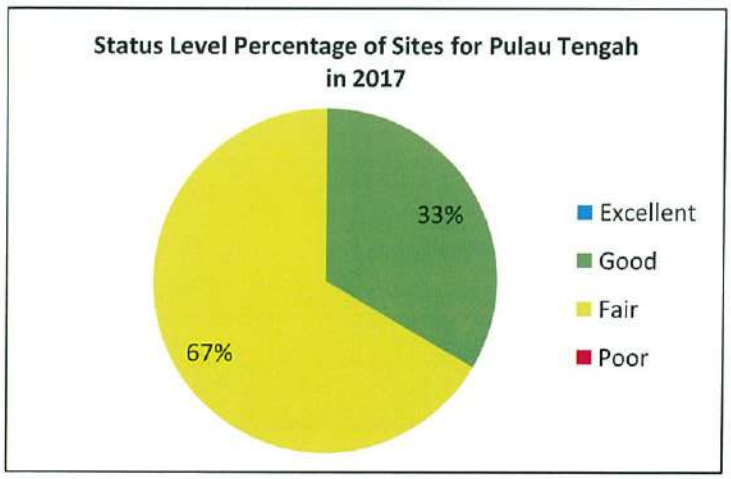
Human impacts such as boat anchor damage, discarded fishing net and trash were observed during surveys. Natural impacts such as COT predation and warm water bleaching were also observed. On a positive note, green turtle, great barracuda and school of barracuda were recorded during surveys.

3.2.11 Pulau Tengah

Pulau Tengah, meaning 'middle island', is a privately owned island and is located approximately 15km off the coast of Mersing, Johor. From 1975 to 1981, the island was home to over 100,000 Vietnamese 'boat people' when it was a United Nation Refugee Counsel Transit Camp for refugees waiting to start their new lives in Europe, Australia and North America. In 1985, it was one of the few islands gazetted as Marine Park due to its abundant marine life and rare species of fish and coral.

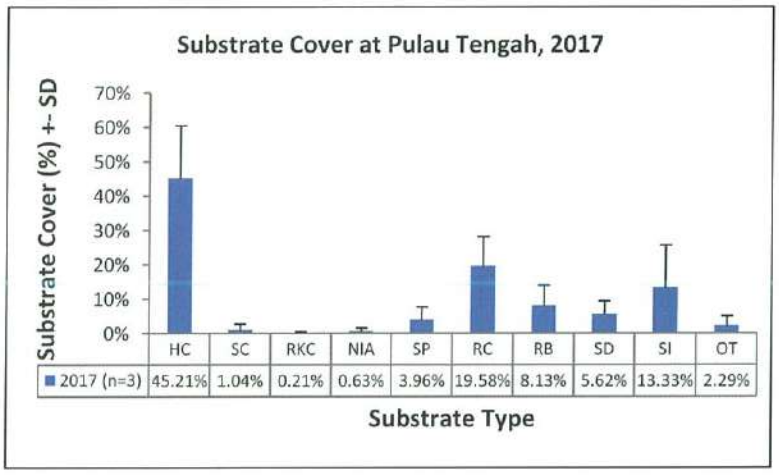
The uninhibited island is home to an upscale resort and is accessible by the resort's private speedboat from the coastal town of Mersing. The speedboat ride takes about 20-30 minutes in good weather. Pulau Tengah's natural environment is rich with sightings of over 100 species of bird, over 300 species of flora, Pacific bottle-nose dolphins, blacktip reef shark, green and hawksbill turtles, otters and dugong.

Map 14: Surveyed sites in Pulau Tengah



A total of 3 coral reef sites were surveyed in Pulau Tengah and 67% of the reefs were in fair condition. The remaining 33% were in good condition

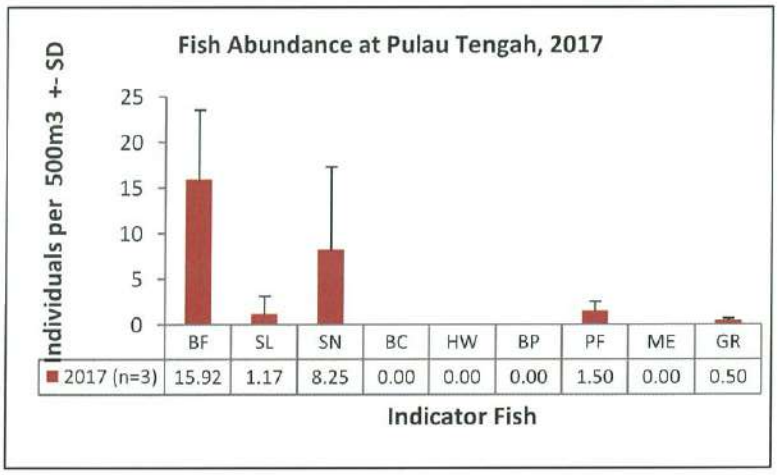
Substrate



Coral reefs around Pulau Tengah were in 'Fair' condition with 46.25% of live coral cover, below the average (54.21%) for Sunda Shelf region.

The level of RB and SI is high at 8.13% and 13.33% respectively. SI level is exceptionally high at SS13.2 Northern Reef with evidence of high sedimentation causing mortality at top part of coral colonies. The high SI level is probably due to the close proximity of Pulau Tengah to mainland and a likely source of this high SI level is terrestrial runoff from Mersing River.

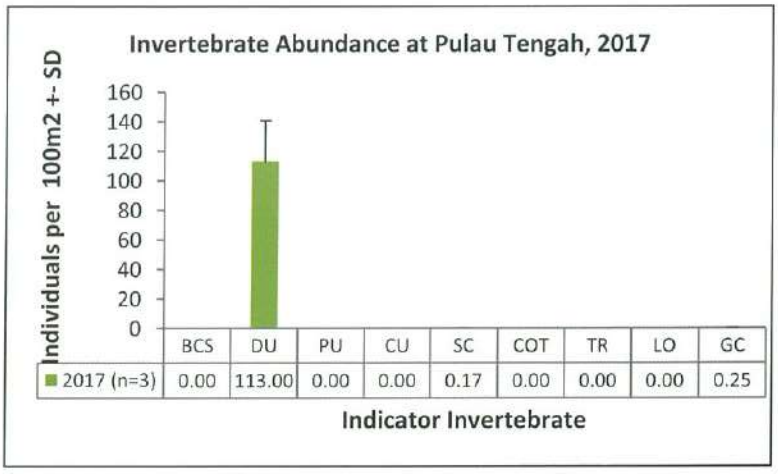
Fish



Highly prized fish such as Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish were not recorded during surveys. Moray Eel were absent too.

The abundance of Butterflyfish was the highest (highest of all islands surveyed in Sunda Shelf region as well), followed by Snapper. Other indicators were recorded in low abundance.

Invertebrates



Only three indicators were observed during surveys, including Diadema Urchin, Sea Cucumber and Giant Clam.

The abundance of Diadema Urchin was high at 113 ind./100m^2. Sea Cucumber and Giant Clam were present in low abundance, less than 1 ind./100m^2).

Discarded fishing nets and trash were recorded during surveys. High sedimentation was recorded at SS13.1 Junior Reef. Bamboo shark was observed at SS13.2 Northern Reef.

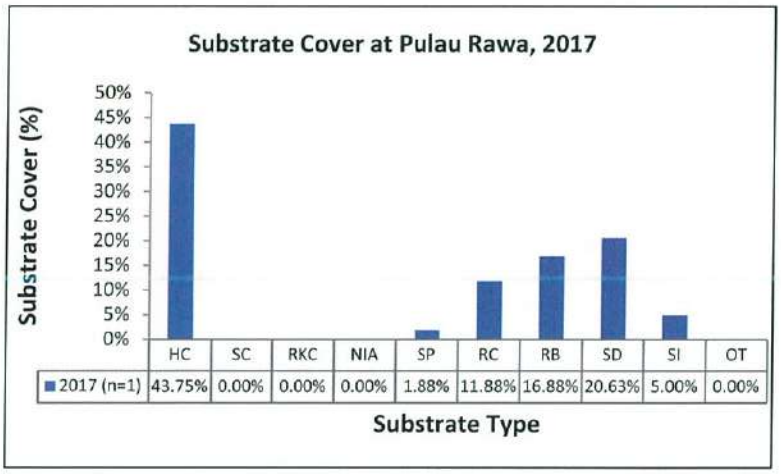
3.2.12 Pulau Rawa

Pulau Rawa is under Mersing District, Johor and is accessible by speedboat from Mersing (20-30 minutes boat ride). Rawa is the local term for white doves, which are abundant in the island. Pulau Rawa is a small island and there are no proper roads, only a few walkways. One side of the island is a beach covered with white sand and the other side is a rocky vertical cliff. The island and its surrounding waters were gazetted as Marine Parks in 1994 under the Fisheries Act 1985.

Map 15: Surveyed sites in Pulau Rawa

Only one site was surveyed a Pulau Rawa.

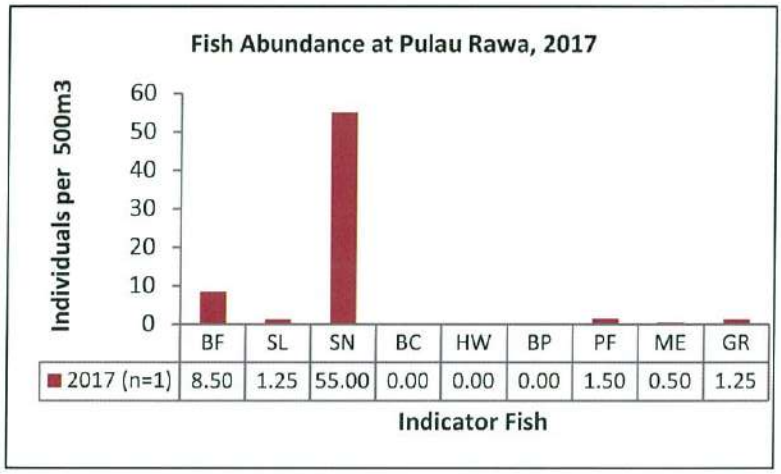
Substrate



The coral reef surveyed at Pulau Rawa was in 'Fair' condition with 43.75% of live coral cover, below the average (54.21%) for Sunda Shelf region.

The level of RB and SI is high at 16.88% and 5% respectively. The high SI level is probably due to the close proximity of Pulau Rawa to mainland and a likely source of this high SI level is terrestrial runoff from Mersing River.

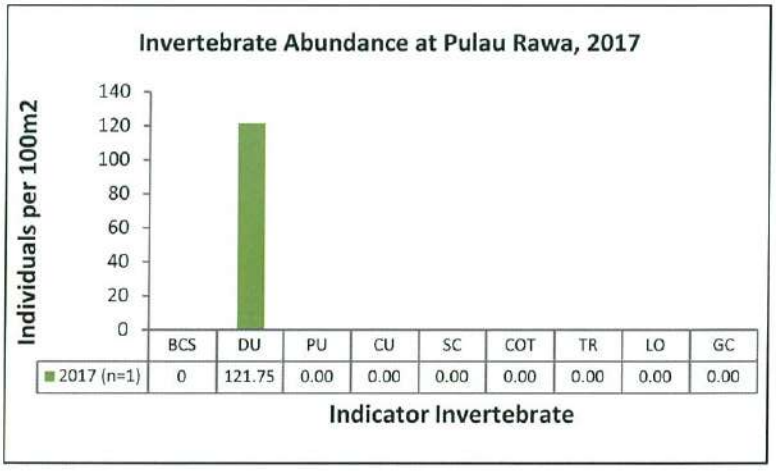
Fish



Highly prized fish such as Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish were not recorded during surveys.

The abundance of Snapper was the highest (highest of all islands surveyed in Sunda Shelf region), followed by Butterflyfish. Other indicators were recorded in low abundance.

Invertebrate



Only Diadema Urchin was recorded and the abundance is high at 121.75 ind./100m^2 (the highest of all islands surveyed in Sunda Shelf region).

Impacts from storm damage and discarded fishing nets were recorded. Turtle was also recorded during survey.

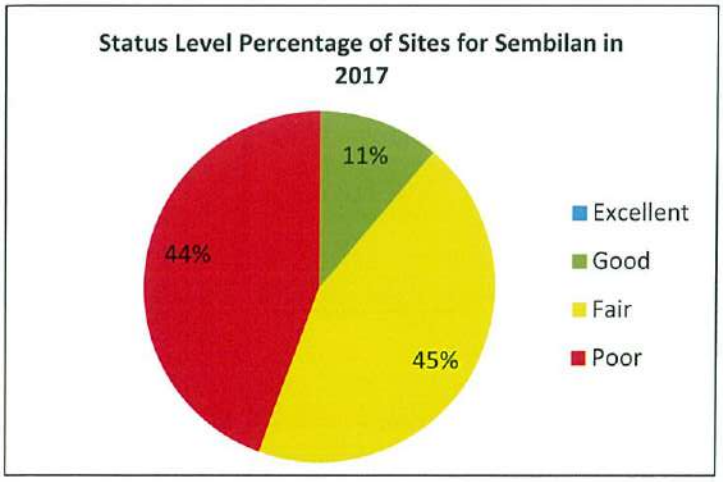
Straits of Malacca

3.2.13 Sembilan Islands

The Sembilan Islands consist of a cluster of nine islands (Pulau Agas, Pulau Payong, Pulau Nipis, Pulau Rumbia, Pulau Lalang, Pulau Saga, Pulau Buluh, Black Rock and White Rock) which are located some 20km from the coast of Perak (Lumut), off the west coast of Peninsular Malaysia, in the Straits of Malacca.

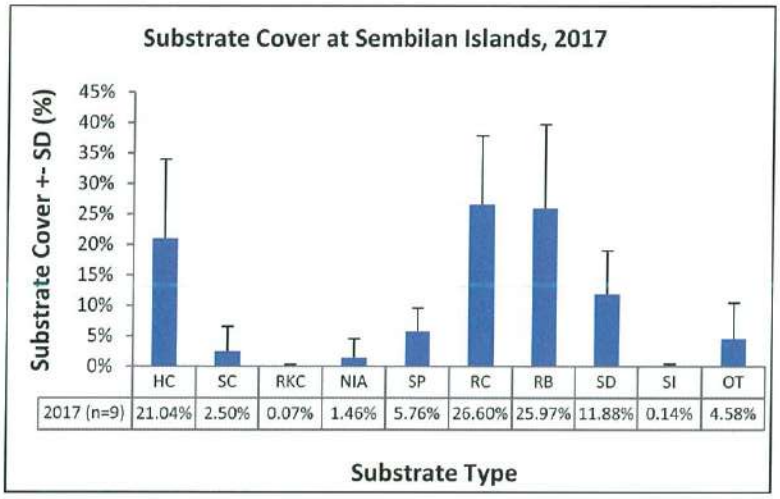
The islands are uninhabited and the only structures on the islands are small rest areas on Pulau Saga, constructed for the use of tourists and fishermen. The islands are a favourite fishing spot among sport and commercial fishermen. They are also occasionally visited by snorkelers and divers from Pangkor and Lumut. They have no protected status; hence tourist and fishing pressure are neither controlled nor monitored.

Map 16: Surveyed sites in Sembilan



A total of 9 coral reef sites were surveyed in Sembilan islands and 11% of the reefs were in good condition. 45% of the reefs were in fair condition, while the remaining 44% were in poor condition. No reefs were in excellent condition.

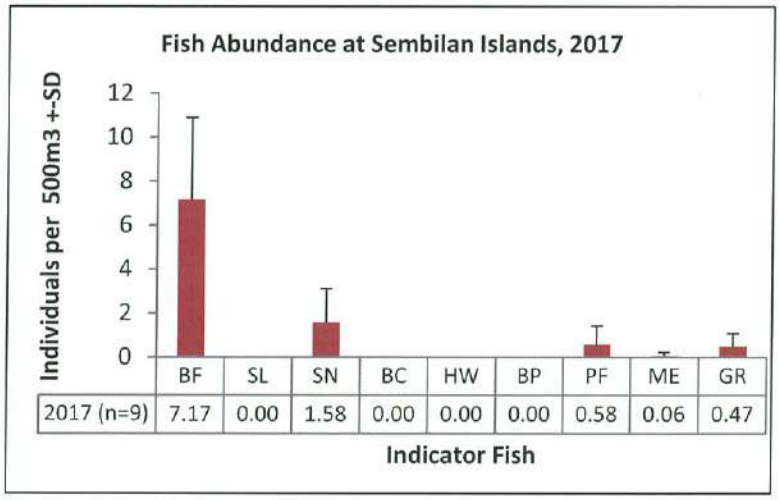
Substrate



Coral reefs around Sembilan islands are considered to be in 'Poor' condition, with 23.54% live coral cover, lower than the average (35.67%) for reefs of the Malacca Strait region.

The level of RB has increase significantly from 12.29% in 2016 to 25.97% in 2017. This indicates significant increase in disturbances in the area. Sembilan islands are not gazetted as a Marine Protected Area and are heavily impacted by development (on the mainland), fishing pressure as well as shipping activity in the Malacca Strait.

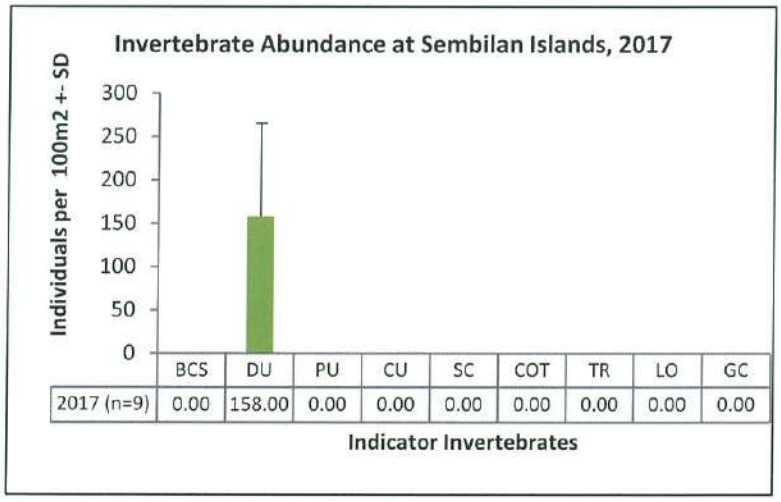
Fish



Highly prized fish such as Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish were not recorded during surveys. Sweetlips was absent as well.

Abundance of Butterflyfish was the highest, followed by Snapper. Other indicator species were present in very low number, less than 1 ind./500m^3 except for Snapper.

Invertebrates



Only Diadema Urchin was recorded during surveys and the abundance was high, the highest within Malacca Strait region.

Boat anchor damage was recorded at MS1.7 Anemone Garden. Discarded fishing nets and trash were recorded at almost all surveyed sites. The severity of all damages in Sembilan islands was the highest within the Malacca Strait region and the severity has increased from last year. On a positive note, pipefish was observed and adult parrotfish and grouper were spotted outside of surveyed area.

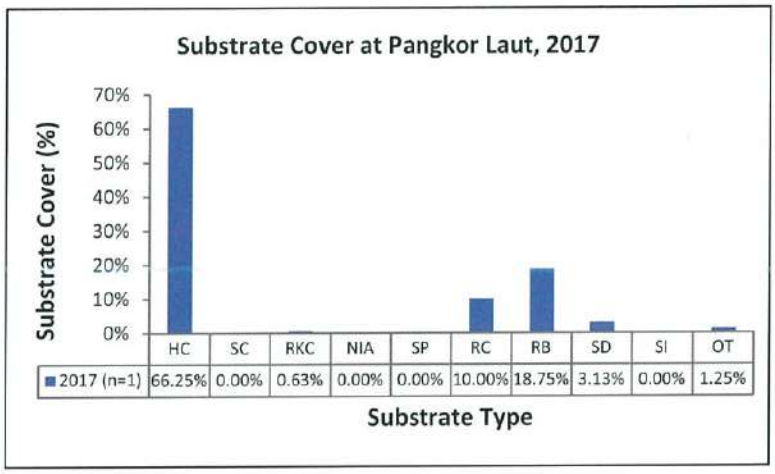
3.2.14 Pangkor Laut Island

Pangkor Laut Island is a small island, privately owned and located 3 miles off the coast of Perak, along the Straits of Malacca. Of the island's 300 acres, a fraction has been developed to house a premier resort.

Map 17: Surveyed sites in Pangkor Laut

Only one site was surveyed at Pangkor Laut.

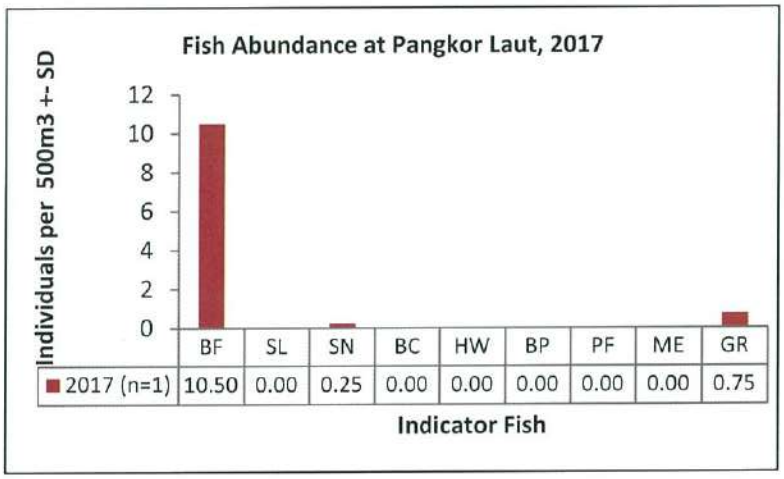
Substrate



The coral reef surveyed at Pangkor Laut is considered to be in 'Good' condition, with 66.25% live coral cover, above the average (35.67%) for reefs of the Malacca Strait region.

The level of RB has increased significantly from last year, indicating very high recent disturbances in the area.

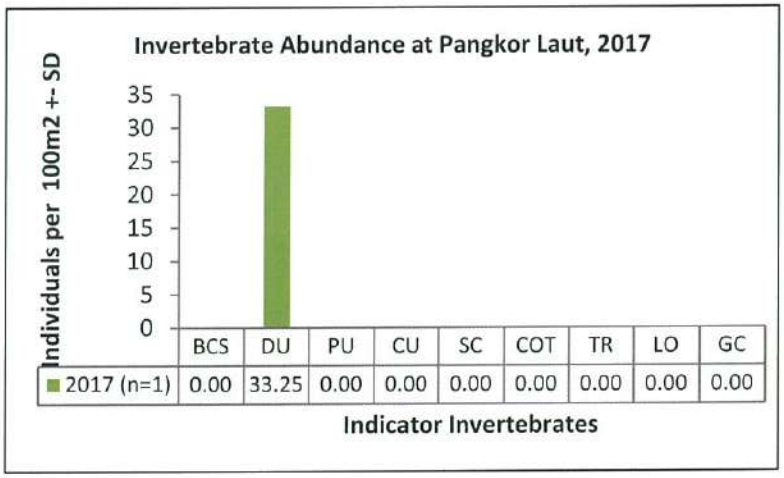
Fish



Only three indicator fish were recorded during surveys. Highly prized fish such as Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish were absent.

The abundance of Butterflyfish was the highest. Snapper and Grouper were present in very low number, less than 1 ind./500m^3

Invertebrates



Similar to previous years, the only indicator species observed was Diadema Urchin and the abundance was high.

Discarded fishing net was recorded during surveys.

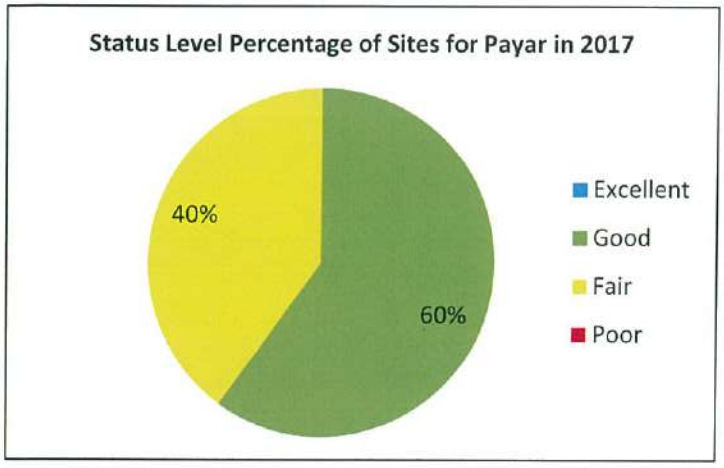
3.3.15 Payar

Payar is one of many islands off the West coast of mainland Kedah in the Straits of Malacca. It is situated 35km south of Langkawi, 59km north of Penang and 28km west of Kuala Kedah. It was gazetted as a marine park in 1994 under the Fisheries Act 1985 (Amended 1991).

The island is a popular destination for tourists (mainly from Langkawi) famous for its corals and reef fishes. Measuring 2km long and 0.25km wide, its sheltered waters are ideal for snorkelling, diving and swimming.

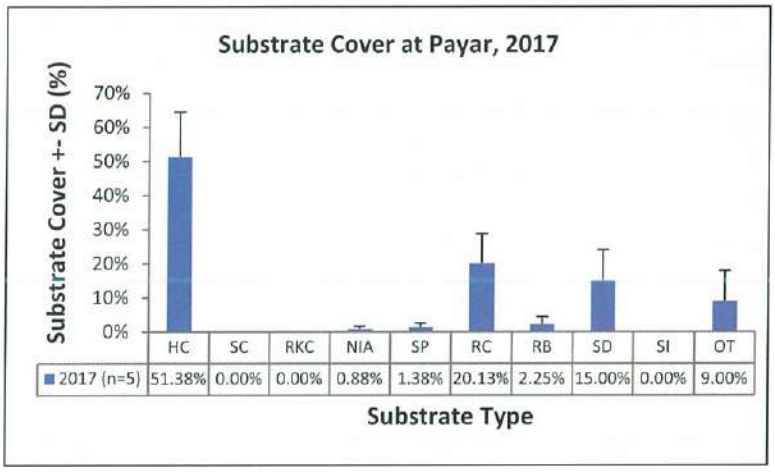
The island is uninhabited and the only operating structures on the island are the marine park centre with facilities for day trip visitors such as gazebos, picnic table and restroom facilities at selected areas. There is also an old abandoned resort. A floating platform moored just off Payar serves as a restaurant and dive platform for tourists.

Map 18: Surveyed sites in Payar



A total of 5 coral reef sites were surveyed in Payar and 60% of the reefs were in good condition. The remaining 40% of the reefs were in fair condition.

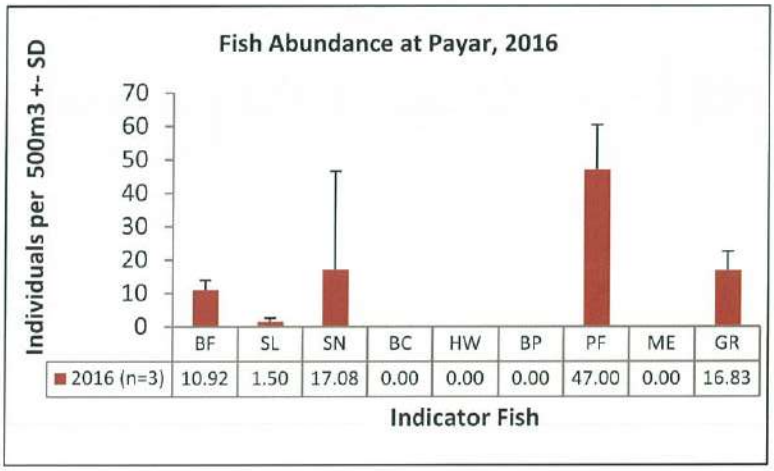
Substrate



Coral reefs around Payar are considered to be in 'Good' condition, with 51.38% live coral cover, higher than the average (35.67%) for reefs of the Malacca Strait region.

The island in general has high level of RC and SD. The level of NIA and RB has increased slightly from last year, indicating recent disturbances in the area

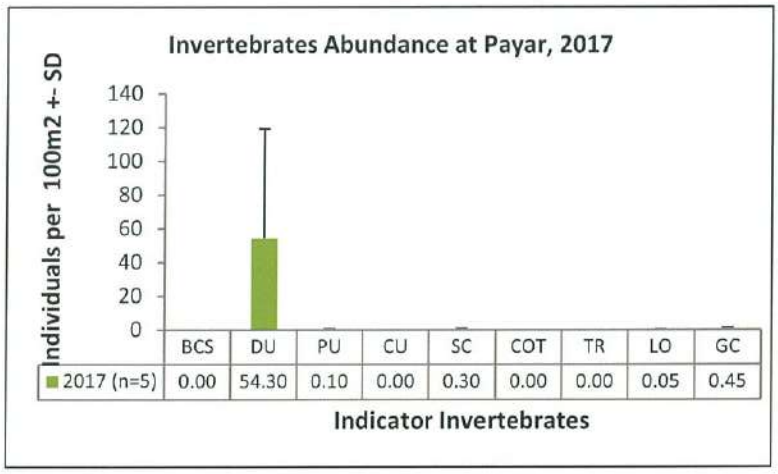
Fish



Five indicator fish were recorded during surveys including Butterflyfish, Sweetlips, Snapper, Parrotfish and Grouper.

The abundance of Parrotfish was the highest, followed by Snapper, Grouper and Butterflyfish; all recorded the highest within the Malacca Strait region. Sweetlips was present in low number.

Invertebrates



Four indicator invertebrates were recorded, including Diadema Urchin, Sea Cucumber, Lobster and Giant Clam.

The abundance of Diadema Urchin was high while the abundance of Sea Cucumber, Lobster and Giant Clam was very low, less than 1 ind./100m^2.

Discarded fishing nets and trash were recorded during surveys. Warm water bleaching was recorded at MS3.3 Langkawi Coral. On a positive note, shark was observed during surveys.

North Borneo

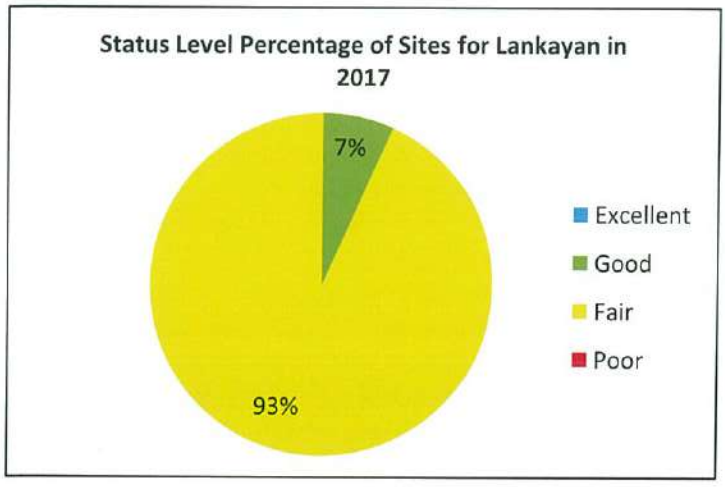
3.2.16 Lankayan

Lankayan is a small island in the Sulu Sea, a 1.5 hour boat ride north of Sandakan. A resort island, Lankayan is part of the Sugud Islands Marine Conservation Area (SIMCA), a large, privately managed MPA off the East coast of Sabah.

SIMCA is remote and distant from populated areas and no communities exist on the islands within the protected area. However, the SIMCA area is known to be a traditional fishing ground and is fished by both artisanal and commercial fishers from Sandakan, Kudat and the Philippines.

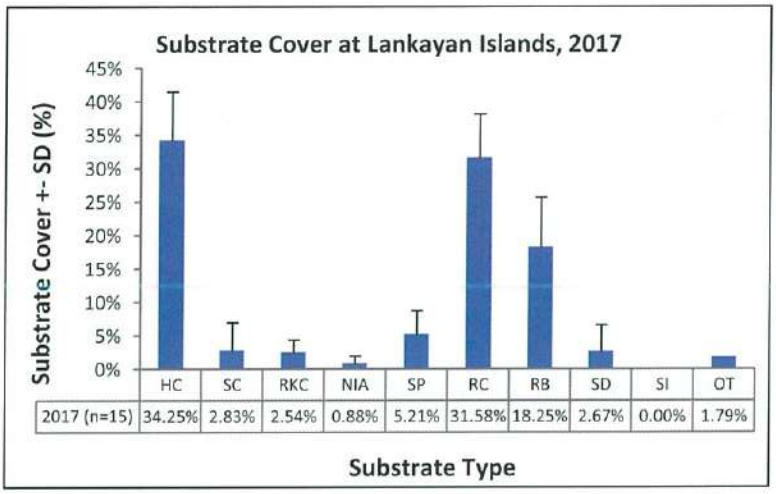
Before the creation of SIMCA, blast fishing was a constant problem, and turtle eggs were poached on a regular basis. Lankayan Island is the only developed island within SIMCA. The 0.05 km^2 island is the site of the Lankayan Island Dive Resort (LIDR), which is the only structure on the otherwise uninhabited island.

Map 19: Surveyed sites in Lankayan



A total of 15 coral reef sites were surveyed in Lankayan islands and 7% of the reefs were in good condition. The remaining 93% of the reefs were in fair condition.

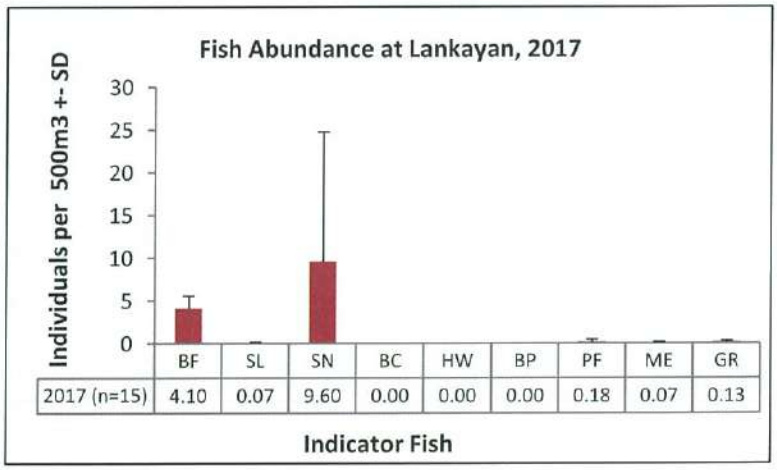
Substrate



The reefs in Lankayan islands are considered to be in 'Fair' condition, with 37.08% live coral cover, close to the average (36.48%) for reefs within the North Borneo region.

The level of RKC and NIA has decreased compared to last year. However the level of SP and RB has increased. These indicate disturbances are still present on the reefs and the reefs still need to be monitored closely.

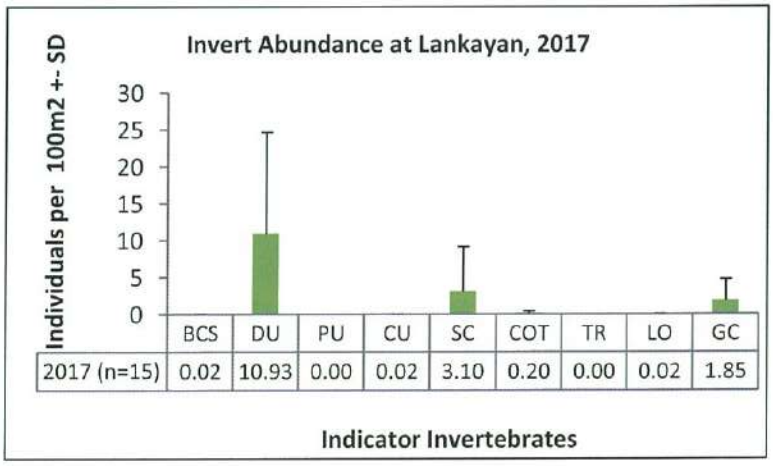
Fish



Highly prized fish such as Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish were absent.

The abundance of Snapper was high, and as in previous years was the highest of all islands surveyed in North Borneo region. The abundance of other indicators was generally low, with the exception of Butterfly fish.

Invertebrates



Six indicator invertebrates were present during surveys including Diadema Urchin, Collector Urchin, Sea Cucumber, Crown-of-thorns, Lobster and Giant Clam.

The abundance of Diadema Urchin was the highest. Other indicators were present in low number. Lankayan is one of the three islands recorded Collector Urchin during surveys.

Damage due to warm water bleaching was recorded at all sites while trash was recorded at some survey sites. On a positive note, shark and turtle were observed during surveys.

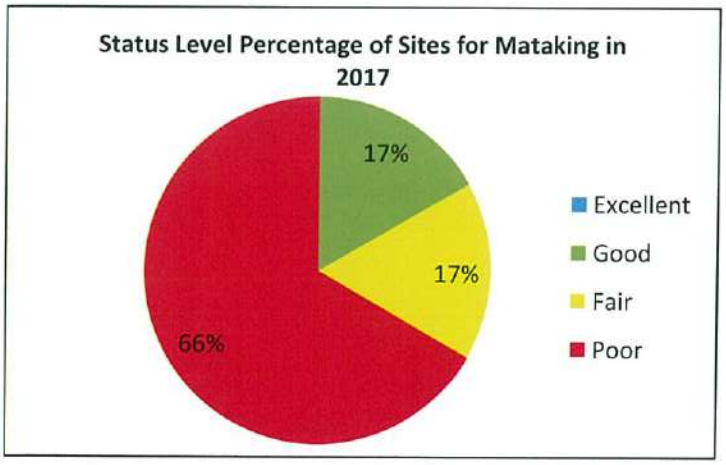
3.2.17 Mataking

Mataking Island is approximately 35km east from the major town of Semporna in the South of Sabah. It is a well known tourist spot and has one resort. Diving and snorkelling are the main activities on the island.

While the island has no legal protected status, the presence of the resorts has effectively created small protected areas, keeping fishermen (including fish bombers) away from parts of the reefs surrounding the island.

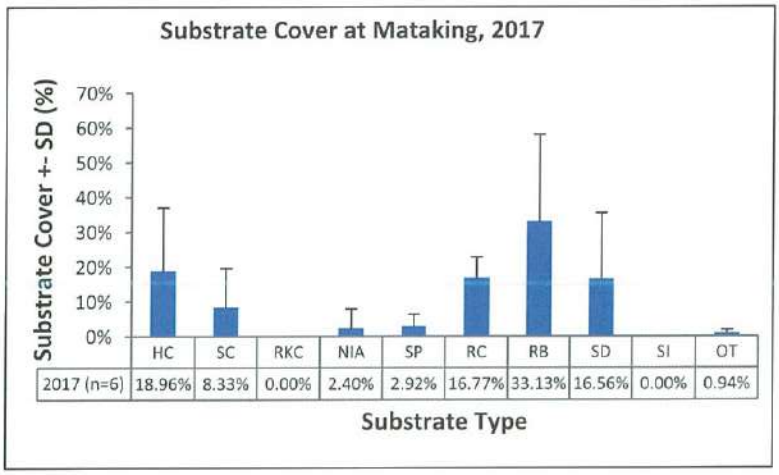
The island has fringing reefs, and coral extends down to almost 30m. Coral reefs around this, and surrounding, islands have been extensively damaged by fish bombing in the past, and fish bombing continues in some areas nearby.

Map 20: Surveyed sites in Mataking



A total of 6 coral reef sites were surveyed in Mataking. 17% of the reefs were in good condition and 17% were in fair condition. The remaining 66% of the reefs were in poor condition.

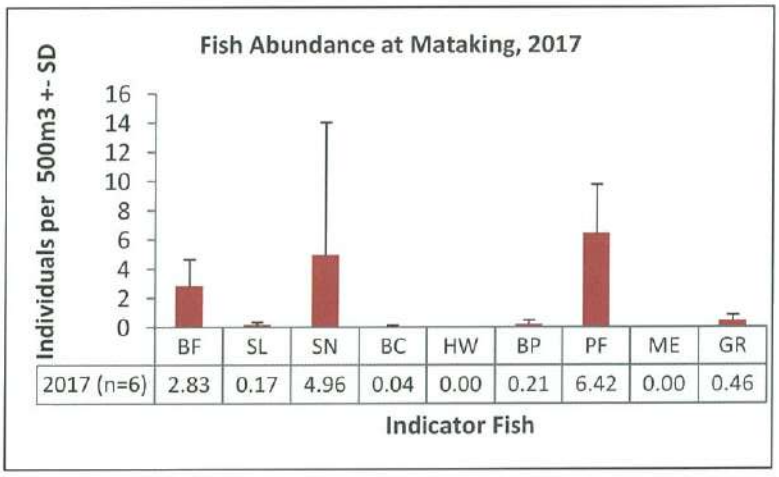
Substrate



The reefs around the island were considered to be in 'Fair' condition, with 27.29% live coral cover, somewhat below the average (36.48%) in the North Borneo region.

The level of RB has increased significantly from 22.71% in 2016 to 33.13% in 2017. NB2.2 Coral Garden recorded as high as 66.25%, NB2.4 Pandanan Bay 58.75% and NB2.6 Sweetlips Rock 36.88%. The increase and high level of RB was due to destructive fishing method involving fish bombing.

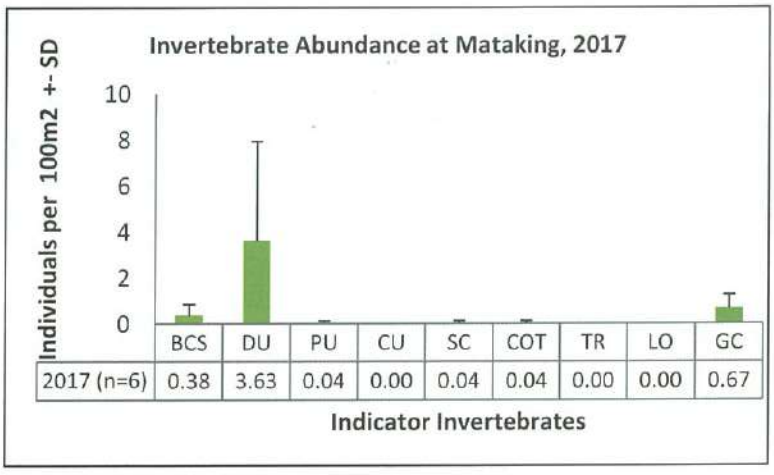
Fish



Only two indicator fish were absent during the surveys (Humphead Wrasse and Moray Eel).

The abundance of Parrotfish was the highest, followed by Snapper and Butterflyfish. Other indicator fish were present in low number, less than 1 ind./500m^3.

Invertebrates



Three indicators were absent from surveys (Collector Urchin, Triton and Lobster).

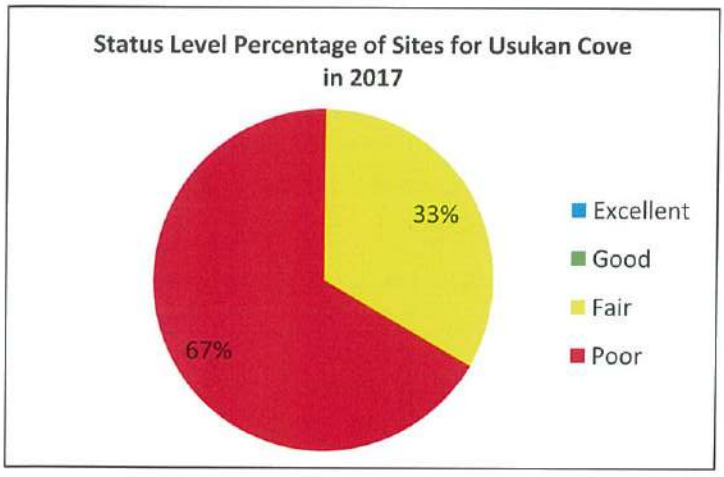
The abundance of Diadema was the highest. Abundance of other indicator was very low, less than 1 ind./100m^2. COT was within the range which a healthy reef can support (0.2-0.3 ind./100m^2)

Damage by fish bombing were observed at all survey sites except for NB2.6 Sweetlips Rock. Boat anchor damage, discarded fishing nets and trash were also recorded during surveys. On a positive note, turtles and spotted eagle ray were observed during surveys.

3.2.18 Usukan Cove

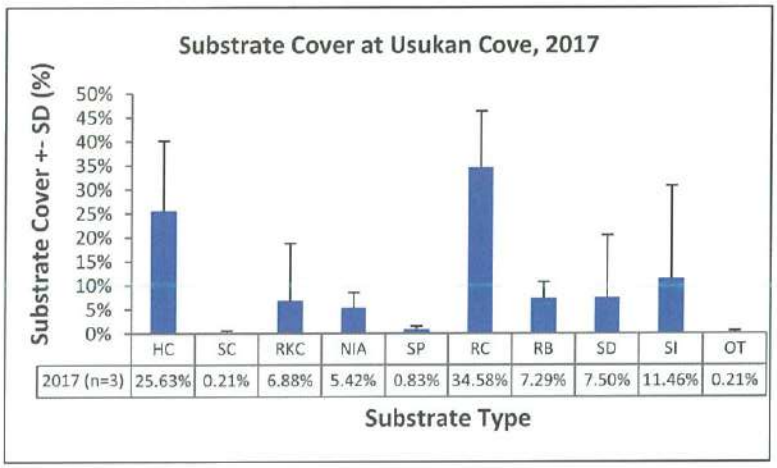
Usukan Cove is located on the North West coast of Sabah approximately half way between Kota Kinabalu and Kudat, in a district called Kota Belud, just beside Kampung Kuala Abai where the jetty to Mantanani Island is situated. Diving and snorkelling as well as fishing are the main activities offered in Usukan Cove.

Map 21: Surveyed sites in Usukan Cove



A total of 3 coral reef sites were surveyed in Usukan Cove and 67% of the reefs were in poor condition. The remaining 33% were in fair condition.

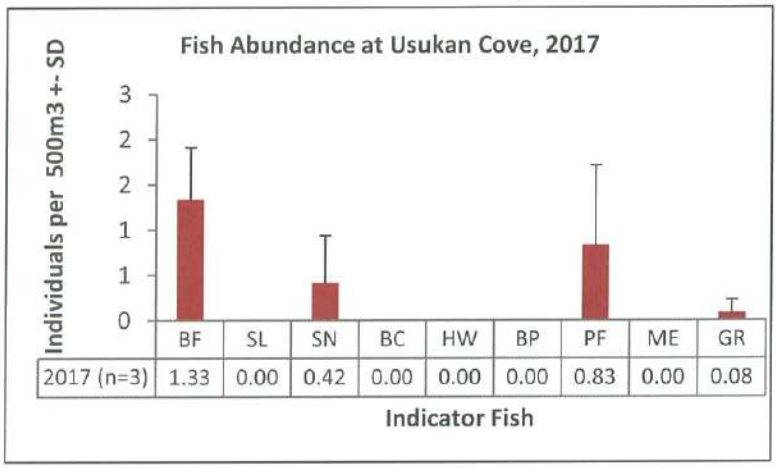
Substrate



Reefs in Usukan Cove are considered to be in 'Fair' condition with 25.83% live coral cover, below the average (36.48%) for North Borneo region.

RB level is high at 7.29% and the site of most concern is NB3.5 Lok Liak which recorded 11.25%. SI level is also high at 11.46% and NB3.1 Usukan Cove Lodge recorded 33.75%.

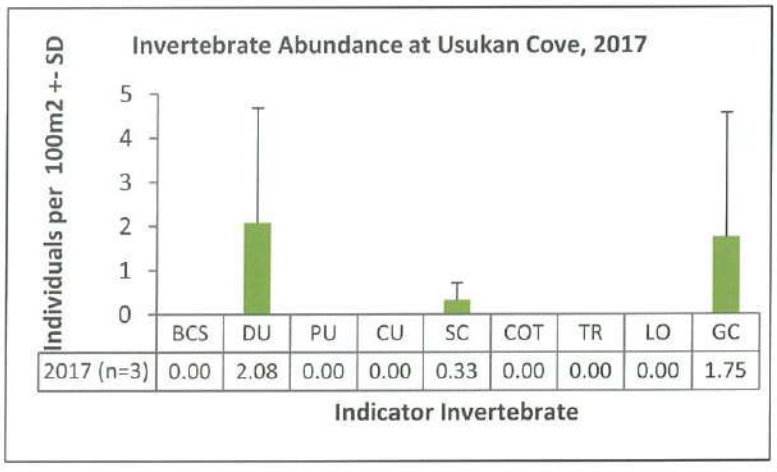
Fish



Five indicator fish were absent from surveys (Sweetlips, Barramundi Cod, Humphead Wrasse, Bumphead Parrotfish and Moray Eel).

Other indicator fish were present in low abundance.

Invertebrates



Only three indicator invertebrates were observed during surveys (Diadema, Urchin, Sea Cucumber and Giant Clam) and their abundance was low.

All survey sites were either affected by boat anchor damage, dynamite fishing, siltation, storm, discarded fishing net, trash or warm water bleaching. Impact from cyanide fishing was recorded at NB3.4 Poduko.

3.2.19 Mantanani

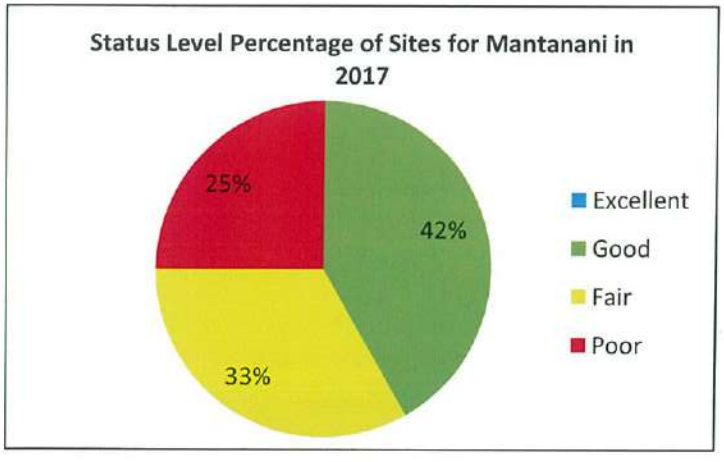
The Mantanani archipelago is located some 30km off the north-west coast of the state of Sabah, opposite the town of Kota Belud. The largest island is Mantanani Besar; the other two are Mantanani Kecil and Linggisan.

Mantanani is mainly populated by Bajau Ubian, with a small population of about 1,000 in two villages. The three main economic activities are fishing, drying salted fish and collecting shellfish.

Mantanani is an increasingly popular snorkelling and diving destination, and tourist numbers have grown four-fold in the last three years, mainly day trippers from Kota Kinabalu. The number of resorts is increasing and there are plans for further development.

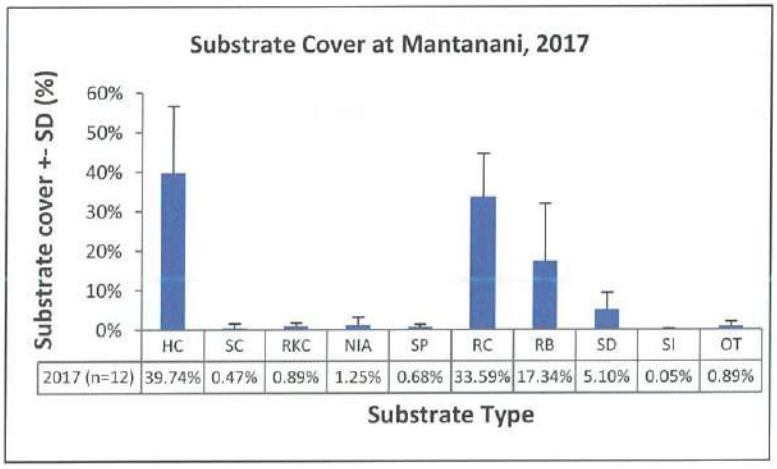
Fish bombing is a major problem in the area. This destructive fishing method has damaged large areas of reef around the islands.

Map 22: Surveyed sites in Mantanani



A total of 12 coral reef sites were surveyed in Mantanani islands and 42% of the reefs were in good condition. 33% were in fair condition and the remaining 25% of the reefs were in poor condition. No reefs were in excellent condition.

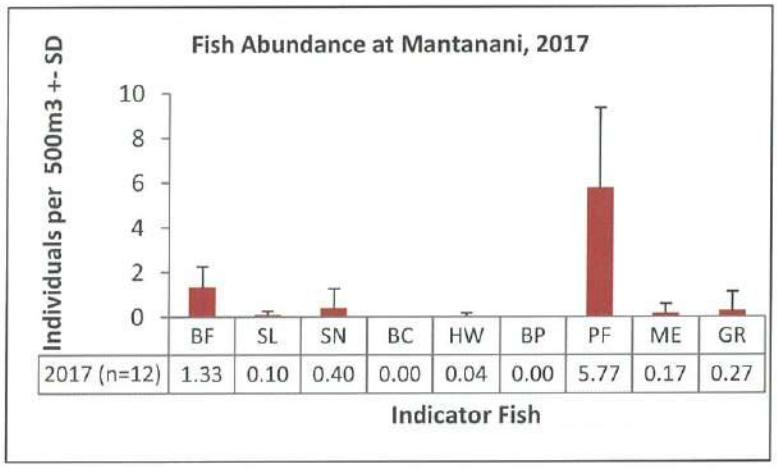
Substrate



Coral reefs around Mantanani islands are considered to be in 'Fair' condition, with 40.21% live coral cover, above the average (36.48%) for reefs in the North Borneo region.

The level of NIA has dropped from 6.14% in 2016 to 1.25% in 2017. The level of RB is still high at 17.34%, with some sites recorded as much as 20-50%. Fish bombing was likely to have caused the damage as dynamite fishing impact was recorded at many sites and blasts were heard during surveys.

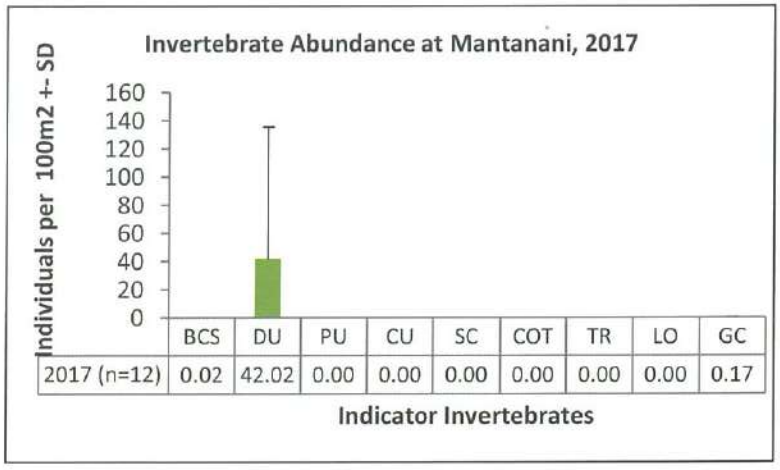
Fish



Only two indicator species were absent from surveys (Barramundi Cod and Bumphead Parrotfish).

The abundance of Parrotfish was the highest, followed by Butterflyfish. All indicators were present in low number. These islands are not gazetted as a Marine Protected Area and are impacted by fishing pressure and destructive fishing method (fish bombing).

Invertebrates



Pencil Urchin and Triton which are targeted for curio trade were not recorded during surveys. Collector Urchin, Sea Cucumber and Lobster which are targeted for food was also absent from the surveys.

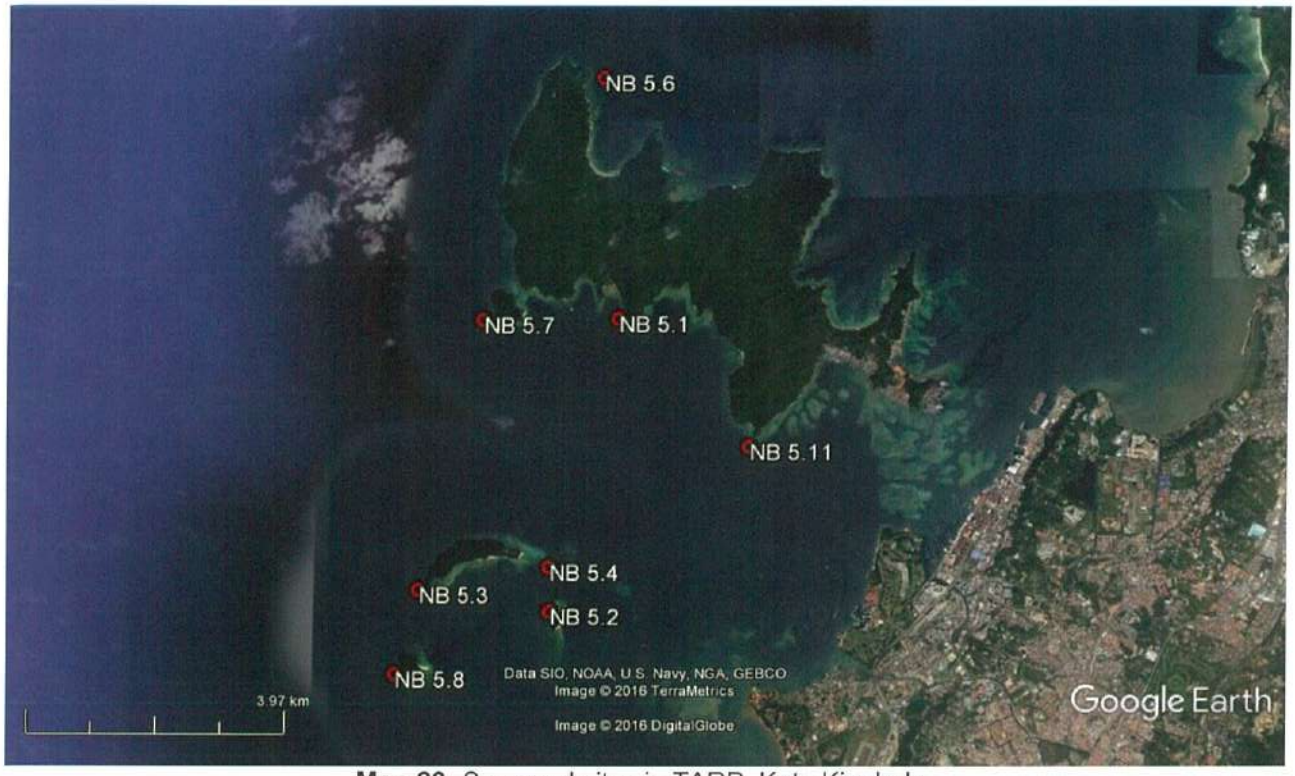
Abundance of Diadema Urchin was high. Other indicator species were present in very low number (Banded Coral Shrimp and Giant Clam), less than 1 ind./100m^2.

Extensive human impacts were seen on most of the reefs; boat anchor damage, dynamite fishing impact, siltation, discarded fishing nets and trash. Fish bombing blast was heard at many sites during surveys. Damage due to warm water bleaching was also observed at many sites. On a positive note, sea krait was recorded at one site.

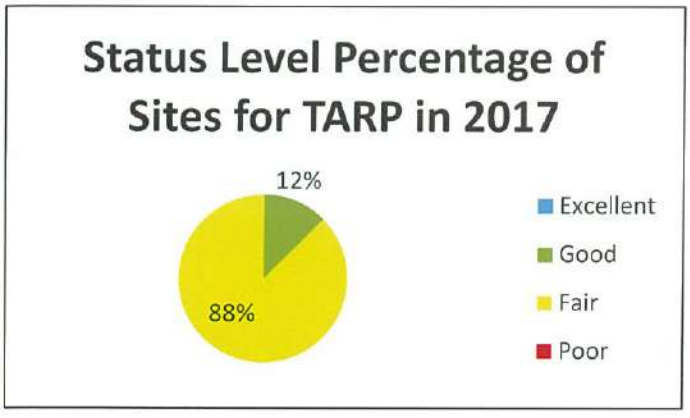
3.2.20 Tunku Abdul Rahman Park, Kota Kinabalu

Tunku Abdul Rahman Park is located between 3 to 8 km off Kota Kinabalu, the capital of Sabah, and covers an area over 4,929 hectares, two thirds of which covers the sea. There is a cluster of islands in the Park comprising Pulau Gaya, Pulau Sapi, Pulau Manukan, Pulau Mamutik and Pulau Sulug. The reefs generally lie in shallow water with little current.

All five islands have tourist facilities such as chalets/rest house, jetty, picnic shelters, barbecue pits, tables, changing rooms and toilets, except for Pulau Sulug which is relatively untouched, remote and undeveloped. The islands receive large numbers of day tourists from Kota Kinabalu.

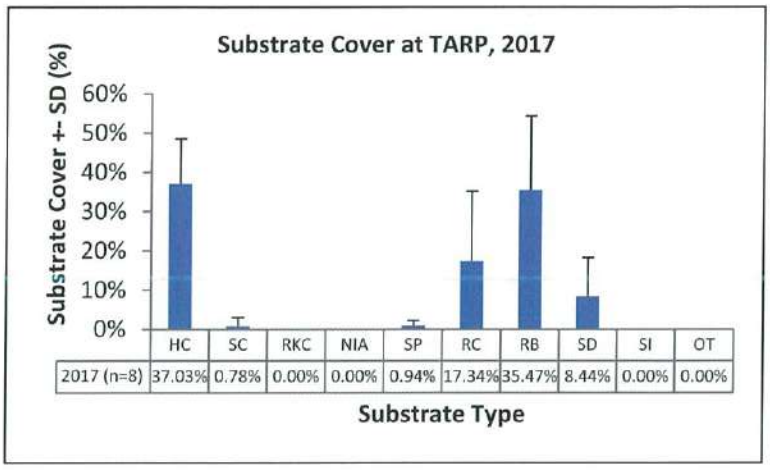


Map 23: Surveyed sites in TARP, Kota Kinabalu



A total of 8 coral reef sites were surveyed in TARP, but complete data are only available for 5 sites. Of those for which data are available, 12% were in good condition. The remaining 88% were in fair condition.

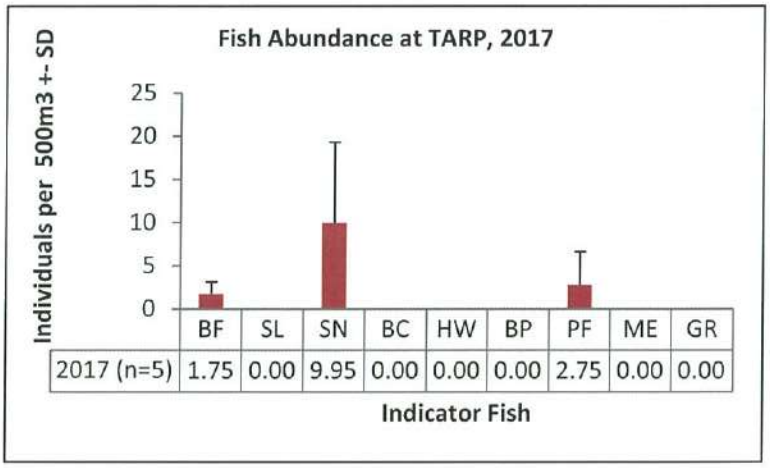
Substrate



Coral reefs around the islands are considered to be in 'Fair condition with 37.81% live coral cover, just above the average (36.48%) for reefs within the North Borneo region.

The level of RB is very high at 35.47%, significantly up from 2017 (19.61%). This is likely to be a result of on-going fish bombing, and impacts such as storms further damaging already weakened reefs.

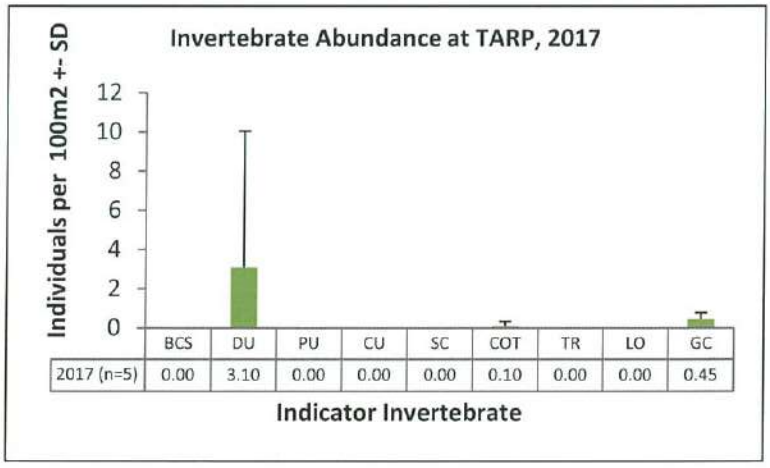
Fish



Only three species were present during surveys (Butterfly fish, Snapper and Parrot Fish).

No high value fish (e.g. Grouper, Bumphead) were spotted, nor were any megafauna. Reefs around TARP are heavily impacted by development, over-fishing and tourism.

Invertebrates



Only three indicators were present during surveys (Diadema Urchin, COT and Giant Clams).

Diadema Urchin was the most abundance indicator invertebrate, though abundance of all indicators present was low.

The abundance of Crown-of-thorns is within what a healthy reef can sustain (0.2-0.3 ind./100m^2).

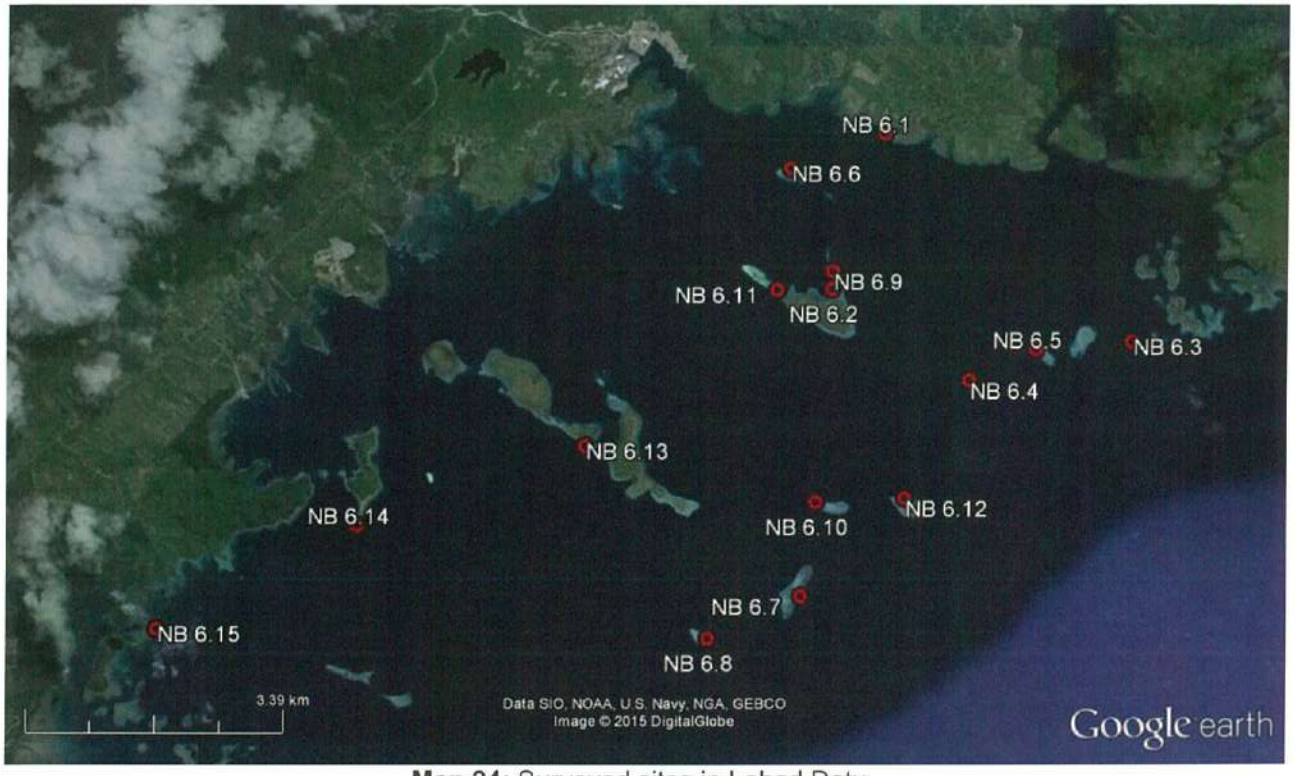
No damage was recorded during surveys.

3.2.21 Lahad Datu

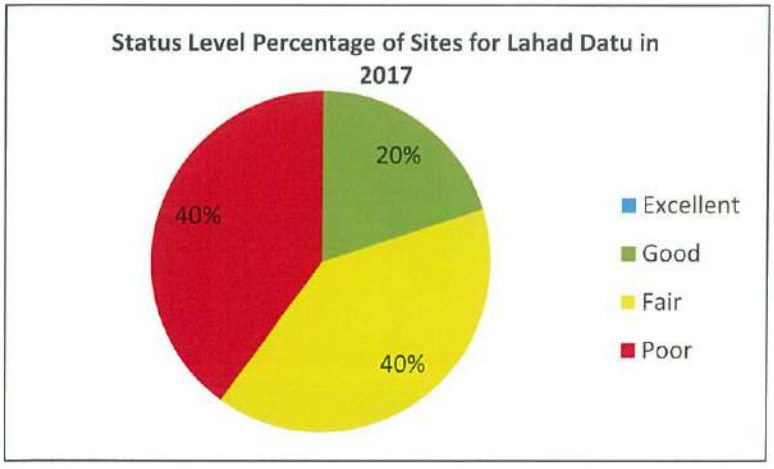
Lahad Datu is a town located in the east of Sabah, Malaysia, on the island of Borneo. It occupies the peninsula on the north side of Darvel Bay – the largest semi-enclosed bay on the east coast of Borneo islands. Administratively, it falls within the Tawau Division and is estimated to have a population of over 156,000 (2000 census).

Currently, there is little development along the coastal areas of Lahad Datu. In Lahad Datu itself, tourism is still limited, though Sabah Urban Development Corporation is trying to promote greater investment in infrastructure. There are two well known nature-based tourism attractions near to Lahad Datu: Tabin Wildlife Reserve and the Danum Valley Conservation Area, and the wider Kinabatangan river basin is also nearby.

Darvel Bay has yet to become established as a popular diving destination. The area includes both fringing and submerged reefs.

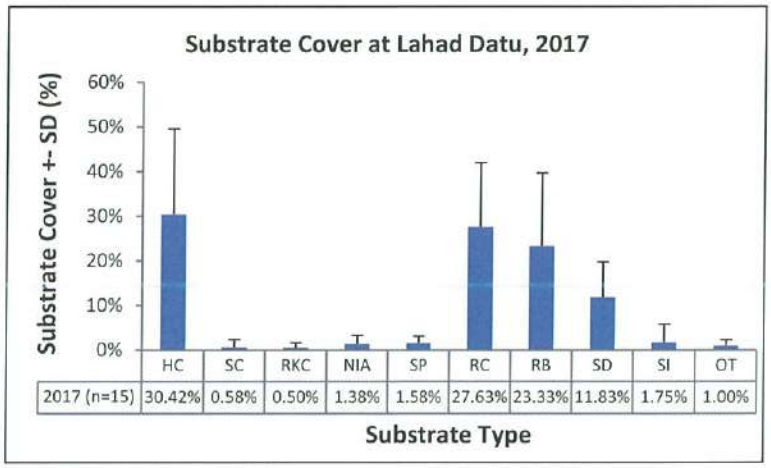


Map 24: Surveyed sites in Lahad Datu



A total of 15 coral reef sites were surveyed in Lahad Datu and 20% of the reefs were in good condition. 40% of the reefs were in fair condition and the remaining 40% were in poor condition. No reefs were in excellent condition.

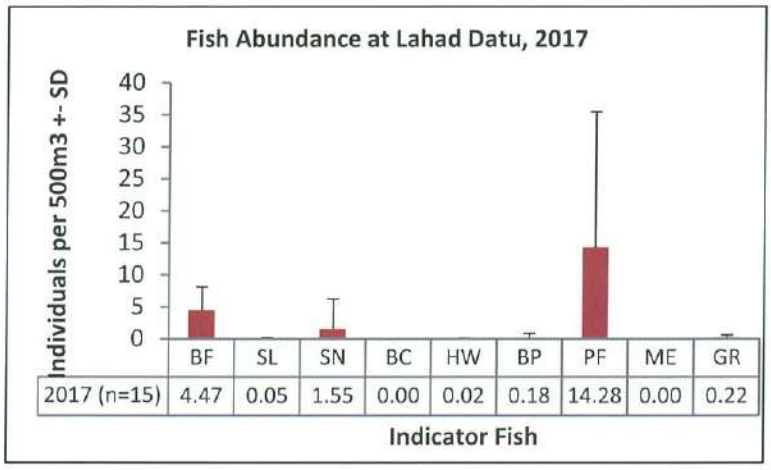
Substrate



Reefs in Lahad Datu are considered to be in 'Fair' condition with live coral cover of 31%, below the average (36.48%) for reefs in the North Borneo region.

The level of RB has increased significantly from 11.88% in 2016 to 23.33% in 2017. 12 out of 15 sites recorded RB level over 20%, with 2 sites recorded as high as 50%; they are NB6.11 Light House and NB 6.14 Pulau Tabun.

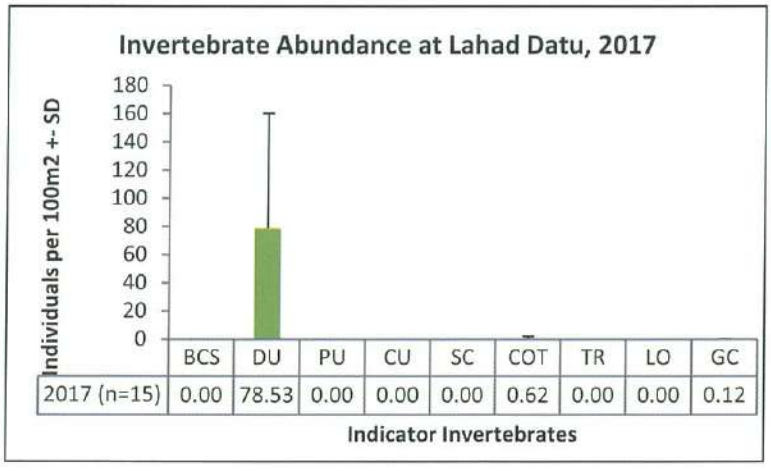
Fish



Only two indicator fish were absent during surveys (Barramundi Cod and Moray Eel).

Parrotfish recorded the highest number, followed by Butterflyfish and Snapper. Other indicators were present in very low number, less than 1 ind./500m^3.

Invertebrates



Only three indicator invertebrates were present during surveys, Diadema Urchin, Crown-of-thorns and Giant Clam.

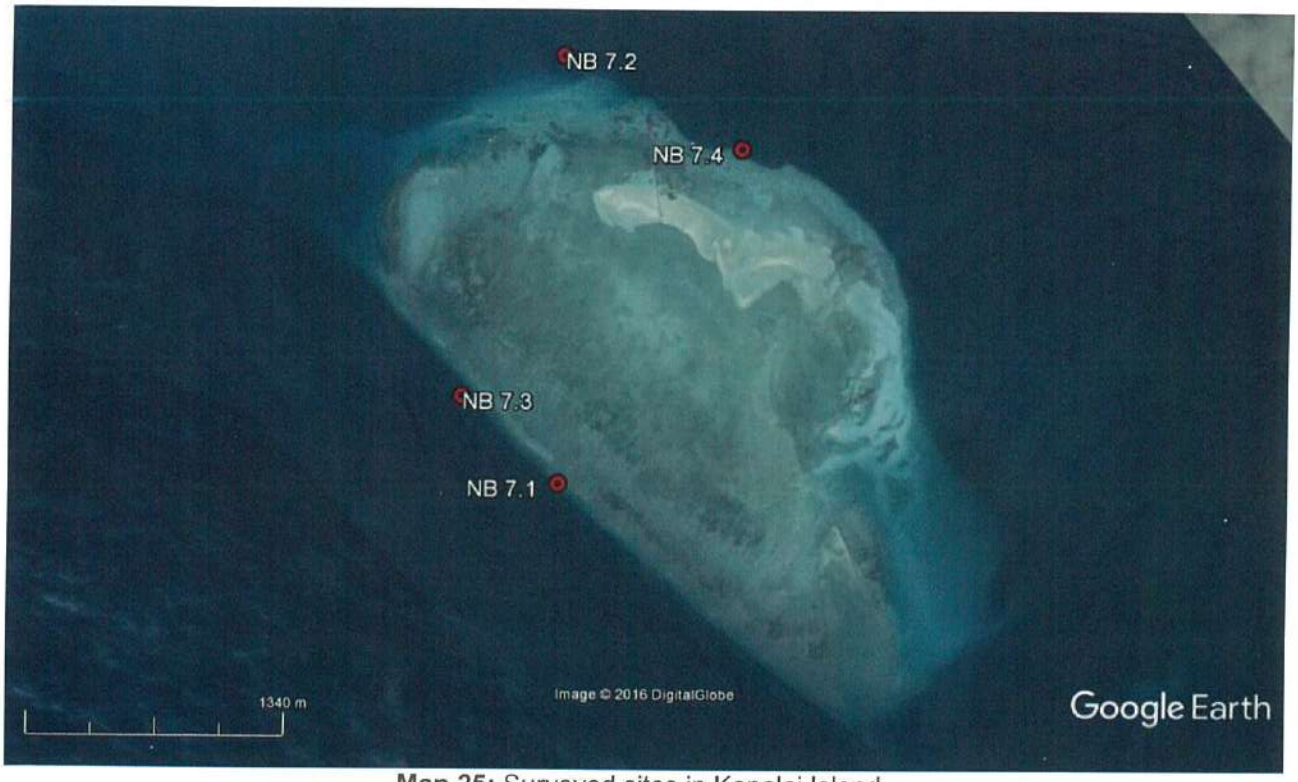
The abundance of Diadema Urchin was high and the highest of all islands surveyed in North Borneo region.

The abundance of Crown-of-thorns was high, slightly above what a healthy reef can sustain (0.2-0.3 ind./100m^2).

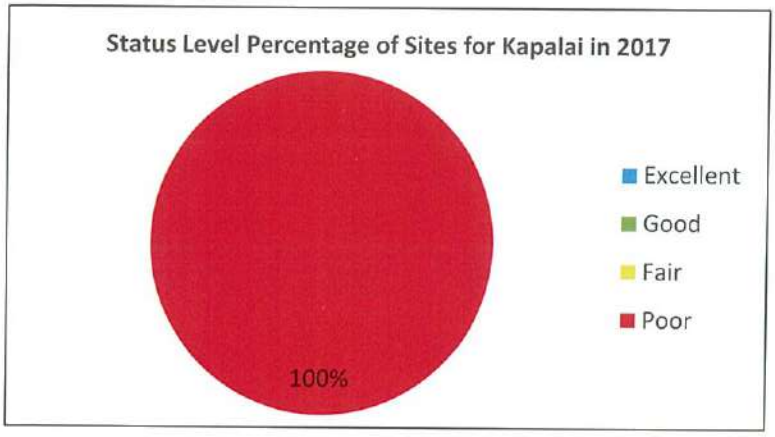
Trash and dynamite fishing impacts were seen on many of the survey sites.

3.2.22 Kapalai

Kapalai Island is located in Tawau, Sabah and 15 kilometres off Sipadan Island. It is known for its scuba diving resorts. Though it is called and island it is actually a sandbar situated on Ligitan Reef. Kapalai used to be a real island with vegetation however erosion over the last few hundred years has reduced the island to sea level. All of the buildings are on stilts resting on the underwater reef. Kapalai is mostly known for its scuba diving. There is only one private resort on the island while the rest is of the island uninhabited.

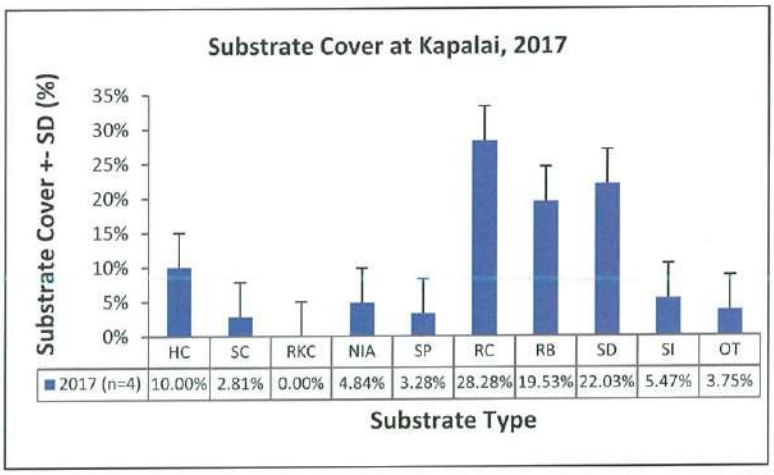


Map 25: Surveyed sites in Kapalai Island



A total of 4 coral reef sites were surveyed in Kapalai Island and 100% of the reefs were in poor condition.

Substrate

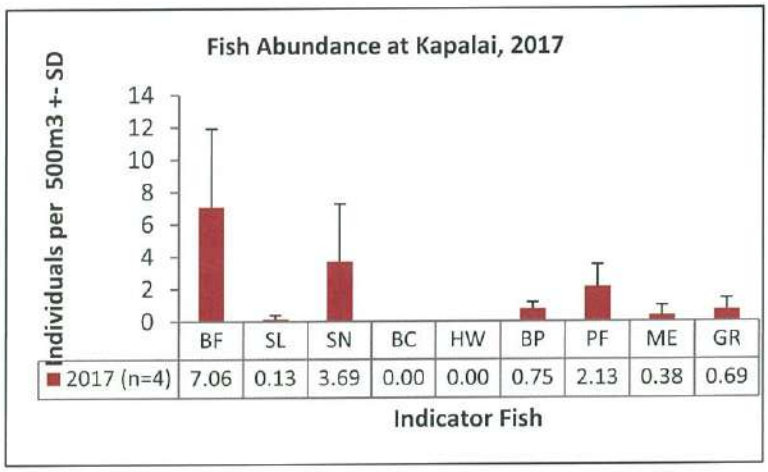


Reefs in Kapalai were considered to be in 'Poor' condition with 12.81% live coral cover, significantly below the average (36.48%) for North Borneo Region, and the lowest of all locations surveyed.

The level of NIA and SP has decreased while the level of RB and SI has increased.

The level of SD was also high and was the highest of all islands surveyed in North Borneo region.

Fish

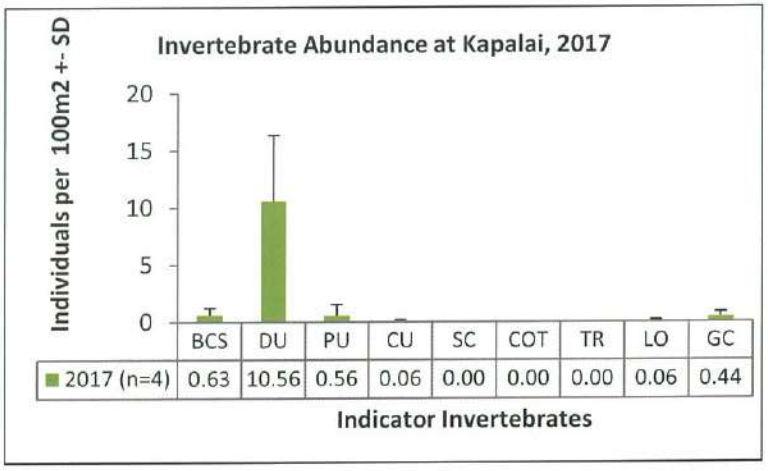


Only two fish were absent during surveys (Barramundi Cod and Humphead Wrasse).

The most abundant fish was Butterflyfish, followed by Snapper and Parrotfish. Other indicators such as Sweetlips, Moray Eel and Grouper were present in low number.

Kapalai recorded the highest number of Bumphead Parrotfish of all islands surveyed in North Borneo region.

Invertebrates



Three indicator invertebrates were absent during surveys, including Sea Cucumber, COT and Triton.

Abundance of Diadema Urchin was the highest. The abundance of other indicators were very low, less than 1 ind./100m^2.

Kapalai recorded the highest number of Pencil Urchin of all islands surveyed in North Borneo region

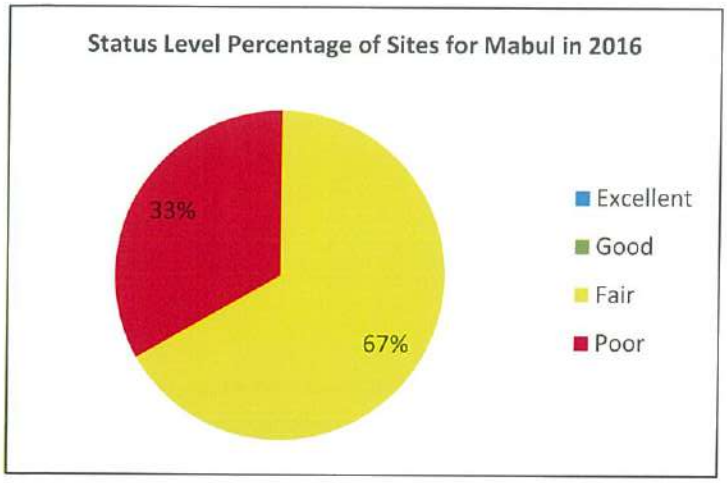
Kapalai recorded the highest number of turtle sighted during surveys in whole Malaysia. Discarded fishing and trash were observed during surveys.

3.2.23 Mabul

Mabul is a small island off the south-eastern coast of Sabah. The island has been a fishing village since the 1970s. In the 1990s, it first became popular to divers due to its proximity to Sipadan Island. Located 15 km from Sipadan, this 20-hectare piece of land surfaces 2–3 m above sea level, consists mostly flat grounds and the aerial view is oval-shaped. Surrounding it are sandy beaches, perched on the northwest corner of a larger 2 km^2 reef. The reef is on the edge of the continental shelf and the seabed surrounding the reef slopes out to 25 to 30 m deep.

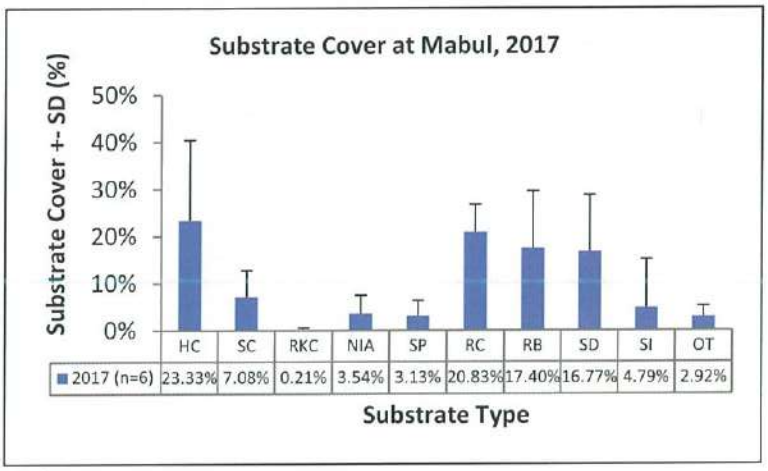
There are several dive resorts operating on Mabul island, which provides accommodation for scuba divers - most located on the island or on stilts over the water, while one is on a converted oil platform about 500 meters from the beach. There are also several home stay and backpacker accommodations which also arrange diving.

Map 26: Surveyed sites in Mabul



A total of 6 coral reef sites were surveyed in Semporna and 67% of the reefs were in fair condition. The remaining 33% were in poor condition. No reefs were in excellent and good condition.

Substrate

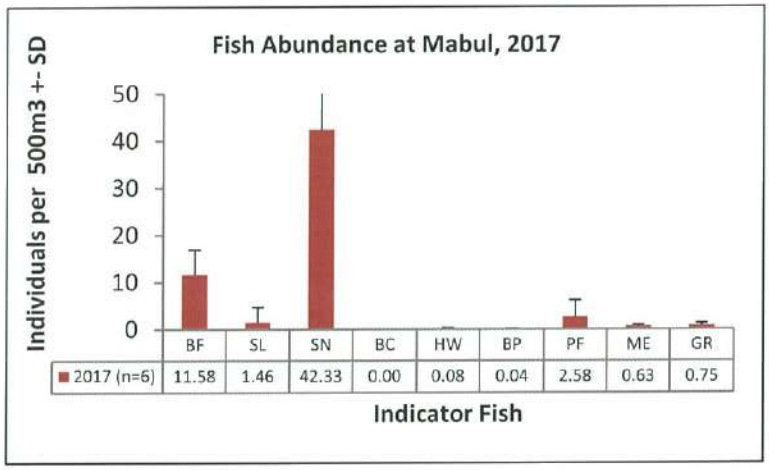


Reefs in Mabul were considered to be in 'Fair' condition with 30.42% live coral cover, somewhat below the average (36.48%) for North Borneo Region.

The high level of RB is likely due to the ongoing practice of fish bombing within the region.

Overall, SI level had increased remained similar to the 2016 level (5.1%). However, it is particularly high at Scuba Junkie House Reef, which recorded as high as 30% and action is required to prevent further decline in reef health.

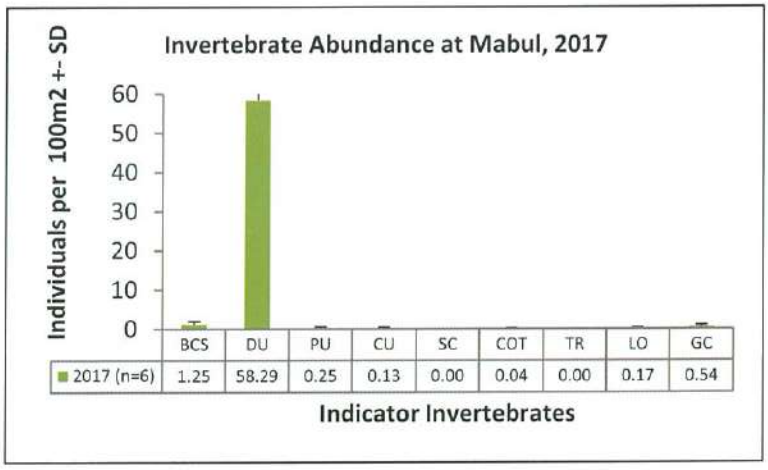
Fish



The abundance of several indicators, though generally low, was the highest of any other location in North Borneo region (Butterflyfish, Sweetlips, Snapper, Moray Eel).

This perhaps reflects the fact that Mabul is a popular dive destination and may escape the worst of over-fishing and destructive fishing that is practised in the area.

Invertebrate



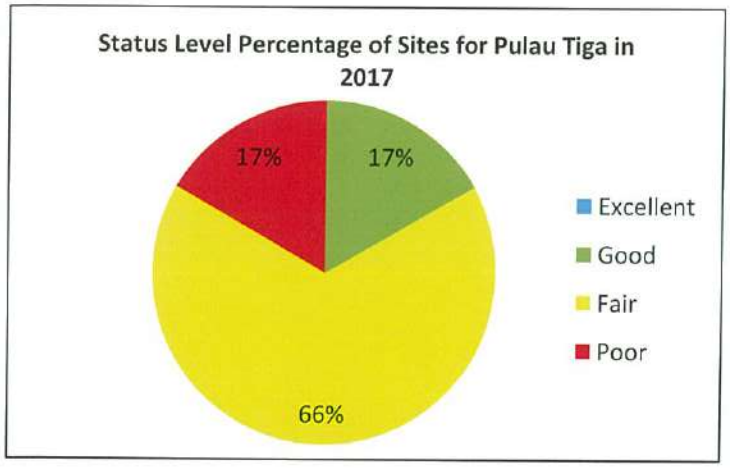
Seven indicator invertebrates were observed during surveys. Abundance of Diadema Urchin was high (and among the highest in North Borneo region). The abundance of other indicators was very low, less than 1 ind./100m^2.

Damage by human and natural impacts was observed during surveys. Signs of coral damage due to boat anchor, dynamite fishing, trash and discarded fishing nets were seen at few sites. Turtle was also recorded during surveys, at 5 out of 6 sites surveyed.

3.24 Pulau Tiga

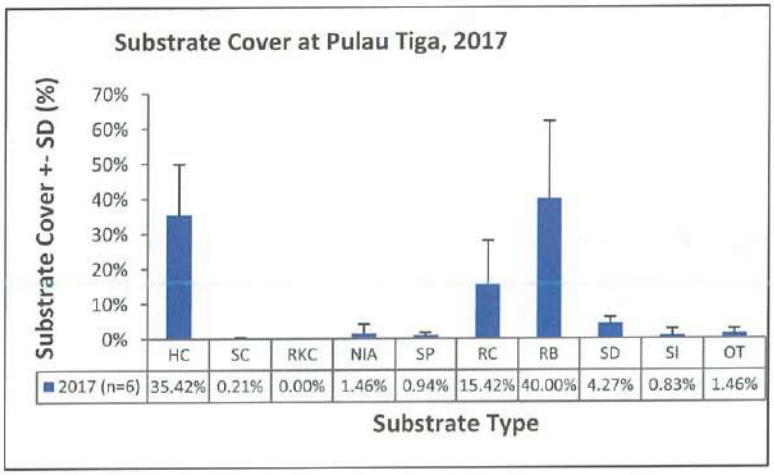
Pulau Tiga is one of a group of small uninhabited islands in Kimanis Bay off the western coast of Sabah. The islands were formed on 21 September 1897, when an earthquake on Mindanao caused a volcanic eruption near Borneo. The island is 607 hectares in size and has a couple of active mud volcanoes at the highest part of the island. Pulau Tiga is one of the three islands that make up Tiga Island National Park. The Park Headquarters are on the island, comprising an office complex and accommodation for the park staff and visiting scientists.

Map 27: Surveyed sites in Pulau Tiga



A total of 6 coral reef sites were surveyed in Pulau Tiga and 66% of the reefs were in fair condition. 17% were in good condition and the remaining 17% were in poor condition.

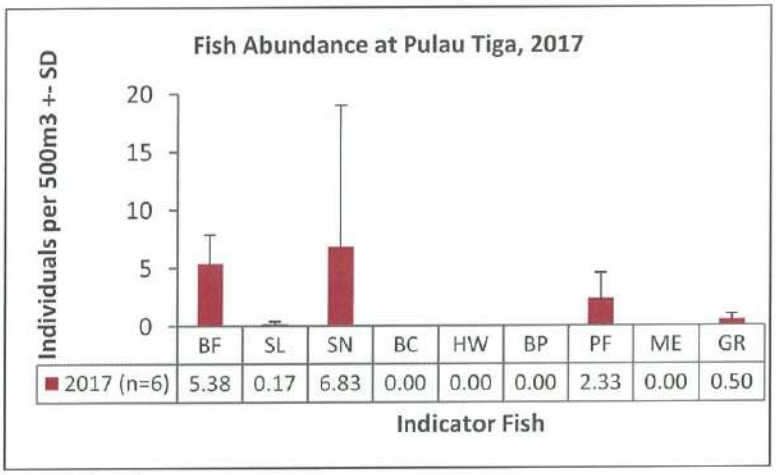
Substrate



Reefs in Pulau Tiga were considered to be in 'Fair' condition with 35.63% live coral cover, similar to the average (36.48%) for North Borneo Region.

NIA level has decreased however the level of RB has increased significantly from 24.17% in 2016 to 40% in 2017, with 4 of 6 sites surveyed recording more than 35% RB. This is a cause for concern and needs to be monitored closely.

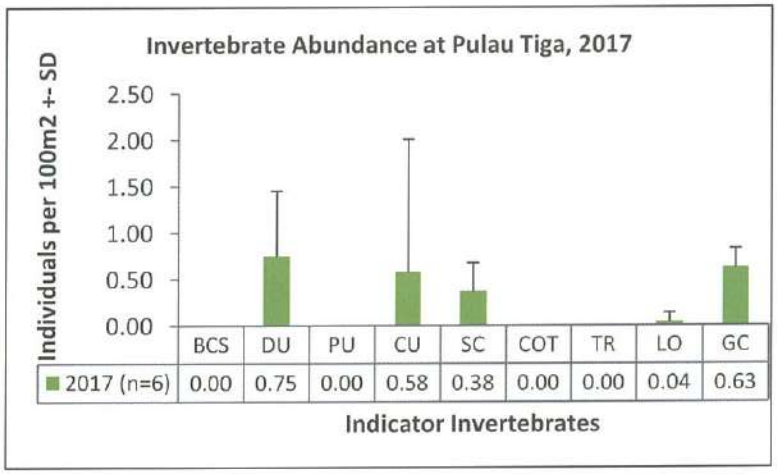
Fish



Four indicators were absent from surveys (Barramundi Cod, Humphead Wrasse, Bumphead Parrotfish and Moray Eel).

The abundance of Snapper was the highest, followed by Butterflyfish and Parrotfish. Abundance of Sweetlips and Grouper were very low, less than 1 ind./500m^3.

Invertebrate



Five indicator invertebrates were observed during surveys, including Diadema Urchin, Collector Urchin, Sea Cucumber, Lobster and Giant Clam.

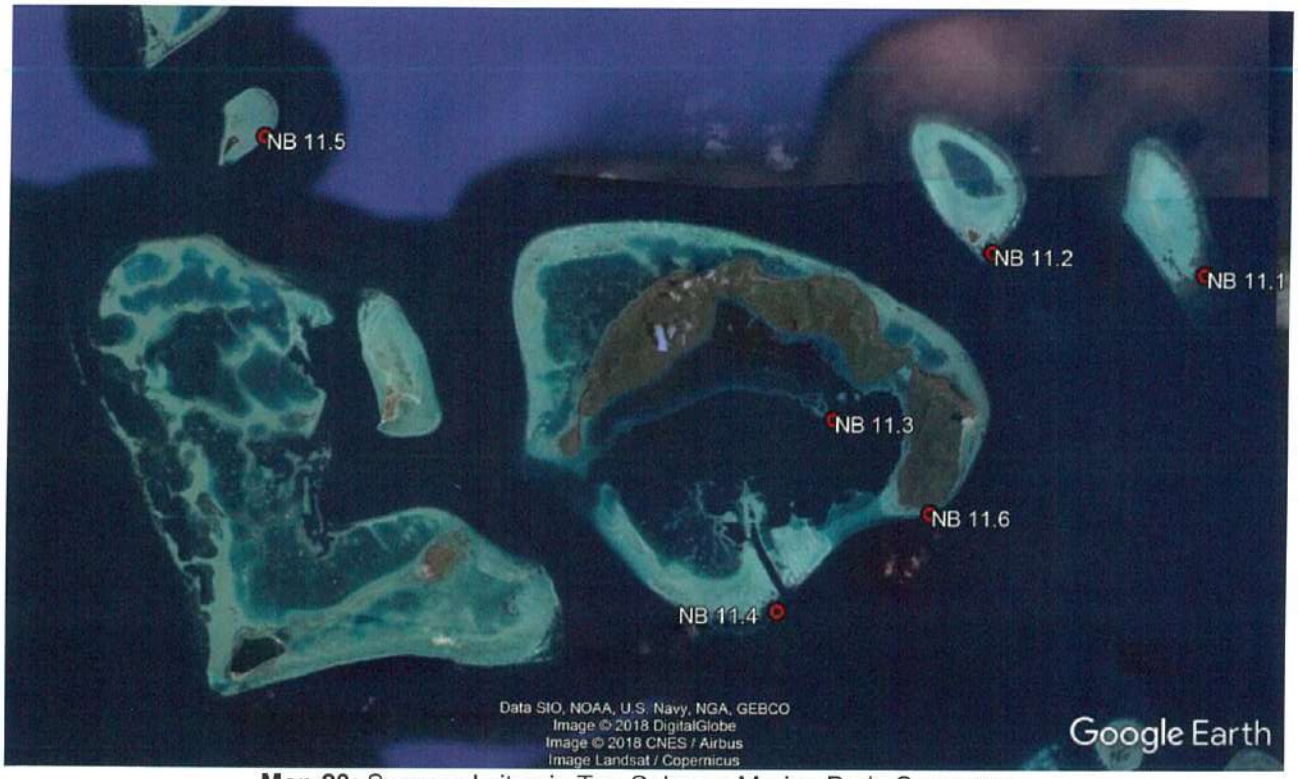
The abundance of all indicators was very low, less than 1 ind./100m^2.

Neither impacts nor rare animals were observed during surveys.

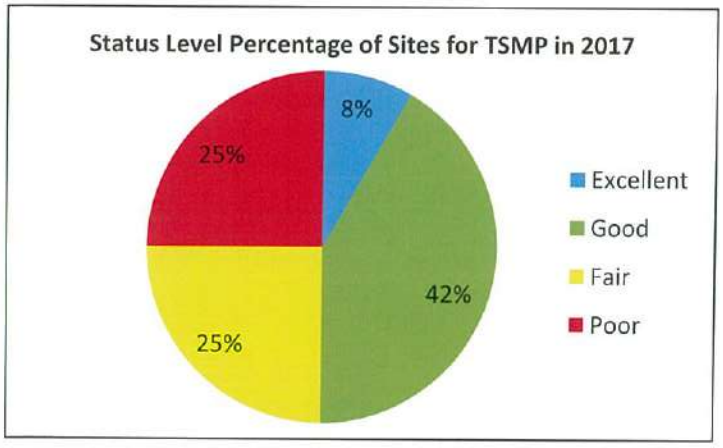
3.2.25 Tun Sakaran Marine Park, Semporna

Tun Sakaran Marine Park is a marine park located off the east coast of the state of Sabah in Malaysia. It consists of the islands of Bodgaya, Boheydulang, Sabangkat, and Salakan, the sand cays of Maiga, Sibuan, and Mantabuan, and the patch reefs of Church and Kapikan.

In 2004, the park became the seventh gazetted area under Sabah Parks with a total area of 100.8 km². There are approximately 2,000 people living within the park.

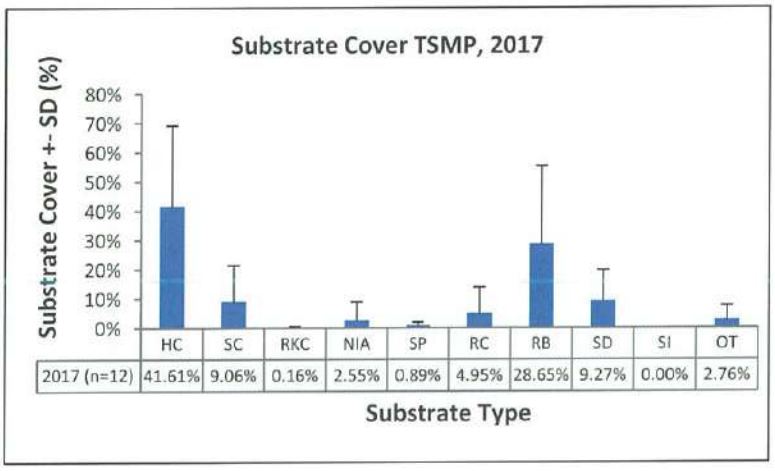


Map 28: Surveyed sites in Tun Sakaran Marine Park, Semporna



A total of 12 coral reef sites were surveyed in TSMP and 42% of the reefs were in good condition. 25% were in fair condition and 25% were in poor condition. The remaining 8% were in excellent condition.

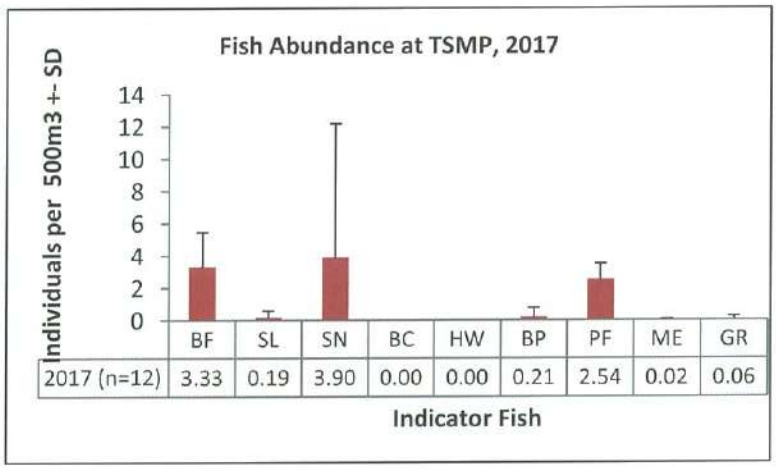
Substrate



Coral reefs within the TSMP were considered to be in 'Good' condition with 50.67% live coral cover, above the average (36.48%) for reefs within the North Borneo region.

The level of RB has increased significantly from 15.80% in 2016 to 28.65% in 2017. Four of the sites recorded more than 50% RB. The high level of RB may be due to illegal fish bombing activities and this is a cause for concern.

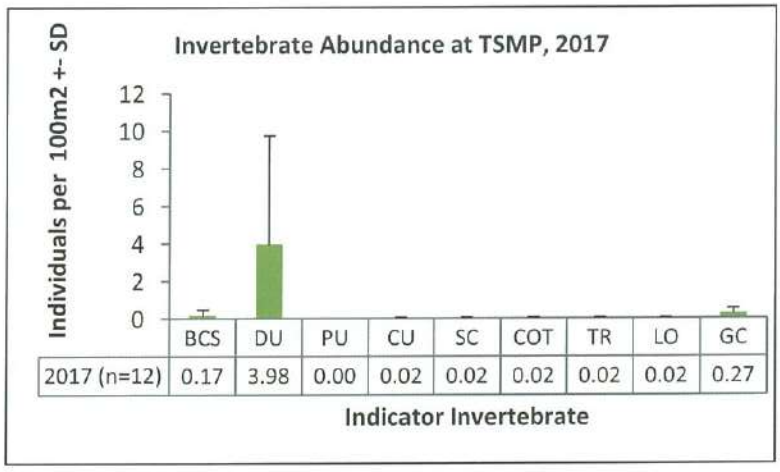
Fish



Snapper was the most abundant indicator fish recorded during surveys, followed by Butterflyfish and Parrotfish.

Barramundi Cod and Humphead Wrasse were absent during surveys while other indicators were present in low number.

Invertebrates



Diadema Urchin was the most abundant indicator invertebrate. Other indicators were recorded in low abundance.

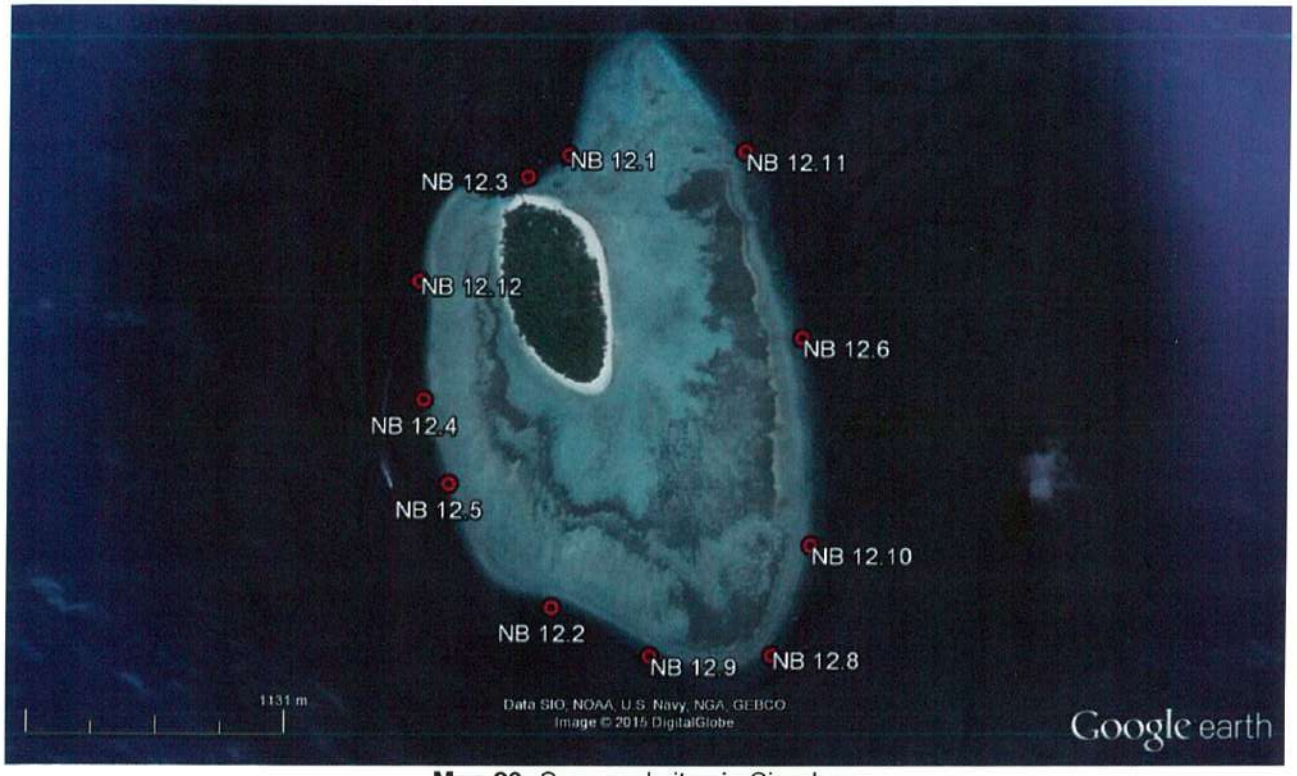
TSMP is one of the two islands recorded Triton during whole surveys.

Turtles were observed during the surveys.

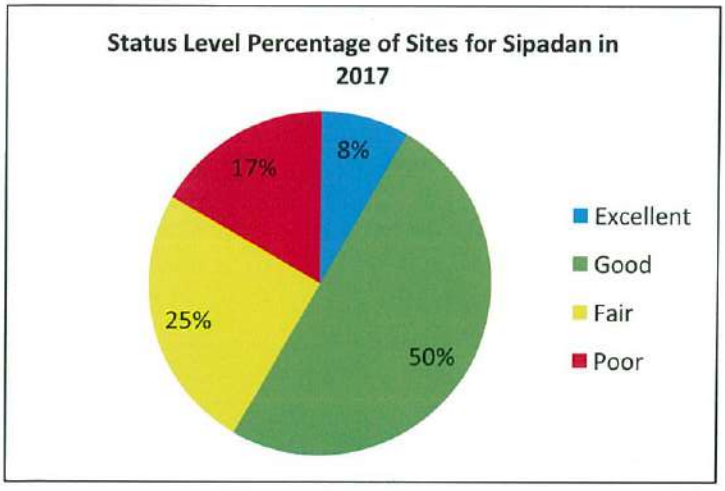
3.2.26 Sipadan

Sipadan is the only oceanic island in Malaysia, rising 600 metres from the seabed. Sipadan is located in the Celebes Sea off the east coast of Sabah, Malaysia. It was formed by living corals growing on top of an extinct volcanic cone that took thousands of years to develop.

Sipadan is located at the heart of the Indo-Pacific basin, the centre of one of the richest marine habitats in the world. More than 3,000 species of fish and hundreds of coral species have been classified in this ecosystem. Sipadan has been rated by many dive journals as one of the top destinations for diving in the world

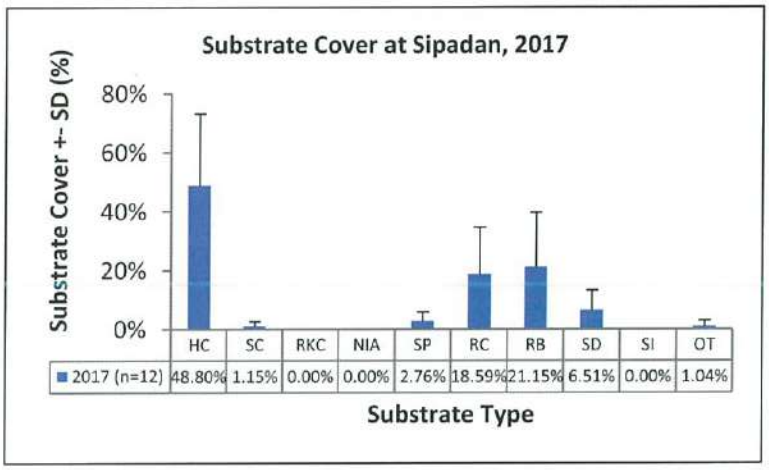


Map 29: Surveyed sites in Sipadan



A total of 12 coral reef sites were surveyed in Sipadan and 50% of the reefs were in good condition. 25% were in fair condition and 17 were in poor condition. The remaining 8% were in excellent condition.

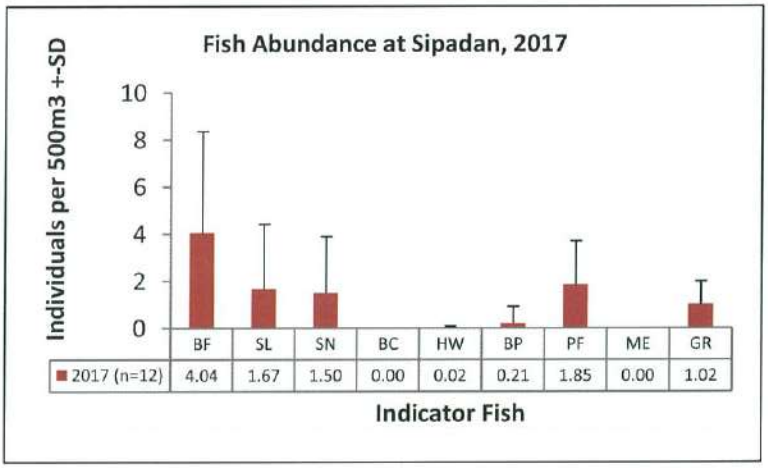
Substrate



Coral reefs within the Sipadan are considered to be in 'Fair' condition with 49.95% live coral cover, the highest of all locations surveyed within the North Borneo region.

A high amount of RB was recorded, up from last year (18.49%). Five sites recorded over 25% RB, with the highest 65.63%. The high and increasing amount of RB may be due storms, recorded during the impact survey. This is a cause for concern and needs to be monitored closely.

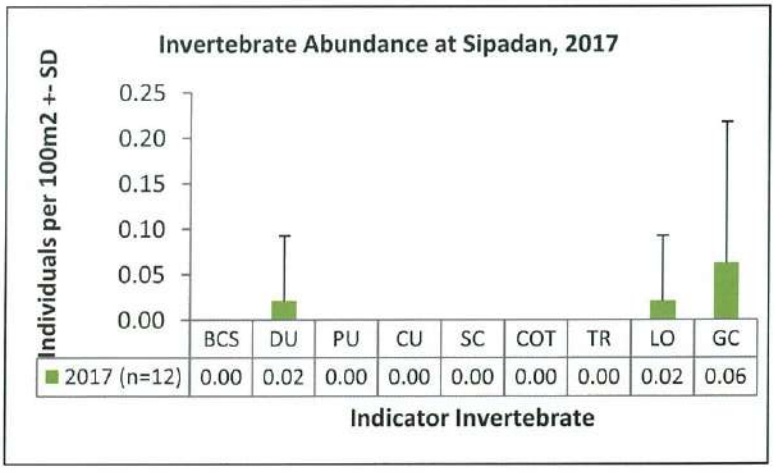
Fish



Butterflyfish was the most abundant indicator recorded during surveys, followed by Parrotfish.

Barramundi Cod, Humphead Wrasse and Moray Eel were absent and other indicators were present in low number.

Invertebrate



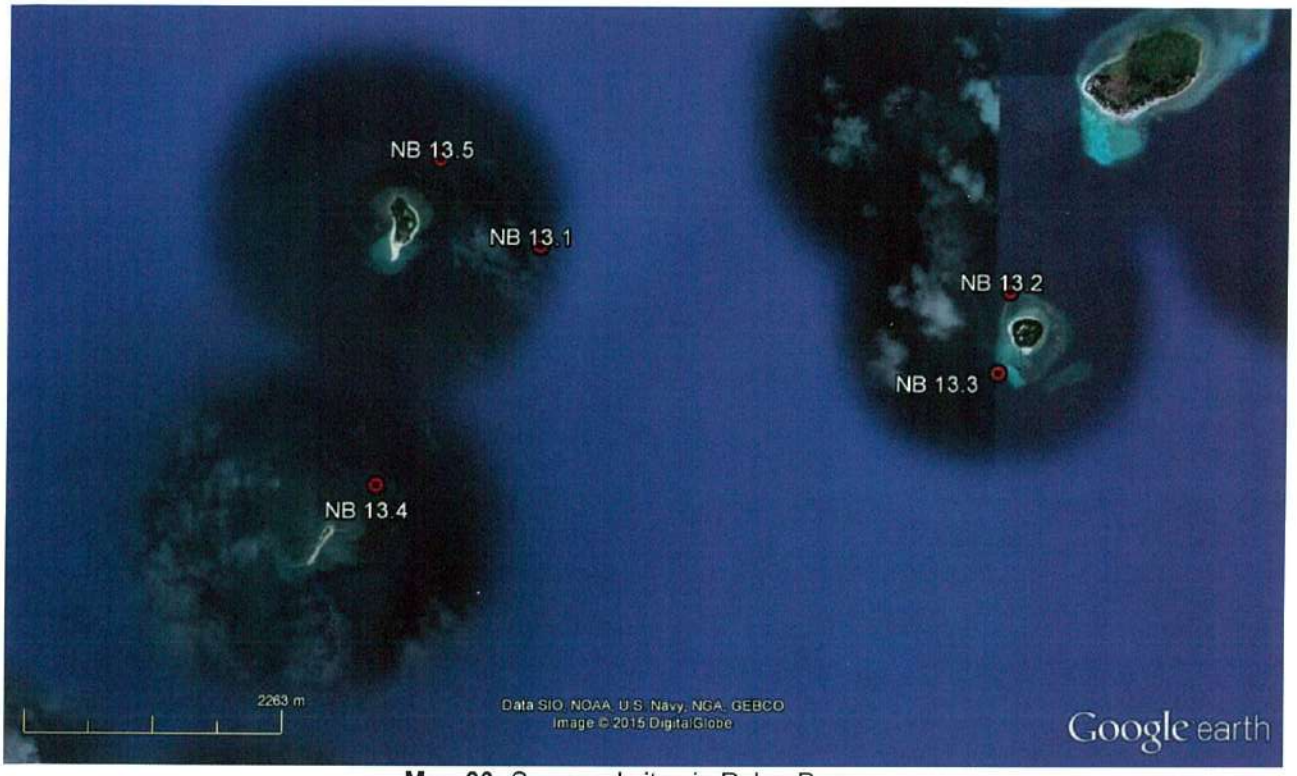
Only three invertebrate indicators were present, all in very low abundance, less than 1 ind./100m^2.

Some of the sites are damaged by storms, fishing nets and trash. On a positive note, turtle and shark were recorded at many sites during surveys.

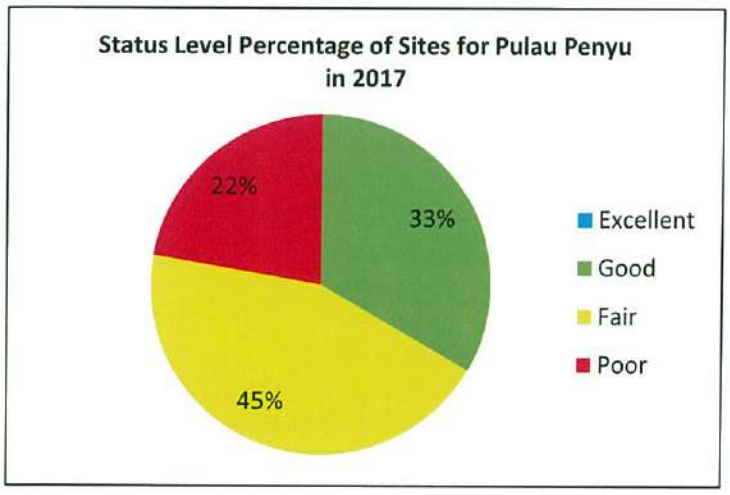
3.2.27 Pulau Penyu

Pulau Penyu lies in the Sulu Sea some 40km north of Sandakan, Sabah. It comprises of three islands; Pulau Selingan, Pulau Bakungan Kecil and Pulau Gulisan. The park gained its popularity from the green and hawksbill turtles which lay their eggs on the beaches of the islands. All the three islands are protected within marine parks on both sides of the Malaysian and Philippine borders. The park covers an area of 17.4km^2 and administered by Sabah Parks.

Only on Selingan are there chalets for overnight visitors, and those who wish to see the turtles laying eggs must stay overnight. However, park rules and regulations are strictly enforced and visitors are not allowed on the beach from sunset to sunrise so as not to disturb the turtles. A ranger will call all visitors to observe only one turtle laying eggs per night.

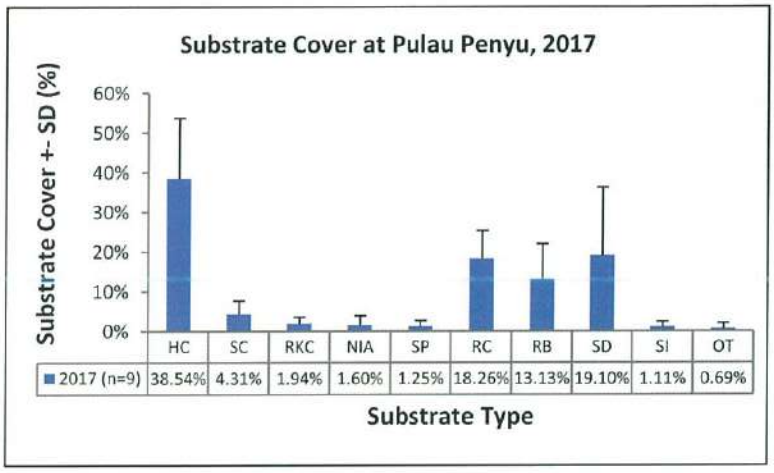


Map 30: Surveyed sites in Pulau Penyu



A total of 9 coral reef sites were surveyed in Pulau Penyu and 33% of the reefs were in good condition. 45% were in fair condition and 22% were in poor condition.

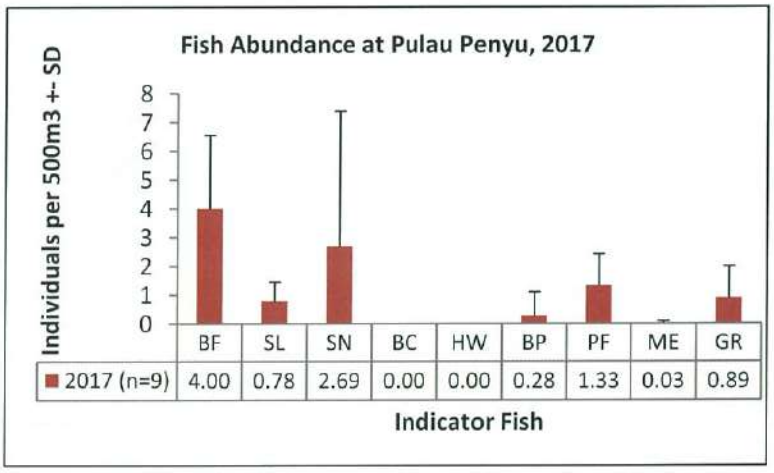
Substrate



Coral reefs in Pulau Penyu were considered to be in 'Fair' condition with 42.85% live coral cover, above the average (36.48%) of reefs within the North Borneo region.

The islands in general have high level of SD. The level of RB is high at 13.13%. RKC and NIA levels have increased from last year, but are still low.

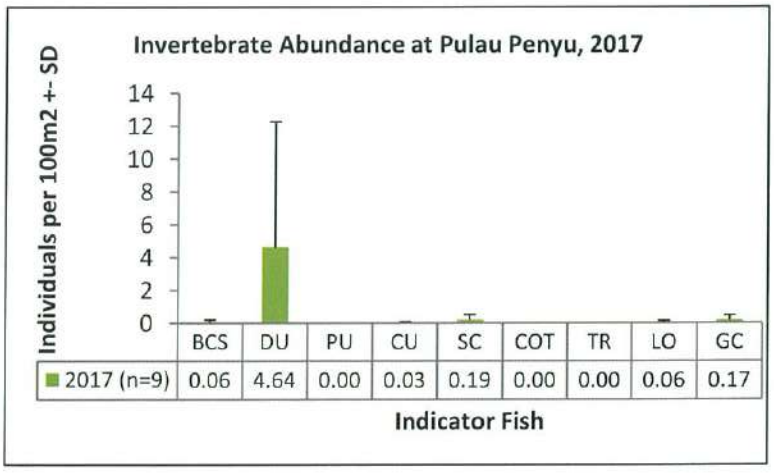
Fish



Butterflyfish was the most abundant indicator recorded during surveys, followed by Snapper.

Sweetlips, Bumphead Parrotfish, Parrotfish, Moray Eel and Grouper were present in low number.

Invertebrate



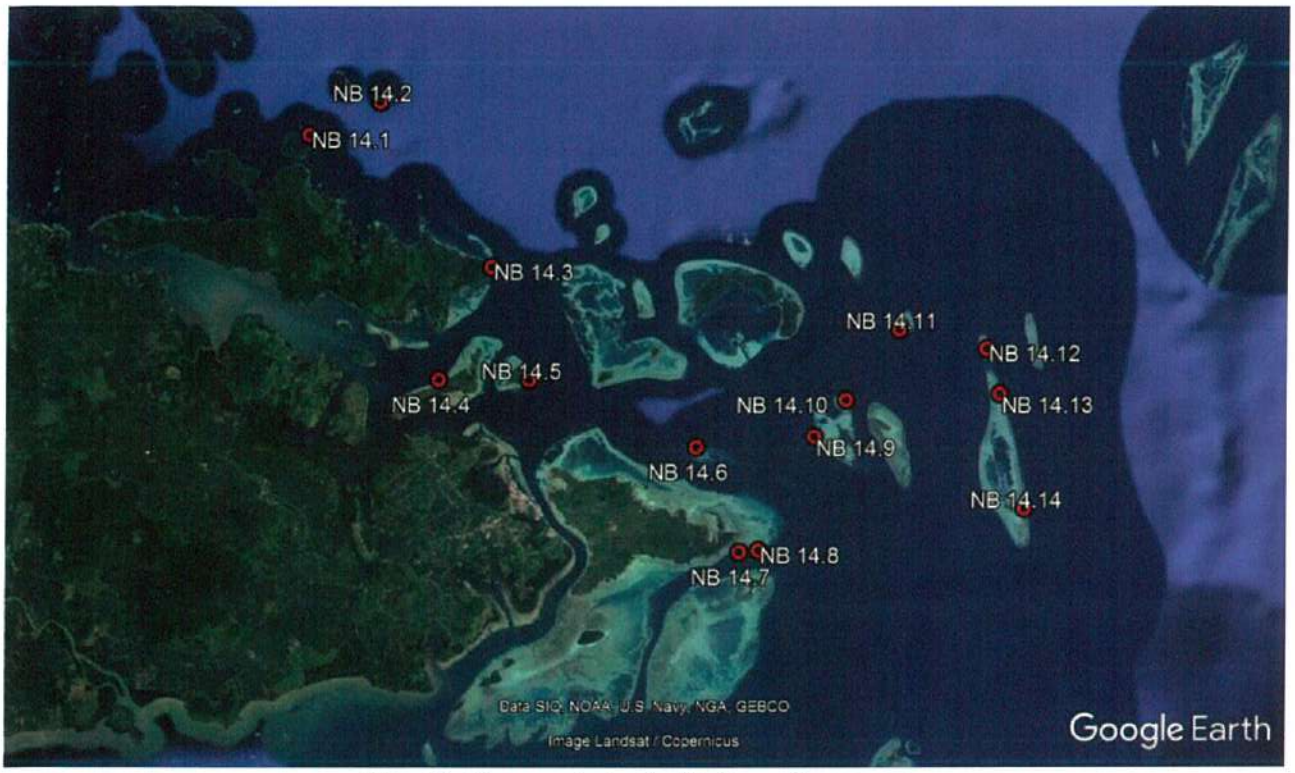
Six indicator invertebrates were observed during surveys, including Banded Coral Shrimp, Diadema Urchin, Collector Urchin, Sea Cucumber, Lobster and Giant Clam. Their abundance were recorded in low number, less than 1 ind./100m^2, except for Diadema Urchin.

Human impact due to discarded fishing net was observed at one site. Turtle was recorded at many survey sites while shark was only recorded at one site.

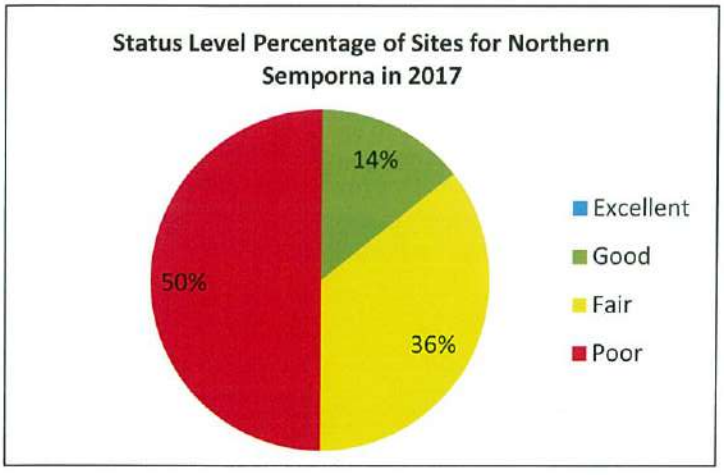
3.2.28 Northern Semporna

Semporna is located at the South Western tip of Sabah, south of Lahad Datu, in the Tawau District. The economy of this town is driven by marine products especially pearl farming and seaweed farming.

Tourism is also an important element of the economy. Semporna is a popular base for tourists visiting Sipadan, Mabul, Kapalai, Mataking, Sibuan, Mantabuan and Pom Pom among others. Tourists to Semporna are mainly visitors looking for water sport activities such as SCUBA diving and snorkelling.

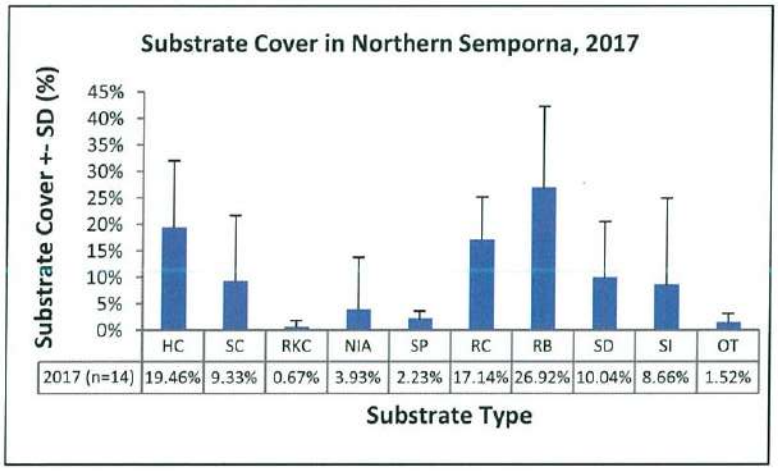


Map 31: Surveyed sites in Northern Semporna



A total of 14 coral reef sites were surveyed in Northern Semporna and 50% of the reefs were in poor condition. 14% were in good condition and the remaining 36% were in fair condition. No reefs were in excellent condition.

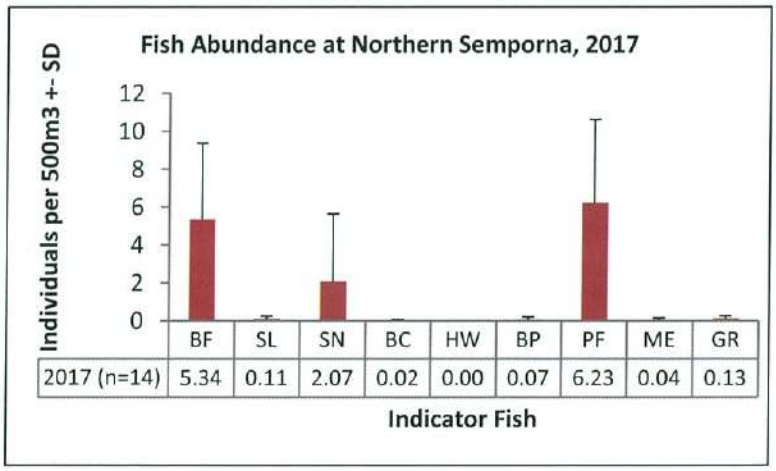
Substrate



Coral reefs in Northern Semporna were considered to be in 'Fair' condition with 28.79% live coral cover, significantly below the average (36.48%) of reefs within the North Borneo region.

The level RB was very high, indicating high level of recent disturbances in the area. The impact surveys recorded high level of damage from boat anchor and dynamite fishing, at many survey sites.

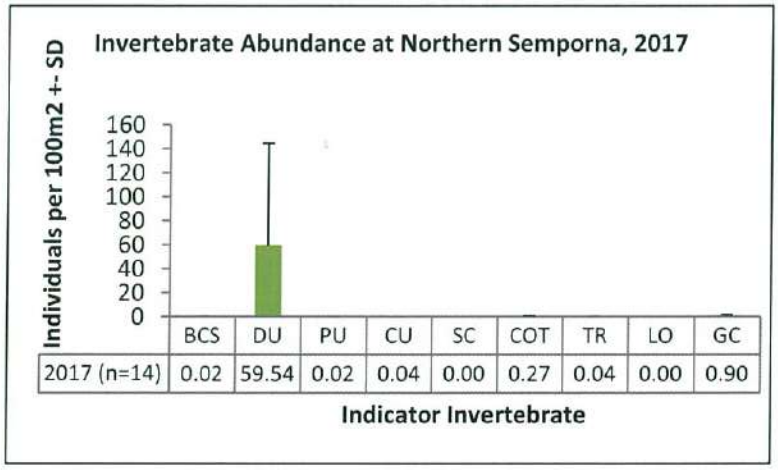
Fish



Parrotfish was the most abundant indicator fish recorded during surveys, followed by Butterflyfish and Snapper.

Sweetlips, Barramundi Cod, Bumphead Parrotfish, Moray Eel and Grouper were present in low number, less than 1 ind./500m^3.

Invertebrate



Diadema Urchin recorded the highest number. Other indicators were present low abundance, less than 1 ind./100m^2. Crown-of-thorns abundance was within the healthy range.

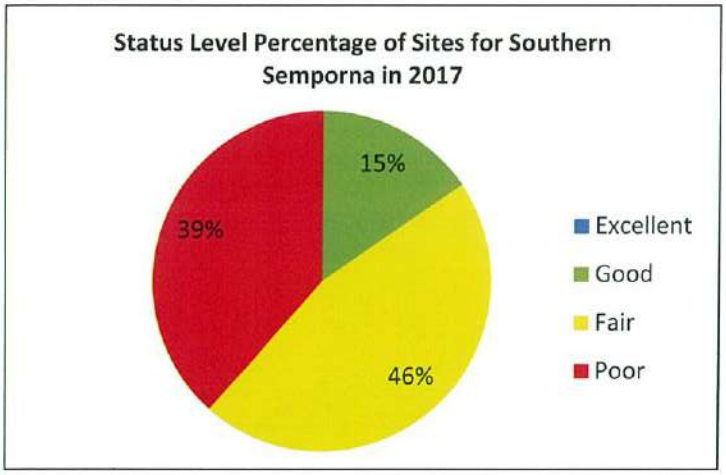
Extensive damage by boat anchor, dynamite fishing, trash and discarded fishing nets was recorded at many sites. Two fish blasts were heard during surveys and one site was impacted by siltation. Damage due to warm water bleaching was also recorded at three sites. On a positive note, turtles, coral cat shark, spotted eagle ray and mandarinfish were observed at a number of sites.

3.2.29 Southern Semporna

Semporna is located at the South Western tip of Sabah, south of Lahad Datu, in the Tawau District. The economy of this town is driven by marine products especially pearl farming and seaweed farming.

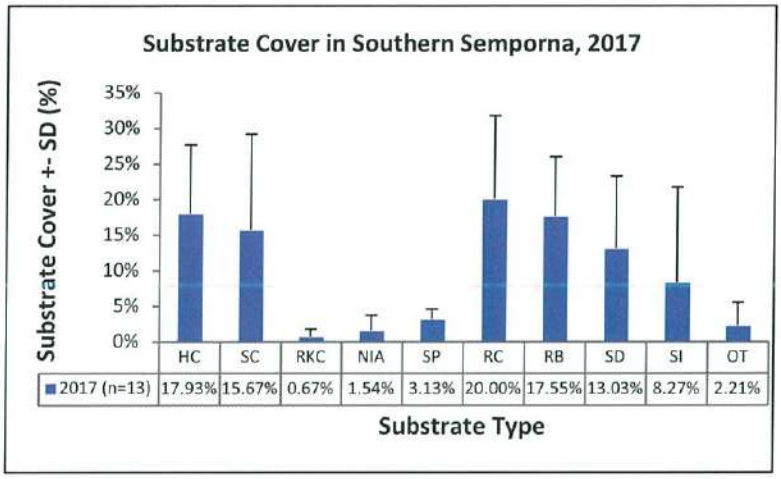
Tourism is also an important element of the economy. Semporna is a popular base for tourists visiting Sipadan, Mabul, Kapalai, Mataking, Sibuan, Mantabuan and Pom Pom among others. Tourists to Semporna are mainly visitors looking for water sport activities such as SCUBA diving and snorkelling.

Map 32: Surveyed sites in Southern Semporna



A total of 13 coral reef sites were surveyed in Southern Semporna and 46% of the reefs were in fair condition. 15% of the reefs were in good condition and the remaining 39% were in poor condition. No reefs were in excellent condition.

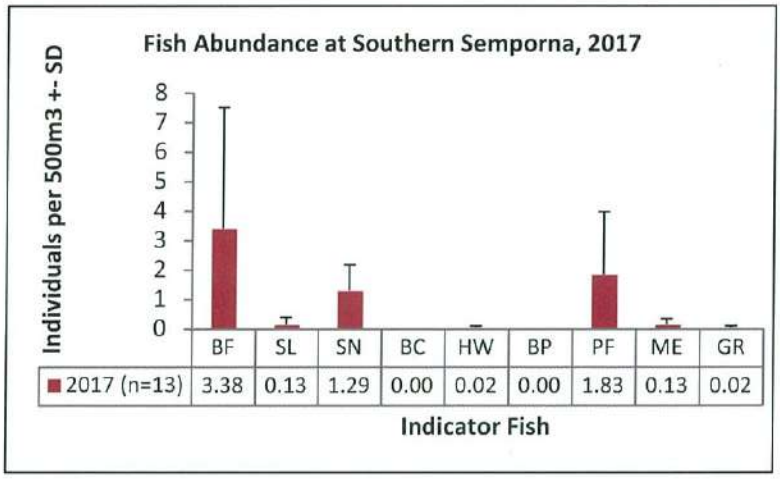
Substrate



Coral reefs in Southern Semporna were considered to be in 'Fair' condition with 33.61% live coral cover, slightly below the average (36.48%) of reefs within the North Borneo region. The live coral cover was largely attributed to the high level of SC (15.67%).

The level of RB is very high, indicating high level of recent disturbances in the area. The impact surveys recorded high level of damage from dynamite fishing, at many survey sites.

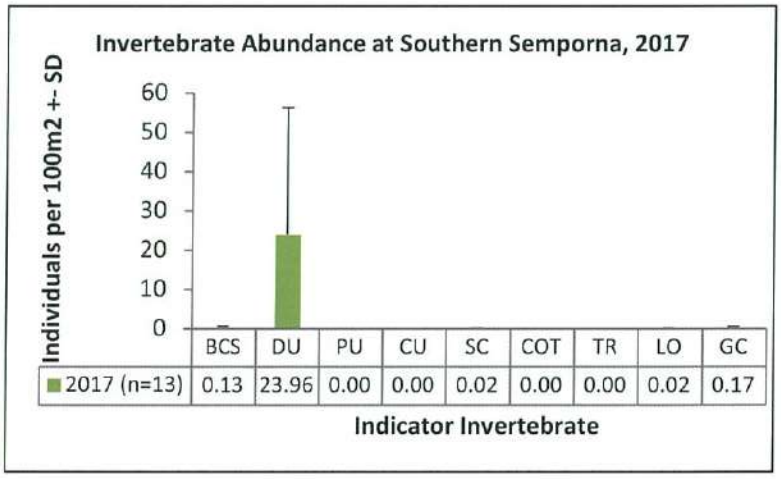
Fish



Butterflyfish was the most abundant indicator fish recorded during surveys, followed by Parrot fish and Snapper.

Sweetlips, Barramundi Cod, Bumphead Parrotfish, Moray Eel and Grouper were present in low number, less than 1 ind./500m^3

Invertebrate



Diadema Urchin was the most abundant indicator recorded during surveys. Other indicators were present in low number, less than 1 ind./100m^2.

4. Eleven Years of Reef Check Data

Reef Check data are primarily used for monitoring coral reef health and comparisons of data over time can highlight significant changes and indicate potential problems. This section reviews data collected over the last 11 years to assess changes to Malaysia's reefs over the period.

4.1 LCC – Change in Key Indicator over 11 years

Live Coral Cover is used as a key indicator of reef health, as high levels of hard and soft corals provide various habitats and food sources for a wide range of marine life, indicating high diversity.

Changes to LCC for Malaysia over the last eleven years are shown in Chart 4 below.

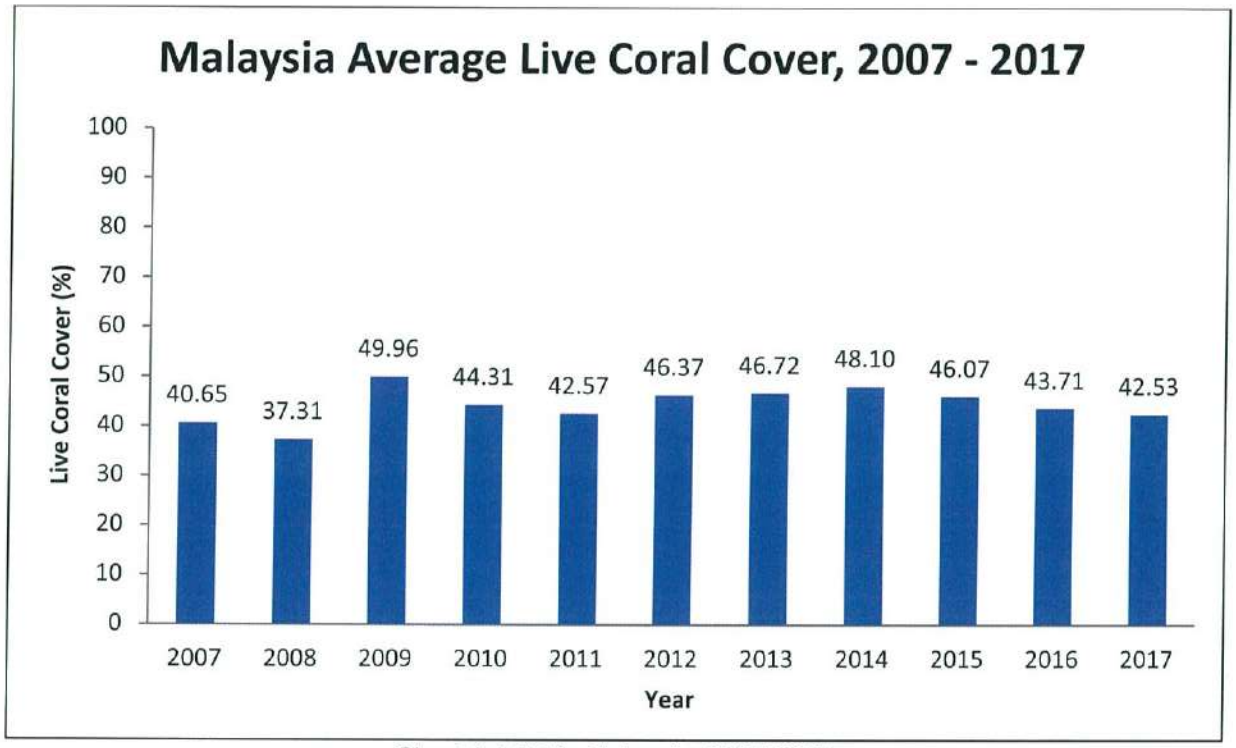


Chart 4: LCC in Malaysia, 2007-2017

During the first 2-3 years of the national survey programme, the data set was very small, and it is difficult to draw meaningful conclusions from changes in LCC. But by 2009 the dataset was larger and therefore perhaps more reliable. The data indicate a decline in LCC between 2009 and 2011, which reflects the major bleaching event in 2010. There are then signs of recovery for the following years (2011-2014) but since then there has been a year on year decline in LCC from a high of just over 48% in 2014 to 42.53% in 2017. This represents a loss of 5.57 percentage points, a significant change.

4.2 Peninsular versus East Malaysia over 11 years

The charts below show changing substrate cover, fish and invertebrate abundance over the last 11 years, separated into Peninsular Malaysia and East Malaysia.

4.1.1 Substrate

As stated previously, LCC can be used as a broad indicator of coral reef health. Data from surveys conducted around Peninsular Malaysia over the last 11 years show that there has been some variation in coral reef health.

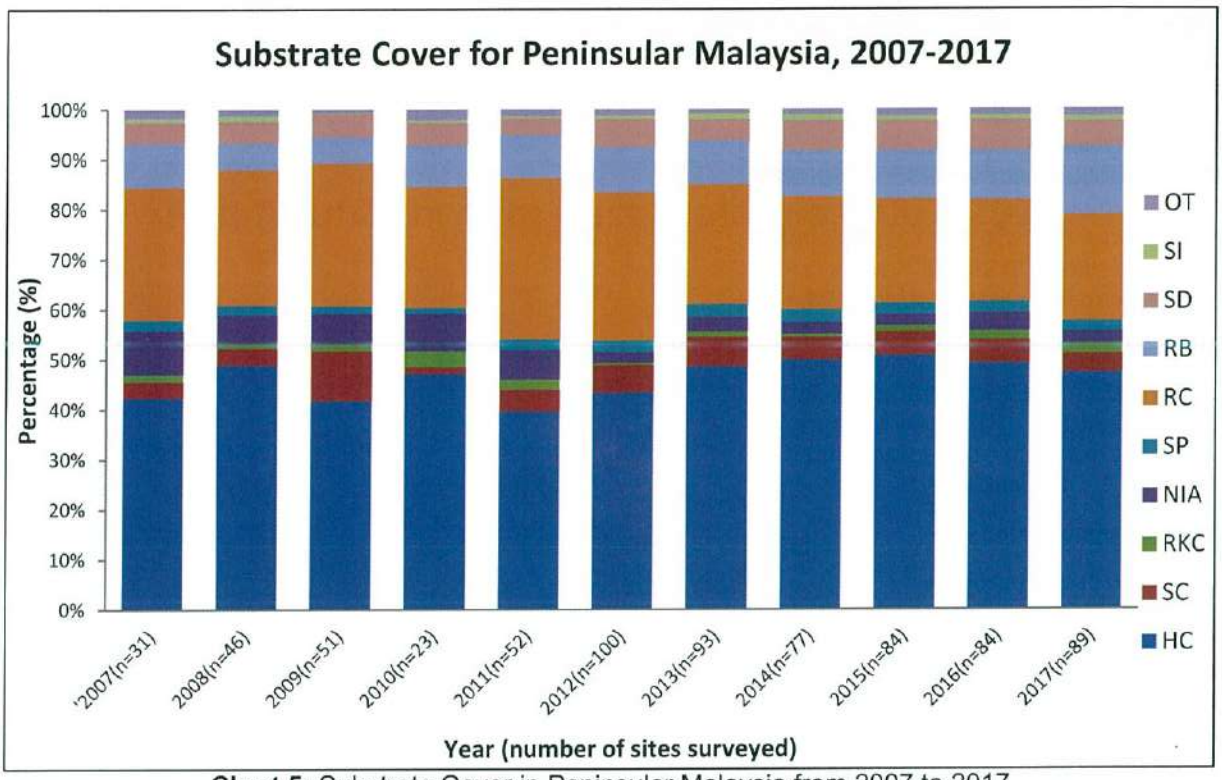


Chart 5: Substrate Cover in Peninsular Malaysia from 2007 to 2017

The decline in LCC from 2009 to 2011 probably reflects the impact of the major bleaching event that happened in 2010. In 2012, LCC in Peninsular Malaysia showed a substantial recovery. This is mirrored by concomitant changes in level of RKC, showing a significant increase in 2010 and decrease in 2012. The level of LCC maintained more or less the same from 2013 to 2015. From 2015 to 2017, LCC dropped slightly mainly due to increase in the amount of NIA, RB and RKC, all indicators of recent disturbances to reefs. The 2016 El Nino phenomenon and bleaching event might also contribute to the drop.

From 2007 to 2012, the level of NIA showed a large decline. However, in the last 6 years NIA level increased gradually. Although slight, the levels of RB and SD have also been increasing steadily over the last 11 years and this needs to be monitored closely as the increase is an indication of disturbances, especially for RB level which has increased from 9.79% in 2016 to 13.50% in 2017.

In East Malaysia, LCC has been consistently in fair condition (see chart 6). The low LCC data point in 2008 can probably be ascribed to the small size of the data set in the early years of monitoring. However, the decline in LCC in 2010 probably reflects the impact of the major bleaching event that happened during that period. By 2012, LCC in Sabah showed a recovery but since then there has been a decline in LCC over the last three years, which is a cause for concern.

The reduction in LCC in 2016 may have been caused by the El Nino weather phenomenon that hit the region last year. However, the increased levels of NIA, RB and RKC at the same time, all negative indicators suggesting recent disturbances to reefs, is perhaps more indicative of declining reef health.

The level of NIA in Sabah gradually increased over the last 5 years and the level of RB has been consistently high over the last 10 years. These indicators support the argument that the level of disturbances on reef in Sabah is high and that some attention to reef health, and management of impacts, is required.

Low fish and invertebrate populations also support this.

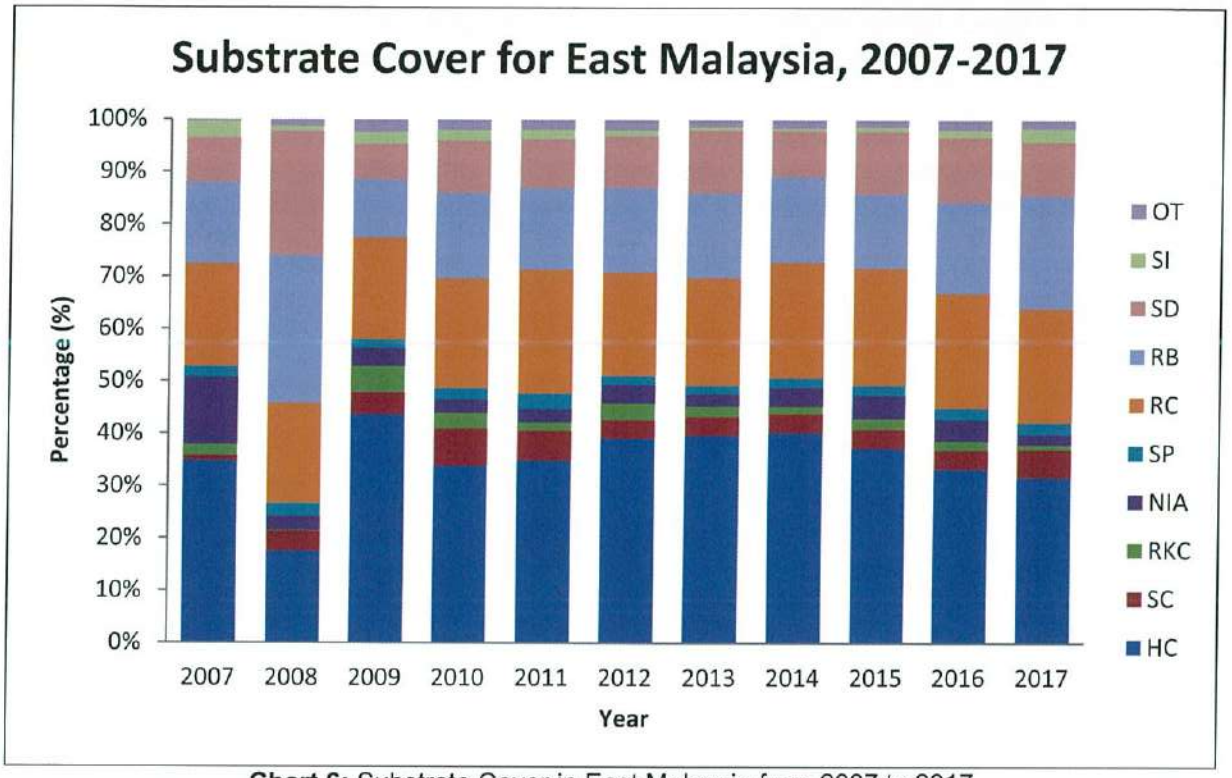


Chart 6: Substrate Cover in East Malaysia from 2007 to 2017

4.1.2 Fish

Over the last 11 years, fish abundances in both Peninsular and East Malaysia show little variation, with the exception of snapper (see charts 7 and 8). Most of the indicator fish remain in very low abundance with no signs of recovery, despite the fact that most sites surveyed (particularly in Peninsular Malaysia) were located within marine protected areas.

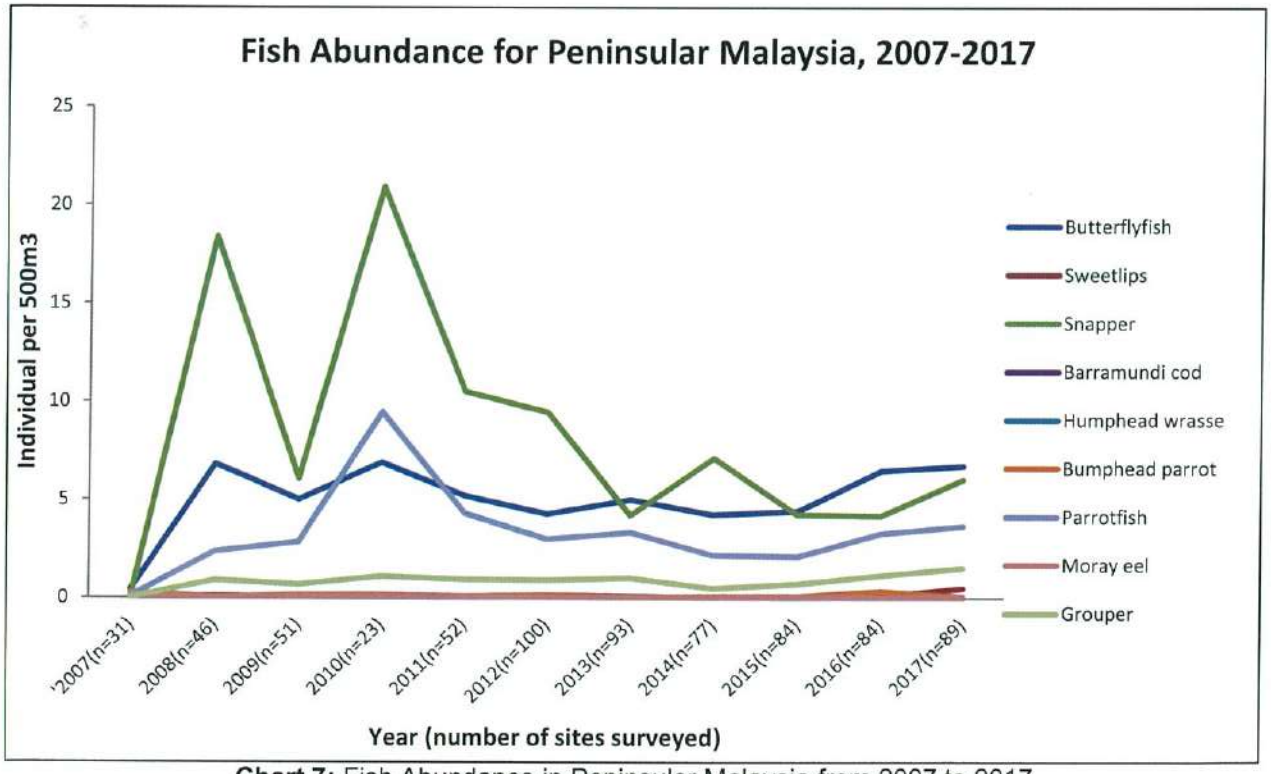


Chart 7: Fish Abundance in Peninsular Malaysia from 2007 to 2017

The average abundance recorded for Sweetlips, Barramundi Cod, Humphead Wrasse, Bumphead Parrotfish and Moray Eel was below 1 individual per 500m^3 throughout the survey period. Snapper, Butterflyfish and Parrotfish were the most abundant fish recorded in both Peninsular and East Malaysia with Snapper showing a decline in the last 5 years.

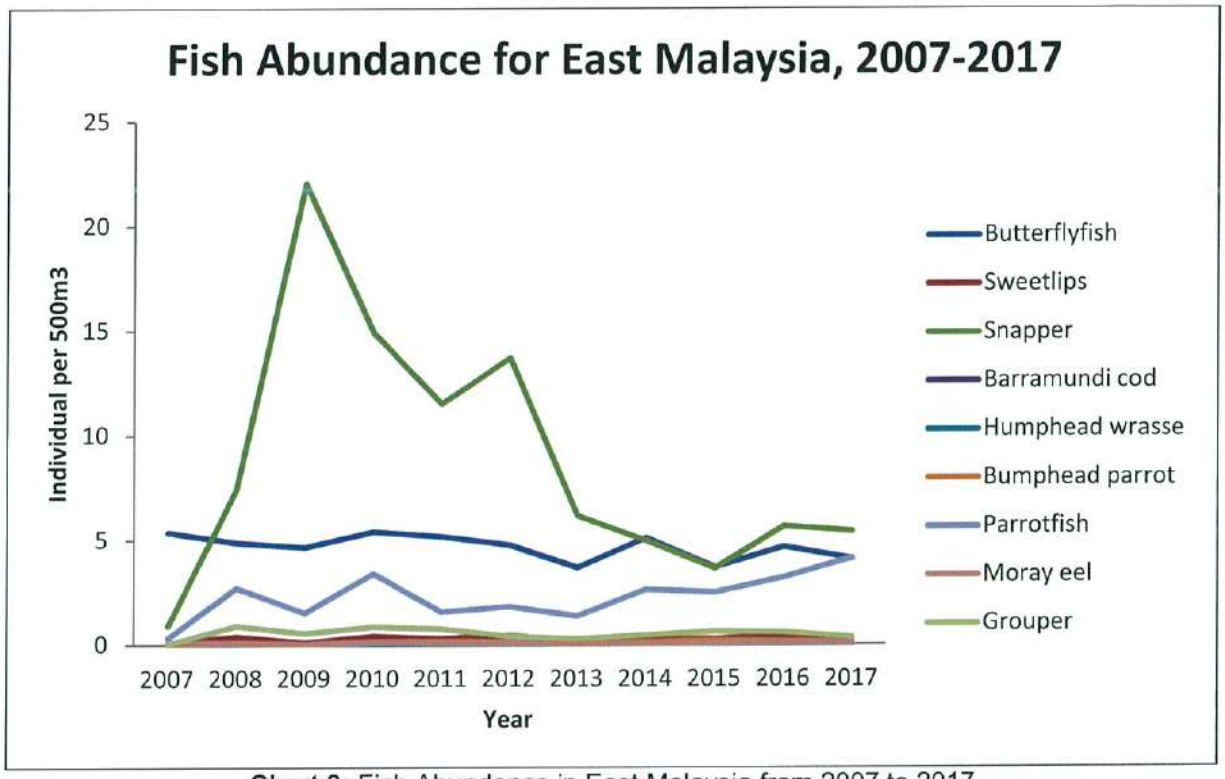


Chart 8: Fish Abundance in East Malaysia from 2007 to 2017

4.1.3 Invertebrate

Similar to fish indicators, invertebrate abundances in both Peninsular and East Malaysia show little variation with most of the indicator invertebrate remaining at very low abundance, with no signs of recovery despite the fact that most of the sites surveyed were located within marine protected areas. The average abundance recorded for Banded Coral Shrimp, Pencil Urchin, Collector Urchin, Triton and Lobster was below 1 individual per 100m^2 throughout the survey period.

Diadema Urchin was the most abundant invertebrate recorded in both Peninsular and East Malaysia with East Malaysia showing a steady increase over the last 5 years, populations perhaps responding to the above noted increase in NIA level.

The number of Crown-of-Thorns recorded in Peninsular Malaysia is a cause for concern. Although their abundance in the last 5 years was less compared to the period 2008 to 2011, their population remains above what a healthy coral reef can support and has been increasing steadily every year. This is an issue and action is needed to control the high number of Crown-of-Thorns in Peninsular Malaysia. Collector Urchins were not recorded in Peninsular over the last 6 years with Pencil Urchin, Triton and Lobster following a similar trend where they were not recorded in the last 2 years of surveys.

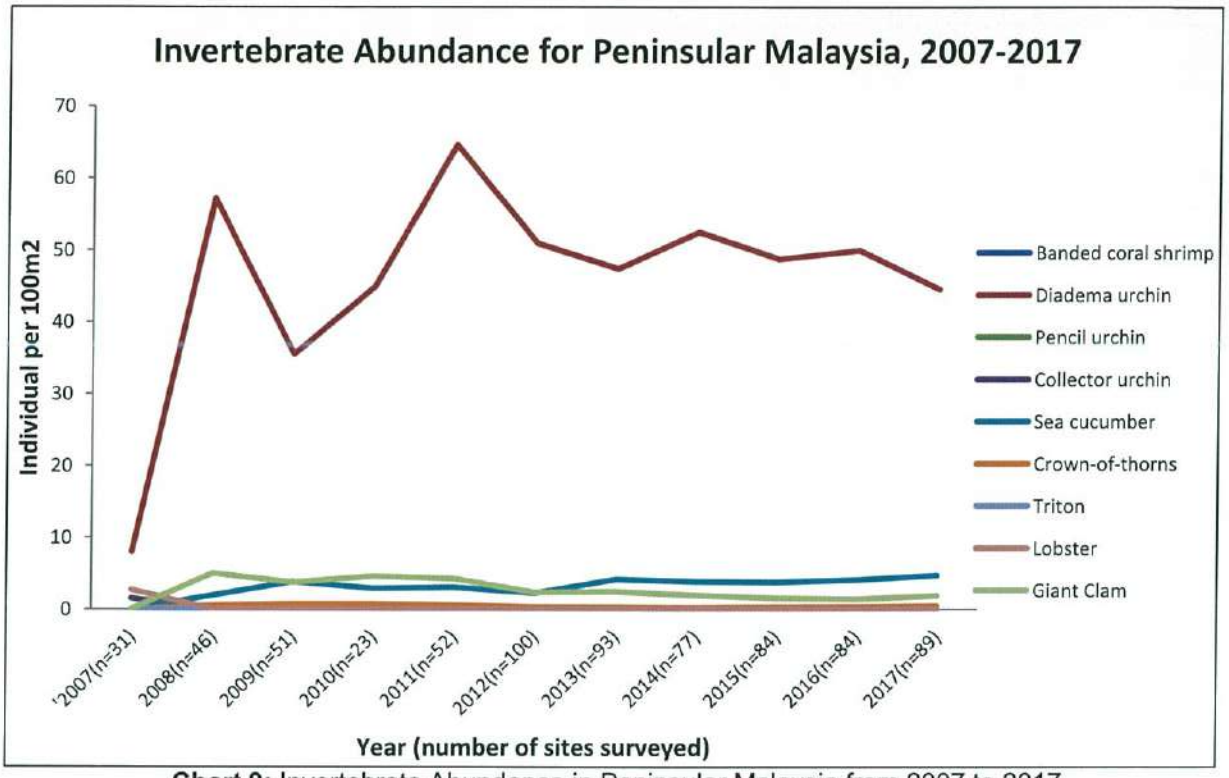


Chart 9: Invertebrate Abundance in Peninsular Malaysia from 2007 to 2017

East Malaysia shows a similar pattern, with large numbers of Diadema urchins but low abundance of other indicators.

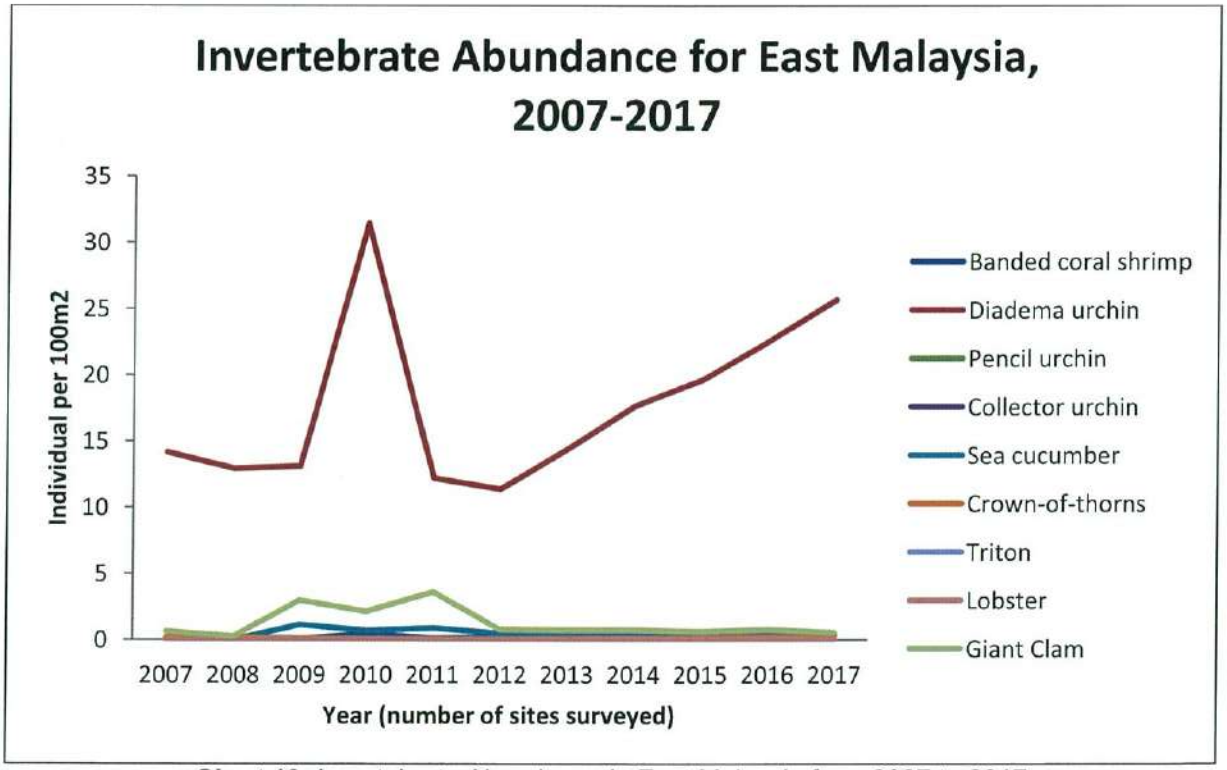


Chart 10: Invertebrate Abundance in East Malaysia from 2007 to 2017

Interestingly, Diadema numbers peaked in both areas in 2010/11, around the time of the bleaching event, and then declined for 1-2 years. Numbers in Peninsular Malaysia stayed high, and in East Malaysia have now recovered. This is the only significant growth in indicator abundance, and as a largely negative indicator should be investigated further.

4.2 Changing Reef Health in Selected Areas

This section provides details of the health of selected coral reefs in nine reef areas around Malaysia over the seven year period from 2011 to 2017. Only sites that were surveyed every year over the period are included in this section, as listed below:

Perhentian (10)	Batu Nisan, D' Lagoon, Sea Bell, Tanjung Besi, Batu Layar, Sharkpoint, Batu Tabir, Tukas Laut, Tiga Ruang and Pulau Rawa
Redang (10)	Chagar Hutang East, Pulau Lima Southern Tip, P. Paku Kecil, P. Pinang, P. Paku Besar, Redang Kalong House Reef, P. Kerengga Besar, P. Kerengga Kecil, Pasir Akar and Terumbu Kili
Tioman (12)	Teluk Kador, Batu Malang, Pirate Reefs, Renggis North, Soyak, Soyak South, Tekek House Reef, Sepoi, Chebeh, Tomok, Labas and Fan Canyon
Tenggol (6)	Turtle Point, Gua Rajawali, Teluk Rajawali, Rajawali Reef, Freshwater Bay and Pasir Tenggara
Bidong & Yu (6)	Heritage Row, P. Karah, P. Tengkorak, Pasir Tenggara, P. Yu Kecil and P. Yu Besar
Kapas (4)	Teluk Jawa, Coral Garden 1, Silent Reef, Coral Garden 3
Mataking (6)	Cahaya Way, Sting Ray City, Pandanan Bay, Coral Garden, Mataking House Reef and Sweetlips Rock
Lankayan (15)	Bimbo Rock, Edwin Rock, Froggie Fort, Goby Rock, Jawfish, Ken's Rock, Lycia Garden, Mel's Rock, Moray Rock, Pegaso, Reef 38, Reef 77, Sandbar S, Veron and Zorro
Miri (6)	Siwa 4A, Siwa Penyu, Anemone Centre, Anemone North, Eve's Garden and Sunday Reef

4.2.1 Perhentian

Data from surveys conducted at Perhentian over the last seven years show that there has been some variation in reef health over that period of time (see chart 11).

The low HC cover in 2011 (35.38%) probably reflects the impact of the major bleaching event experienced in 2010. 2012 surveys then show a substantial recovery and HC cover has remained more or less the same through to 2016.

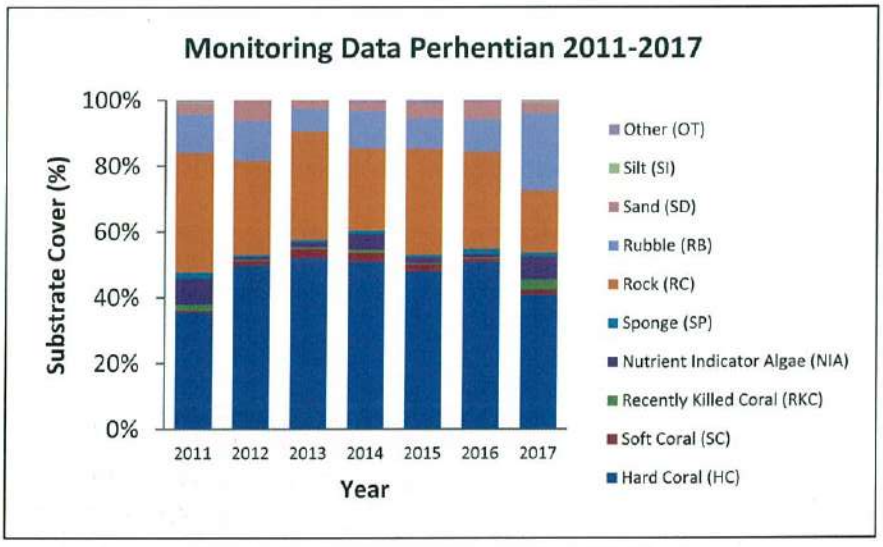


Chart 11: Perhentian Monitoring Data 2011-2017

In 2017, HC cover decreased significantly (by 10%), while at the same time RKC, NIA and RB all increased. In particular, the level of RB, which had remained around 9% to 12% from 2011 to 2016, increased significantly from 10% in 2016 to 24% in 2017. The sites of most concern are Batu Nisan, Seabell and Tiga Ruang, which recorded over 40% RB. These are all popular snorkelling sites, and it is possible that damage to reefs is resulting from physical impacts by snorkelers, boats, anchors, etc.

The level of NIA has been very inconsistent over the years, fluctuating from a post bleaching high of 7.94% in 2011 down to 0.75% in 2012 as corals recovered, but then up to 4.75% by 2014. By 2016 the amount of NIA had decreased again to around 1%, but then increased to 6.94% in 2017.

These relatively high levels of NIA are probably indicative of raised levels of nutrient in the waters around the islands. This is supported by water testing data (2009) that indicate the presence of sewage pollution around Perhentian, and a review of sewage treatment systems (2011) that highlighted the inadequate sewage treatment systems at many resorts. The reasons for the variation are unknown but could possibly represent a natural control mechanism such as herbivory, where high NIA cover promotes grazing by herbivorous fish such as parrot fish.

The level of SD had been increasing gradually over the last 5 years since 2012. Although the increase is very slight each year, over the 5 years the increase can be an indication of disturbance as dead coral breaks off and is eroded into sand by wave action.

From a management perspective, these wide variations present some challenges as they suggest that the reefs, while being damaged by anthropogenic impacts (particularly sewage pollution and tourism impacts) can recover quickly once stressors (e.g., bleaching) are removed.

Taken together, these data suggest that Perhentian's reefs have a degree of natural resilience, indicated by the recovery in HC after the 2010 bleaching event. However, local impacts are also negatively affecting the health of the island's reefs. It is recommended that DMPM consider actions to:

- Improve supervision of tourists
- Manage development of new resorts
- Improve sewage treatment facilities
- Monitor numbers of tourists to establish better data on visitor numbers.

Control of tourism activities, development and improving sewage treatment could have significant benefits for coral reefs around the islands.

4.2.2 Redang

The overall condition of coral reefs around Redang Island has generally been good between 2011 and 2015 with average LCC at or above 50% in most years. The low HC cover in 2010 and the increase by 2012 are similar to that for other monitoring sites, indicating recovery from the 2010 bleaching event. However, the lack of further recovery into 2013-2014 seen in other islands could be caused by a localised bleaching event in Redang in 2013-14. Further declines to 2017, while still with high LCC, are also a concern.

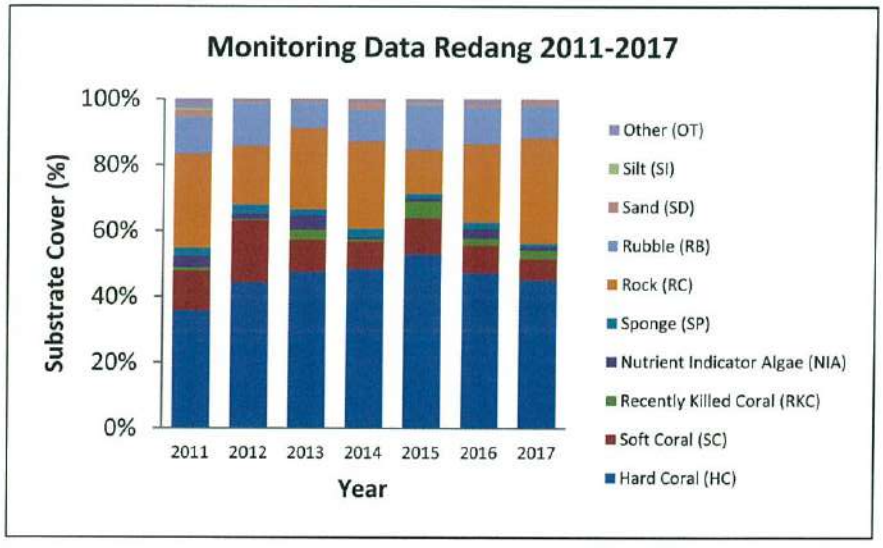


Chart 12: Redang Monitoring Data 2011-2017

The wider variation in SC, from a high of nearly 20% in 2012 to a more typical 10% after 2013 perhaps reflects opportunistic growth of SC in some areas damaged by the bleaching event, which has subsequently been re-colonised by HC.

In contrast, the decline in LCC over the last three years, combined with an increase in RC, could be partly due to the high numbers of Crown of Thorns found on the island's reefs, which have been above what is considered an "acceptable" level since 2012 (according to CRC Reef Research Centre in Australia, a healthy coral reef can support a population of 20-30 COTs per hectare (10,000m^2), or 0.2-0.3 individuals per 100m^2).

The level of RB in Redang has remained high, in the range of 8 to 14%, over the last seven years. The sites of most concern are Pulau Kerengga Kecil and Pulau Kerengga Besar where RB level recorded during 2017 survey was more than 20%. The precise reason is unknown but could be due to large visitor numbers or natural damage caused by storms/waves. Continued monitoring of reef health and other parameters (such as visitor numbers) may help to clarify the situation.

There is only one significant anomaly in the data – the spikes in RKC in 2013 and 2015, which showed a significant increase from 0.31% in 2012 to 3.59% in 2013 and from 0.63% in 2014 to 5.86% in 2015. In 2016 and 2017 surveys, the results showed some good recovery – decrease in RKC level to around 2 to 3%. Again, long term monitoring may contribute to better understanding of these changes, which appear to be localised.

Similarly to Perhentian, the variables in the data suggest that Redang's reefs have good natural resilience (e.g. recovery from bleaching), but are susceptible to local impacts. It is recommended that DMPM consider actions to:

- Control numbers of Crown of Thorns starfish to reduce the impact of these predators
- Improve supervision of tourists to reduce physical damage on heavily used sites
- Monitor numbers of tourists to establish better data on visitor numbers.

4.2.3 Tioman

The data from surveys conducted on Tioman over the last seven years show similar variations in reef health over the period. The condition of the coral reefs surveyed around the island has been consistently good over the years, with LCC cover above 50% with the exception of 46.79% in 2011 – again reflecting the mortality caused by the 2010 bleaching. In subsequent years, LCC has been consistently above 58%.

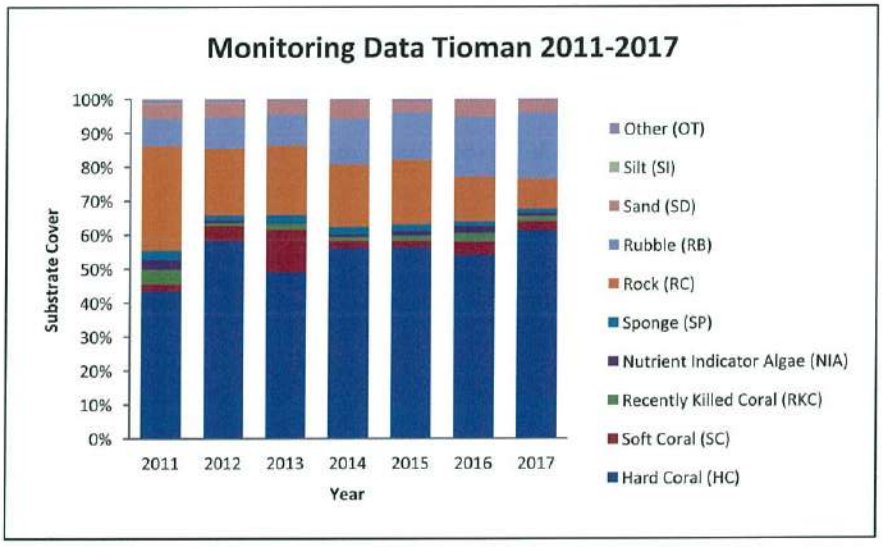


Chart 13: Tioman Monitoring Data 2011-2017

The increasing level of RB, combined with reduction in RC, in Tioman is a cause for concern as this could reflect a loss in substrate that can be re-colonised by corals, an important element in reef regeneration. The level of RB remained in the range of 8 to 10% over the first three years of the survey period, but has since gradually increased to nearly 20%. The sites of most concern are Soyak South and Labas with RB level recorded over 50%. Both these sites are popular with divers or snorkelers. Other sites which recorded worrying levels of RB are Fan Canyon, Tekek House Reef and Teluk Kador which recorded over 20%, and which are also popular sites with tourists.

As noted previously, RB can be an indicator of recent and long term disturbances, and it is the change in level of RB that is indicative of a developing problem. The continuous increase in RB level suggests there is a need for management intervention, to ascertain the cause and find solutions to reduce damage to these reefs.

The levels of RKC and NIA in Tioman finally saw a dip in 2017 after increasing over the last 3 to 4 years. However this still need to be monitored closely.

As noted for the other islands, the data suggest a combination of natural resilience and localised impacts from tourists or development. Decreasing RC cover reduces the amount of substrate for recolonisation and there may be a need to manage numbers of tourists at busy sites. It is recommended that DMPM consider actions to:

- Manage numbers of tourists at busy sites and consider establishing Limits of Acceptable Change for selected reef health indicators
- Improve sewage treatment facilities and manage development of new resorts, particularly with regard to the proposed new airport development.

4.2.4 Tenggol

The data from surveys conducted at Tenggol since 2011 show the expected patterns, reported for other islands, reflecting resilience (e.g. through bleaching recovery) combined with variable local impacts affecting reef health (figure 4).

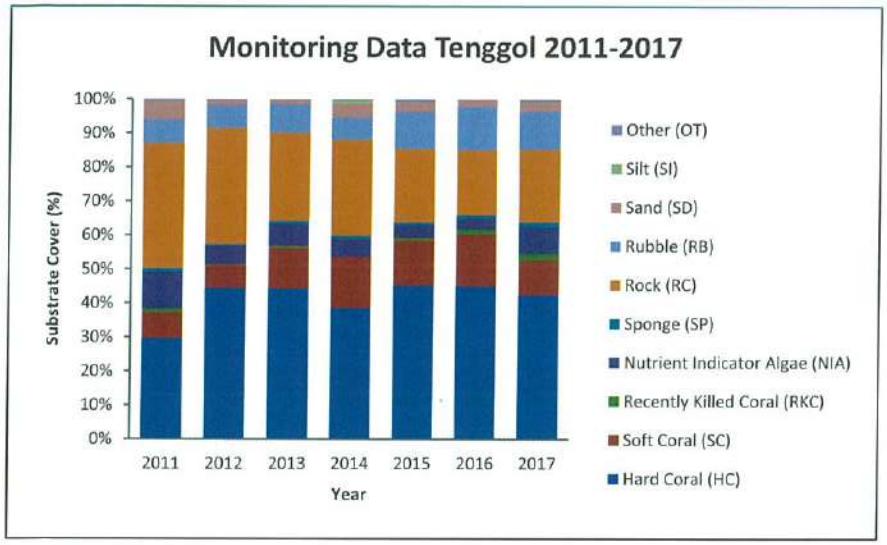


Chart 14: Tenggol Monitoring Data 2011-2017

The overall condition of coral reefs around Tenggol Island since the 2010 bleaching event has been good, with average LCC above 50%.

However, in the last 5 years there appears to have been something of a shift from RC to SC (partially reversed in 2017). In some reefs we have observed such changes as being due to zoanthid soft corals colonizing long-dead branching hard corals, so that while the "headline" LCC appears healthy,, the reef is actually undergoing a significant shift to a potentially less stable state – soft coral does not contribute to reef extension. The colonisation of zoanthid on dead branching hard corals reduces available space for hard coral recruits (new hard corals) to attach themselves and grow, thus potentially impeding reef recovery and extension. However, some recent publications suggest that SC "cleans and prepares" dead coral for new HC recruits, leading to reef recovery. Future surveys might provide data to support this theory, as they track changes to HC and SC cover.

A further concern is the relatively high level of RB, which has been increasing over the years. From 2011 to 2014, the level of RB remained in the range of 6.6 to 8.5%. In 2015, RB level increased to 10.94% and has maintained more or less the same, though this average masks changes at specific sites. The site of most concern is Pasir Tenggara which recorded 3.75% RB in 2011 which increased substantially to 14.38% and 20.63% in 2012 and 2013 respectively. In 2015 and 2016, the level had increased further to over 40%. In 2017, the level has decreased and recorded 31.88%. The cause of this change is unknown at this time but should be investigated to identify possible mitigation measures.

The level of NIA varied between 2011 and 2017, gradually reducing from 10.9% in 2011 to 3.2% in 2016. However in 2017, the level has increased to 8.02%. Freshwater Bay, Pasir Tenggara, Turtle Point and Teluk Rajawali all recorded huge increase in NIA level. It is possible this is a result of increasing numbers of tourists visiting the island, which might also explain the increase in RB in some sites noted above.

Until recently Tenggol hosted only three resorts, all located on the same stretch of beach. However, in the last 2-3 years, Tenggol has increased significantly in popularity among both divers and snorkelers. Many more visitors are now staying in accommodation on the mainland (in Dunggun) and making day trips to the island. It is difficult to monitor how many people are travelling to the island, and to monitor the activities, given that DMPM does not have a permanent base in the area. It is recommended that DMPM consider actions to:

- Establish a permanent operating base either on the island or on the mainland
- Monitor number of visitors and consider establishing Limits of Acceptable Change for selected reef health indicators
- Develop a better understanding of visitor activities, to ensure supervision of both divers and snorkelers is adequate to avoid damage to the marine environment.

4.2.5 Bidong & Yu

The sites around the two islands show a similar trend in LCC to other East coast sites, recovering from the 2010 bleaching event. However, as with Redang, the lack of further recovery through 2014 perhaps reflects the localised bleaching incident in the area in 2013-14.

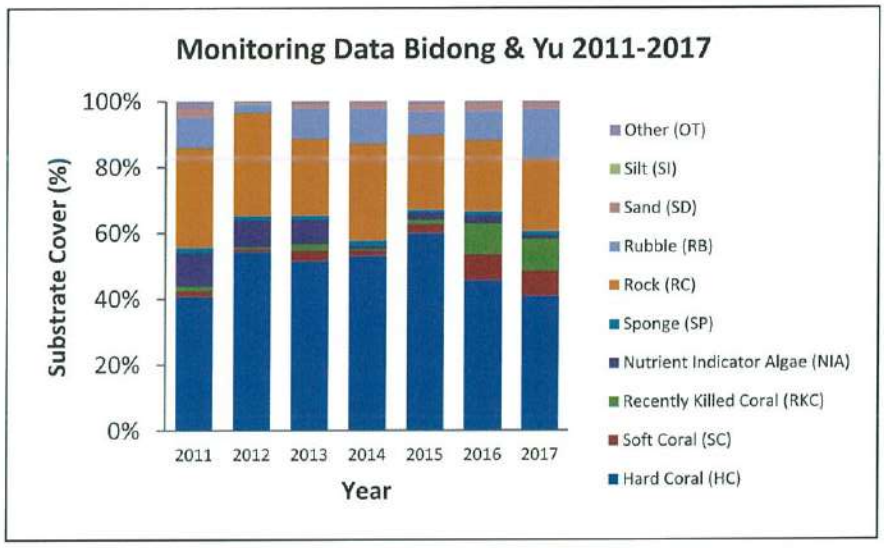


Chart 15: Bidong/Yu Monitoring Data 2011-2017

After an apparent recovery in 2015, LCC level dropped considerably in 2016 and further in 2017. This may be due to COT abundance: since 2013, the abundance of COT was above what a healthy reef can sustain. In 2016 surveys, damage due to COT and Drupella predation was recorded.

At the same time, Bidong and Yu also appear to be undergoing a shift from RC to SC, with zoanthid colonising dead corals in a manner seen elsewhere following bleaching or other disturbances.

As a result, the level of SC increased considerably in 2016 and 2017, while LCC overall dropped, mirrored in increased RKC (2016) and later RB (2017).

It is recommended that DMPM consider actions to:

- Control COT numbers
- Install temperature loggers and conduct water quality tests to monitor changes in conditions that may be affecting reef health.

4.2.6 Kapas

The data on coral reef health in Kapas show a similar pattern to other areas, with recovery since the bleaching of 2010. Following a peak of LCC in 2013, there has been an apparent decline in health through to 2016. 2017 surveys show a substantial recovery.

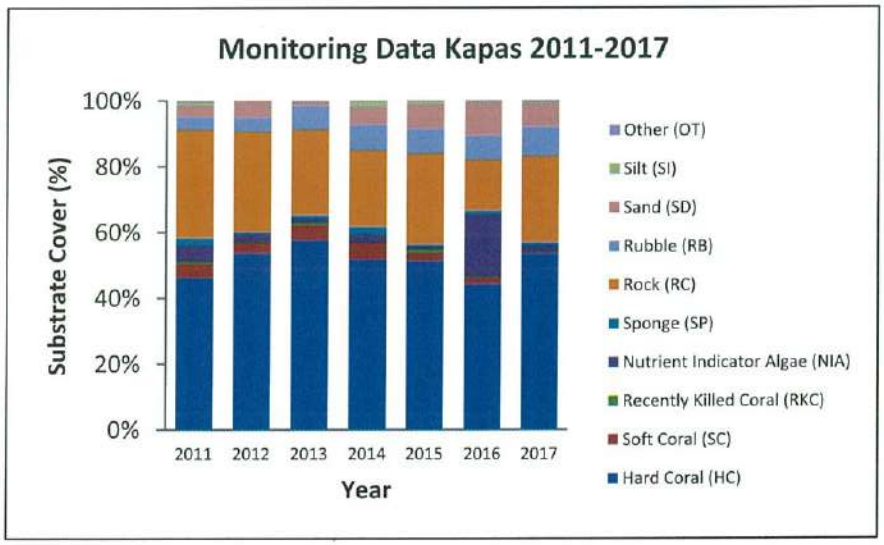


Chart 16: Kapas Monitoring Data 2011-2017

The other significant change over the period is in RB and NIA level. The level of RB increased gradually from around 4% in 2011-2012 to over 9% in 2017. The level of NIA showed a gradual decline from 5% in 2011 to 0.78% in 2015, however in 2016 it showed a very significant increase to 18.75%. In 2017, the level decreased drastically to 2.03%. The cause of these changes needs to be determined (thought to be localised bleaching) so that preventive measure can be taken to ensure no continuing damage to the reefs around the island.

It is recommended that DMPM consider actions to:

- Install temperature loggers and conduct water quality tests to monitor changes in conditions that may be affecting reef health
- Monitor visitor numbers and supervision standards.

4.2.7 Mataking

The data from surveys conducted on Mataking show little significant change for the first six years of surveys, with the overall condition of reefs around the island remaining fair (average LCC above 25%). In 2017, LCC dropped greatly although the reefs still remain in fair condition.

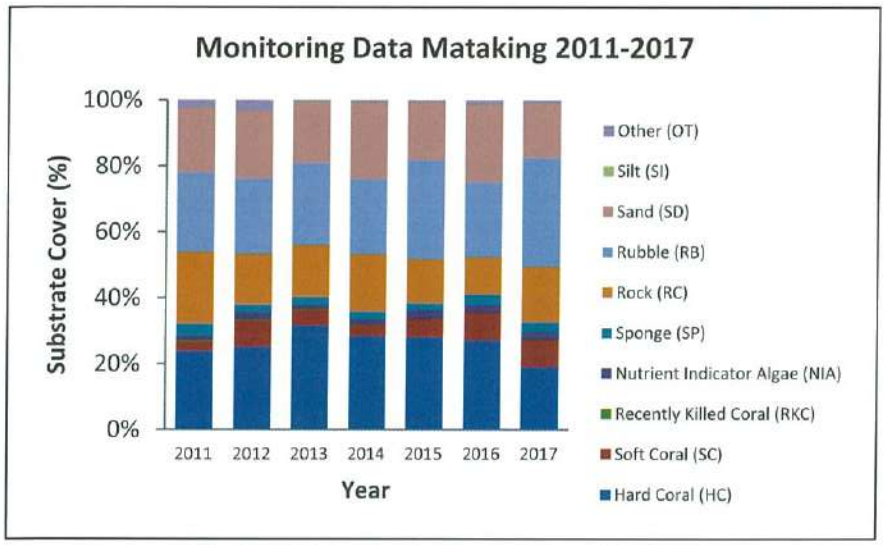


Chart 17: Mataking Monitoring Data 2011-2017

The level of RB has remained very high in the range 22 to 33% in the last seven years. Although some of the variability results from lack of permanent transect markers, most of this is a result of known historical and on-going fish bombing in the area. The sites of most concern are Coral Garden and Pandanan Bay where RB level recorded during the 2017 survey was 66.25% and 58.75% respectively.

It is unlikely that reefs in the area will have the chance to regenerate unless the problem of fish bombing is addressed. This is a common problem in Sabah, and is seen elsewhere in our results. Urgent action is required by the relevant authorities to address the issue.

It is recommended that the authorities in Sabah consider actions to reduce fish bombing in the area, for example by establishing additional protected areas and collaborating with resorts on patrolling and enforcement.

4.2.8 Lankayan

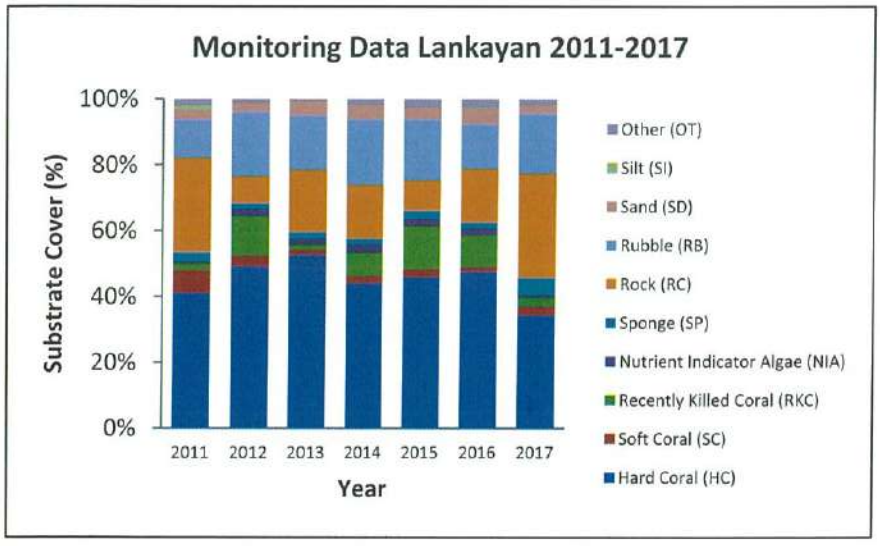


Chart 18: Lankayan Monitoring Data 2011-2017

There is wide variation in data from Lankayan. HC cover increased significantly from 2011 (41.13%) to 2013 (52.58%), but then reduced considerably in 2014 to 44%. From 2015 to 2016, the reefs showed gradual recovery and recorded 47.58% in 2016. In 2017, HC cover decreased again and recorded the lowest in seven years of surveys at 34.25%. The other wide variation over the period is RKC level; varies from 2 to 13% over the last seven years. Same goes to RB level which varies from 11 to 20%.

Overall, reefs around Lankayan are healthier than other areas of Sabah (higher LCC), probably due to the presence of the SIMCA protected area.

4.2.9 Miri

Surveys conducted in Miri show that the health of reefs varies between fair and good. It is thought that some of the variability in data is a result of not having fixed transects: all the reefs surveyed off Miri are submerged and in open ocean locations, in which it is difficult to establish fixed transects. Although GPS coordinates are used to identify reef areas, locating specific start points can be challenging, possibly causing some of the variation in data.

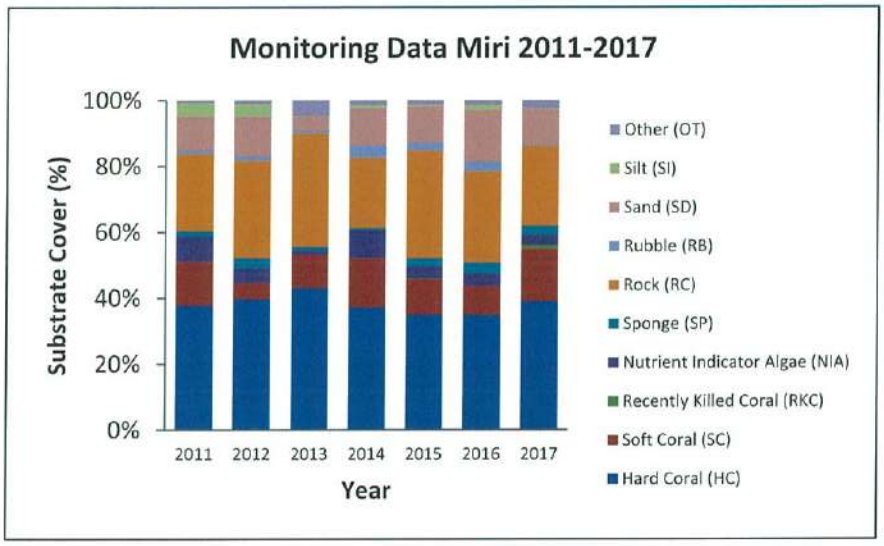


Chart 19: Miri Monitoring Data 2011-2017

Most sites are some distance off shore, and few areas suffer significantly from the impacts of siltation/sedimentation (with the obvious exception of those close to the shore). The main impact to reefs in Miri appears to be over-fishing, with fish populations consistently low. Controlling fishing will have the impact of allowing fish populations (particularly herbivores) to recover, preventing the increase in NIA seen in two of the five years of surveys.

New reef areas are being opened up for leisure diving and there is a need to increase the number of sites surveyed in Miri to ensure a consistent picture of reef health can be developed.

5. Summary and Recommendations

5.1 Summary

On average, reefs in Malaysia are in fair condition, as measured by widely used coral reef health criteria. Average Live Coral Cover (LCC) for Malaysia is 42.53% (2016: 43.71%). However, it should be noted that the average masks a wide range of variation in reef health, from reefs with over 85% LCC to reefs with below 4% LCC.

Using LCC as a measure, coral reefs in Peninsular Malaysia can be said to be in "better" condition than reefs in East Malaysia. In contrast, diversity and abundance of most fish and invertebrate indicators are higher in East Malaysia.

Average populations of both fish and invertebrate indicators are universally low. Assuming the maximum abundance of any given indicator is an estimate of the potential abundance for any reef, the average abundance of all indicators is several magnitudes lower than the potential (see table below), though this comparison is not necessarily valid for negative indicators such as COT.

Table 3: Average and Maximum abundance of Indicator Species

Fish				Invertebrates			
Indicator	Abundance			Indicator	Abundance		
	Avg.	Max.	Max. Site		Avg.	Max.	Max. Site
Butterflyfish	5.13	19.5	Lembu, Payar	Banded Coral Shrimp	0.08	2.25	Stingray City, Mabul
Sweetlips	0.40	13.25	Kaca, Payar	Diadema	33.11	320	Riza Garden, Mantanani
Snapper	5.65	223.75	SJ House Reef, Mabul	Pencil Urchin	0.02	0.75	Scuba Junkie House Reef, Mabul
Barramundi Cod	0	0.25	Omadal, Semporna/ Mataking/ Teluk Dalam, Tioman	Collector Urchin	0.03	3.5	Mid Reef, Pulau Tiga
Humphead Wrasse	0.01	0.25	Si Amil/ Tenggol	Sea Cucumber	2.09	70.50	Soyak South, Tioman
Bumphead Parrotfish	0.10	3.5	Rajawali, Tenggol	Crown of Thorns	0.26	6.0	Pulau Tengkorak, Bidong
Parrotfish	3.95	86	House Reef, Lahad Datu	Triton	0	0.25	South Rim, TSMP Pygmy Point, North Semporna Batik, North Semporna
Moray Eel	0.06	1.5	Stingray Point, Mantanani	Lobster	0.02	0.5	Panglima, Mabul
Grouper	0.81	44.5	Kaca, Payar	Giant Clam	1.06	28.25	Gua Rajawali, Tenggol

Analysis of data from surveys conducted since 2011 show few significant changes over time. The data highlight the differences between reefs in different areas, and support the need for local management as conditions vary in each reef area.

Key threats facing coral reefs in Peninsular Malaysia are development and tourism related, with most impacts arising from land-based pollution, sewage pollution, land use change or direct impacts (boats, anchors, users).

Coral reefs in East Malaysia face different threats. In Sabah and Sarawak, threats appear to be population related, with impacts arising from resource use (over-fishing and destructive fishing) and lack of management (few MPAs, limited enforcement and patrolling of extensive coastline).

The "snapshot" of reef health provided by the 2017 survey data suggests reefs in Malaysia are relatively healthy ("fair" LCC, high diversity of fish and invertebrate indicators). However, an analysis of 11 years of Reef Check surveys shows changes in indicator species abundance over the period that suggest possible declining reef health across Malaysia in recent years. Some concerning trends can be identified:

- Level of LCC, which recovered after the 2010 bleaching event, has been declining for the last four years, as levels of negative indicators (NIA, RB, RKC) have been increasing
- Food fish abundance is decreasing, while at the same time Parrotfish abundance – an algae grazer – is increasing
- Invertebrate indicators are scarce, with the exception of diadema urchin, the abundance of which has increased over the last five years.

Such trends, should they continue, could have very serious consequences for both those communities that rely on reefs for their food supply, as well as the tourism industry, which relies on healthy reefs to attract millions of tourists to Malaysia every year.

5.2 Recommendations

The 2017 Reef Check survey report indicates a reduction in live coral cover (LCC) in Malaysia of over 5%compared to 2016. This fall of 5 percentage points is greater than a threshold that has previously been generally accepted as within the limits of the methodology. This decline must trigger a response to conduct more detailed assessments of the causes of decline on each island.

Separate recommendations are made for each island for which long-term data are available in the preceding section. However, in summary, these can be stated as:

- Monitor numbers of tourists at busy sites, assess supervision standards and consider establishing Limits of Acceptable Change for selected reef health indicators
- Restrict development of new resorts to areas where the impact will be minimal and prevent development in areas not currently disturbed to prevent "spread" of tourism facilities
- Improve sewage treatment facilities and waste management systems to ensure pollution of the marine environment is eliminated or minimised
- Address local impacts through appropriate control programmes (e.g. COT collection programmes, mooring buoy replacement programmes)
- Introduce programmes and regulations to promote and encourage improved environmental performance among all tourism operators on the islands (e.g. Green Fins, Green Resorts)
- Introduce public awareness and education campaigns for visitors to the islands and local stakeholders.

In particular, success in improving management will require that the different levels of government work together more effectively to ensure the effectiveness of managed areas. Whatever happens on land affects marine ecosystems, and planning needs to take this into account. Therefore, Federal, State and local institutions need to collaborate to avoid overlap and ensure they are not working against each other. For example State government should not allow development in areas of Marine Parks deemed especially sensitive to construction impacts; unregulated growth in tourist numbers should be avoided.

RCM strongly recommends establishing a co-management approach to managing marine resources. A Management Committee would ideally include representation from all stakeholders (Federal government, State government, local government, community, tourism operators). This would ensure greater coordination of development, management and conservation activities. It also provides local stakeholders (communities, tourism operators) with a voice in decisions that affect their livelihoods, something that there is a strong demand for on the Marine Park islands in particular.

Managing tourism and tourism growth will be a key factor in long term conservation of coral reefs and other marine ecosystems. Many tourists visiting Malaysia travel to the islands to dive and snorkel; resort development, transport infrastructure, waste management – all these are affected by tourist numbers, and in turn affect ecosystems. We recommend that tourism policy is reviewed to consider the trade-off between high volume/low value mass tourism (which appears to be the current strategy) and the potential for low volume/high value tourism, which Malaysia's status as a mega-biodiversity country should encourage.

Given these broad recommendations, management issues remain the broadly the same as in previous years, albeit with increased urgency given the significant decline in LCC of over 5 percentage points. Threats to coral reefs can be divided into two broad categories:

- Local threats are those that arise within coral reef areas due to human intervention and activity. They include pollution, sedimentation, over-fishing and direct impacts by reef users
- Global threats arise outside coral reef areas. They are associated with climate change and include coral bleaching and ocean acidification.

There is little that coral reef managers can do about the global threats and coral reef management strategies should focus on addressing the local threats. Identifying local threats, community involvement, funding, building resilience and governance all need to be addressed if local management is to be effective.

5.2.1 Local Threats, Local Management

Many threats to coral reefs arise at the local (island) level, often due to tourism development and local community activities. Such threats are often location specific. Addressing these threats therefore needs action at the local level. This is reflected in the Aichi Biodiversity Targets, of which Target10 states that:

> **By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.**

In Malaysia, key local threats are:

- Tourism development
- Over-fishing/destructive fishing
- Pollution and waste.

We recommend that management authorities allocate sufficient resources to assist the successful dissemination and implementation of the Aichi Target Action Plans developed by RCM in collaboration with DMPM, in consultation with government departments that are responsible for development.

It is further recommended that management authorities review current strategies and plans for existing managed areas to strengthen local management and involve local communities in decision making. This will lead to local "buy-in" to management plans, and "ownership" of change initiatives.

5.2.2 Communities and Governance

A common success factor in marine managed areas around the world is having a co-management arrangement – involving local stakeholders in the design and management of managed areas. In Malaysia, however, management of protected areas largely remains a "top-down" affair, with decisions often made by government agencies without consultation with local stakeholders.

It is recommended that management authorities promote co-management and pursue strategies that provide for devolving decision making and some management responsibilities to local communities. This will require changes to both policy and legislation but is likely to show dividends by gaining commitment and buy-in from the very stakeholders that rely on reefs for food and livelihoods.

Capacity building programmes will be required to transfer some management skills to local communities. In addition, economic development programmes will help communities to become more involved in providing products and services to tourism (possibly including sustainable seafood products). Greater education and awareness about the important ecosystem functions of reefs will be required for all stakeholders (including state and local agencies) to support these initiatives and promote buy-in from local communities.

RCM is working on developing capacity building in co-management that would usefully serve such an approach.

5.2.3 Funding and the Private Sector

Government cannot support all of the costs of management. It is recommended that management authorities strengthen or introduce "Payment for Ecosystem Services" revenue collection systems, identifying those beneficiary groups that can afford to pay for the benefits they gain from using ecosystem services. The focus will largely be on tourism, and existing tourism fee systems should be extended to cover other areas.

The private sector is taking a greater role in managing protected areas. Private sector operators often have a greater incentive to manage and conserve an area, for example because it enhances their business, or provides greater economic security for local communities. The benefit to government of private sector management is that government no longer has to fund conservation; the operator takes responsibility for raising funds for management and conservation.

Malaysia already has one example of a private-public partnership in reef conservation – the Sugud Island Marine Conservation Area (SIMCA). It is recommended that the model be adapted and used in other areas to increase private sector involvement in management of marine areas. It is essential that local communities be fully consulted and involved in any management agreements and discussion of management plans, as they are most likely to be affected by, and beneficiaries of, such agreements. Their buy-in is essential for success.

Collection and utilisation of fees must be transparent and it is strongly recommended that management authorities identify suitable funding mechanisms to ensure accountability to all stakeholders for use of funds collected. Research conducted in Sabah indicates that tourists, tourism operators and local communities all support the concept of tourism fees but a common caveat is "as long as the money is spent properly". In Peninsular Malaysia, the Department of Marine Parks recently introduced a monthly conservation charge for dive operators; a similar response was received from them – happy to pay as long as they know where the money is being spent.

5.2.4 Resilience

Resilience describes the ability of a system to cope with or adapt to change. The resilience of coral reefs is the biological ability of coral reefs to recover from natural disturbances such as storms and bleaching episodes. Action on resilience is closely linked to the need to reduce local impacts.

Some reef areas are known to be more resilient than others, and are better able to overcome these external influences. They are therefore essential in seeding damaged areas and contributing to the recovery of those areas.

It is recommended that management authorities conduct reef resilience studies to identify resilient areas of reefs and to develop specific management strategies to protect those areas.

5.2.5 Expand Marine Managed Areas (MMAs) to Protect Marine Resources

Large areas of coral reefs around Malaysia remain unmanaged. Protecting reefs in gazetted areas can contribute to increasing their resilience to both natural (e.g. storms, disease) and man-made (e.g. fishing, pollution, sedimentation) impacts.

Target 11 of the Aichi Targets states that:

> **By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes.**

Currently only approximately 1.4% of Malaysia's territorial waters are in managed areas. There is an urgent need to increase the amount of coral reef within managed areas, and to put in place the necessary resources to ensure effective enforcement.

In particular, consideration should be given to allowing local stakeholders (communities and tourism operators) to have the authority to establish managed areas, which they can manage on a local level. RCM's project in Mantanani and the recently gazetted Tun Mustapha Park both serve as examples of managed areas developed with extensive consultation and involvement of local stakeholders, and we recommend that management authorities identify additional areas that can be similarly managed. Any MPA development strategy should provide for the inclusion of zones in MPAs, to provide for flexibility in management.

5.2.6 Networking MPAs

Scientists increasingly recognise the benefits of incorporating individual MPAs into networks. Networks can be more representative of marine habitats and therefore are more resilient to major environmental changes.

Malaysia currently has a number of individual Marine Parks off the East coast of Peninsular Malaysia and round the coasts of Sabah and Sarawak that are all managed individually. It is recommended that management authorities consider creating larger managed areas, with zones for multiple users (as is the case with the Great Barrier Reef), by networking existing managed areas (Marine Parks or similar) together with related ecosystems (seagrass beds, mangroves) and fisheries management areas. Such a managed area could be created off the East coast of Peninsular Malaysia, incorporating the entire coastal area, and with no-take zones for conservation (existing Marine Parks), fisheries protected areas (e.g. submerged reefs off the East coast) and fisheries areas. Similar groupings of existing managed areas could be identified in Sabah (e.g. Semporna islands and Lahad Datu) and Sarawak (Miri-Sibuti coastal area).

Establishing such networked system would have numerous benefits, including:

- Coordinating management of related marine ecosystems (coral reefs, seagrass beds, mangroves)
- Leveraging financial resources from tourist islands to protect submerged, non-tourist reefs
- Protecting food security
- Assisting in the introduction of EAFM
- Contributing to Aichi Target 11, requiring 10% of coastal waters to be incorporated into managed areas.

Such an initiative would require extensive consultation with local communities, fishing communities and state planning departments, as well as other stakeholders.

5.3 Conclusion

The 2017 review of the health of coral reefs around Malaysia indicates that reefs are generally in "fair" condition, though it is acknowledged that these averages mask variations in different reef areas.

Coral reefs are an important biological and economic resource in Malaysia, providing food and jobs for thousands of people. Reefs must be conserved for the benefit of future generations.

An analysis of 11 years of monitoring data highlights some potentially worrying trends. Management authorities and other government agencies are encouraged to take action now to protect Malaysia's remaining reefs, safeguarding the huge economic benefits they provide. Improving management and reducing local threats should help to ensure reefs are strong and resilient, and able to withstand major disruptions from global threats in the future.

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Reef Check Malaysia cannot work in isolation. We continue to maintain a close working relationship with the **Department of Marine Park Malaysia**, Ministry of Natural Resources and Environment, and **Sabah Parks**. In addition, we work with scientists at several universities and our **Scientific Advisory Council** (current members are Affendi Yang Amri and Jillian Ooi at UM, and Gopinath Nagaraj at FanLi Consulting) to ensure our work is scientifically robust. Finally our **Board of Trustees** (Ning Baizura, Datuk Hiswani Harun, Lim Jit Cheng, Kevin Hiew and Ruth Yeoh) provides advice on governance and fund raising. We are grateful to them for their guidance and expertise.

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Reef Check Certified Facilities

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Scuba Junkie, Mabul/KK
Tioman Dive Centre, Tioman
Reef Guardian, Lankayan
Mataking Reef & Dive Resort

Other dive operators

Aqua Sports Divers, Kapas
Usukan Cove Lodge Dive Centre
Scooba Tank and Mari Mari Dive Lodge, Mantanani
Mantanani Dream
Excel Dive, Mantanani
Dugong Beach Mantanani
TRACC, Pom Pom
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Appendix 1: Survey Sites (2017)

Sunda Shelf

No.	Site Name	Island	Coordinate
SS 1.1	Batu Layar	Perhentian	5 54.722 N 102 44.693 E
SS 1.2	Batu Nisan	Perhentian	5 55.259 N 102 43.536 E
SS 1.3	Batu Tabir	Perhentian	5 56.345 N 102 43.321 E
SS 1.4	Tukas Laut	Perhentian	5 53.162 N 102 46.216 E
SS 1.5	Tiga Ruang	Perhentian	5 54.867 N 102 45.244 E
SS 1.6	D' Lagoon	Perhentian	5 55.927 N 102 43.395 E
SS 1.7	P. Rawa	Perhentian	5 57.777 N 102 40.833 E
SS 1.8	Sea Bell	Perhentian	5 54.636 N 102 42.589 E
SS 1.9	Shark Point	Perhentian	5 53.044 N 102 44.821 E
SS 1.10	Tanjung Basi	Perhentian	5 55.387 N 102 45.518 E
SS 2.1	Teluk Mat Delah	Redang	5 47.970 N 103 01.017 E
SS 2.2	Chagar Hutang East	Redang	5 49.038 N 103 00.597 E
SS 2.3	P. Kerengga Besar	Redang	5 45.261 N 103 01.737 E
SS 2.4	P. Kerengga Kecil	Redang	5 45.519 N 103 01.751 E
SS 2.5	P. Lima Southern Tip	Redang	5 46.397 N 103 03.553 E
SS 2.6	P. Paku Besar	Redang	5 46.777 N 103 02.557 E
SS 2.7	P. Paku Kecil	Redang	5 46.305 N 103 02.338 E
SS 2.8	P. Pinang Marine Park Centre	Redang	5 44.814 N 102 59.987 E
SS 2.9	Pasir Akar	Redang	5 44.398 N 102 59.955 E
SS 2.10	Redang Kalong HR	Redang	5 45.660 N 103 01.584 E
SS 2.11	Terumbu Kili	Redang	5 43.928 N 102 59.825 E
SS 2.12	Mak Simpan	Redang	5 47.302 N 102 59.556 E
SS 3.1	Pirates Reef	Tioman	2 49.428 N 104 09.445 E
SS 3.2	Renggis North	Tioman	2 48.594 N 104 08.183 E
SS 3.3	Fan Canyon	Tioman	2 54.650 N 104 06.753 E
SS 3.4	Soyak South	Tioman	2 52.480 N 104 08.810 E
SS 3.5	Soyak North	Tioman	2 52.560 N 104 08.884 E
SS 3.6	Batu Malang	Tioman	2 54.139 N 104 06.148 E
SS 3.7	Tekek House Reef	Tioman	2 48.960 N 104 09.062 E
SS 3.8	Chebeh	Tioman	2 55.946 N 104 05.814 E
SS 3.9	Sepoi	Tioman	2 53.883 N 104 03.100 E
SS 3.10	Teluk Kador	Tioman	2 54.891 N 104 06.507 E
SS 3.11	Tumuk	Tioman	2 47.581 N 104 07.335 E
SS 3.12	Labas	Tioman	2 53.318 N 104 03.920 E
SS 3.13	Teluk Dalam	Tioman	2 52.456 N 104 11.254 E
SS 3.14	Jahat East	Tioman	2 40.127 N 104 10.518 E
SS 3.15	Munjor South	Tioman	2 44.492 N 104 13.068 E
SS 3.16	Nayak	Tioman	2 46.758 N 104 12.760 E
SS 3.17	Saing	Tioman	2 45.502 N 104 11.950 E
SS 4.1	Coral Garden 1	Kapas	5 14.113 N 103 15.678 E
SS 4.2	Coral Garden 3	Kapas	5 14.149 N 103 15.782 E

SS 4.3	Silent Reef	Kapas	5 13.785 N 103 16.079 E
SS 4.4	Teluk Jawa	Kapas	5 12.526 N 103 16.165 E
SS 4.5	Jellyfish City	Kapas	5 13.468 N 103 15.658 E
SS 5.1	Heritage Row	Bidong/Yu	5 36.922 N 103 03.412 E
SS 5.2	Pasir Tenggara	Bidong/Yu	5 36.607 N 103 03.780 E
SS 5.3	P. Karah	Bidong/Yu	5 35.935 N 103 03.851 E
SS 5.4	P. Tengkorak	Bidong/Yu	5 39.967 N 103 04.277 E
SS 5.5	P. Yu Besar	Bidong/Yu	5 38.615 N 103 09.063 E
SS 5.6	P. Yu Kecil	Bidong/Yu	5 37.533 N 103 09.570 E
SS 6.1	Freshwater Bay	Tenggol	4 48.546 N 103 40.669 E
SS 6.2	Gua Rajawali	Tenggol	4 48.768 N 103 40.556 E
SS 6.3	Pasir Tenggara	Tenggol	4 48.021 N 103 40.456 E
SS 6.4	Rajawali Reef	Tenggol	4 49.037 N 103 40.755 E
SS 6.5	Turtle Point	Tenggol	4 48.364 N 103 40.468 E
SS 6.6	Teluk Rajawali	Tenggol	4 48.931 N 103 40.824 E
SS 7.1	Bumphead Bay	Pemanggil	2 35.066 N 104 20.180 E
SS 7.2	Lobster Bay	Pemanggil	2 34.237 N 104 19.306 E
SS 7.3	Pemanggil Village South	Pemanggil	2 34.761 N 104 18.945 E
SS 7.4	Tridacna Bay	Pemanggil	2 35.790 N 104 19.588 E
SS 8.1	P. Mentinggi	Tinggi	2 16.405 N 104 06.940 E
SS 8.2	P. Nanga	Tinggi	2 16.274 N 104 07.640 E
SS 8.3	P. Ibol	Tinggi	2 18.183 N 104 08.935 E
SS 8.4	P. Tanjung Gua Subang	Tinggi	2 18.792 N 104 07.552 E
SS 9.1	Buntut Meriam	Sibu	2 13.860 N 104 03.130 E
SS 9.2	Malang Acha	Sibu	2 11.040 N 104 06.409 E
SS 9.3	Beach 3	Sibu	2 11.268 N 104 05.888 E
SS 9.4	Sibu Hujung	Sibu	2 10.374 N 104 06.721 E
SS 9.5	Sibu Kukus	Sibu	2 10.696 N 104 06.553 E
SS 9.6	The Coconut	Sibu	2 13.567 N 104 03.184 E
SS 11.1	Siwa 4A	Miri	4 16.383 N 113 48.883 E
SS 11.2	Siwa Penyu	Miri	4 16.583 N 113 49.050 E
SS 11.3	Anemone Centre	Miri	4 17.550 N 113 49.550 E
SS 11.4	Anemone North	Miri	4 17.616 N 113 49.566 E
SS 11.5	Eve's Garden	Miri	4 20.583 N 113 53.900 E
SS 11.6	Sunday Reef	Miri	4 17.217 N 113 49.167 E
SS 13.1	Junior Reef	Pulau Tengah	2 28.410 N 103 57.533 E
SS 13.2	Northern Reef	Pulau Tengah	2 28.912 N 103 57.385 E
SS 13.3	Sunrise Reef	Pulau Tengah	2 28.405 N 103 57.694 E
SS 14.1	Leeward North	Pulau Rawa	2 31.400 N 103 58.417 E

Malacca Strait

No.	Site Name	Island	Coordinate
MS 1.1	Pasir Tengkorak P. Lalang	Sembilan	4 00.162 N 100 32.802 E
MS 1.2	Site 1 P.Saga	Sembilan	4 00.732 N 100 32.694 E
MS 1.3	Site 2 P. Lalang	Sembilan	4 00.099 N 100 32.945 E
MS 1.4	Site 2 P. Rumbia	Sembilan	4 01.344 N 100 32.874 E
MS 1.5	Zoanthid Garden P. Rumbia	Sembilan	4 01.926 N 100 33.000 E
MS 1.6	P. Buluh	Sembilan	3 59.650 N 100 32.048 E
MS 1.7	Anemone Garden P. Saji	Sembilan	4 00.390N 100 32.088 E
MS 1.8	Frogfish P. Nipis	Sembilan	4 03.450 N 100 32.382 E
MS 1.9	Rock Garden	Sembilan	4 00.684 N 100 32.106 E
MS 2.1	Pangkor Laut	Pangkor	4 11.393 N 100 32.899 E
MS 3.1	Coral Garden	Payar	6 03.371 N 100 02.157 E
MS 3.2	Singapore Bay	Payar	6 03.639 N 100 02.472 E
MS 3.3	Langkawi Coral	Payar	6 03.951 N 100 02.606 E
MS 3.4	Kaca	Payar	6 04.389 N 100 03.444 E
MS 3.5	Lembu	Payar	6 04.293 N 100 03.067 E

North Borneo

No.	Site Name	Island	Coordinate
NB 1.1	Bimbo Rock	Lankayan	6 31.240 N 117 55.763 E
NB 1.2	Edwin Rock	Lankayan	6 30.806 N 117 55.499 E
NB 1.3	Froggie Fort	Lankayan	6 30.806 N 117 54.337 E
NB 1.4	Goby Rock	Lankayan	6 28.745 N 117 53.448 E
NB 1.5	Jawfish	Lankayan	6 29.182 N 117 54.670 E
NB 1.6	Ken's Rock	Lankayan	6 30.393 N 117 55.651 E
NB 1.7	Lycia Garden	Lankayan	6 29.895 N 117 55.634 E
NB 1.8	Mel's Rock	Lankayan	6 29.140 N 117 53.584 E
NB 1.9	Moray Reef	Lankayan	6 33.125 N 117 56.141 E
NB 1.10	Pegaso	Lankayan	6 33.726 N 117 55.210 E
NB 1.11	Reef 38	Lankayan	6 32.619 N 117 55.201 E
NB 1.12	Reef 77	Lankayan	6 33.124 N 117 55.482 E
NB 1.13	Sandbar S	Lankayan	6 29.900 N 117 54.681 E
NB 1.14	Veron	Lankayan	6 31.259 N 117 54.944 E
NB 1.15	Zorro	Lankayan	6 30.470 N 117 55.218 E
NB 2.1	Cahaya Way	Mataking	4 30.252 N 118 56.504 E
NB 2.2	Coral Garden	Mataking	4 34.212 N 118 57.415 E
NB 2.3	Mataking House Reef	Mataking	4 34.758 N 118 56.415 E
NB 2.4	Pandanan Bay	Mataking	4 34.907 N 118 54.795 E
NB 2.5	Stingray City	Mataking	4 33.359 N 118 55.627 E
NB 2.6	Sweetlips Rock	Mataking	4 35.960 N 118 56.454 E
NB 3.1	Usukan Cove Lodge	Usukan Cove	6 22.455 N 116 20.586 E
NB 3.4	Poduko	Usukan Cove	6 22.322 N 116 19.438 E
NB 3.5	Lok Liak	Usukan Cove	6 22.126 N 116 19.101 E
NB 4.1	Sahara	Mantanani	6 43.295 N 116 20.905 E

NB 4.2	Abalone	Mantanani	6 43.207 N 116 22.105 E
NB 4.3	Police Gate	Mantanani	6 42.730 N 116 20.313 E
NB 4.4	Italian Place	Mantanani	6 42.308 N 116 19.232 E
NB 4.5	Riza Garden	Mantanani	6 42.136 N 116 21.812 E
NB 4.6	Linggisan	Mantanani	6 42.832 N 116 20.084 E
NB 4.7	Stingray Point	Mantanani	6 42.764 N 116 19.771 E
NB 4.8	Indian Brothers	Mantanani	6 43.191 N 116 20.454 E
NB 4.9	Mari Mari House Reef	Mantanani	6 42.396 N 116 19.275 E
NB 4.10	Coral Reef	Mantanani	6 42.389 N 116 20.840 E
NB 4.11	Kolam	Mantanani	6 43.930 N 116 21.567 E
NB 4.12	South East Point	Mantanani	6 42.454 N 116 22.329 E
NB 5.1	Base Camp	TARP, Kota Kinabalu	6 00.491 N 116 01.322 E
NB 5.2	Mamutik	TARP, Kota Kinabalu	5 58.067 N 116 00.756 E
NB 5.3	Manukan West	TARP, Kota Kinabalu	5 58.246 N 115 59.659 E
NB 5.4	Mid Reef	TARP, Kota Kinabalu	5 58.433 N 116 00.750 E
NB 5.6	Police Beach	TARP, Kota Kinabalu	6 02.483 N 116 01.183 E
NB 5.7	Sapi	TARP, Kota Kinabalu	6 00.479 N 116 00.190 E
NB 5.8	Sulug	TARP, Kota Kinabalu	5 57.547 N 115 59.464 E
NB 5.11	Tanjung Wokong	TARP, Kota Kinabalu	5 59.433 N 116 02.417 E
NB 6.1	House Reef	Lahad Datu	4 58.027 N 118 15.841 E
NB 6.2	Cabbage Reef	Lahad Datu	4 56.927 N 118 15.470 E
NB 6.3	Paradise	Lahad Datu	4 56.548 N 118 17.637 E
NB 6.4	Lam's Point	Lahad Datu	4 56.275 N 118 16.464 E
NB 6.5	Nemo Garden	Lahad Datu	4 56.494 N 118 16.945 E
NB 6.6	Fish Eyes	Lahad Datu	4 57.782 N 118 15.165 E
NB 6.7	Mid Reef	Lahad Datu	4 54.740 N 118 15.256 E
NB 6.8	Small Reef	Lahad Datu	4 54.444N 118 14.595 E
NB 6.9	Adam's Point	Lahad Datu	4 57.052 N 118 15.473 E
NB 6.10	Ira's Reef	Lahad Datu	4 55.412 N 118 15.363 E
NB 6.11	Light House	Lahad Datu	4 56.922 N 118 15.076 E
NB 6.12	Pulau Burung	Lahad Datu	4 55.439 N 118 16.003 E
NB 6.13	Pulau Laila	Lahad Datu	4 55.811 N 118 13.711 E
NB 6.14	Pulau Tabun	Lahad Datu	4 55.246 N 118 12.076 E
NB 6.15	Tumunong Hallo	Lahad Datu	4 54.510 N 118 10.644 E
NB 7.1	Kapalai Rock	Kapalai	4 12.615 N 118 40.797 E
NB 7.2	Great Wall	Kapalai	4 13.767 N 118 40.800 E
NB 7.3	Little Okinawa	Kapalai	4 12.850 N 118 40.533 E
NB 7.4	Cleaning Station	Kapalai	4 13.517 N 118 41.283 E
NB 8.1	Eel Garden	Mabul	4 13.883 N 118 38.017 E
NB 8.2	Ribbon Valley	Mabul	4 14.046 N 118 38.255 E
NB 8.3	Stingray City	Mabul	4 14.222 N 118 37.641 E
NB 8.4	Panglima	Mabul	4 14.922 N 118 37.529 E
NB 8.5	Paradise	Mabul	4 14.989 N 118 37.830 E
NB 8.6	Scuba Junkie House Reef	Mabul	4 14.938 N 118 37.925 E
NB 10.1	Lutjanus	Pulau Tiga	5 43.213 N 115 38.688 E

NB 10.2	Larai-Larai	Pulau Tiga	5 43.017 N 115 38.097 E
NB 10.3	Tanjung Putri	Pulau Tiga	5 42.517 N 115 39.195 E
NB 10.4	Tagi Beach	Pulau Tiga	5 42.768 N 115 40.347 E
NB 10.5	Senanggol	Pulau Tiga	5 42.482 N 115 41.958 E
NB 10.6	Mid Reef	Pulau Tiga	5 42.302 N 115 37.705 E
NB 11.1	Kapikan Reef	TSMP, Semporna	4 37.698 N 118 50.112 E
NB 11.2	Mantabuan	TSMP, Semporna	4 37.933 N 118 47.798 E
NB 11.3	Ribbon Reef	TSMP, Semporna	4 36.135 N 118 46.090 E
NB 11.4	South Rim	TSMP, Semporna	4 34.078 N 118 45.498 E
NB 11.5	Sibuan	TSMP, Semporna	4 39.154 N 118 39.884 E
NB 11.6	Tanjung Kenangan	TSMP, Semporna	4 35.127 N 118 47.155 E
NB 12.1	Barracuda Point	Sipadan	4 07.130 N 118 37.745 E
NB 12.2	Coral Garden	Sipadan	4 06.342 N 118 37.722 E
NB 12.3	Drop Off	Sipadan	4 07.092 N 118 37.675 E
NB 12.4	Hanging Garden	Sipadan	4 06.703 N 118 37.495 E
NB 12.5	Lobster Lair	Sipadan	4 06.557 N 118 37.540 E
NB 12.6	Mid Reef	Sipadan	4 06.812 N 118 38.158 E
NB 12.8	South Point	Sipadan	4 06.258 N 118 38.110 E
NB 12.9	Staghorn Crest	Sipadan	4 06.257 N 118 37.895 E
NB 12.10	Turtle Patch	Sipadan	4 06.450 N 118 38.177 E
NB 12.11	White Tip	Sipadan	4 07.137 N 118 38.055 E
NB 12.12	West Ridge North	Sipadan	4 06.910 N 118 37.487 E
NB 13.1	Mid Reef	Pulau Penyu	6 10.402 N 118 04.287 E
NB 13.2	Pulau Bakungan 1	Pulau Penyu	6 10.192 N 118 06.538 E
NB 13.3	Pulau Bakungan 2	Pulau Penyu	6 09.805 N 118 06.483 E
NB 13.4	Pulau Gulisan	Pulau Penyu	6 09.268 N 118 03.512 E
NB 13.5	Selingan	Pulau Penyu	6 10.813 N 118 03.803 E
NB 14.1	Batik	Northern Semporna	4 43.242 N 118 27.984 E
NB 14.2	Adal	Northern Semporna	4 44.560 N 118 30.821 E
NB 14.3	Timbun Mata	Northern Semporna	4 37.993 N 118 35.360 E
NB 14.4	Melanta Silawa	Northern Semporna	4 33.521 N 118 33.272 E
NB 14.5	Larapan	Northern Semporna	4 33.599 N 118 36.900 E
NB 14.6	Pasalat	Northern Semporna	4 30.851 N 118 43.520 E
NB 14.7	Palang-Palang	Northern Semporna	4 26.684 N 118 45.309 E
NB 14.8	Ormadal Utara	Northern Semporna	4 26.752 N 118 46.067 E
NB 14.9	Baturua	Northern Semporna	4 31.263 N 118 48.287 E
NB 14.10	Macromania Baturua	Northern Semporna	4 32.722 N 118 49.547 E
NB 14.11	Pom-Pom	Northern Semporna	4 35.515 N 118 51.678 E
NB 14.12	Treasure Hunt	Northern Semporna	4 34.750 N 118 55.222 E
NB 14.13	Jalan-Jalan	Northern Semporna	4 32.960 N 118 55.750 E
NB 14.14	Pygmy Point	Northern Semporna	4 28.405 N 118 56.762 E
NB 15.1	Hand Rock	Southern Semporna	4 08.455 N 118 10.792 E
NB 15.2	Darby Bank	Southern Semporna	4 06.751 N 118 13.504 E
NB 15.3	Alert Patches	Southern Semporna	4 08.364 N 118 14.039 E
NB 15.4	Second Reef	Southern Semporna	4 10.533 N 118 17.973 E

NB 15.5	Friedrich Heaven 1	Southern Semporna	4 14.363 N 118 26.011 E
NB 15.6	Yoshi Point 1	Southern Semporna	4 15.307 N 118 32.028 E
NB 15.7	Yoshi Point 2	Southern Semporna	4 14.193 N 118 33.190 E
NB 15.8	Cust Reef	Southern Semporna	4 17.226 N 118 43.520 E
NB 15.9	Denawan	Southern Semporna	4 18.017 N 118 50.433 E
NB 15.10	Third Beach, Si Amil	Southern Semporna	4 18.965 N 118 52.508 E
NB 15.11	Second Beach, Si Amil	Southern Semporna	4 18.801 N 118 52.574 E
NB 15.12	Ligitan 4	Southern Semporna	4 11.038 N 118 51.773 E
NB 15.13	Ligitan 5	Southern Semporna	4 12.380 N 118 47.088 E

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