Status of Coral Reefs in Malaysia, 2016

Reef Check Malaysia

May 2017

Contents

Executive Summary

1. A total of 209 sites were surveyed in 2016 (2015: 242), 84 in Peninsular Malaysia and 125 in East Malaysia. The surveys are a continuation of a successful National Reef Check Survey Programme that has now run for 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 43.71% (2015: 45.95%). The low level of recently killed corals indicates few immediate threats and continuing recovery from the 2010 bleaching event that killed coral reefs around South East Asia.

4. Low levels of abundance of high-value species of fish (such as grouper) and shellfish (such as lobster) were recorded, indicating slow recovery from past overfishing and possible continuing problems with poaching inside Marine Protected Areas.

5. Some coral reefs show increasing amounts of algae, suggesting that they are suffering from an ecosystem imbalance due to elevated nutrient inputs, possibly from sewage and agriculture activities (particularly plantations), coupled with low herbivory by fish and sea urchins.

6. A series of recommendations is provided with a focus on better education and enforcement of existing laws to protect and conserve coral reefs.

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

Please note: Each Annual Survey Report is written as a stand-alone document that can be read without having to refer back to previous reports. As such, much of this and the following section, which remains valid and relevant, is a repetition from previous reports, copied here to provide the reader with an uninterrupted flow of argument and rationale.

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 Bhd (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 2016, the tenth 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 ten years RCM has trained over 700 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 tenth annual Malaysia coral reef survey report and details the results of Reef Check surveys carried out during 2016. 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.

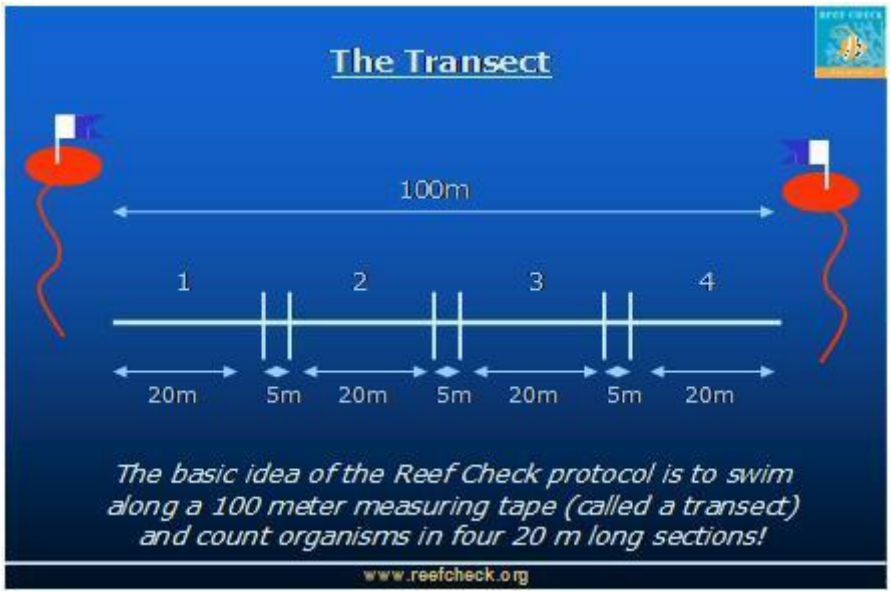


Figure 1: The Transect

2.3 Survey Sites

In 2016, a total of 209 sites were surveyed, 84 of which were in Peninsular Malaysia and the remaining 125 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, and Tioman). 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, TSMP, TARP 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.

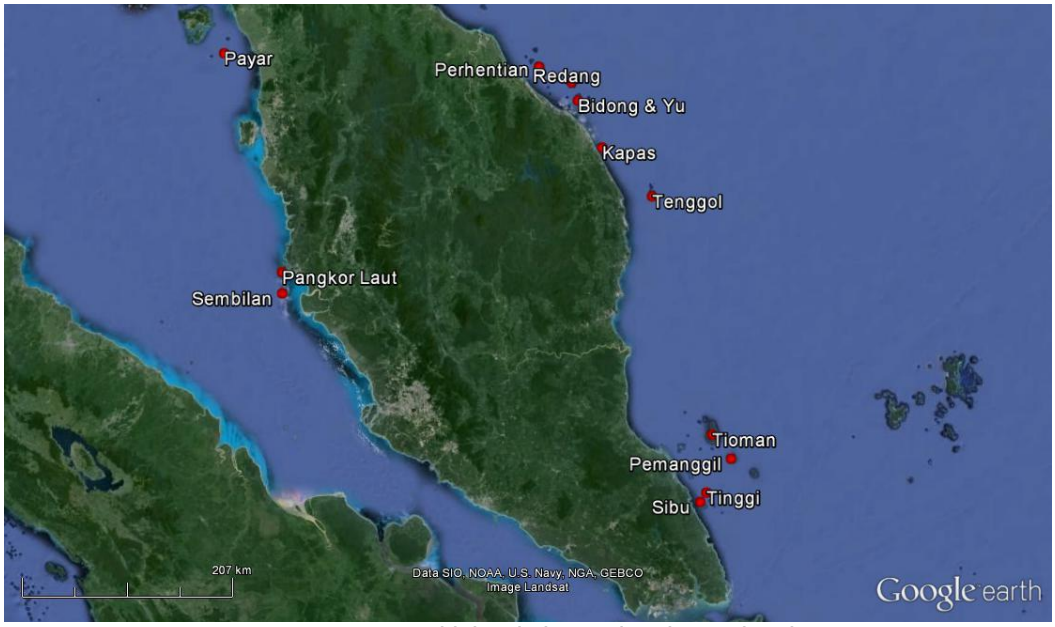
The list of sites surveyed is shown in appendix 1.

3. 2016 Survey Results and Analysis

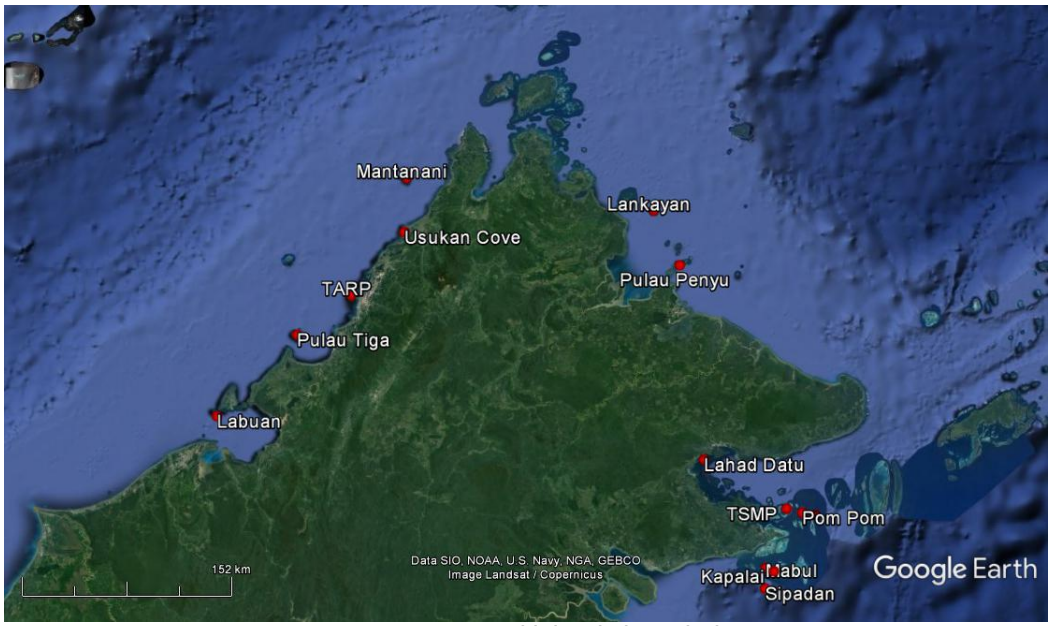
This section presents the results from surveys conducted in 2016, providing an overview of the condition of coral reefs in Malaysia as a whole, and a detailed analysis of the health of reefs in surveyed reef areas.

3.1 Status of Coral Reefs in Malaysia 2016

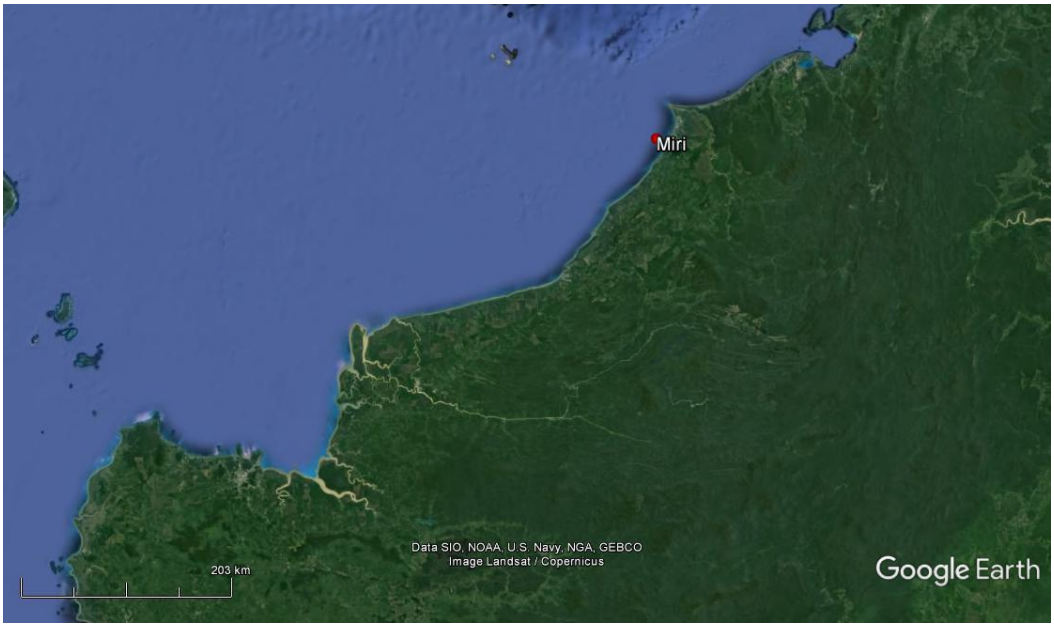
The results from all 209 surveys were compiled to provide an overview of the status of coral reefs around Malaysia. Sites surveyed off Peninsular Malaysia are mostly islands which are important tourist destinations while the islands and reefs off Sabah and Sarawak are less frequently visited but face other problems such as destructive fishing practices.



Map 1: Surveyed islands in Peninsular Malaysia



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



Map 3: Surveyed islands in Sarawak

3.1.1 Substrate

The table below shows the Coral Reef Health Criteria developed by Chou *et al*, 1994.

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 43.71% (45.95% in 2015). The decrease in LCC from 2015 is likely due to several causes but indicates a slight decline in reef health overall.

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 was 14.36% in 2016. This has not changed much over the last few years, however the level of RB recorded in 2016 was the highest since the start of Reef Check surveys in 2007. Nearly 40% of reefs in Malaysia had RB in the range 10-29% of RB and 8.6% of reefs recorded RB in the range 30-49%. At some sites, RB level was even higher, such as 73.75% at Mandarin House Reef (Pom Pom), 70.63% at Lobster Lair (Pom Pom), 68.13% at New Life (Pom Pom), 60% at Pandan-Pandan (Usukan Cove), 59.38% at TRACC House Reef, 56.88% at Labas (Tioman) and 51.88% at Coral Garden (Mataking). Many of these (excluding Labas) are areas in which fish bombing is known to occur.

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 2016 was low (3.92%), similar to 2015 (3.70%); 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. 13.40% of reefs in Malaysia recorded NIA in the range 10-30% and some were higher than this, for example 40.63% at Silent Reef (Kapas) and 44.38% at Fish Eyes (Lahad Datu).

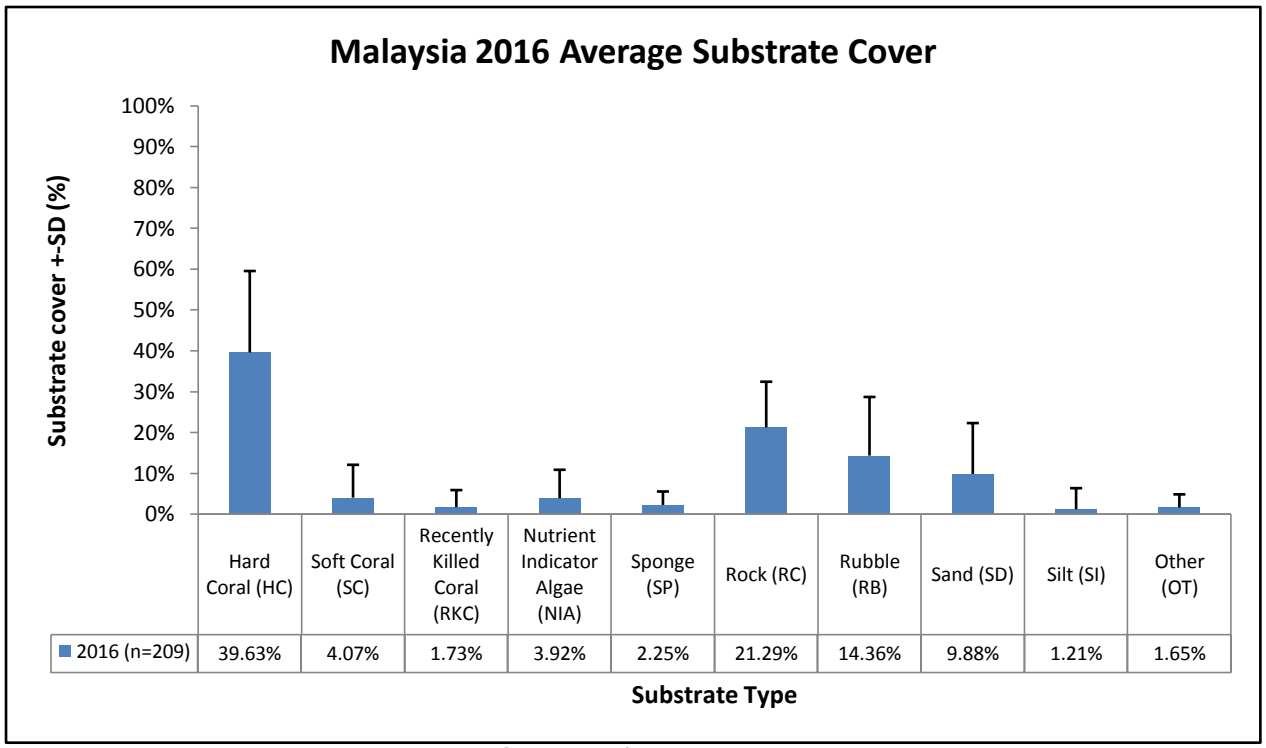


Chart 1: Substrate Cover

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 (1.73%) in 2016 mirrored that of 2015 (1.73%). At some sites, the level of RKC was significantly higher such as 31.25% at Pulau Karah (Bidong), 23.75% at Moray Reef (Lankayan) and Reef 77 (Lankayan) and 18.13% at Froggie Fort (Lankayan).

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 development. Silt can smother corals, depriving them of sunlight and causing coral death. The average level of SI for Malaysia is low at 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 this is reflected at some sites; Poduko and Usukan Cove Lodge at Usukan Cove, Tumunong Hallo at Lahad Datu and Scuba Junkie House Reef at Mabul where all sites recorded over 75% increase in SI level from the last survey.

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 2.25%, 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 2016 the average cover of RC on Malaysian reefs was 21.29%. It should be noted that new coral recruits cannot settle onto RC that has significant algae 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.

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 has not differed much since 2012 and is considered normal.

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 was 1.65% in 2016.

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 2016 surveys are shown below (Chart 2).

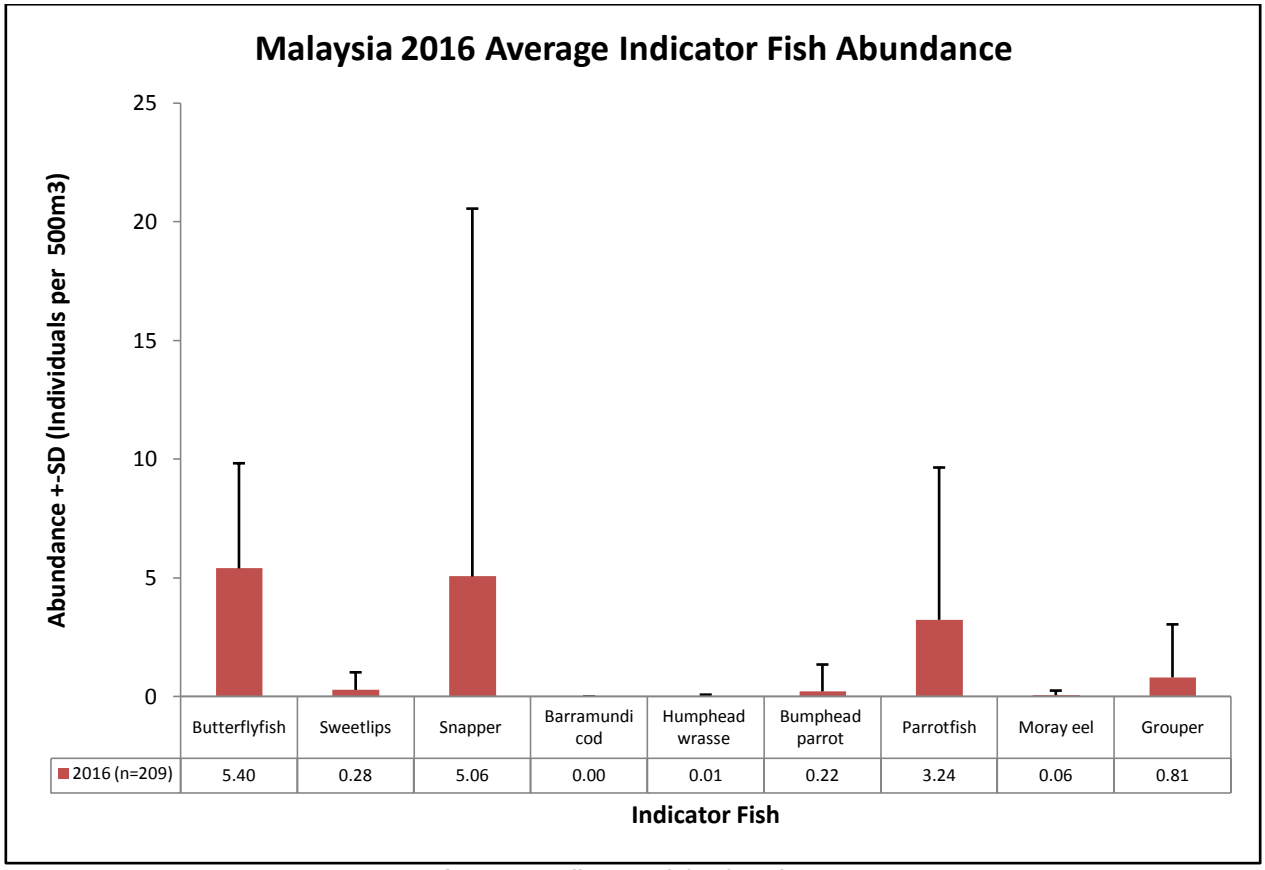


Chart 2: Indicator Fish Abundance

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 5.40 individuals per 500m^3 in 2016, showing a slight increase 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 2016 was 3.24 individuals per 500m^3, a slight increase from last year.

3.1.3 Invertebrates

The invertebrate indicators are targeted for different reasons:

- Collected for Curio trade: Pencil Urchin, Triton Shell
- Collected for Food: Banded Coral Shrimp, 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.

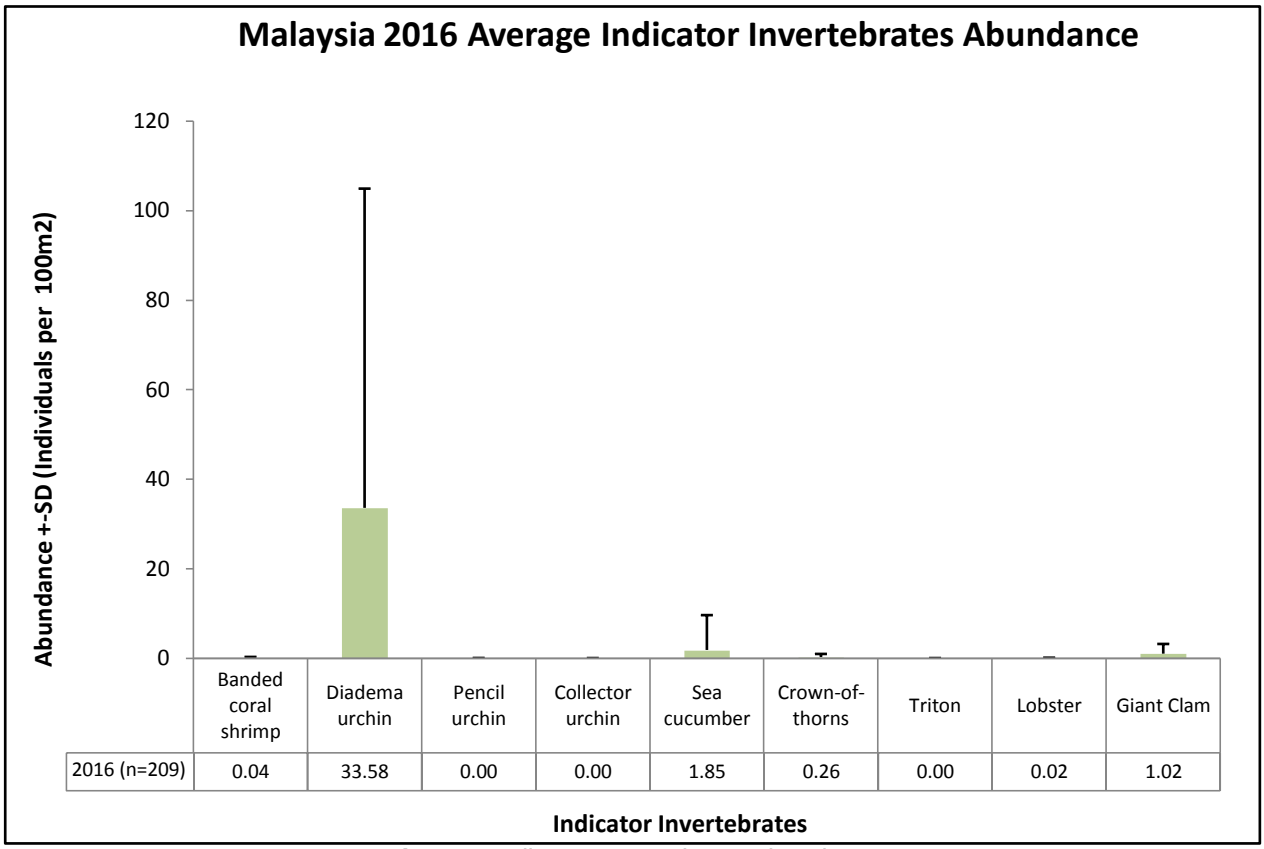


Chart 3: Indicator Invertebrate Abundance

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 – zero). The abundance of Sea Cucumber is low at 1.85 individuals per 100m^2. Giant Clam recorded an average of 1.02 individuals per 100m^2. 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 abundance of COTs found during surveys, 0.26 per 100m^2, suggested that COT numbers are not a threat to the reefs. However there are some islands where COT numbers are an issue and action is needed to control the high number. The islands are Bidong and Yu 1.38 individuals per 100m^2, Kapas 1.05, Pemanggil 0.88, Redang 0.77 and Lahad Datu 0.98; where all islands recorded above the acceptable limit.

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	51.75
Redang	12	Marine Park	55.42
Tioman	18	Marine Park	59.48
Kapas	5	Marine Park	50.13
Bidong and Yu	6	Marine Park	53.33
Tenggol	6	Marine Park	60.31
Pemanggil	4	Marine Park	48.44
Tinggi	4	Marine Park	64.22
Sibu	6	Marine Park	63.75
Miri	6	Miri-Sibuti Coral Reefs National Park	43.65
Malacca Strait			
Sembilan	9	No protection	31.18
Pangkor Laut	1	No protection	88.75
Payar	3	Marine Park	44.38
North Borneo			
Lankayan	15	SIMCA	48.92
Mataking	6	No protection	35.52
Mabul	6	No protection	27.60
Kapalai	4	No protection	11.25
Mantanani	11	No protection	32.05
Usukan Cove	6	No protection	33.02
Lahad Datu	15	No protection	20.50
Labuan	3	Marine Park	41.67
Pom Pom	4	No protection	18.75
Tunku Abdul Rahman Park	8	Tunku Abdul Rahman Park	50.23
Tun Sakaran Marine Park	14	Tun Sakaran Marine Park	47.59
Sipadan Island	12	Sipadan Island Park	43.49
Pulau Tiga	6	Pulau Tiga Park	43.44
Pulau Penyu	9	Turtle Islands Park	31.67
Total	**209**	**Average**	**43.71**

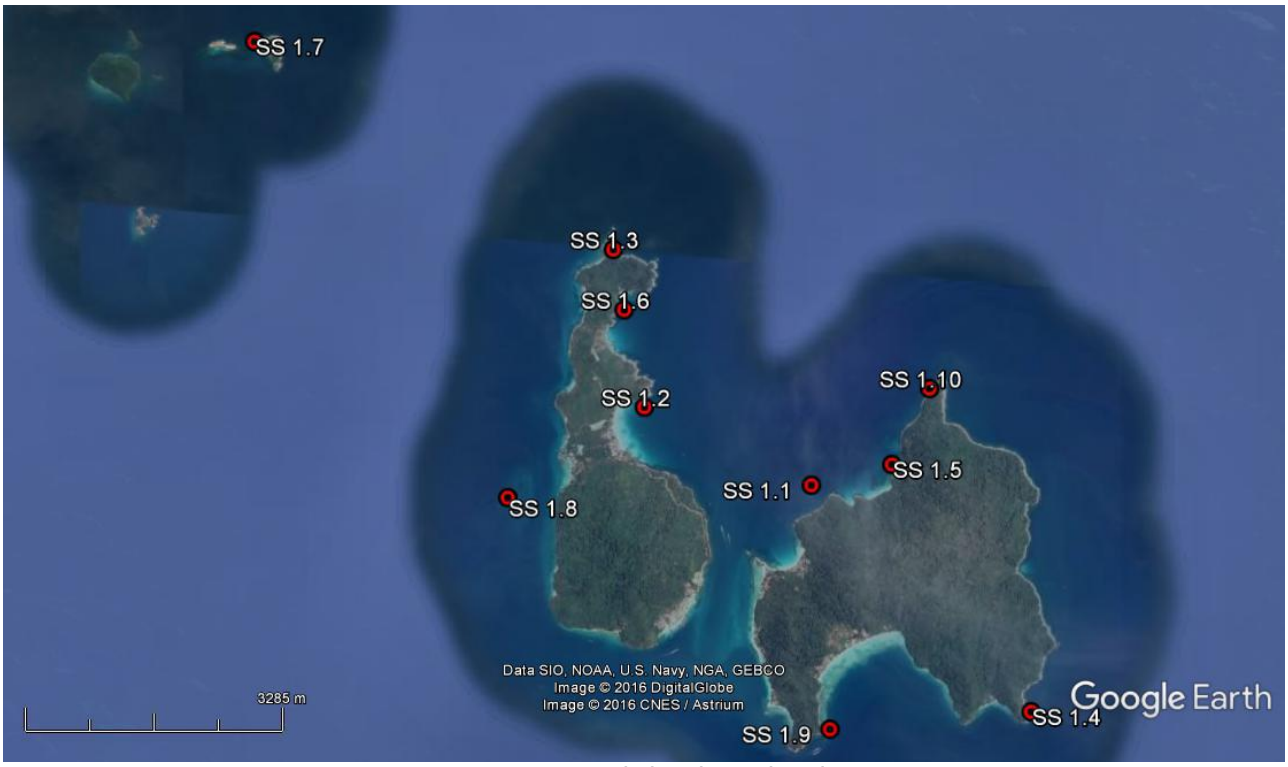
Sunda Shelf Region

3.2.1 Perhentian

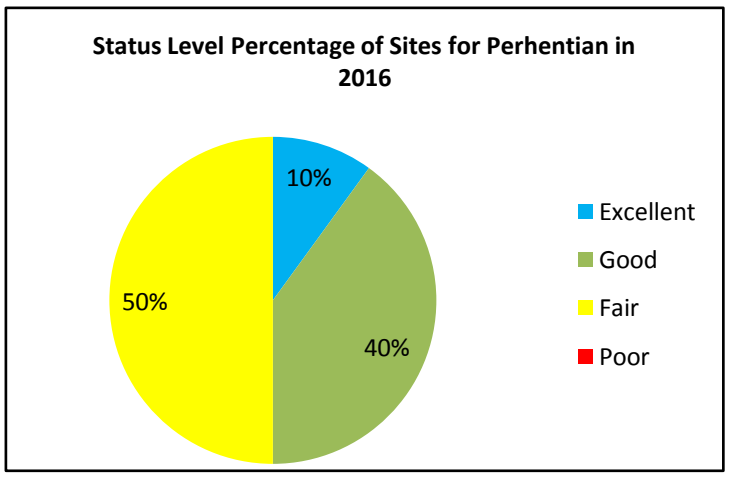
The Perhentian islands are located some 20km from Kuala Besut off the East coast of Terengganu, Malaysia. The islands have one village with a population of approximately 2,300, most of who work in tourism, the main industry on the islands. The islands are gazetted as a Marine Park (since 1994).

A popular tourist destination, particularly among backpackers, there are some 40 resorts, mainly small, family run chalets with a couple of large resorts, and 15 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.

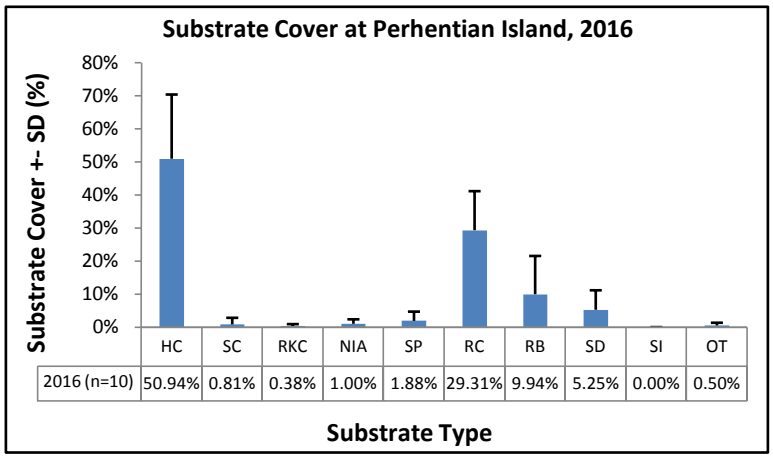


Map 4: Surveyed sites in Perhentian



A total of 10 coral reef sites were surveyed in Perhentian and 50% of the sites were in fair condition. Only 10% were in excellent condition, while 40% were in good condition. No reefs were in poor condition.

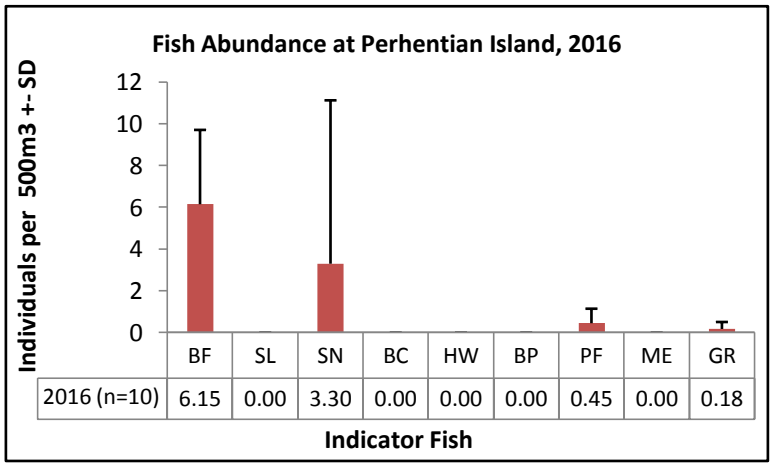
Substrate



Coral reefs around the Perhentian islands are considered to be in 'Good' condition, with 51.75% live coral cover, below the average (55.59%) for reefs within the Sunda Shelf region.

The level of RB was high, especially at SS1.2 Batu Nisan (28.75%), SS1.5 Tiga Ruang (22.50%), SS1.6 D'Lagoon (21.25%) and SS1.7 Pulau Rawa (20%). This indicates recent disturbances present on reefs in Perhentian.

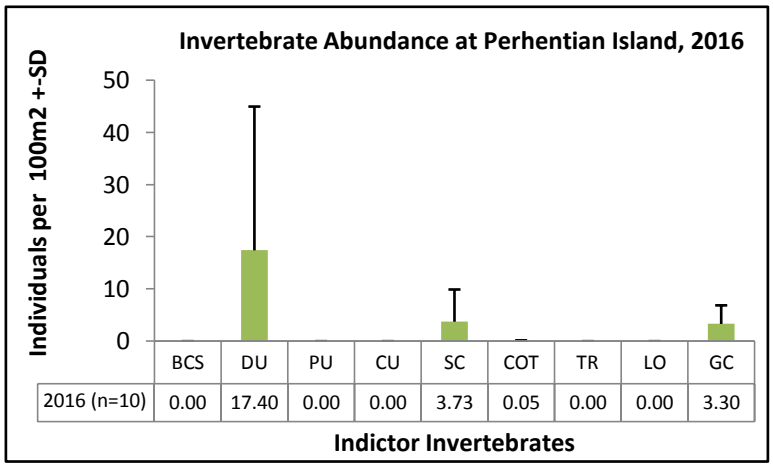
Fish



Only four indicator fish were recorded during surveys. The most abundant fish recorded was Butterflyfish, followed by Snapper. Parrotfish 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



Five out of nine indicator invertebrate were absent from the surveys (Banded Coral Shrimp, Pencil Urchin, Collector Urchin, Triton and Lobster).

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

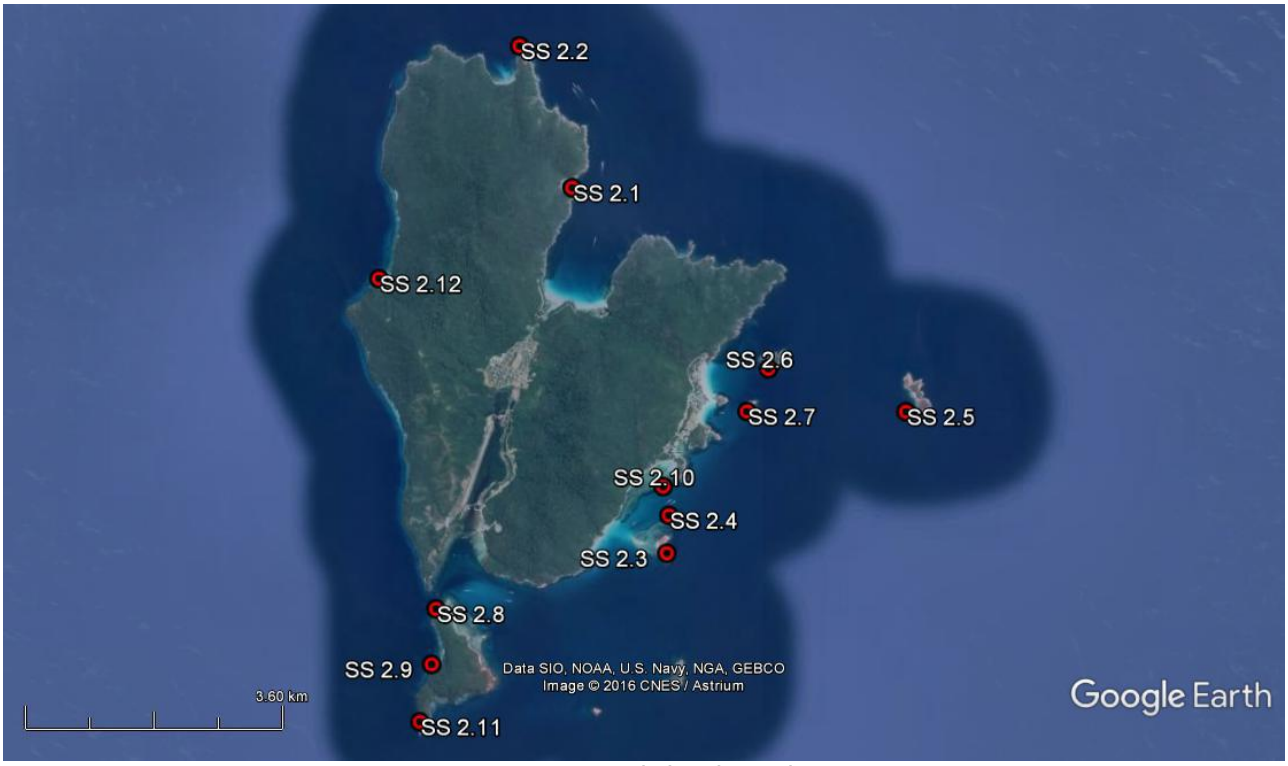
Half of the reefs surveyed were damaged by Drupella predation. Discarded fishing nets and trash were also found during surveys. On a positive note, shark was sighted at SS1.2 Batu Nisan.

3.2.2 Redang

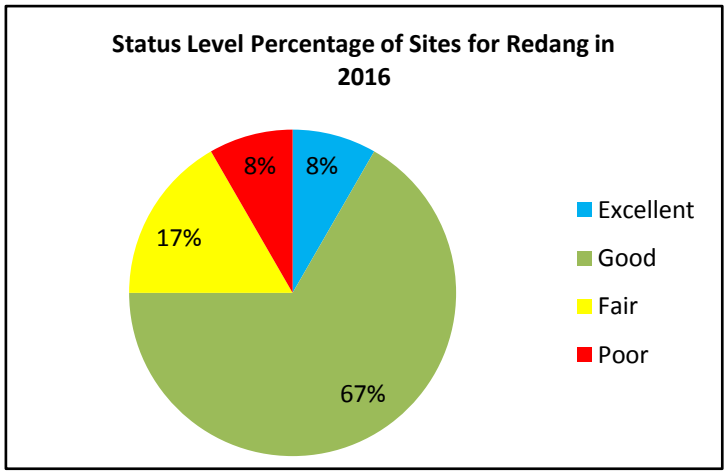
Redang Island is located some 25km from Merang, off the East coast of Terengganu, Malaysia. The island has a population of approximately 1,500, only a small proportion of who work in tourism, the main industry on the islands. The islands are gazetted as a Marine Park (since 1994).

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.

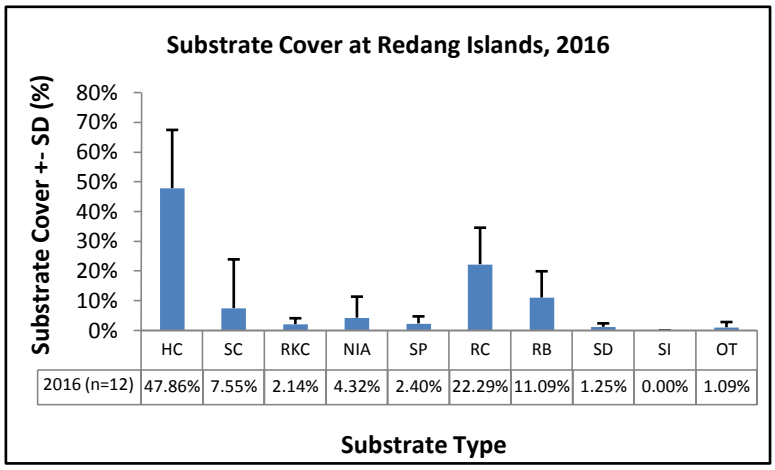


Map 5: Surveyed sites in Redang



A total of 12 coral reef sites were surveyed in Redang and 8% of the sites were in excellent condition. 67% were in good condition and 17% were in fair condition. The remaining 8% of the reefs were in poor condition.

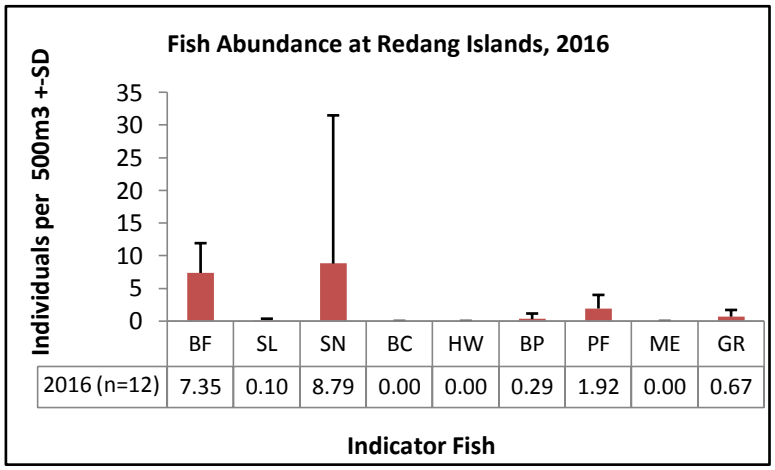
Substrate



The reefs around Redang islands are considered to be in 'Good' condition, with live coral cover of 55.42% and slightly below the average (55.59%) for reefs within the Sunda Shelf region.

The level of RB was high especially at SS2.4 Kerengga Kecil (27.50%); SS2.5 Pulau Lima Southern Tip (24.38%), and SS2.6 Pulau Paku Besar (20.63%). The level of NIA increased from last year. These indicate high recent disturbances in the area.

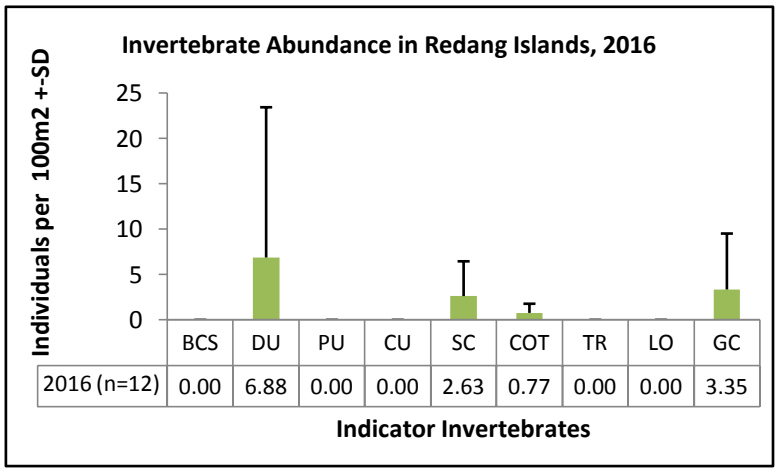
Fish



Only three indicator fish were absent during surveys, including Barramundi Cod, Humphead Wrasse and Moray Eel. Snapper recorded the highest number, followed by Butterflyfish. Sweetlips, Parrotfish and Grouper recorded low abundance.

This year there was more Bumphead Parrotfish sightings, they were observed at 3 sites; SS2.8 Pulau Pinang Marine Park Centre, SS2.9 Pasir Akar and SS2.11 Terumbu Kili.

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 was still very high at 0.77 ind./100m^2, and the number is way above what a healthy reef can sustain (0.2-0.3 ind./100m^2). Nutrient runoff into the sea must be managed and fish feeding must be stopped to avoid COT blooms in the future.

Half of the reefs in Redang were heavily damaged by COT and Drupella predation. The only human impact recorded during survey was trash at SS2.5 Pulau Lima Southern Tip. Shark was observed at 3 of the survey sites.

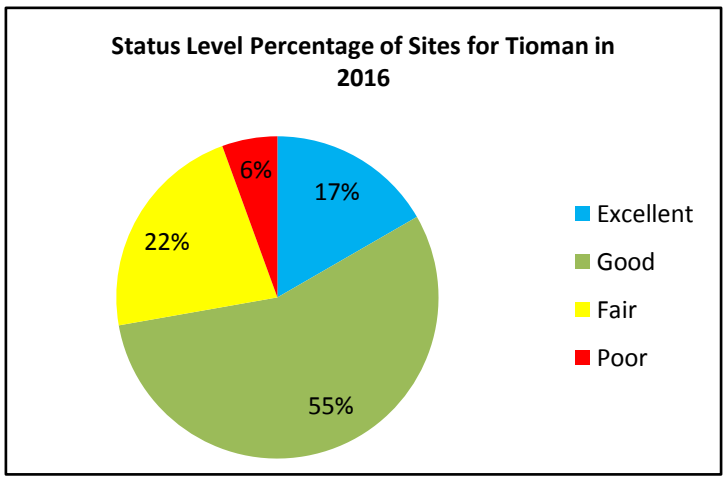
3.2.3 Tioman

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 3,000 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 in recent years it has been eclipsed by other destinations (particularly Redang and Perhentian). As a result, resort development has been at a slower pace, with no significant new resorts in the last 12 years. There are some 60 resorts on the island, mainly small family run operations, and 15 dive operators.

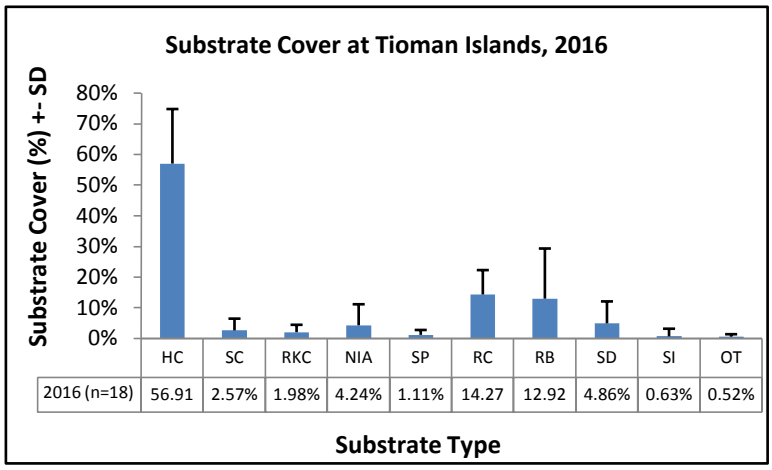
There is a small power generation station on the island, supplying electricity to all areas. The island has abundant fresh water, and a municipal incinerator was constructed some years ago. The island is served by an airport as well as boat services.

Map 6: Surveyed sites in Tioman



A total of 18 coral reef sites were surveyed in Tioman and 17% of the reefs were in excellent condition. 55% were in good condition, while 22% were in fair condition. 6% of the reefs were in poor condition.

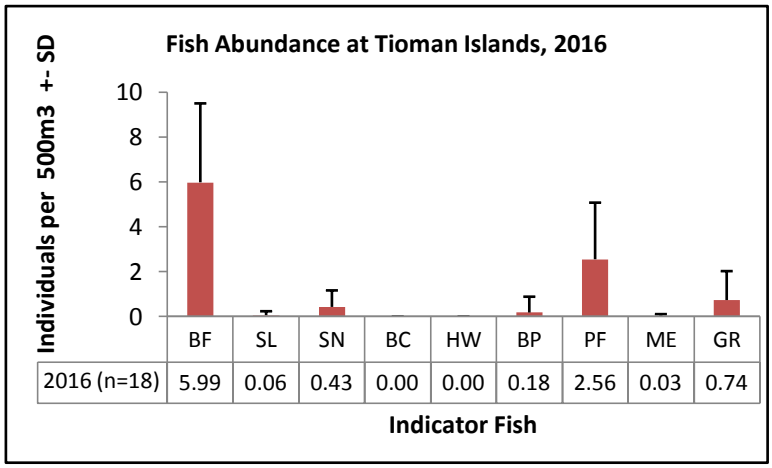
Substrate



The reefs in Tioman are considered to be in 'Good' condition, with 59.48% live coral cover, above the average for reefs of the Sunda Shelf region (55.59%).

Level of RB was high and this reflects some recent disturbances in Tioman. Six of the survey sites recorded more than 15% of RB and the level was exceptionally high at SS3.12 Labas, recording as much as 56.88% (although it had dropped greatly from last year 71.88%). The level of NIA was also high, especially at SS3.13 Teluk Dalam (25%).

Fish

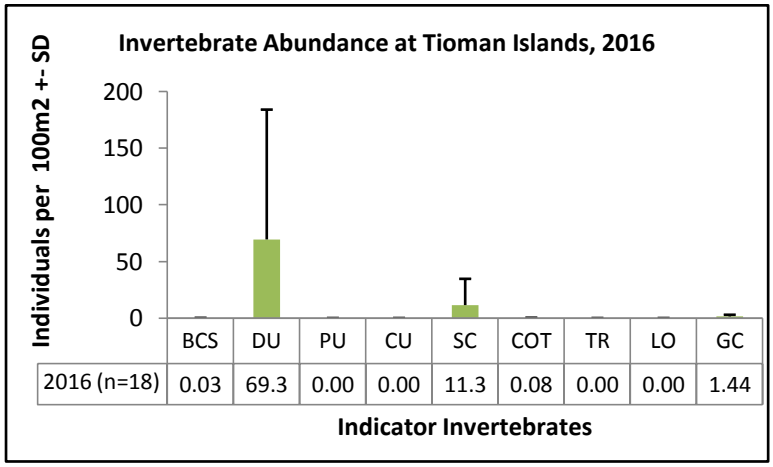


Most of the indicator fish were observed except for Barramundi Cod and Humphead Wrasse.

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

Bumphead Parrotfish were observed at SS3.12 Labas and SS3.13 Teluk Dalam.

Invertebrates



Four targeted species were absent, including Pencil Urchin, Collector Urchin, Triton and Lobster.

The number of Diadema was high (the second highest of all islands surveyed in the Sunda Shelf region). Diadema abundance was exceptionally high at SS3.8 Chebeh, recording as many as 358.5 ind./100m^2.

Tioman recorded the highest number of Sea Cucumber in the Sunda Shelf region.

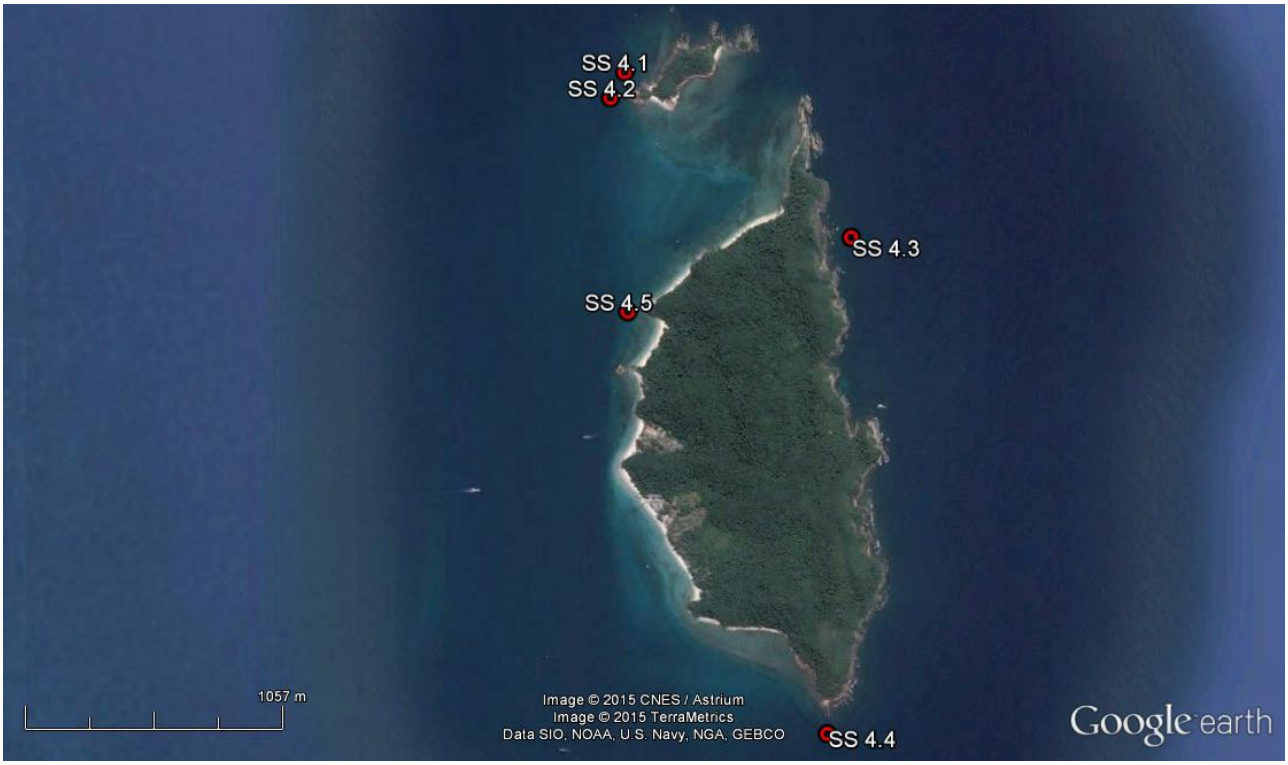
Boat anchor damage, discarded fish nets and trash were recorded during surveys. Some of the reefs were also impacted by warm water bleaching. Shark was observed at one survey site.

3.2.4 Kapas

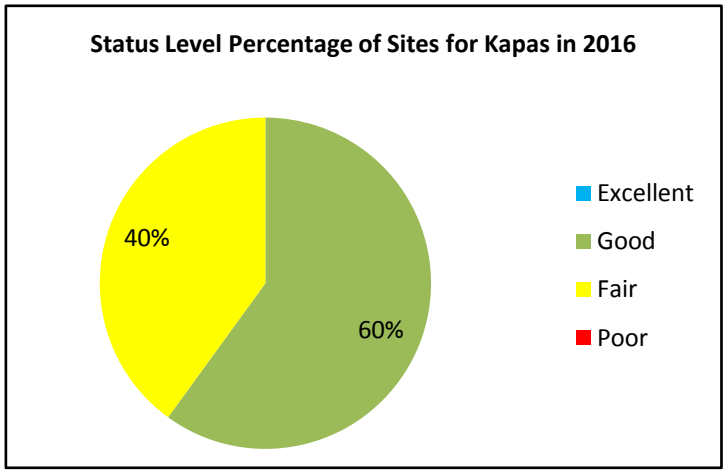
Kapas Island is located just 6km from Marang, off the East coast of Terengganu, Malaysia. This small island has no local population. The islands are gazetted as a Marine Park (since 1994).

The island is not a major tourist destination due to its small size, but does have an established tourist market, with four 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.

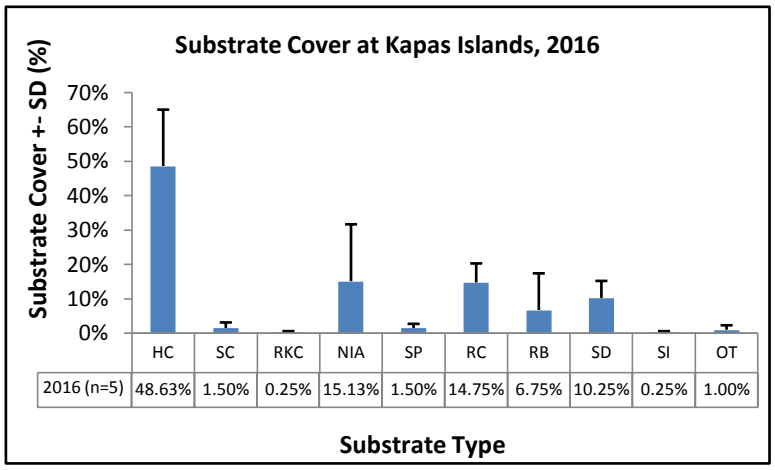


Map 7: Surveyed sites in Kapas



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

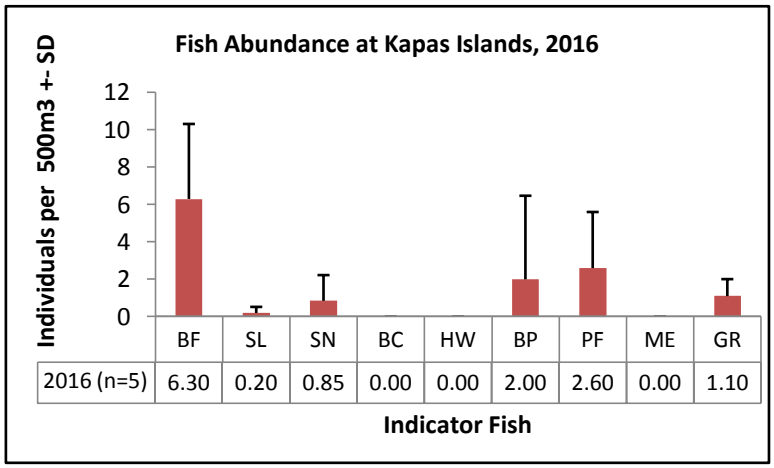
Substrate



Coral reefs around Kapas islands are considered to be in 'Good' condition, with 50.13% live coral cover, below the average (55.59%) for all islands surveyed in the Sunda Shelf region.

The level of NIA increased considerably from last year 0.63%. This is a cause for concern and need to be monitored closely.

Fish

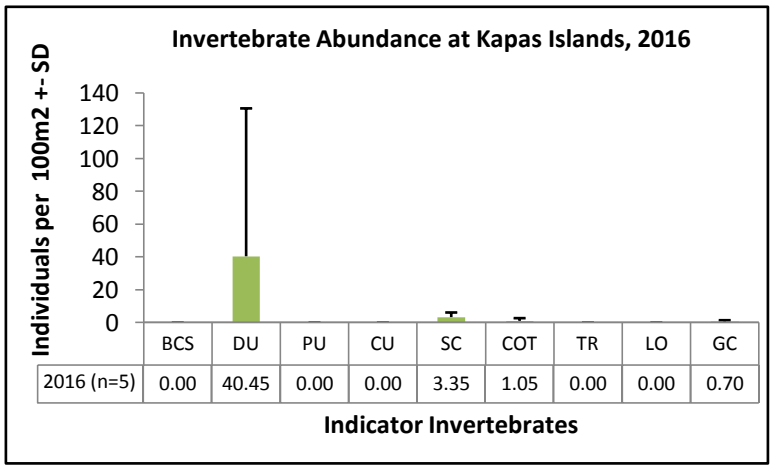


The most abundant fish were Butterflyfish, followed Parrotfish. Sweetlips and Snapper were present in low number.

A school of Bumphead Parrotfish was recorded at SS4.4 Teluk Jawa.

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

Invertebrates



Four targeted species were present, including Diadema Urchin, Sea Cucumber, Crown-of-thorns and Giant Clam.

Abundance of Diadema Urchin was the highest, followed by Sea Cucumber. Giant Clam was present in low number.

COT abundance increased from last year and the number is way above what a healthy reef can sustain (0.2-0.3 ind./100m^2).

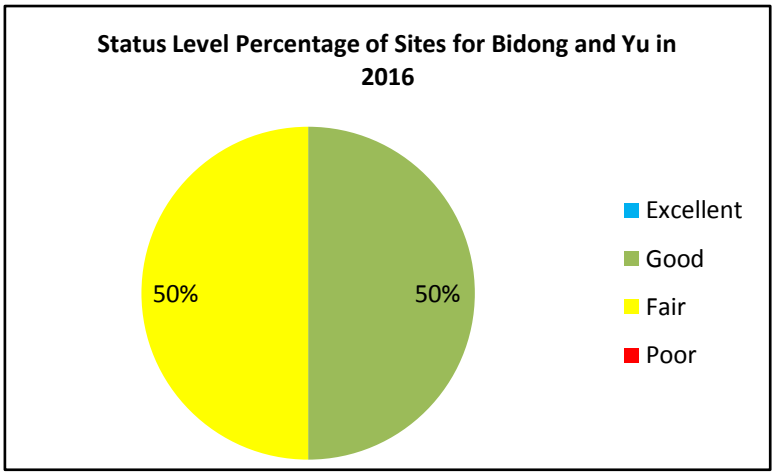
Natural and human damage to the reefs were observed during surveys. Damage due to warm water bleaching was observed at 4 sites while boat anchor damage and COT predation were observed at many of the sites.

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.

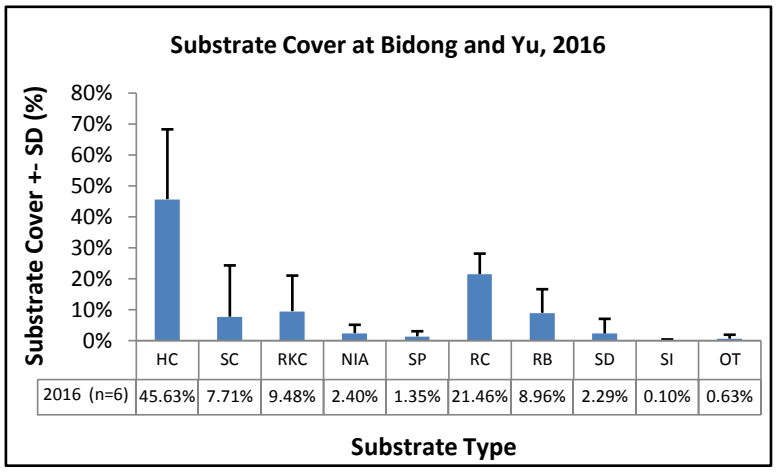
Bidong has mainly been a research base for University Malaysia Terengganu but has recently grown in popularity as a diving destination. Bidong has some sandy beaches and fringing reefs while Pulau Yu Besar and Kecil are mainly small rocky islands, with boulder slopes dropping to 25-30m, with some coral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

Map 8: Surveyed sites in Bidong and Yu



A total of 6 coral reef sites were surveyed in Bidong and Yu. 50% of the sites were in good condition, while 50% were in fair condition.

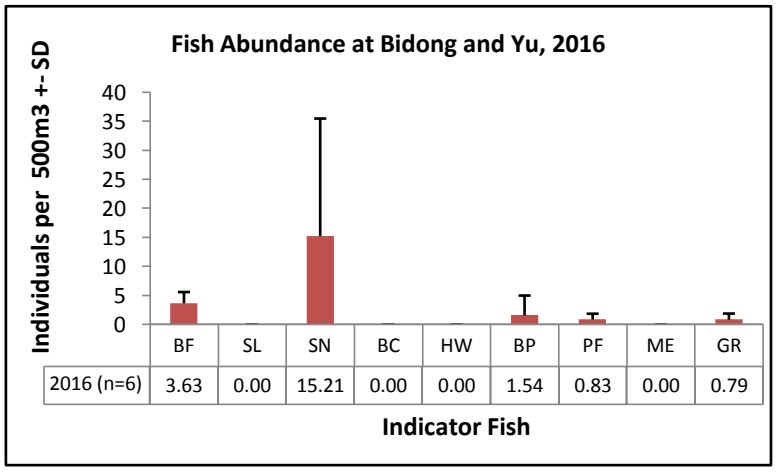
Substrate



Coral reefs around Bidong and Yu islands are considered to be in 'Good' condition, with 53.33% live coral cover, lower than the average (55.59%) for reefs in Sunda Shelf region.

Level of RKC increased greatly from 1.46% in 2015 to 9.48% in 2016. This is highly likely due to COT predation as high number of COT was recorded during surveys. SC level also increased considerably from last year, especially at SS5.2 Pasir Tenggara where 41.25% of the reefs were covered with zoanthid.

Fish

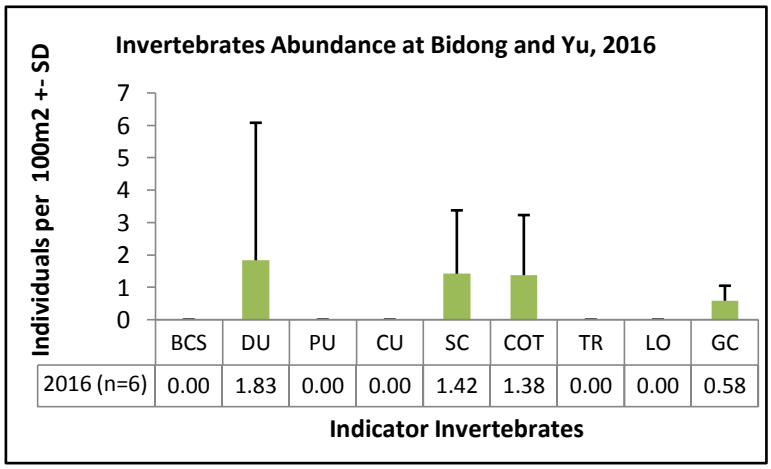


Four indicator species were completely absent from surveys (Sweetlips, Barramundi Cod, Humphead Wrasse and Moray Eel).

Abundance of Snapper in Bidong and Yu is the second highest of all islands surveyed in Sunda Shelf region.

Bumphead Parrotfish were recorded at two sites; SS5.2 Pasir Tenggara and SS5.5 Yu Besar.

Invertebrates



As in most sites, several targeted species were absent, including Banded Coral Shrimp, Pencil and Collector Urchin, Triton and Lobster.

The abundance of COT decreased this year, however the level was still way above acceptable limits (0.2-0.3 ind./100m^2). COT population in Bidong and Yu again was the highest of all islands surveyed in Sunda Shelf region and this is a cause for concern. Nutrient runoff into the sea must be managed to avoid further COT blooms.

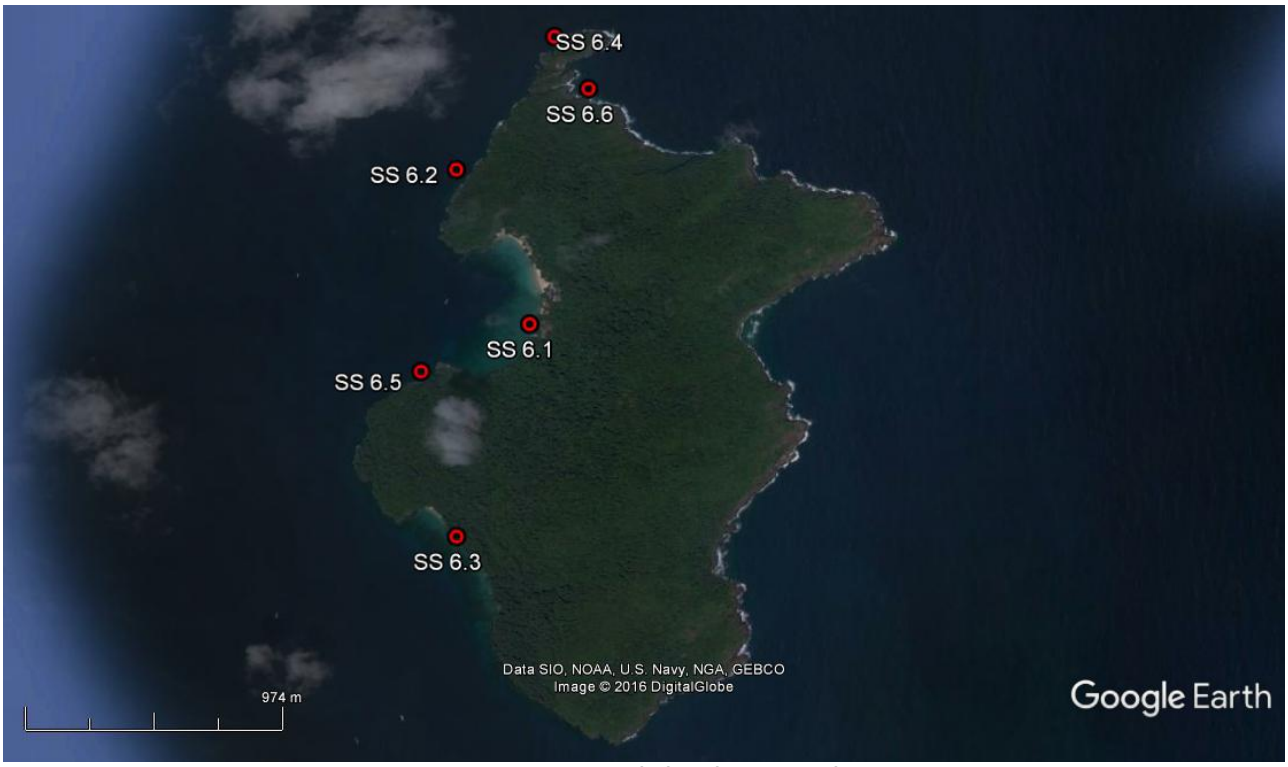
The reefs were mainly damaged by COT and Drupella predation. Fish net was also recorded at one site. Green turtle was recorded at SS5.1 Heritage Row and Hawksbill turtle was recorded at SS5.2 Pasir Tenggara.

3.2.6 Tenggol

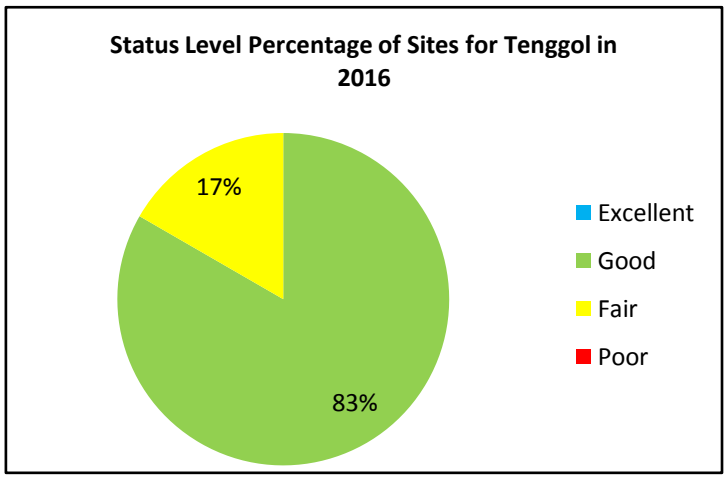
Tenggol Island is located approximately 30km from Dungun, off the East coast of Terengganu, Malaysia. This small island has no local population. The island is gazetted as a Marine Park (since 1994).

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.

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

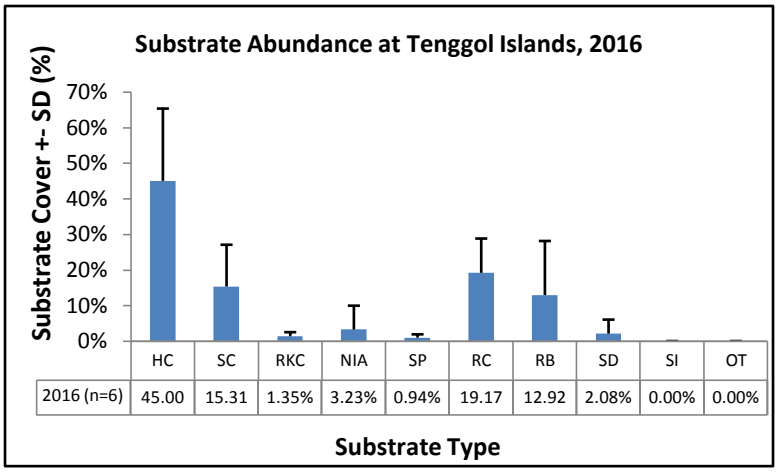


Map 9: Surveyed sites in Tenggol



A total of 6 coral reef sites were surveyed in Tenggol. 83% of the sites were in good condition, while the remaining 17% were in fair condition.

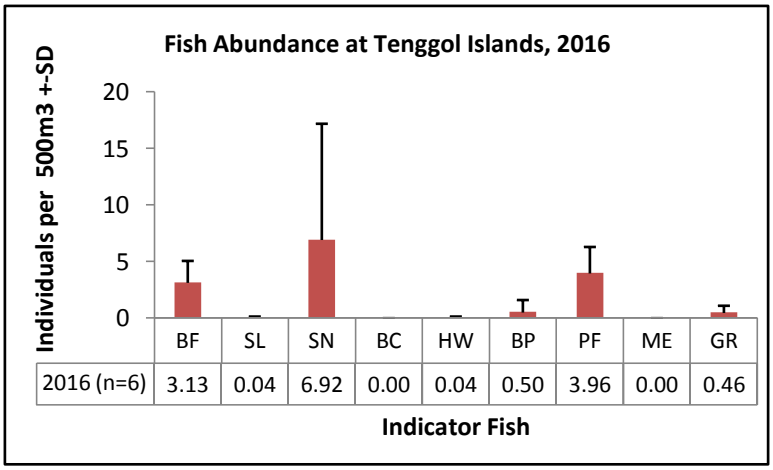
Substrate



The reefs in Tenggol were considered to be in 'Good' condition, with 60.31% live coral cover, above the average (55.59%) for reefs of the Sunda Shelf region.

Although the level of NIA has decreased, the level of RB and SP has increased. This still indicates some recent disturbances in Tenggol and needs to be monitored closely.

Fish



Only two indicator species were completely absent from surveys (Barramundi Cod and Moray Eel).

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

Bumphead Parrotfish was recorded at two sites. Humphead Wrasse was also recorded during surveys and Tenggol is one of the two islands within the Sunda Shelf region recorded Humphead Wrasse during surveys.

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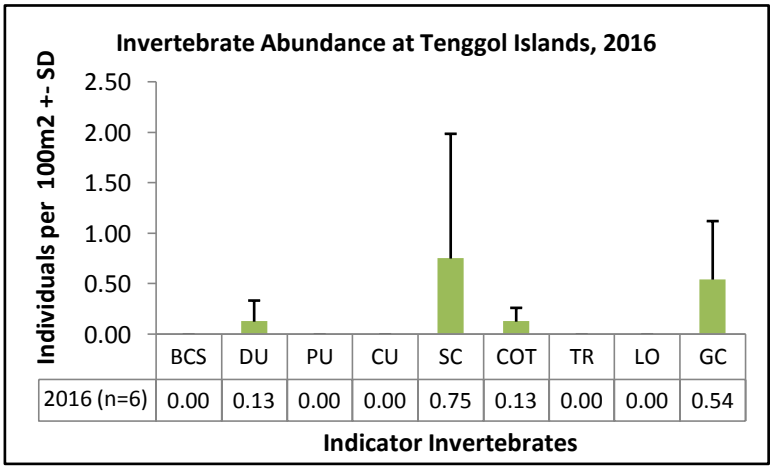
Invertebrates



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

Abundance of other indicator species was very low, including Diadema Urchin, Sea Cucumber and Giant Clam. The abundance of COT remains within the range which a healthy reef can support.

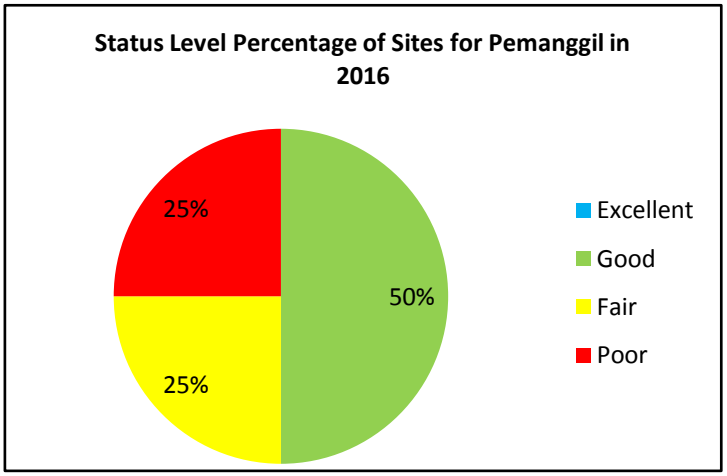
Damage due to warm water bleaching was observed at all sites except for SS6.2 Gua Rajawali. Gua Rajawali instead was impacted by boat anchor damage.

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).

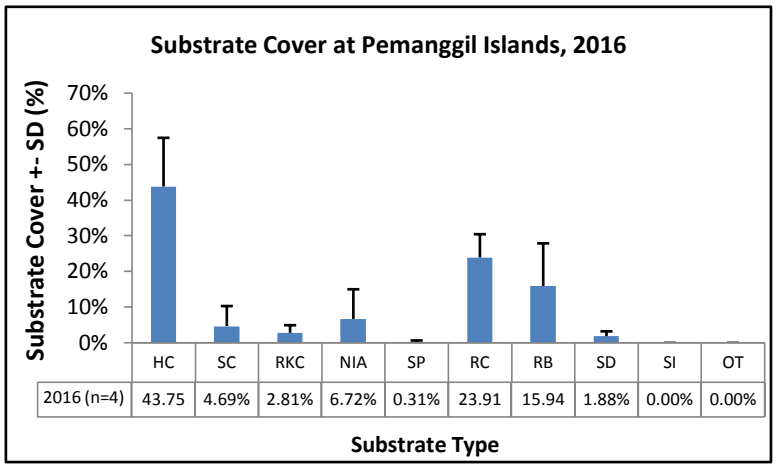
The island is sparsely populated and has for many years been a frequent stopover point for fishermen.

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. 25% were in fair condition while the remaining 25% were in poor condition.

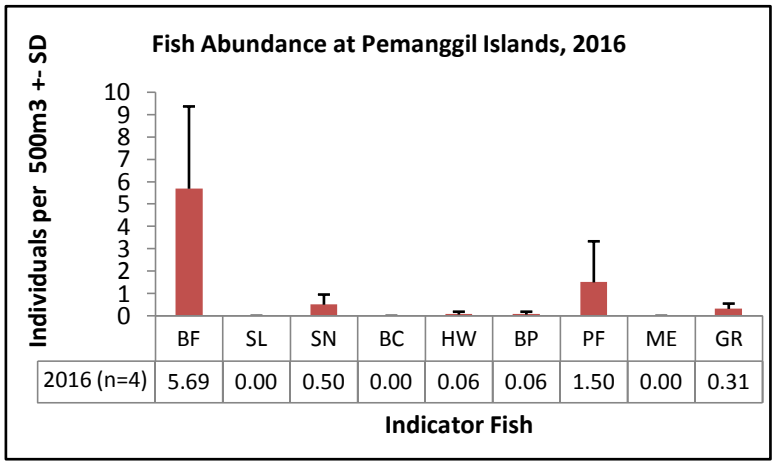
Substrate



The reefs in Pemanggil are considered to be in 'Fair' condition, with 48.44% live coral cover, below the average (55.59%) for reefs of the Sunda Shelf region.

The level of RKC, NIA and RB increased from last year. RB level in Pemanggil is still the highest of all islands surveyed in Sunda Shelf region. This is probably still due to the massive flood and landslide that happened during 2014 monsoon.

Fish

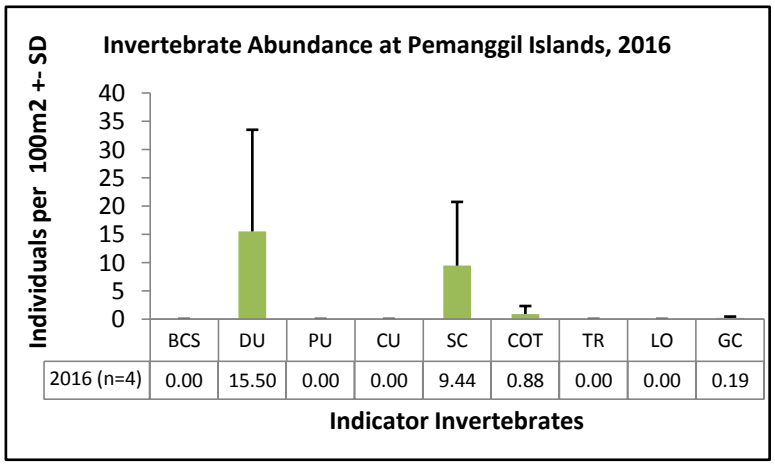


Only three indicator species were absent during surveys (Sweetlips, Barramundi Cod and Moray Eel).

The abundance of Butterflyfish was the highest, followed by Parrotfish. Other indicator species were present in very low number.

Bumphead Parrotfish was recorded at one site. Humphead Wrasse was also recorded during surveys and Pemanggil is one of the two islands within the Sunda Shelf region recorded Humphead Wrasse during surveys.

Invertebrates



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

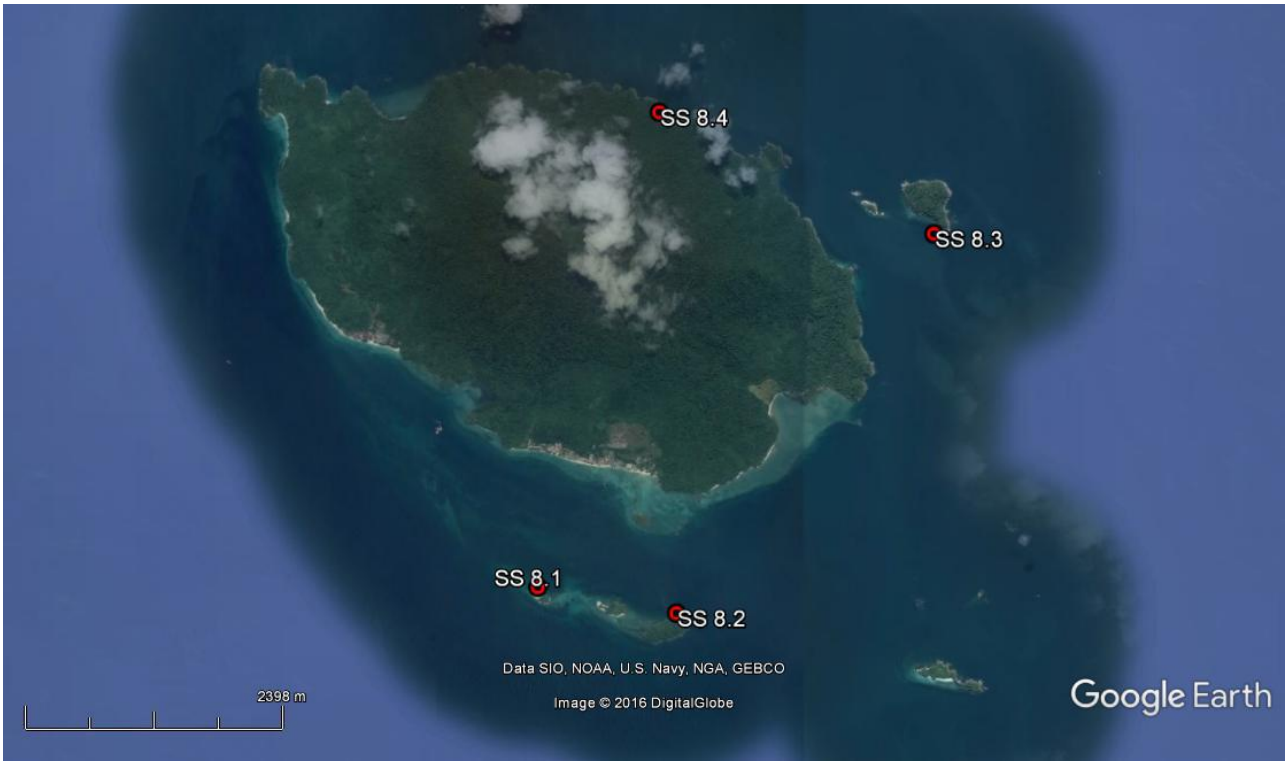
Diadema Urchin recorded the highest number, followed by Sea Cucumber. The abundance of COT increased from last year and the abundance is above what a healthy reef can sustain (0.2-0.3 ind./100m^2).

All of the reefs, except SS7.1 Bumphead Bay, were damaged by COT predation. Two of the sites are also impacted by discarded fishing nets.

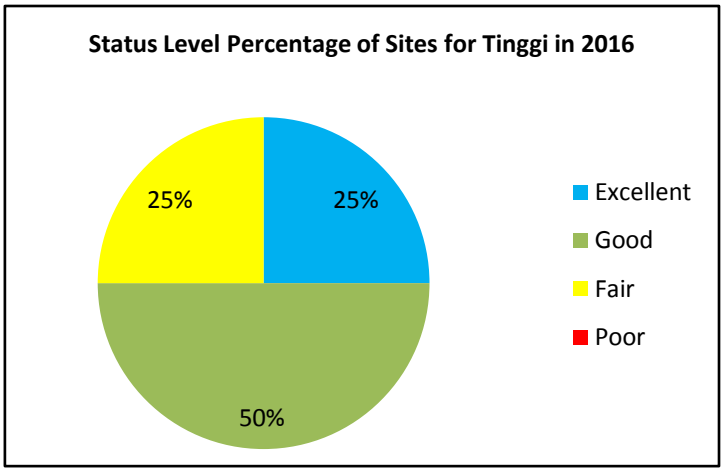
3.2.8 Tinggi

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.

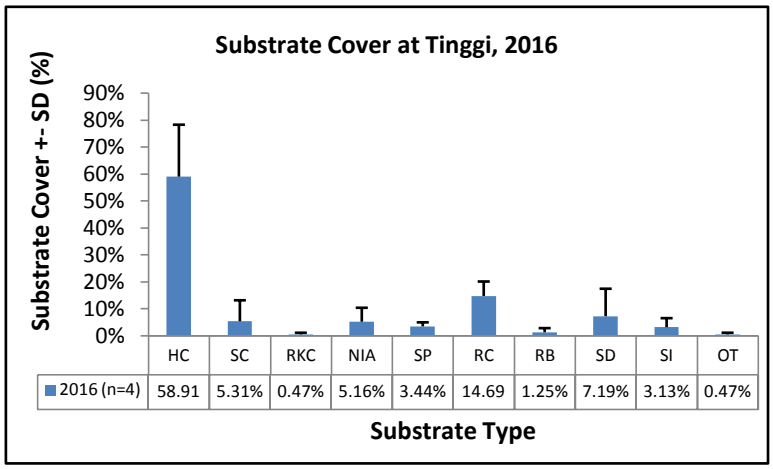


Map 11: Surveyed sites in Tinggi



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.

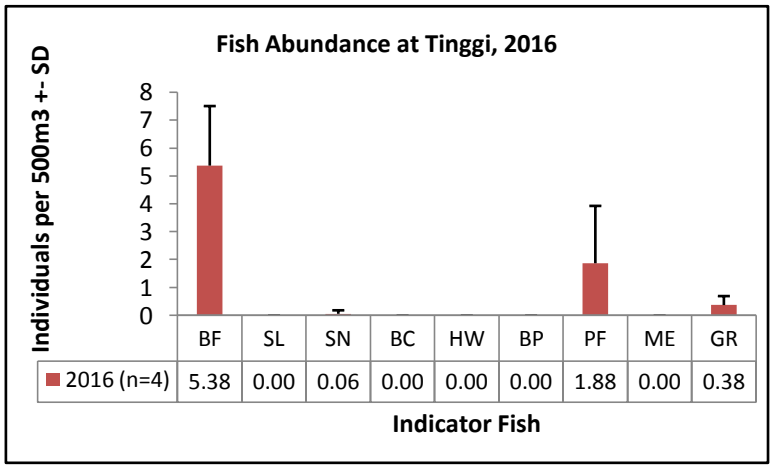
Substrate



Coral reefs around Tinggi Island were in 'Good' condition, with 64.22% live coral cover, above the average (55.59%) for reefs in the Sunda Shelf region.

The level of SI is high, probably due to the close proximity of Tinggi Island to the mainland and a likely source of this high SI level is the rivers and other terrestrial runoff from Tanjung Leman. The level of NIA is also high, especially at SS8.4 Tanjung Gua Sumbang which has increased from 10.63% in 2015 to 11.25% in 2016.

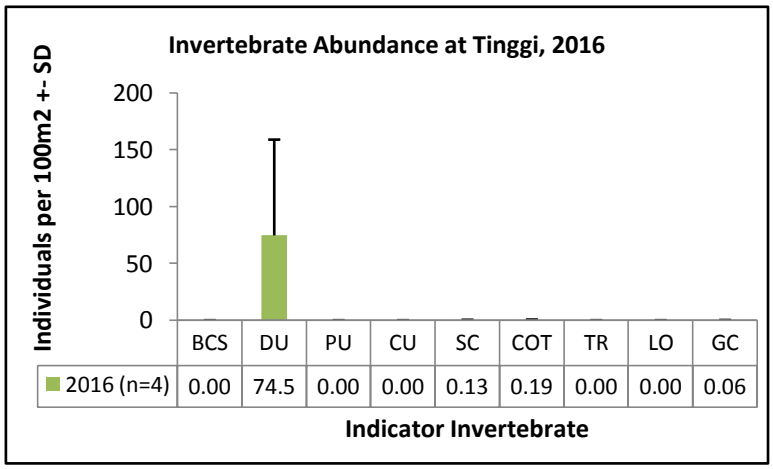
Fish



Only four indicator species were present during surveys, including Butterflyfish, Snapper, Parrotfish and Grouper.

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

Invertebrates



Most of the indicators were absent from surveys (Banded Coral Shrimp, Pencil and Collector Urchin, Triton and Lobster).

Abundance of Diadema Urchin was high (the highest of all islands surveyed in Sunda Shelf region). The abundance of Sea Cucumber and Giant Clam was very low, less than 0.2 ind./100m^2.

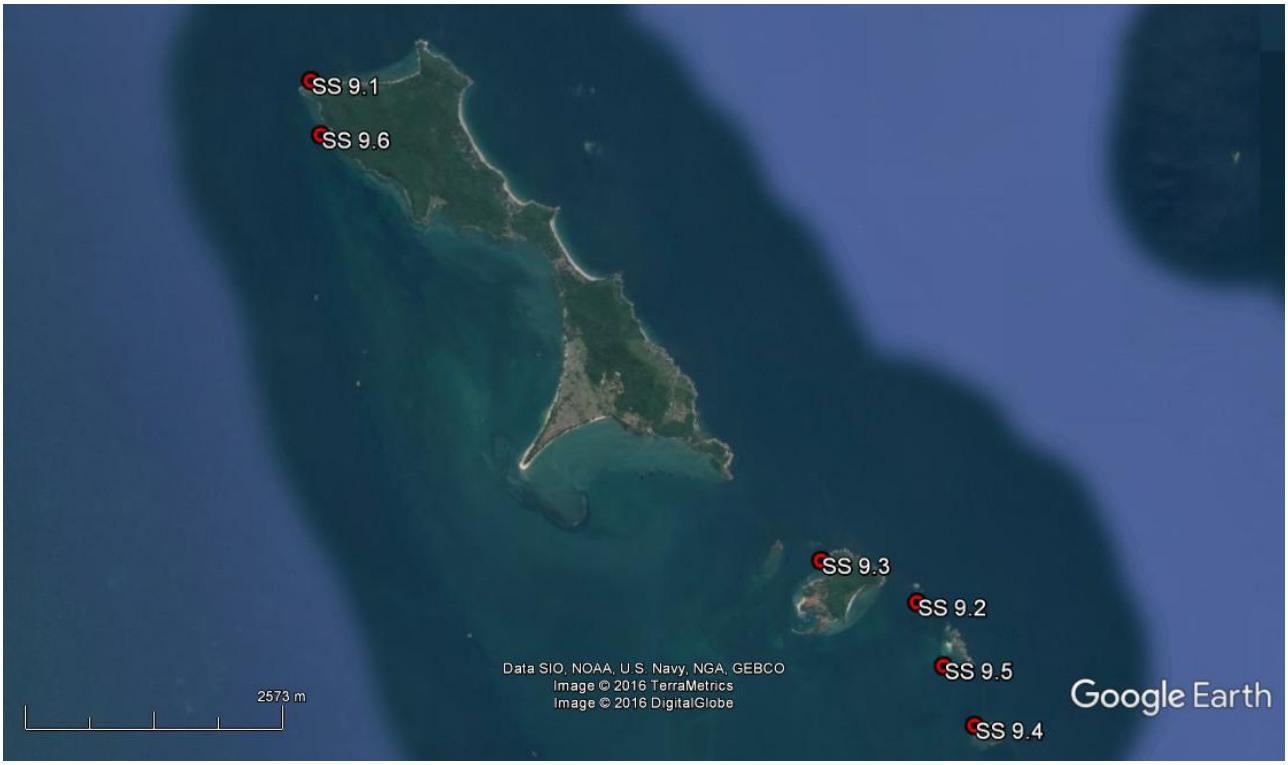
The abundance of COT was within the range which a healthy reef can support

Boat anchor damage, discarded fishing nets and trash were observed at many of the survey sites.

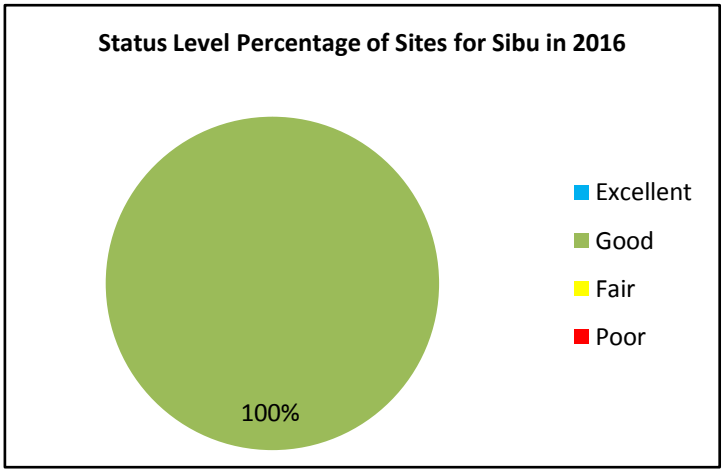
3.2.9 Sibu

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, typically used as a weekend or short vacation destination from Singapore.

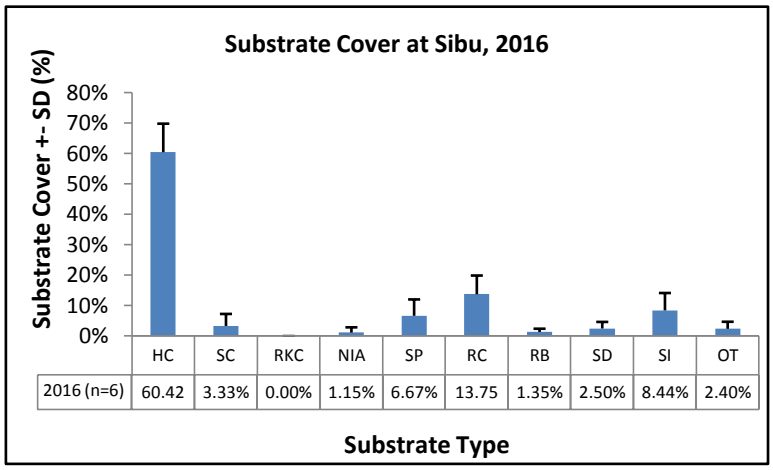


Map 12: Surveyed sites in Sibu



A total of 6 coral reef sites were surveyed in Sibu Islands. All of the sites were in good condition.

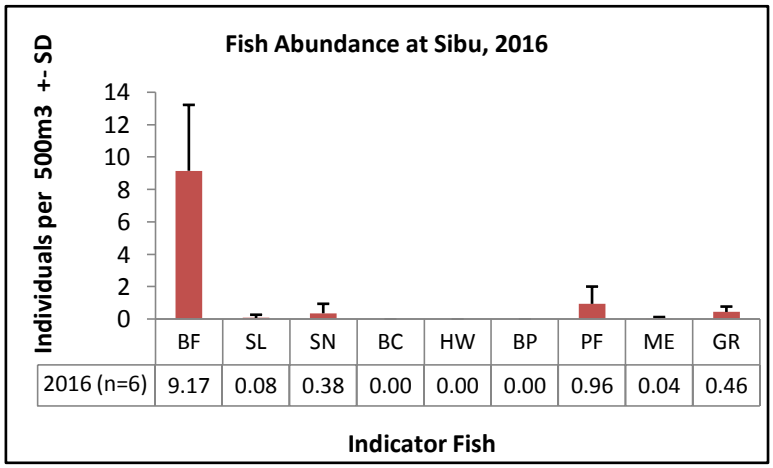
Substrate



Coral reefs around Sibu Island were in 'Good' condition, with 63.75% live coral cover, above the average (55.59%) for reefs in the Sunda Shelf region.

The level of SI has increased and it is the highest of all islands surveyed in Sunda Shelf. This probably due to the close proximity of these islands to the mainland and a likely source of this high SI level is the rivers and other terrestrial runoff from Tanjung Leman. The level of NIA has also increased slightly from last year.

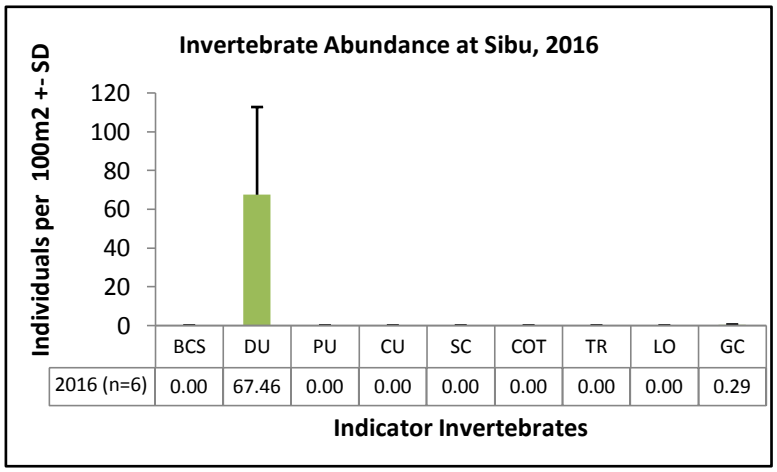
Fish



Three indicator species were absent from surveys (Barramundi Cod, Humphead Wrasse and Bumphead Parrot).

Butterflyfish was the most abundant targeted fish recorded, also the highest of all islands surveyed in Sunda Shelf region. Abundance of other indicators was very low, including Sweetlips, Snapper, Parrotfish, Moray Eel and Grouper, less than 1 ind./500m^3.

Invertebrates



Most of the indicators were absent from surveys. Only two indicators were observed, Diadema Urchin and Giant Clam.

Abundance of Diadema Urchin was high and was the highest of all the islands surveyed in Sunda Shelf region. The abundance of Giant Clam was very low.

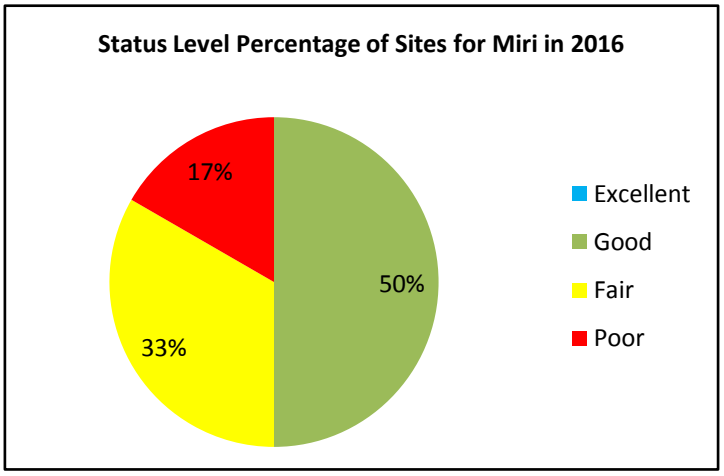
Human impacts such as boat anchor damage, discarded fishing nets and trash were observed at some sites during surveys.

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.

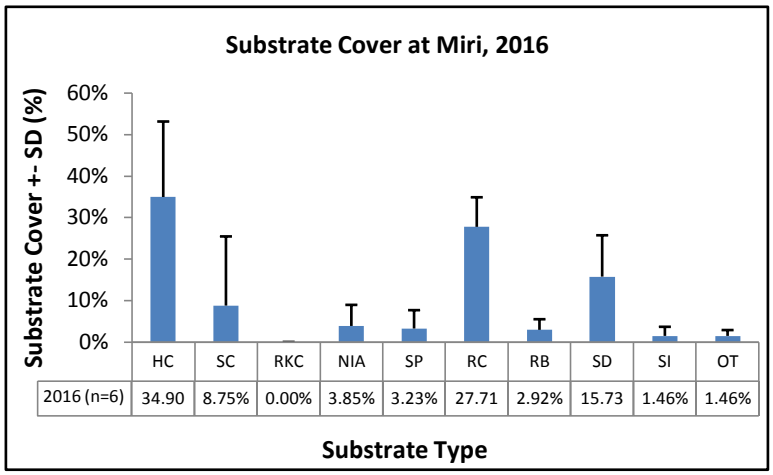
Miri has extensive submerged offshore reefs, generally flat in profile, in depths ranging from 7 to 30m. The reefs and its surrounding water, 186930 hectares areas that covers the Miri and Sibuti districts, were gazetted as Miri-Sibuti Coral Reefs National Park in 2007 under the National Parks and Nature 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 50% of the sites were in good condition. 33% were in fair condition and the remaining 17% were in poor condition.

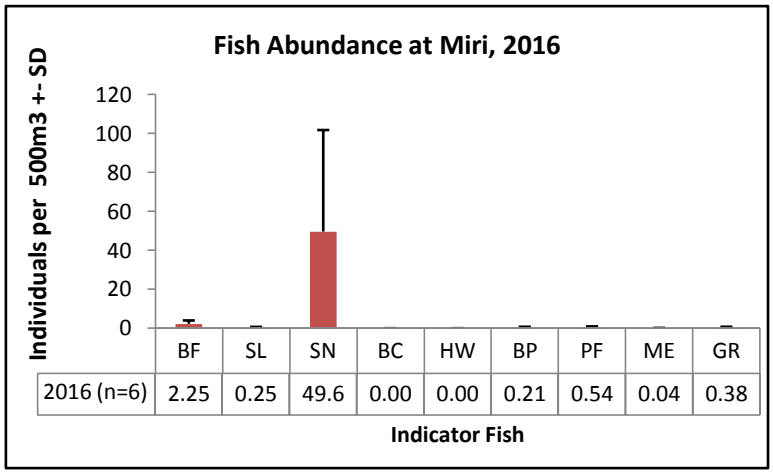
Substrate



Coral reefs around Miri were in 'Fair' condition with 43.65% of live coral cover, below the average (55.59%) for Sunda Shelf region.

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

Fish

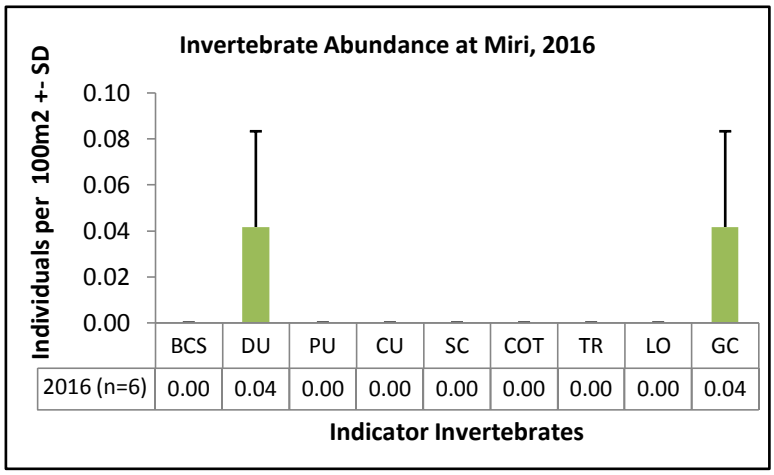


Only two indicator species were absent from surveys (Barramundi Cod and Humphead Wrasse).

For the last four years, the abundance of Snapper in Miri was the highest of all islands surveyed in Sunda Shelf region.

Abundance of other indicators was generally low.

Invertebrates



Only two indicators were observed during surveyed, including Diadema Urchin and Giant Clam. The abundance of these two indicators was very low.

Damage due to warm water bleaching was observed at two sites; SS11.2 Siwa Penyu, SS11.3 Anemone Centre and SS11.5 Eve's Garden.

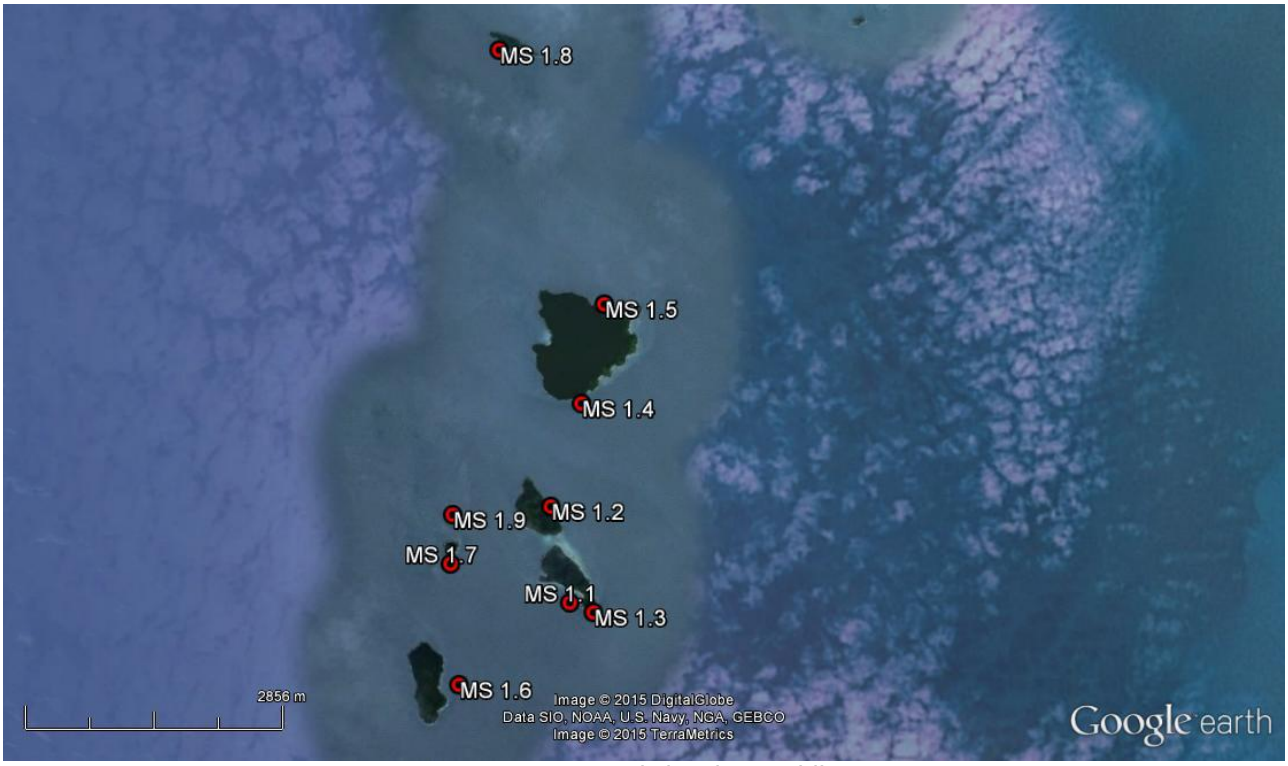
Straits of Malacca

3.2.11 Sembilan Islands

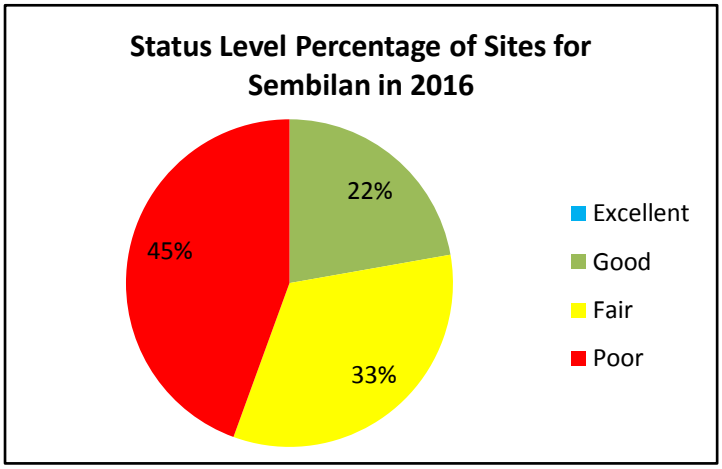
The Sembilan Islands consist of a cluster of nine islands (Pulau Agas, Pulau Payong, Pulau Nipis, Pulau Rumbia, Pulau Lalang, Pulau Saga, Pulau Buluh, Black Rock and White Rock) which are located some 20km from the coast of Perak (Lumut), off the west coast of Peninsular Malaysia, in the Straits of Malacca.

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.

Pangkor Laut Island is an island off the coast of Perak, reached by ferry either from the old jetty or from Marina Island jetty both located in Lumut. It is promoted as a low-key tourist destination by the Malaysian government, but fishing, seafood and other fishing-related products remain major industries.

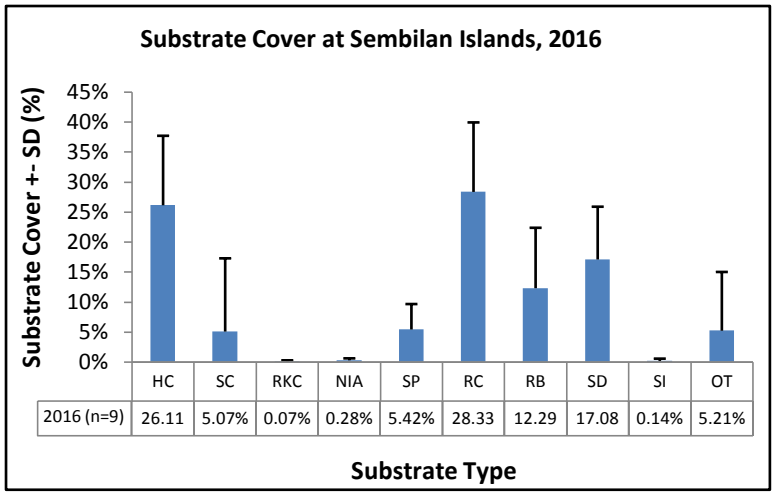


Map 15: Surveyed sites in Sembilan



A total of 9 coral reef sites were surveyed in Sembilan islands and 22% of the reefs were in good condition. 33% of the reefs were in fair condition, while the remaining 45% were in poor condition. No reefs were in excellent condition.

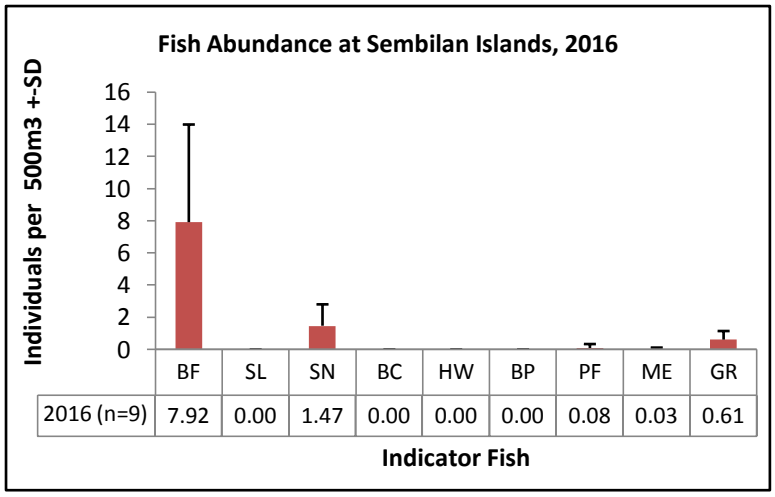
Substrate



Coral reefs around Sembilan islands are considered to be in 'Fair' condition, with 31.18% live coral cover, lower than the average (38.65%) for reefs of the Malacca Strait region.

The islands in general have high level of RC and SD. The level of RB was also high, indicating high level of recent 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.

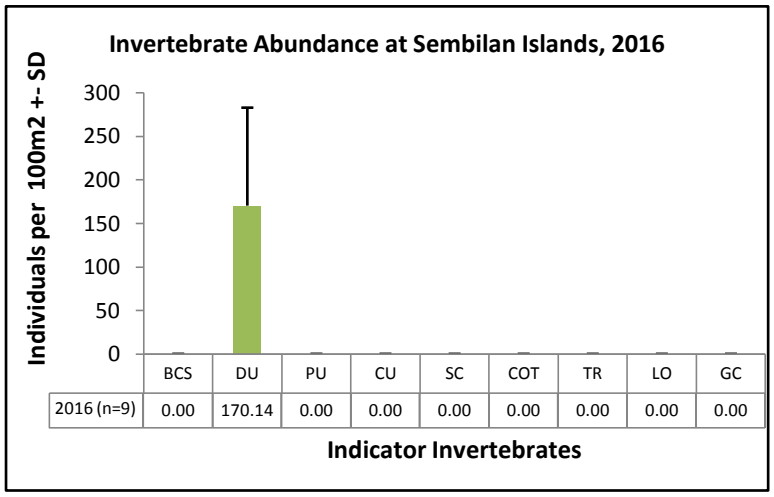
Fish



Five indicator species were present during surveys – Butterflyfish, Snapper, Parrotfish, Moray Eel and Grouper.

Abundance of Butterflyfish was the highest. 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.

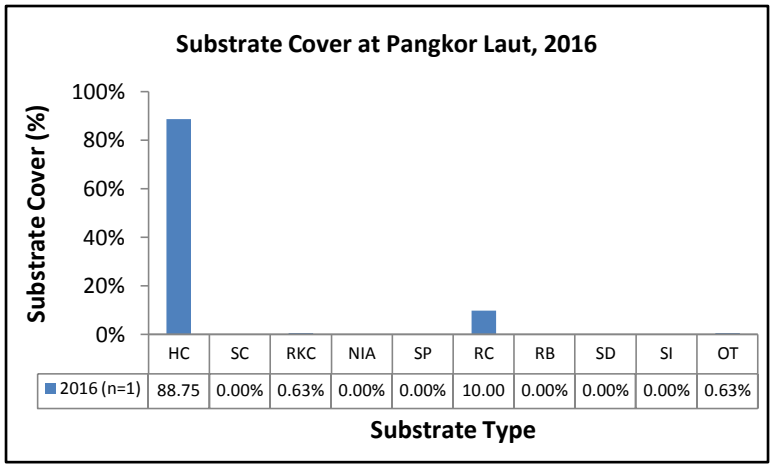
Boat anchor damage was recorded at MS1.7 Anemone Garden while trash was recorded at almost all of the survey sites. Warm water bleaching was recorded at MS1.6 Pulau Buluh and MS1.8 Frogfish. On a positive note, seahorse was recorded at four sites.

3.2.12 Pangkor Laut Island

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

Map 16: Surveyed sites in Pangkor Laut

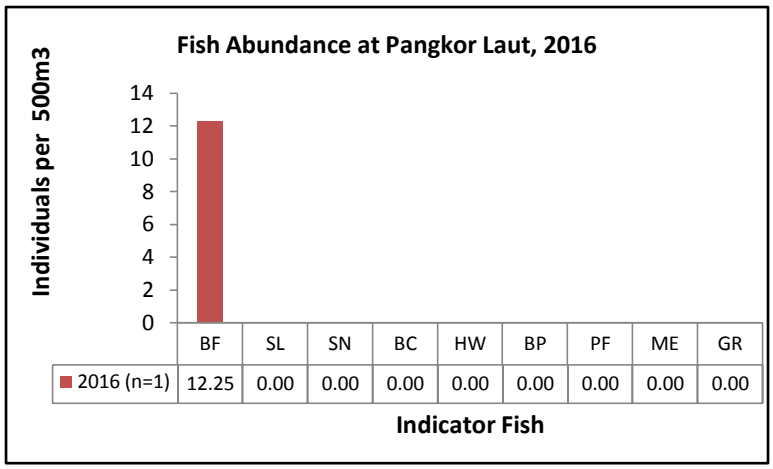
Substrate



Coral reefs around Pangkor Laut are considered to be in 'Excellent' condition, with 88.75% live coral cover, above the average (38.65%) for reefs of the Malacca Strait region.

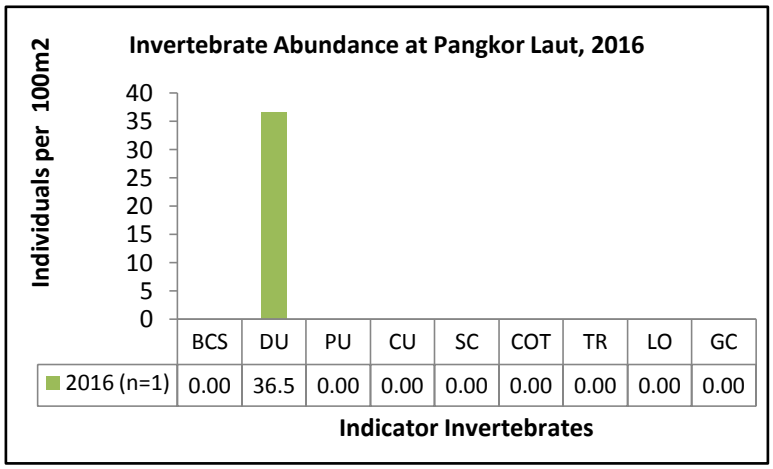
The level of RB decreased considerably from last year, indicating reduce recent disturbances in the area.

Fish



Similar to last year only Butterflyfish was present during surveys, however the abundance was higher this year.

Invertebrates



Similar to last year the only indicator species observed was Diadema Urchin and the abundance was high.

No damage was observed on the reef.

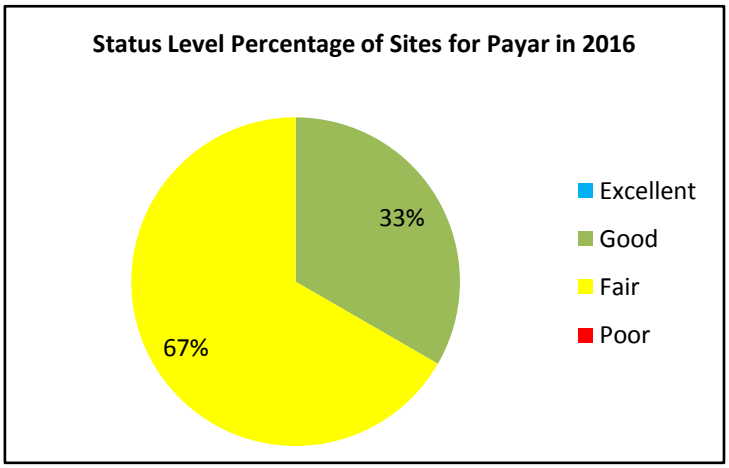
3.3.13 Payar

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.

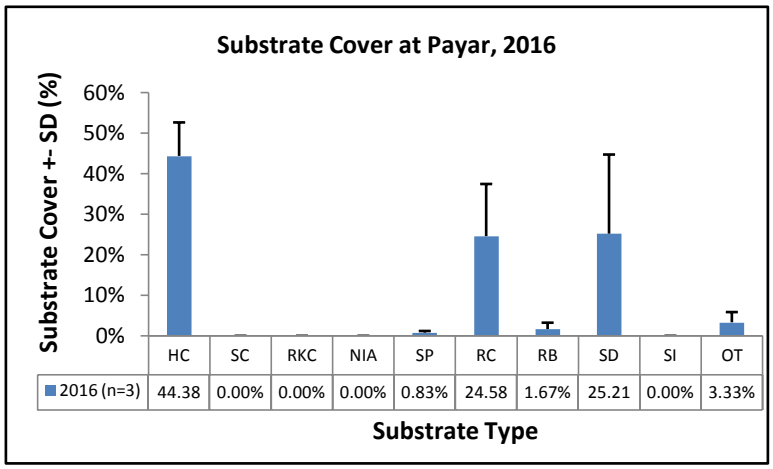
The island is uninhabited and the only operating structures on the island are the marine park centre with facilities for day trip visitors such as gazebos, picnic table and restroom facilities at selected areas. There is also an old abandoned resort. A floating platform moored just off Payar serves as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

Map 17: Surveyed sites in Payar



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

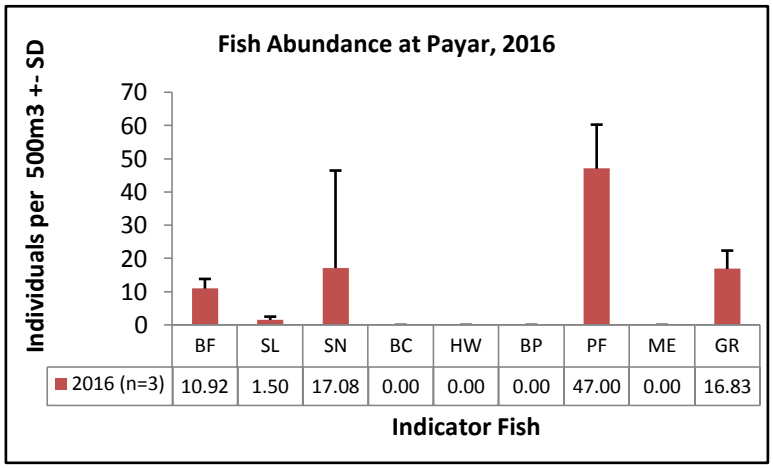
Substrate



Coral reefs around Payar are considered to be in 'Fair' condition, with 44.38% live coral cover, higher than the average (38.65%) for reefs of the Malacca Strait region.

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

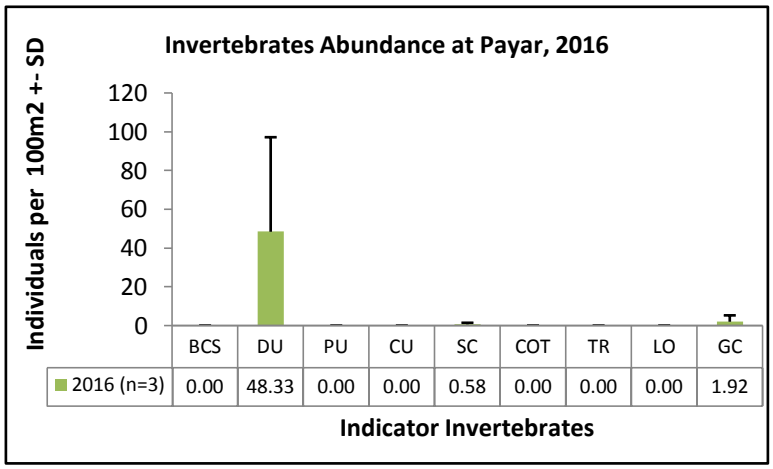
Fish



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. Indicator fish recorded during surveys were high in abundance except for sweetlips.

Invertebrates



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

The abundance of Diadema Urchin was high while the abundance of Sea Cucumber and Giant Clam was very low.

Only natural impact was observed on the reefs; warm water bleaching at all sites. Shark was also observed during surveys.

North Borneo

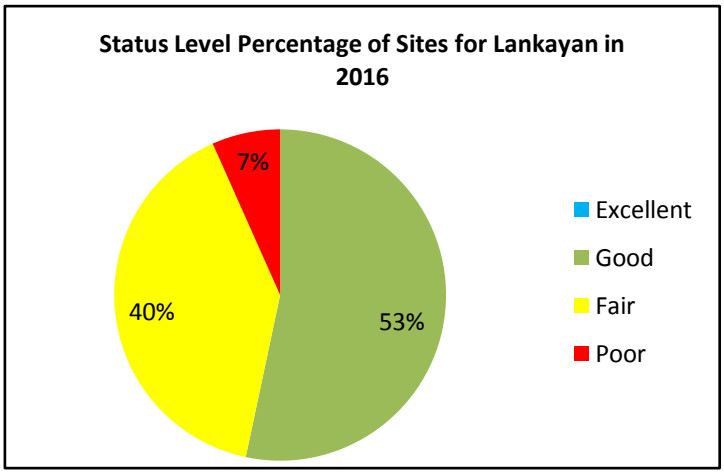
3.2.14 Lankayan

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.

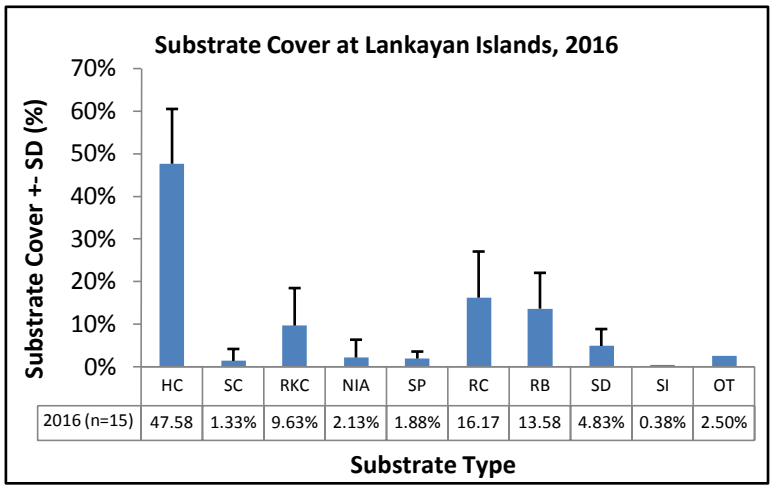
Before the creation of SIMCA, blast fishing was a constant problem, and turtle eggs were poached on a regular basis. Lankayan Island is the only developed island within SIMCA. The 0.05 km^2 island is the site of the Lankayan Island Dive Resort (LIDR), which is the only structure on the otherwise uninhabited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

Map 18: Surveyed sites in Lankayan



A total of 15 coral reef sites were surveyed in Lankayan islands and 53% of the reefs were in good condition. 40% were in fair condition and the remaining 7% of the reefs were in poor condition.

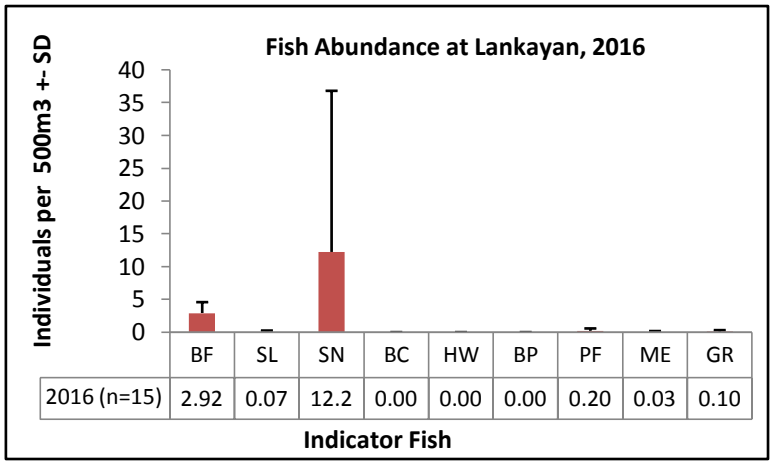
Substrate



The reefs in Lankayan islands are considered to be in 'Fair' condition, with 48.92% live coral cover, above the average (36.57%) for reefs within the North Borneo region.

Although RKC level has dropped from 13.13% in 2015 to 9.63% in 2016, it was still the highest of all islands surveyed in North Borneo region. The level of RB has also dropped; from 18.54% in 2015 to 13.58%. These indicate lower recent disturbances to reefs. However, these still need to be monitored closely.

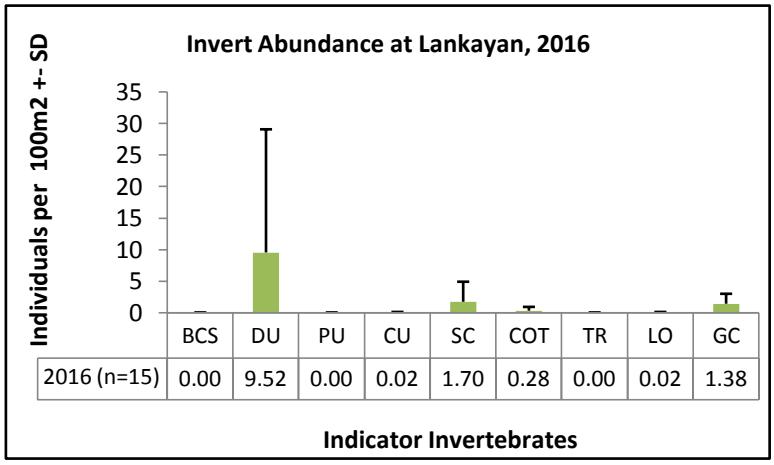
Fish



Three indicator fish were absent during surveys including Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish.

The abundance of Snapper was high and was still 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 the only impacts seen on reefs during surveys and it was recorded at all sites. On a positive note, whitetip shark, adult hawksbill turtle and eagle ray were observed during surveys.

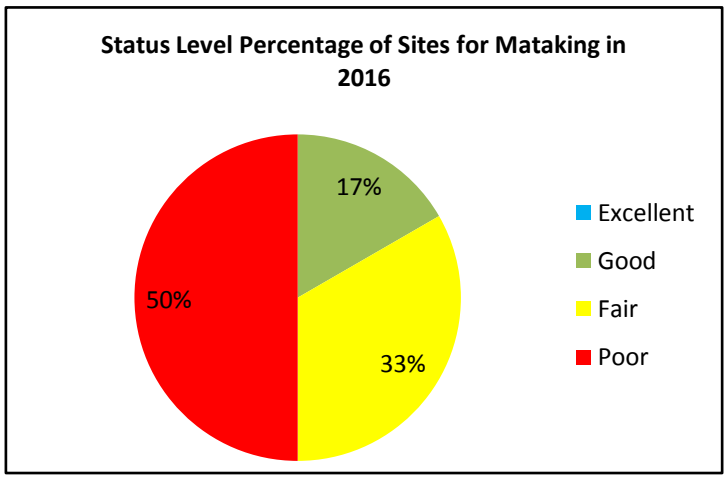
3.2.15 Mataking

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.

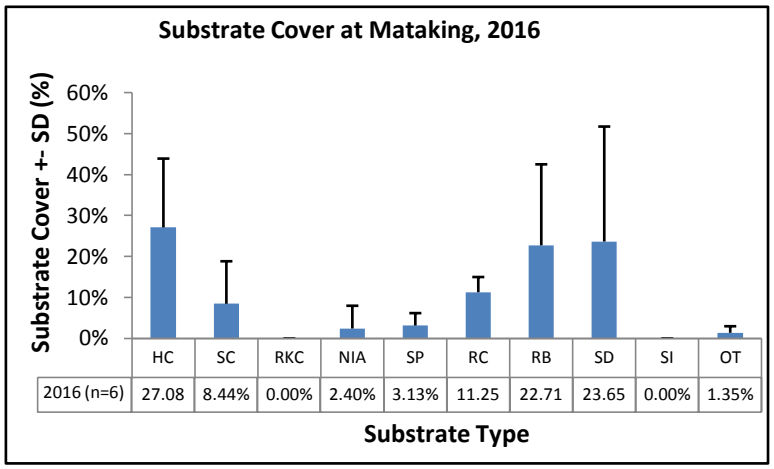
The island has fringing reefs, and coral extends down to almost 30m. Coral reefs around this, and surrounding, islands have been extensively damaged by fish bombing in the past, and fish bombing continues in some areas nearby.

Map 19: Surveyed sites in Mataking



A total of 6 coral reef sites were surveyed in Mataking. 17% of the reefs were in good condition and 33% were in fair condition. The remaining 50% of the reefs were in poor condition.

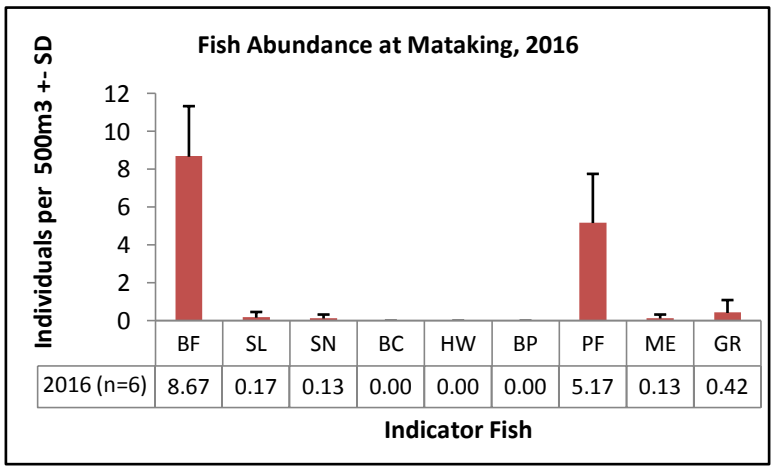
Substrate



The reefs around the island were considered to be in 'Fair' condition, with 35.52% live coral cover, slightly below the average (36.57%) in the North Borneo region.

The reef in Mataking had high amount of RB, with an average of 22.71%, rising to as high as 51.88% at NB2.2 Coral Garden and 41.88% at NB2.6 Sweetlips Rock. On a positive note, the amount recorded had reduced significantly from last year.

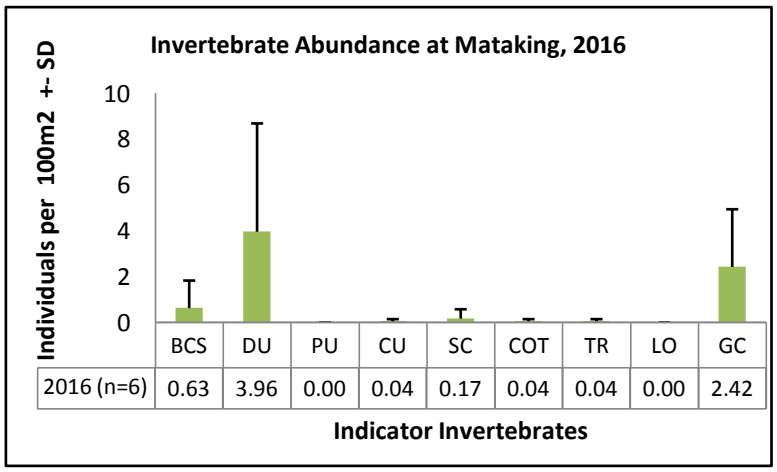
Fish



Three indicator fish were absent during the surveys (Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish).

The abundance of Butterflyfish was the highest, followed by Parrotfish. Other indicator fish were present in low number.

Invertebrates



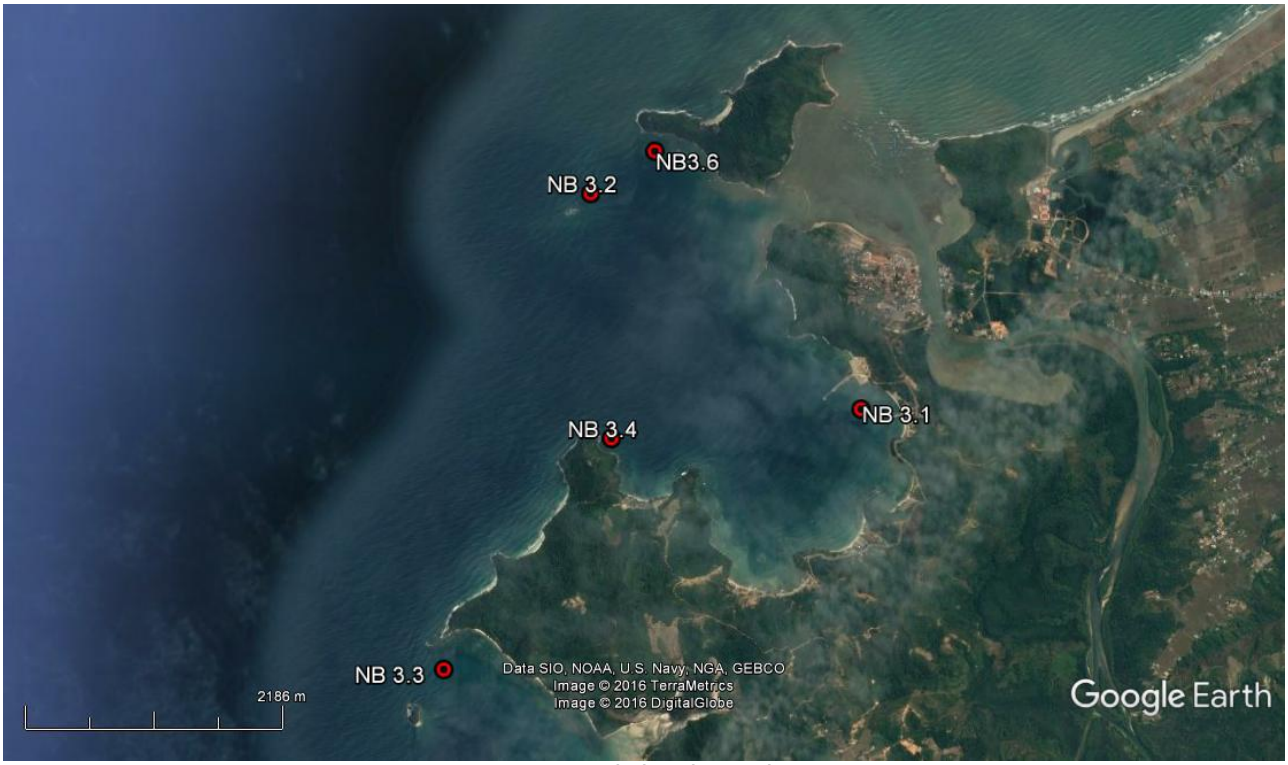
Only two indicators were absent from surveys (Pencil Urchin and Lobster).

The abundance of Diadema was the highest, followed by Giant Clam. Abundance of other indicator was low. Mataking is one of the three islands that recorded Triton and Collector Urchin during surveys.

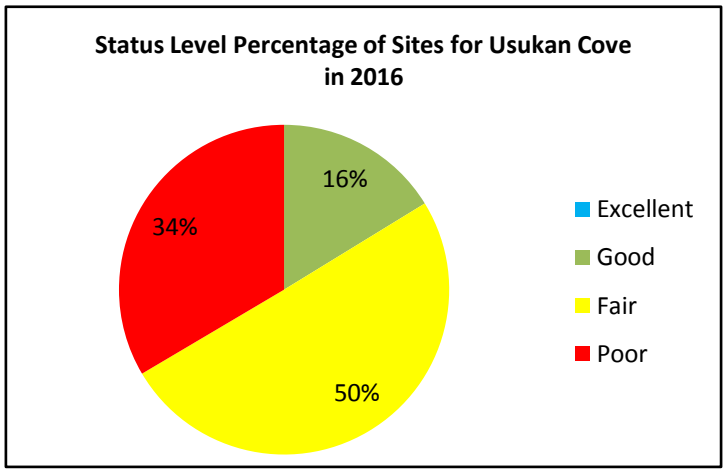
Trash was seen on reefs during surveys. Mataking recorded the highest number of turtle sighted during surveys in whole Malaysia and 5 out of 6 sites surveyed recorded turtle sighting.

3.2.16 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.

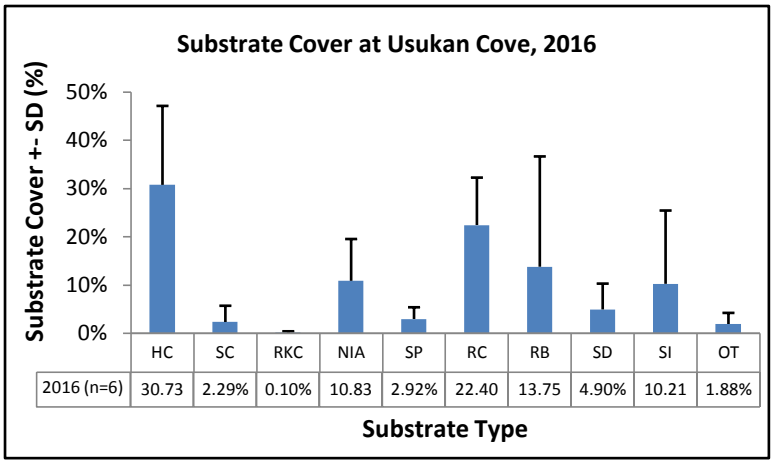


Map 20: Surveyed sites in Usukan Cove



A total of 6 coral reef sites were surveyed in Usukan Cove and 16% of the reefs were in good condition. 50% were in fair condition while the remaining 34% were in poor condition. No reefs were in excellent condition.

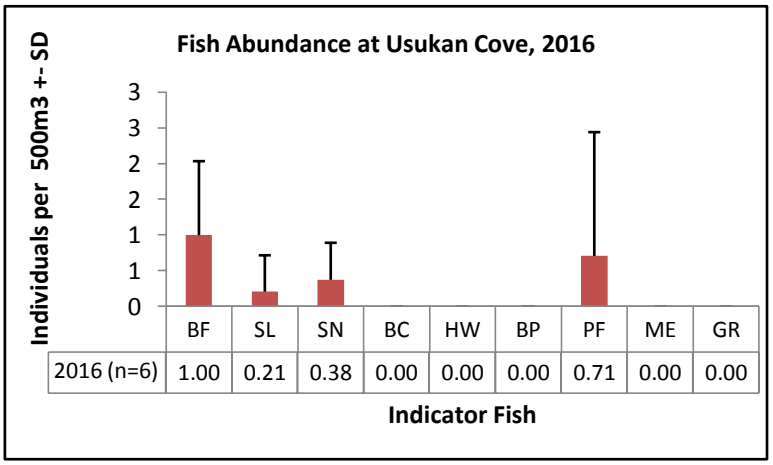
Substrate



Reefs in Usukan Cove are considered to be in 'Fair' condition with 33.02% live coral cover, below the average (36.57%) for North Borneo region.

Although the level of NIA had decreased, the level of RB and SI had increased. RB level had increased from 10.75% in 2015 to 13.75% in 2016 while SI level had increased significantly from 0.88% in 2015 to 10.21% in 2016. The sites of most concern are NB3.1 Usukan Cove Lodge (32.50%) and NB3.4 Poduko (26.88%).

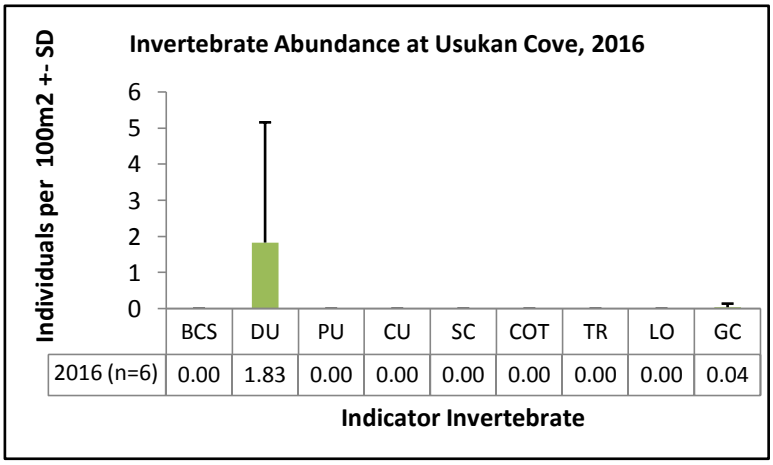
Fish



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

Other indicator fish were present in low abundance.

Invertebrates



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

All survey sites were affected by warm water bleaching. Extensive human impacts were also seen on the reefs with signs of boat anchor damage, dynamite fishing and trash.

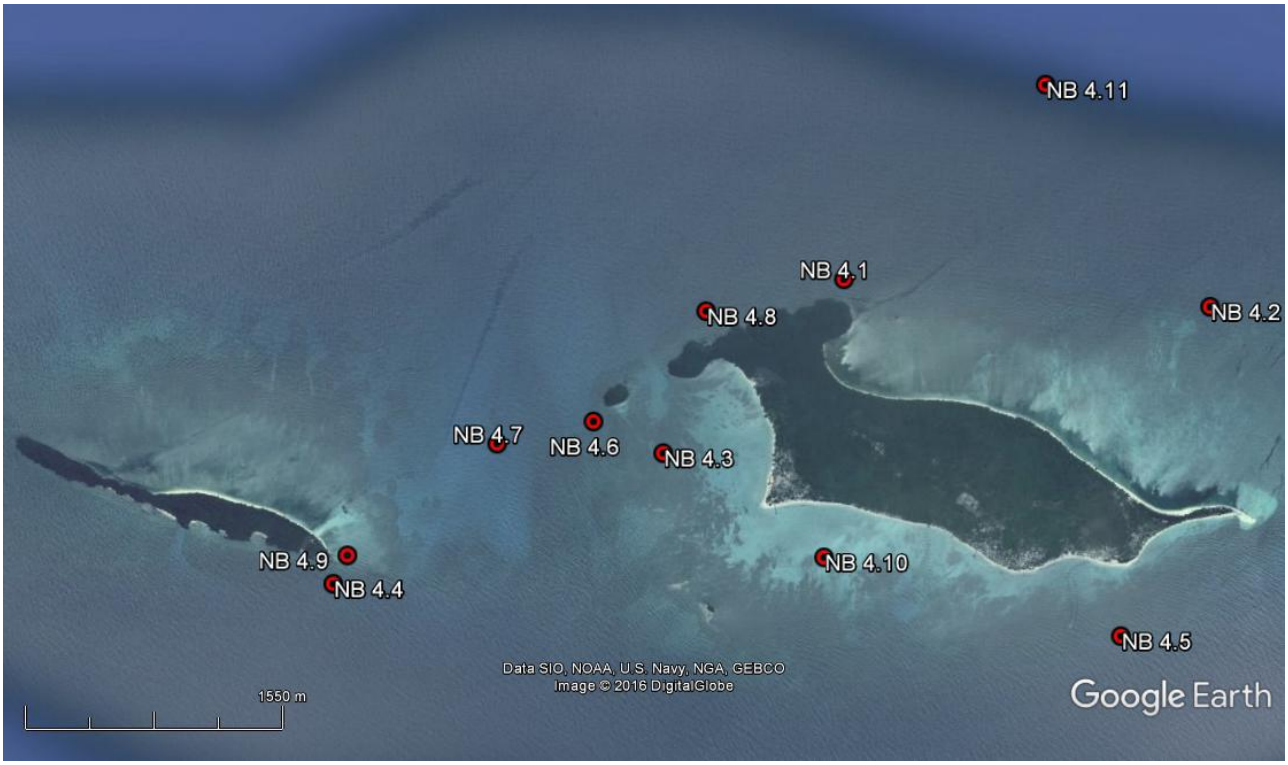
3.2.17 Mantanani

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

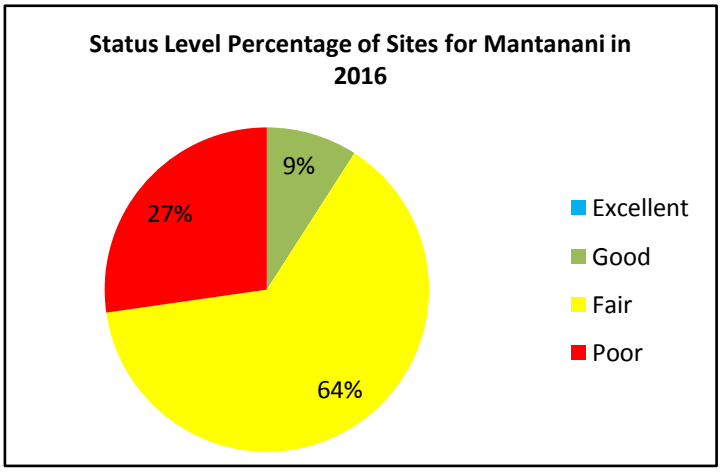
Mantanani is mainly populated by Bajau Ubian, with a small population of about 1,000 in two villages. The three main economic activities are fishing, drying salted fish and collecting shellfish.

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.

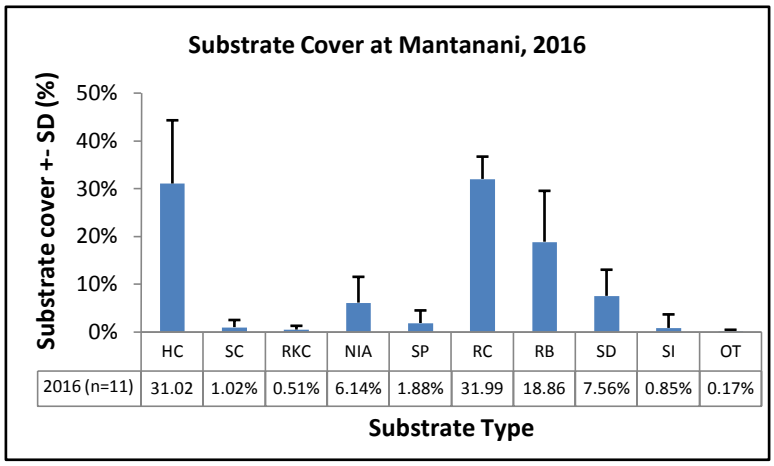


Map 21: Surveyed sites in Mantanani



A total of 11 coral reef sites were surveyed in Mantanani islands and 64% of the reefs were in fair condition. 9% were in good condition and the remaining 27% of the reefs were in poor condition. No reefs were in excellent condition.

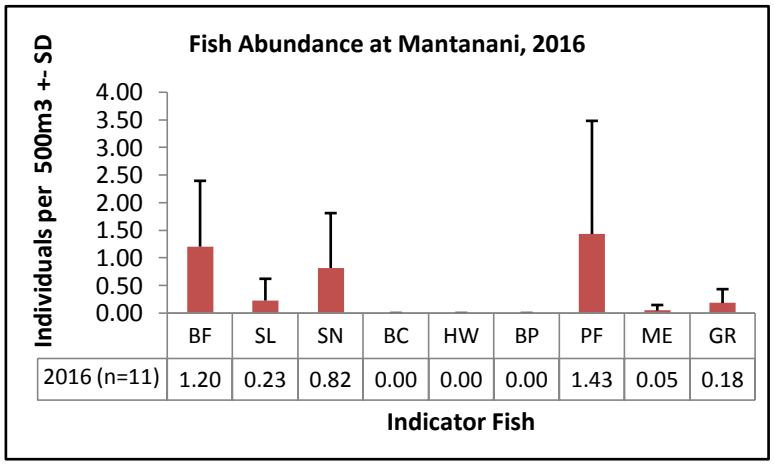
Substrate



Coral reefs around Mantanani islands are considered to be in 'Fair' condition, with 32.05% live coral cover, below the average (36.57%) for reefs in the North Borneo region.

The level of RB had increased significantly from 5.34% in 2015 to 18.86% in 2016. 6 out of the 11 sites surveyed recorded more than 20% RB. Fish bombing was likely to have caused the damage as dynamite dishing impact was recorded at many sites and fish blast was heard during survey.

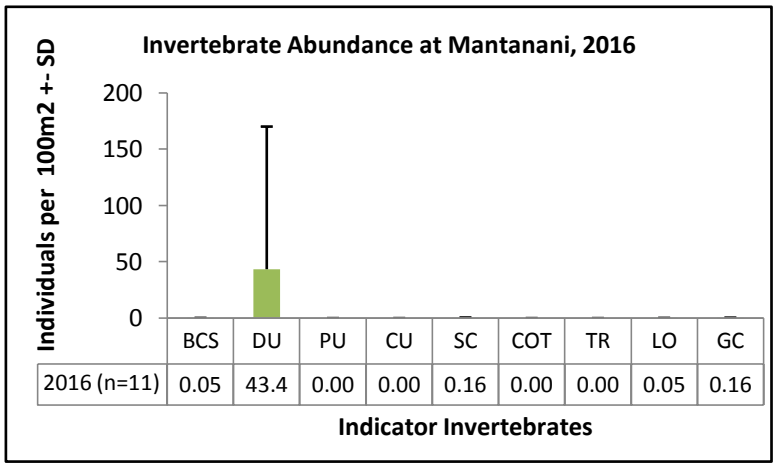
Fish



Three indicator species were completely absent from surveys (Barramundi Cod, Humphead Wrasse 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



Four indicator species were absent, including Pencil and Collector Urchin, Crown-of-thorns and Triton.

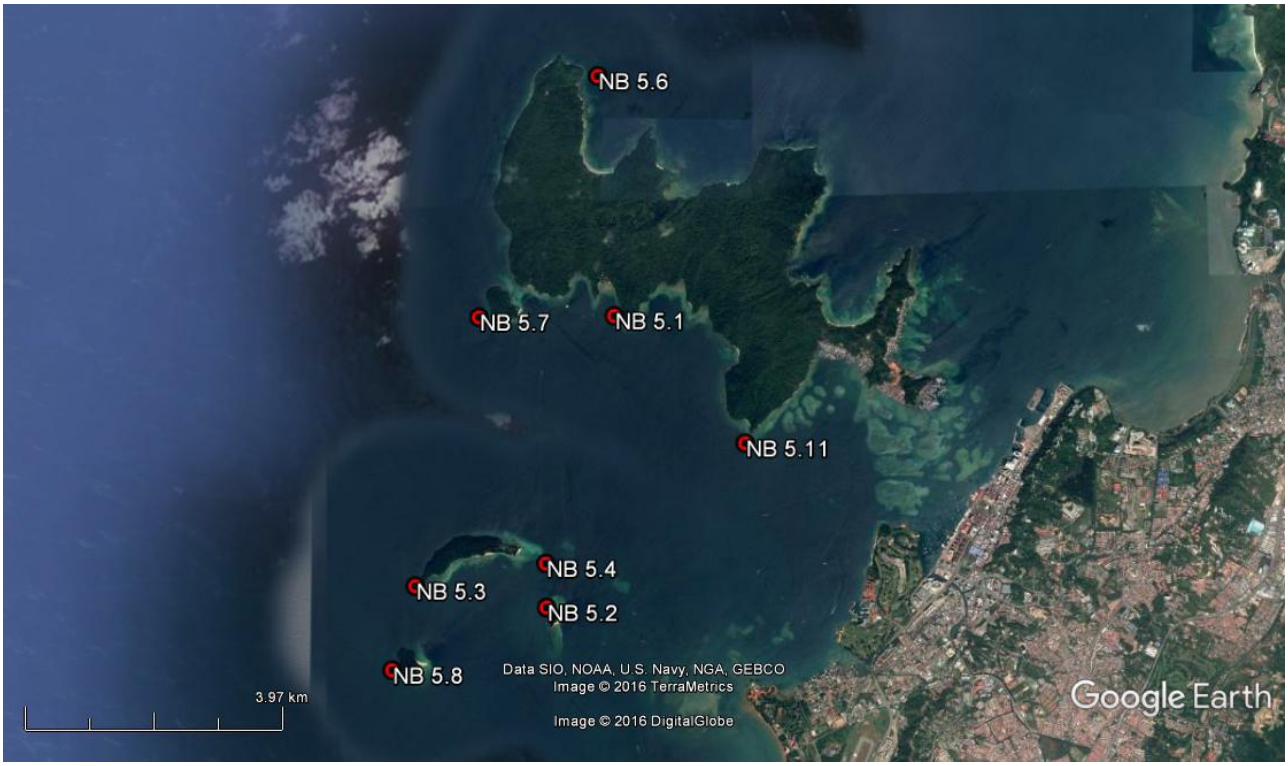
Abundance of Diadema Urchin was high. Other indicator species were present in very low number (Banded Coral Shrimp, Sea Cucumber, Lobster and Giant Clam).

Extensive human impacts were seen on most of the reefs. 8 out of 11 sites surveyed recorded dynamite fishing impacts. Signs of boat anchor damage, discarded fishing nets and trash were also visible during surveys. Fish bombing blast was heard at one site during surveys. Damage due to warn water bleaching was also observed at two sites. On a positive note, turtle was recorded at NB4.5 Riza Garden.

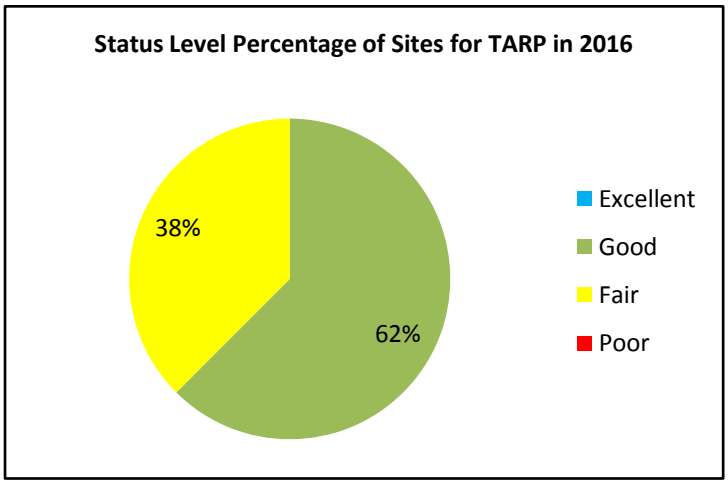
3.2.18 Tunku Abdul Rahman Park, Kota Kinabalu

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.

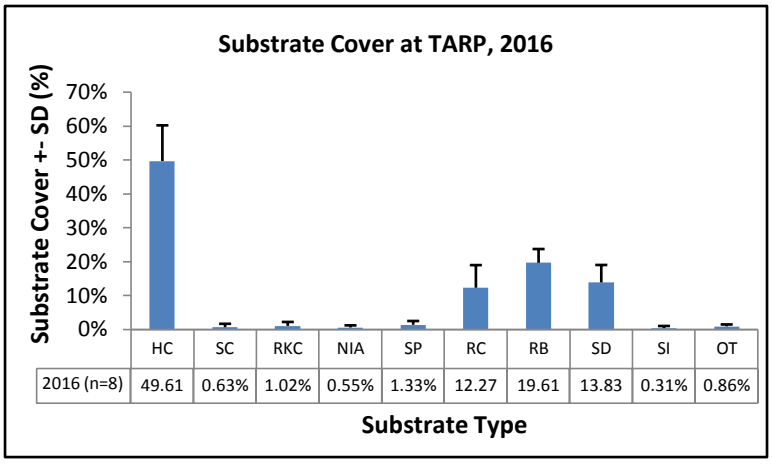


Map 22: Surveyed sites in TARP, Kota Kinabalu



A total of 8 coral reef sites were surveyed in TARP and 62% of the reefs were in good condition. The remaining 38% were in fair condition.

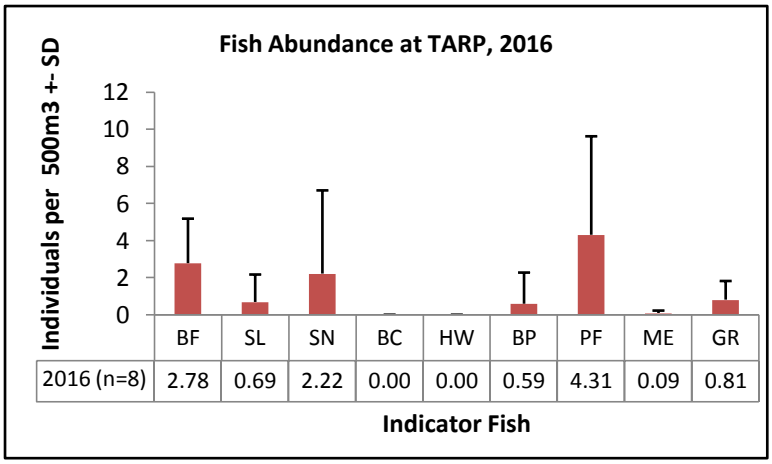
Substrate



Coral reefs around the islands are considered to be in 'Good' condition with 50.23% live coral cover, above the average (36.57%) for reefs within the North Borneo region.

The level of RB is high at 19.61% although it has dropped slightly from last year (20.10%). This needs to be monitored closely.

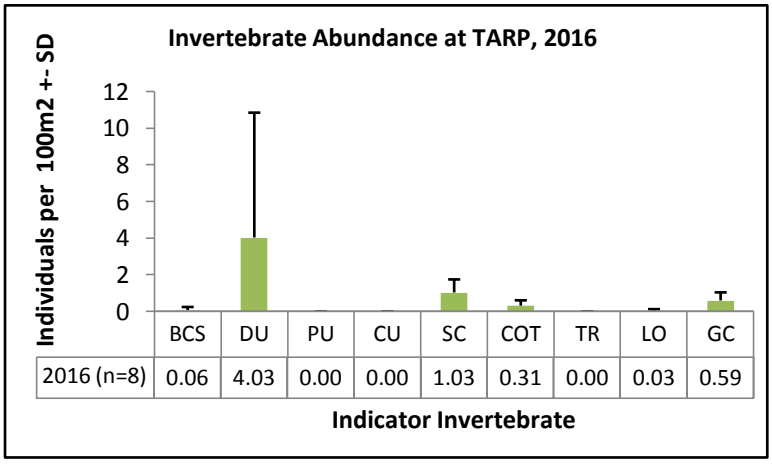
Fish



Only two indicator species were absent from surveys (Barramundi Cod and Humphead Wrasse).

Parrotfish was the most abundant indicator fish, followed by Butterflyfish and Snapper. Abundance of other indicators were very low (Sweetlips, Bumphead Parrotfish, Moray Eel and Grouper).

Invertebrates



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

Diadema Urchin was the most abundance indicator invertebrate, followed by Sea Cucumber. Abundance of other species was low (Banded Coral Shrimp, Sea Cucumber, Lobster and Giant Clam).

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

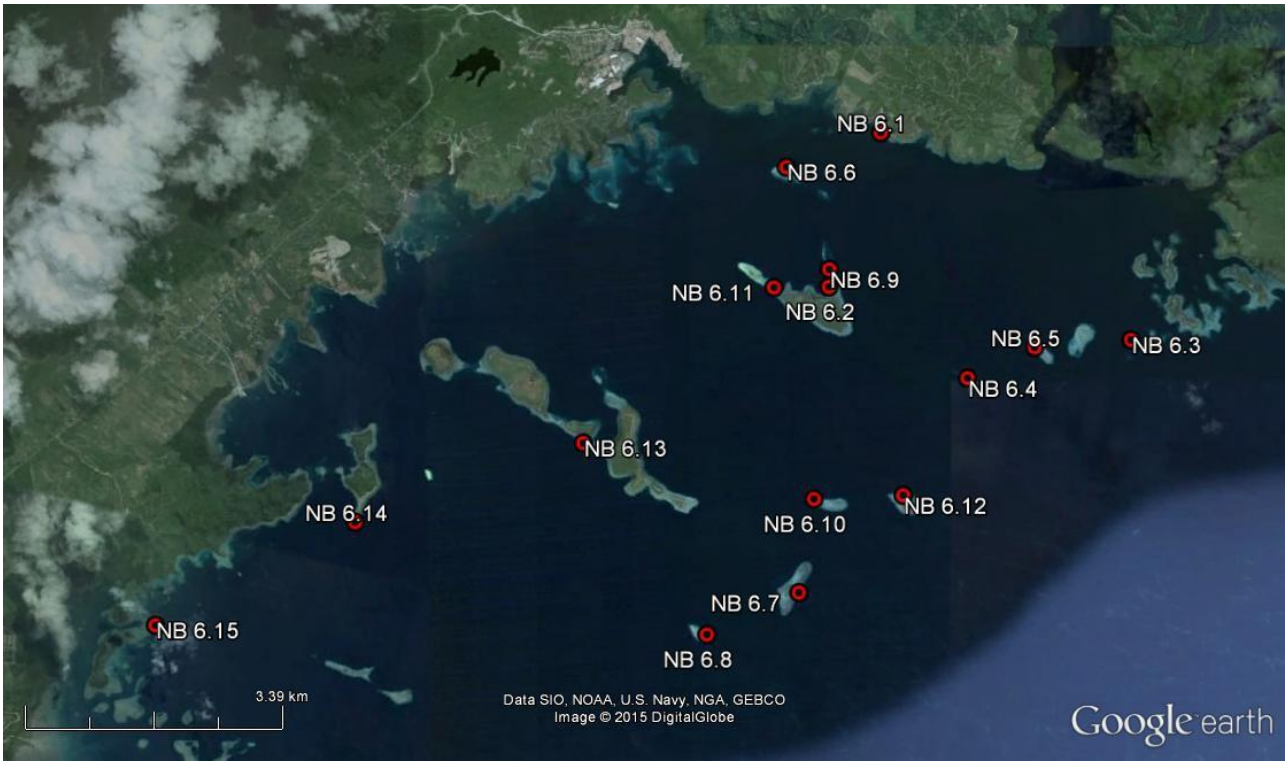
No damage was recorded during surveys.

3.2.19 Lahad Datu

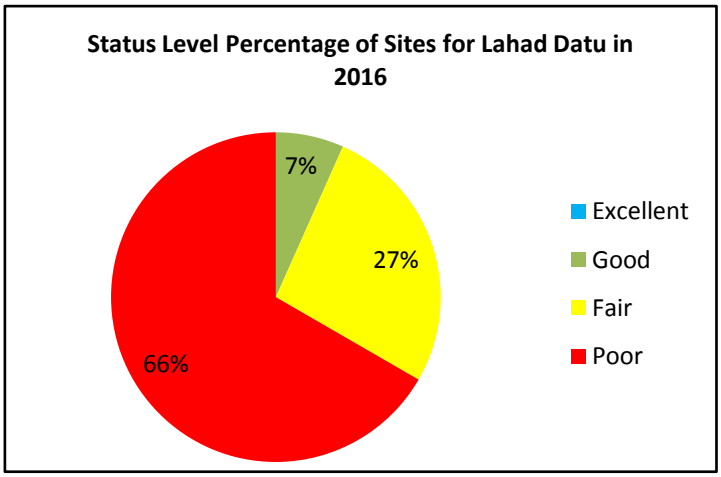
Lahad Datu is a town located in the east of Sabah, Malaysia, on the island of Borneo. It occupies the peninsula on the north side of Darvel Bay – the largest semi-enclosed bay on the east coast of Borneo islands. Administratively, it falls within the Tawau Division and is estimated to have a population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

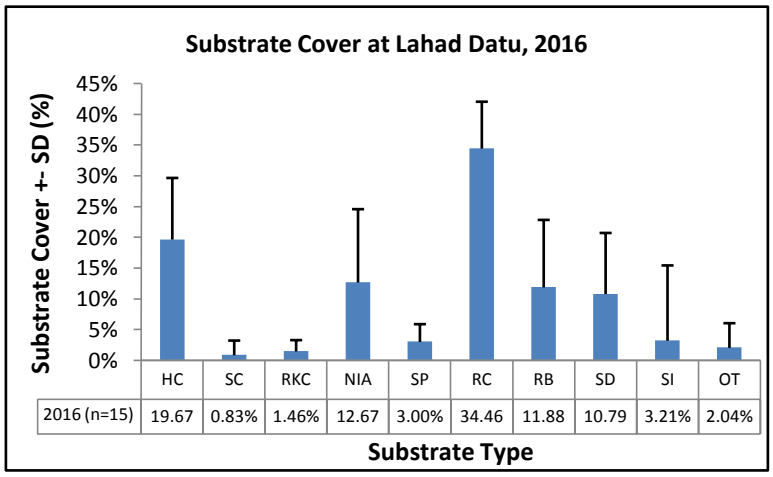


Map 23: Surveyed sites in Lahad Datu



A total of 15 coral reef sites were surveyed in Lahad Datu and 7% of the reefs were in good condition. 27% of the reefs were in fair condition and the remaining 66% were in poor condition. No reefs were in excellent condition.

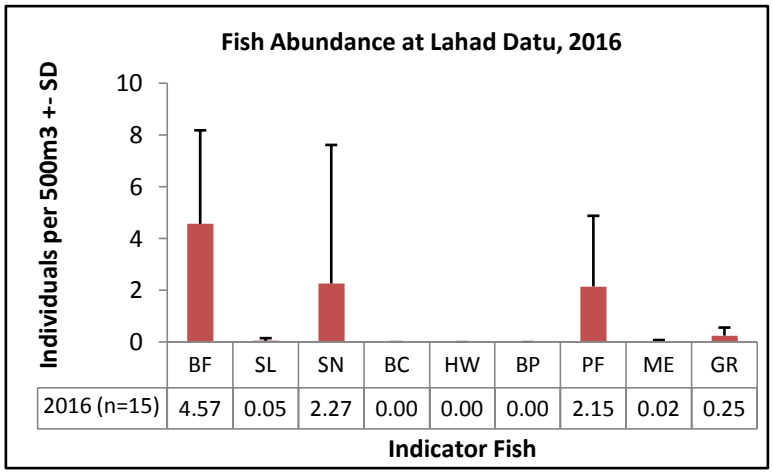
Substrate



Reefs in Lahad Datu are considered to be in 'Poor' condition with live coral cover of 20.50%, below the average (36.57%) for reefs in the North Borneo region.

NIA level (highest in North Borneo region) had increased significantly from 3.38% in 2015 to 12.67% in 2016. The level is especially high at NB6.6 Fish Eyes (44.38%), NB6.1 House Reef (29.38%) and NB6.11 Light House (22.50%). The level of SI had also increased; from 0.42% in 2015 to 3.21% in 2016.

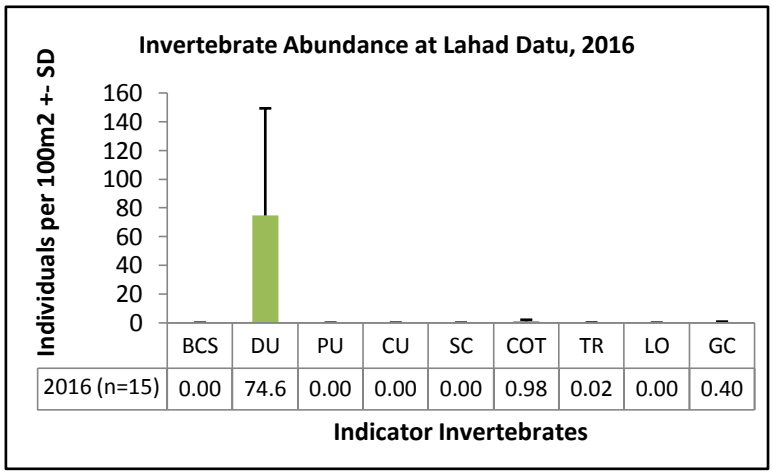
Fish



Only three indicator fish were absent during surveys (Barramundi Cod, Humphead Wrasse and Bumphead Parrotfish).

Butterflyfish recorded the highest number, followed by Snapper and Parrotfish. Other indicators were present in very low number.

Invertebrates



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

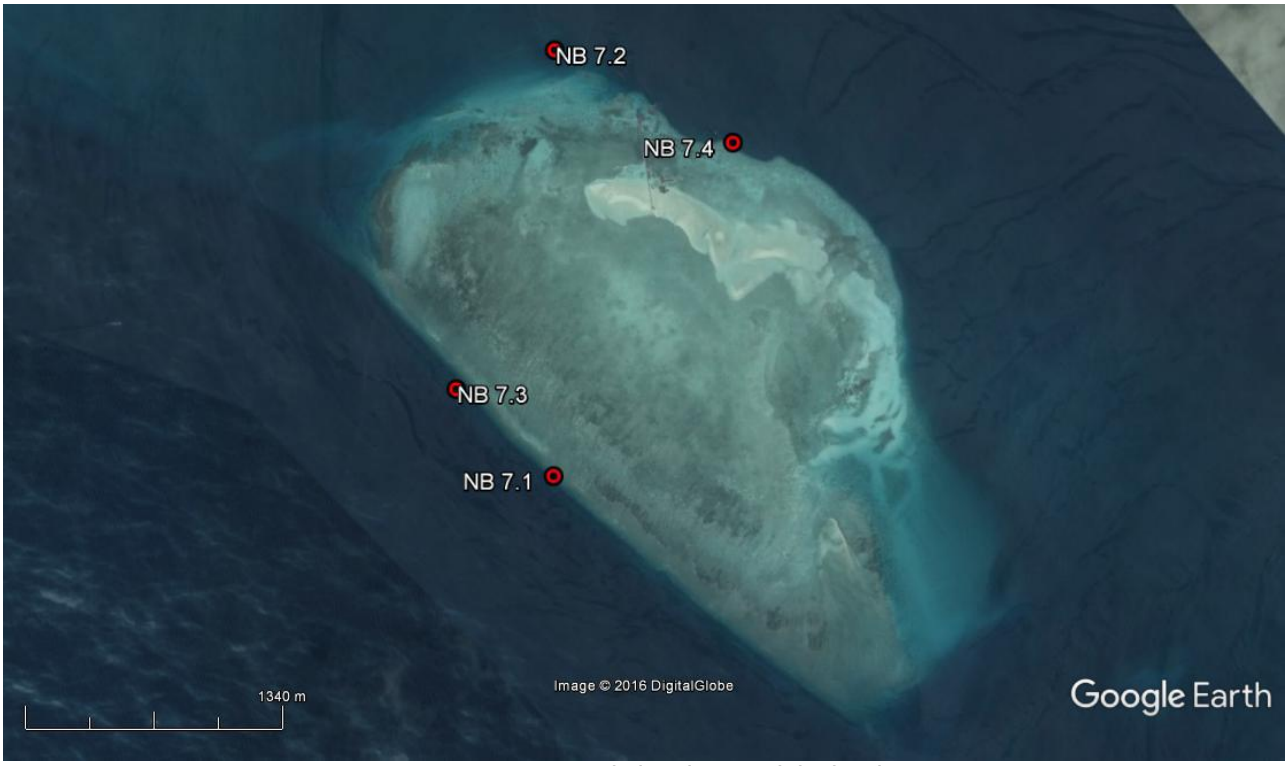
The abundance of Diadema Urchin was the second highest of all islands surveyed in North Borneo region. Lahad Datu is one of the three islands that recorded Triton during surveys.

The abundance of Crown-of-thorns was high and the number is way above what a healthy reef can sustain (0.2-0.3 ind./100m^2).

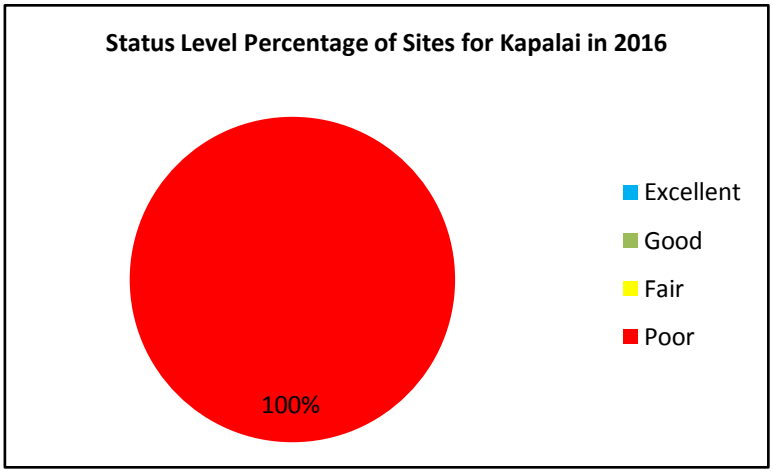
Discarded fishing nets, trash, boat anchor damage and dynamite fishing impacts were seen on many of the survey sites and many sites were damaged by Crown-of-thorns. NB6.15 Tumunong Hallo was highly impacted by siltation; the level of SI at the site was 47.50%.

3.2.20 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.

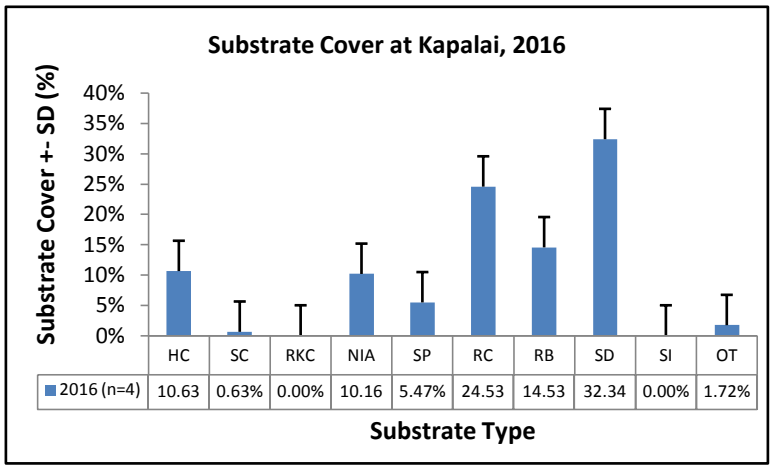


Map 24: Surveyed sites in Kapalai Island



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

Substrate

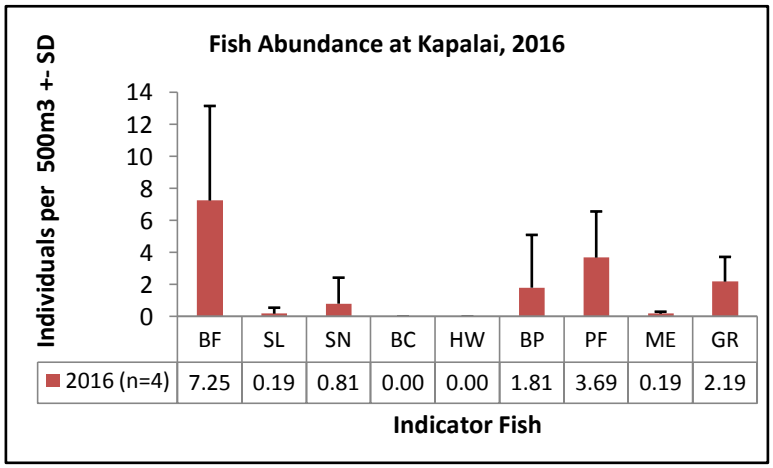


Reefs in Kapalai were considered to be in 'Poor' condition with 11.25% live coral cover and were way below the average (36.57%) for North Borneo Region.

The high level of RB was likely due to the ongoing practice of fish bombing within the region. NIA level had increased greatly from 1.38% in 2015 to 10.16% in 2016.

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

Fish

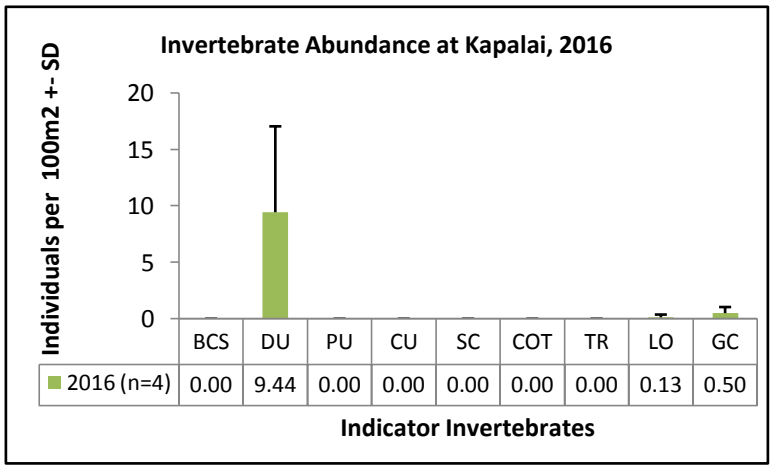


Only two fish were absent during surveys (Barramundi Cod and Humphead Wrasse).

The most abundance fish was Butterflyfish, followed by Parrotfish. Other indicators such as Sweetlips, Snapper and Moray Eel 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 observed during surveys, including Diadema Urchin, Lobster and Giant Clam.

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

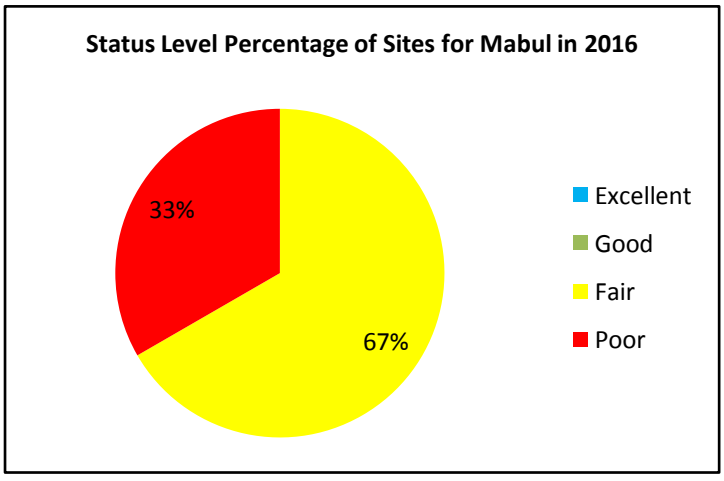
Kapalai recorded the second highest number of turtle sighted during surveys in whole Malaysia. Boat anchor damage and trash were observed during surveys. Two sites were also impacted by warm water bleaching.

3.2.21 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.

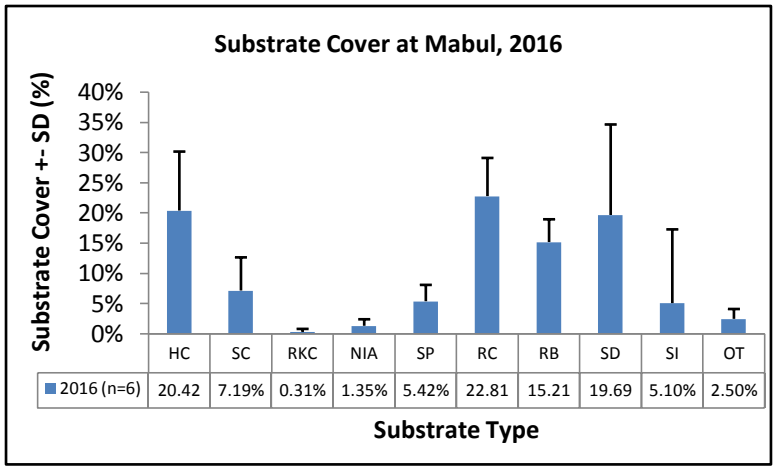
There are several dive resorts operating on Mabul island, which provides accommodation for scuba divers - most located on the island or on stilts over the water, while one is on a converted oil platform about 500 meters from the beach. There are also several home stay and backpacker accommodations which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

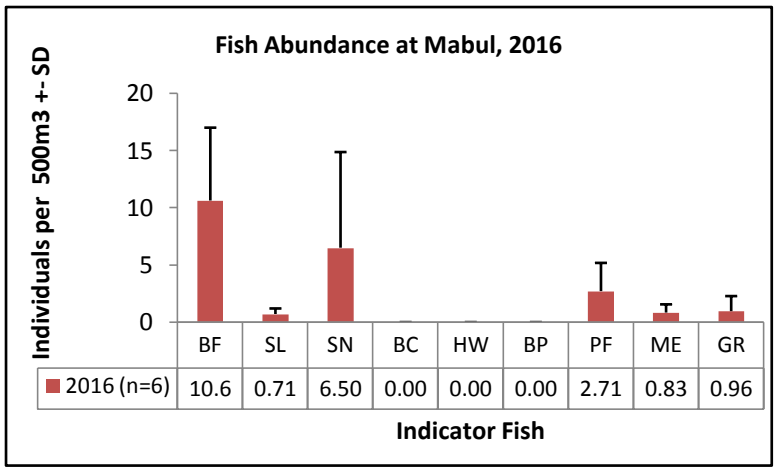


Reefs in Mabul were considered to be in 'Fair' condition with 27.60% live coral cover and were below the average (36.57%) for North Borneo Region.

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

SI level had increased from 4.38% in 2015 to 5.1% in 2016. The site that needs to be monitored is NB8.6 Scuba Junkie House Reef, which recorded as high as 30%.

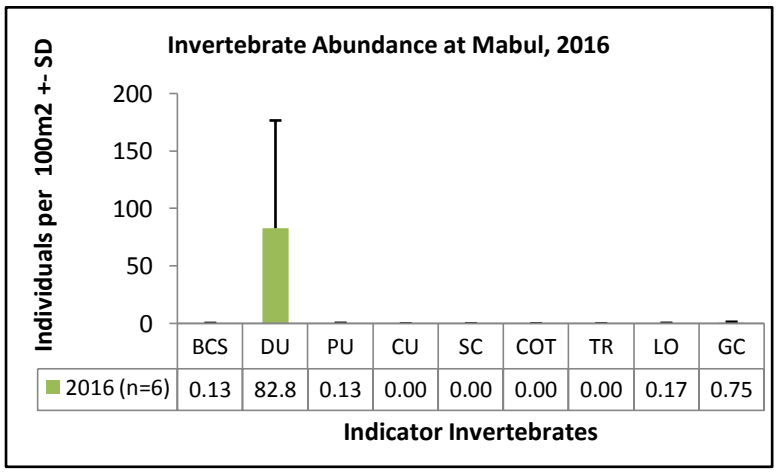
Fish



The abundance of Butterflyfish was the highest (second highest in North Borneo region), followed by Snapper and Parrotfish. Sweetlip, Moray Eel and Grouper were recorded in low number.

Prize food fish such as Barramundi Cod and Humphead Wrasse were absent.

Invertebrate



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

Mabul is the only island recorded Pencil Urchin during surveys in whole Malaysia.

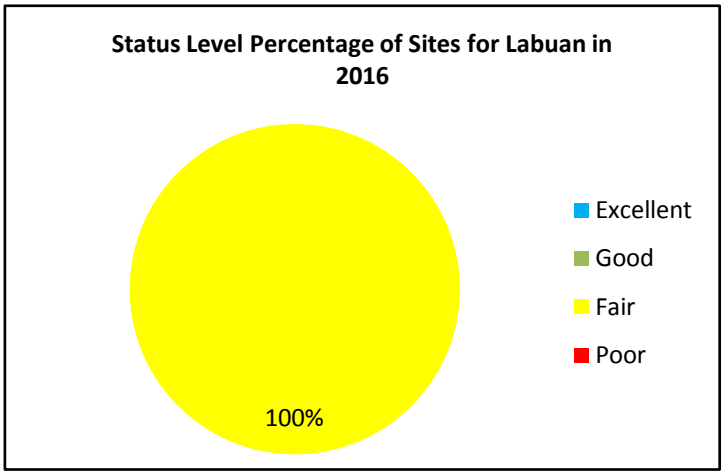
Damage by human and natural impacts was observed during surveys. Signs of coral damage due to boat anchor, dynamite fishing, trash and discarded fishing nets were seen at few sites. Turtle was also recorded during surveys, at 5 out of 6 sites surveyed.

3.2.22 Labuan

Labuan, officially the Federal Territory of Labuan, is a federal territory of Malaysia. Labuan is made up of one large island and six smaller islands (Pulau Daat, Pulau Burung, Pulau Kuraman, Pulau Papan, Pulau Rusukan Besar and Pulau Rusukan Kecil), and is located off the west coast of Sabah. Labuan is best known as an offshore financial centre offering international financial and business services since 1990 as well as being an offshore support hub for deepwater oil and gas activities in the region. It is also a tourist destination for people travelling through Sabah and for scuba divers.

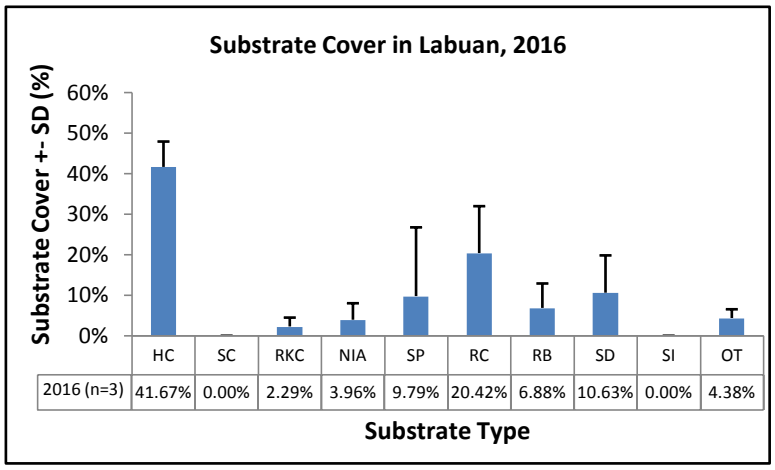
Three out of the six smaller islands form the Labuan Marine Park; they are Pulau Kuraman, Pulau Rusukan Besar and Pulau Rusukan Kecil. These three islands are located 2km off the southern part of Labuan Main Island. These islands are sparsely populated and are popular with expatriates, divers and those who travel between Labuan and Brunei.

Map 31: Surveyed sites in Labuan



A total of 3 coral reef sites were surveyed in Labuan and 100% of the reefs were in fair condition.

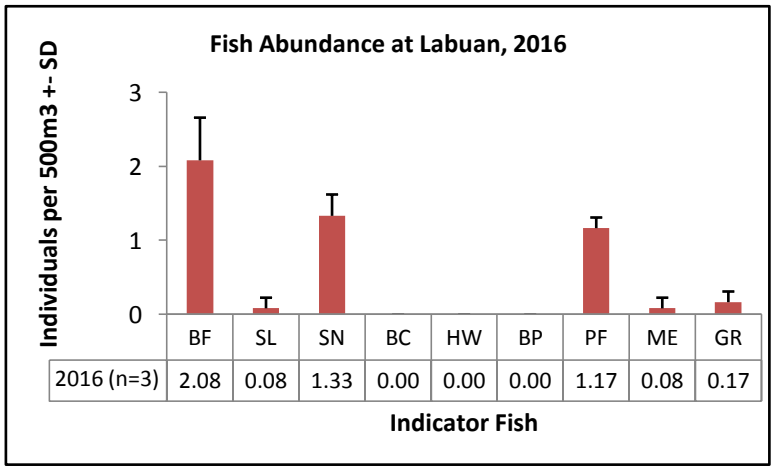
Substrate



Coral reefs in Labuan were considered to be in 'Fair' condition with 41.67% live coral cover and above the average (36.57%) of reefs within the North Borneo region.

The level of NIA and RB was high, indicating high level of recent disturbances in the area.

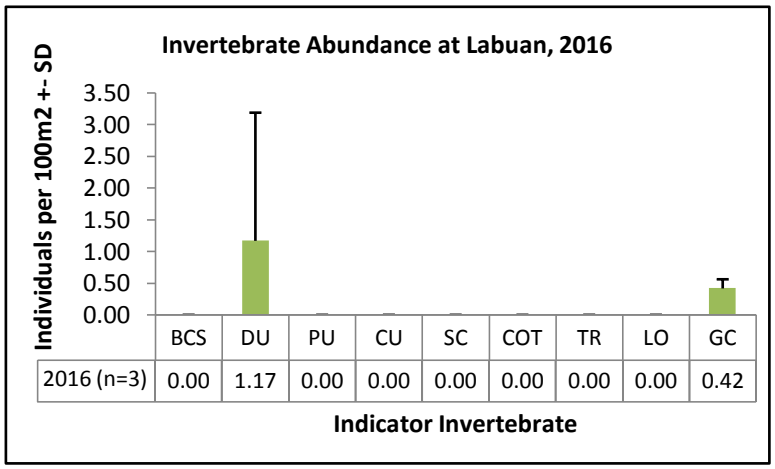
Fish



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

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

Invertebrate

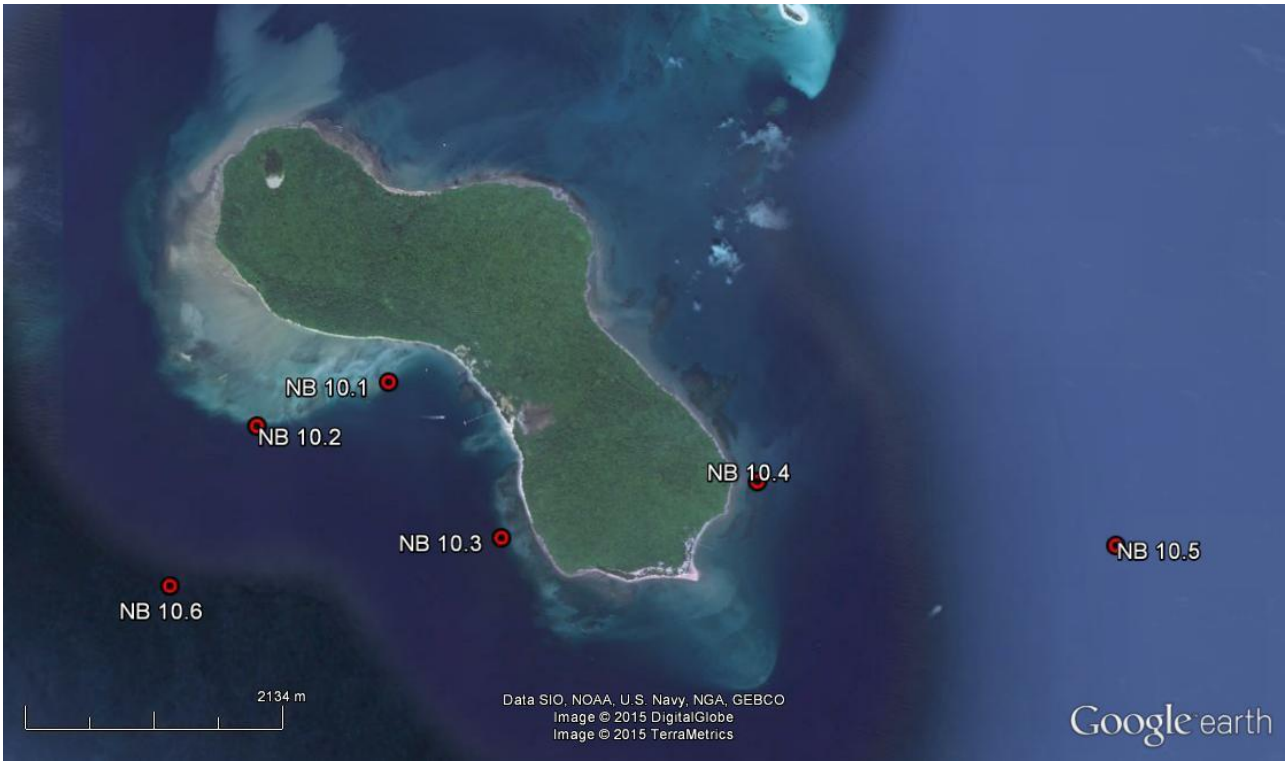


Only two indicator invertebrates were observed during surveys, including Diadema Urchin and Giant Clam. The abundance recorded was low.

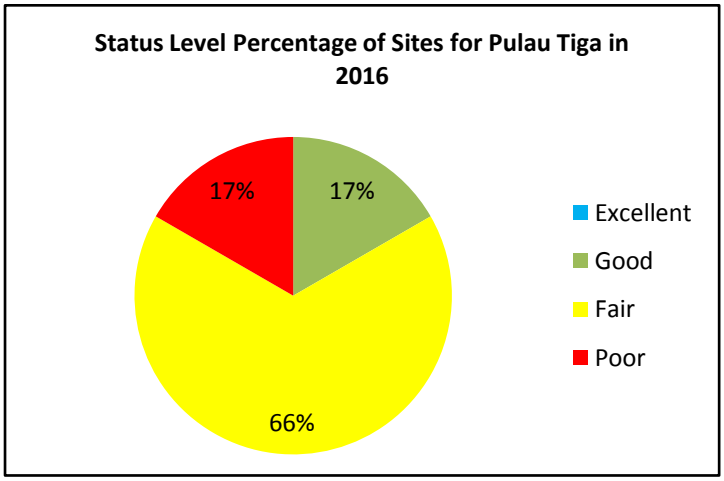
Warm water bleaching was observed at one site NB9.2 Boya Jo.

3.23 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.

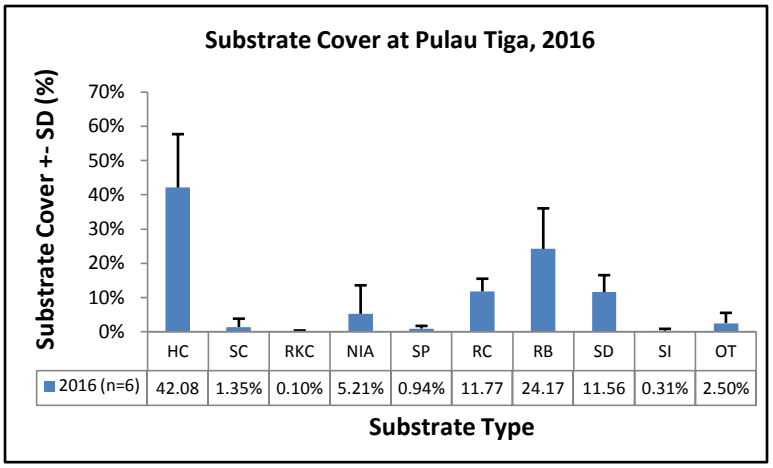


Map 27: Surveyed sites in Pulau Tiga



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.

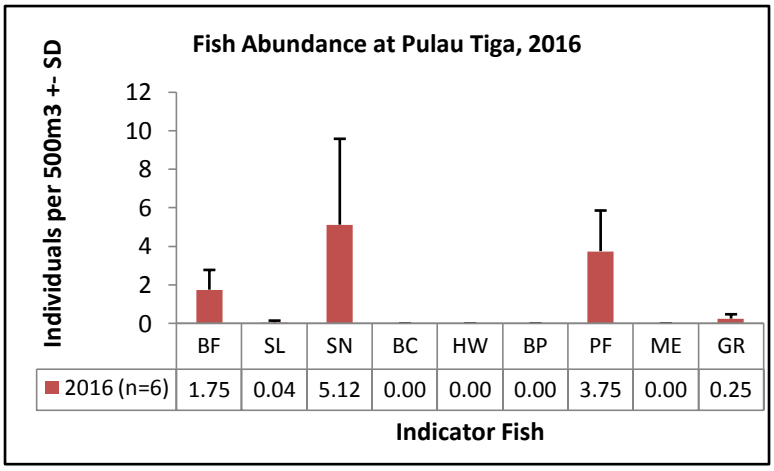
Substrate



Reefs in Pulau Tiga were considered to be in 'Fair' condition with 43.44% live coral cover and were above the average (36.57%) for North Borneo Region.

The level of RB was high with 4 sites recorded more than 20%. The level has increased from 1.25% in 2015 to 5.21% in 2016. This is a cause for concern and needs to be monitored closely.

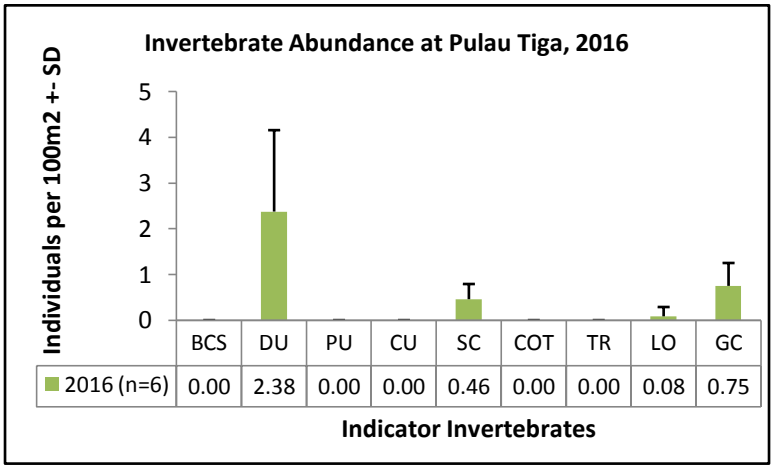
Fish



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

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

Invertebrate



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

The abundance of Diadema was the highest. Sea Cucumber, Lobster and Giant Clam were present in low number.

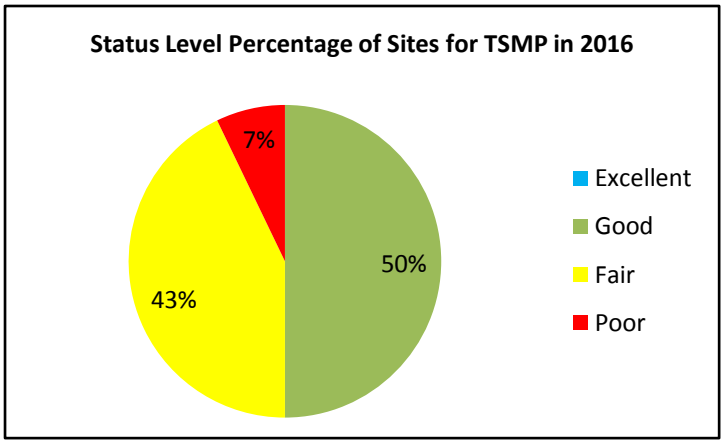
Boat anchor damage and discarded fishing nets were observed during surveys. Shark was also observed during surveys.

3.2.24 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.

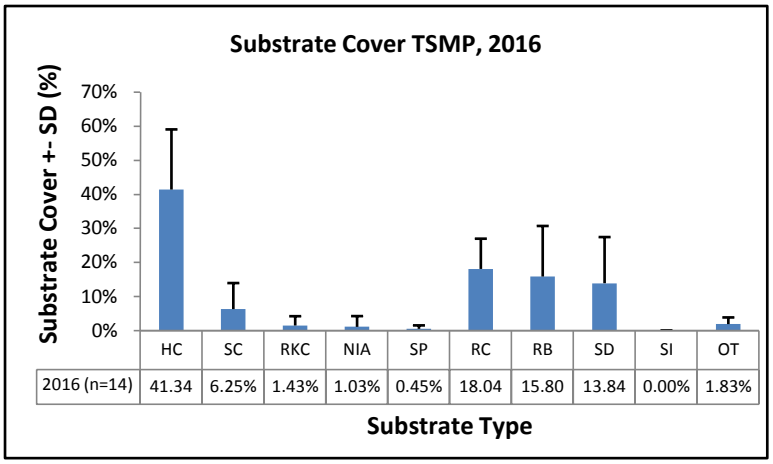
In 2004, the park became the seventh gazetted area under Sabah Parks with a total area of 100.8 km². There are approximately 2,000 people living within the park.

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



A total of 14 coral reef sites were surveyed in TSMP and 50% of the reefs were in good condition. 43% were in fair condition and 7% were in poor condition.

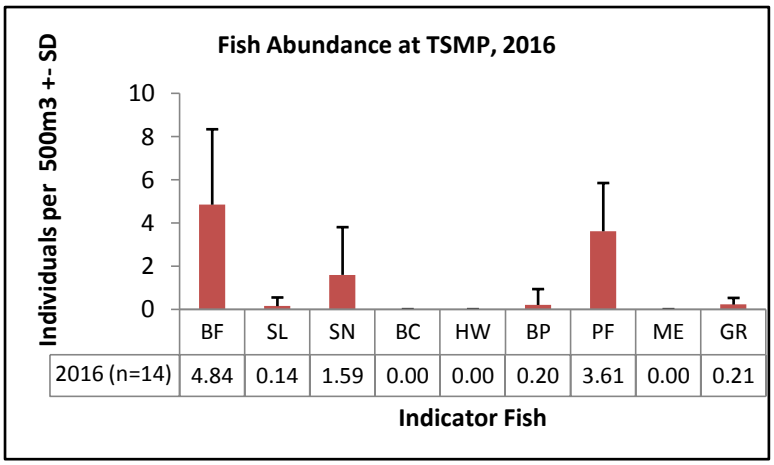
Substrate



Coral reefs within the TSMP were considered to be in 'Fair' condition with 47.59% live coral cover, below the average (36.57%) for reefs within the North Borneo region.

The level of RB has increased from 12.29% in 2015 to 15.80% in 2016. NB11.1 Dead End Channel and NB11.7 Tanjung Kenangan recorded exceptional high level of RB. The high level of RB may be due to illegal fish bombing activities. The level of RKC has decreased from 3.85% in 2015 to 1.43% in 2016.

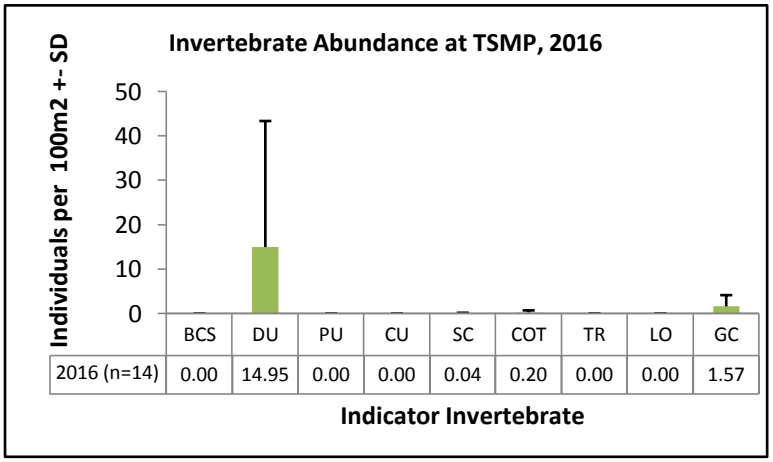
Fish



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

Barramundi Cod, Humphead Wrasse and Moray Eel 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.

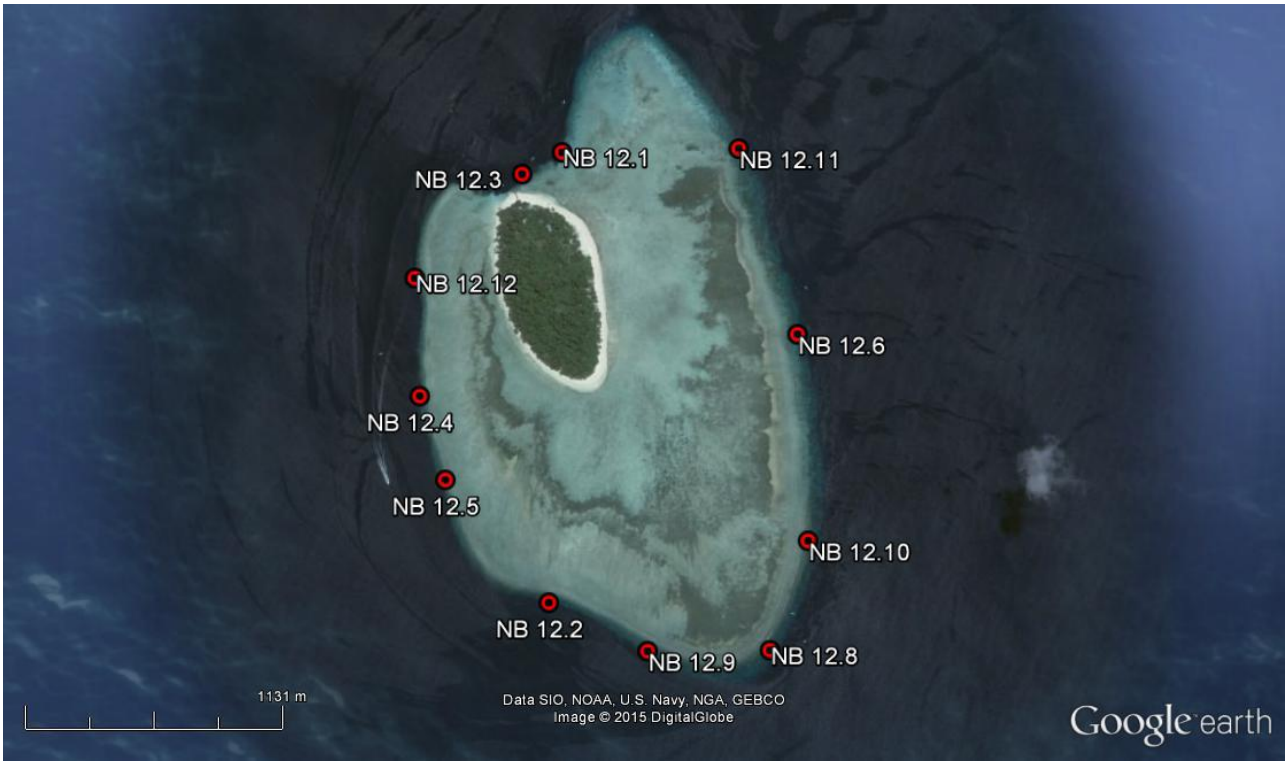
TSMP is one of the three islands recorded Triton during whole surveys.

Turtle and shark were observed during the surveys.

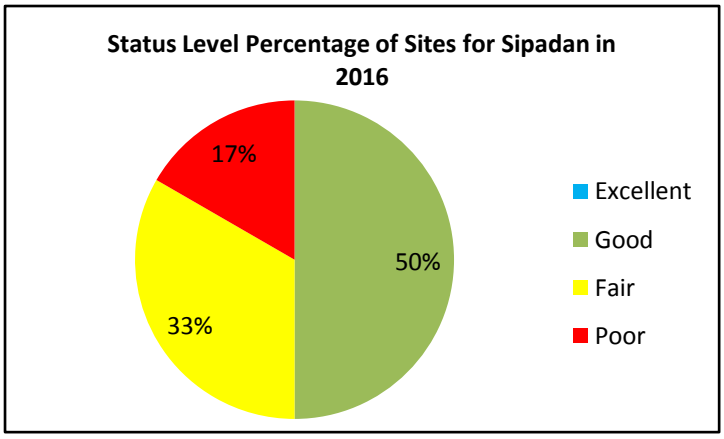
3.2.25 Sipadan

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

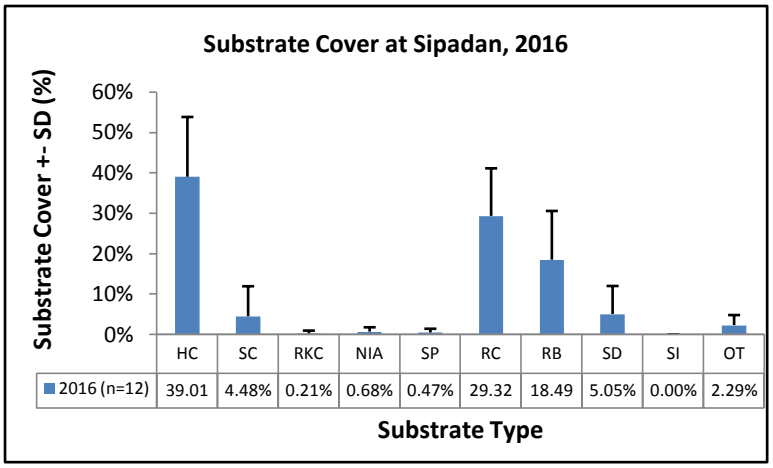


Map 29: Surveyed sites in Sipadan



A total of 11 coral reef sites were surveyed in Sipadan and 50% of the reefs were in good condition. 33% were in fair condition and the remaining 17% were in poor condition. No reefs were in excellent condition.

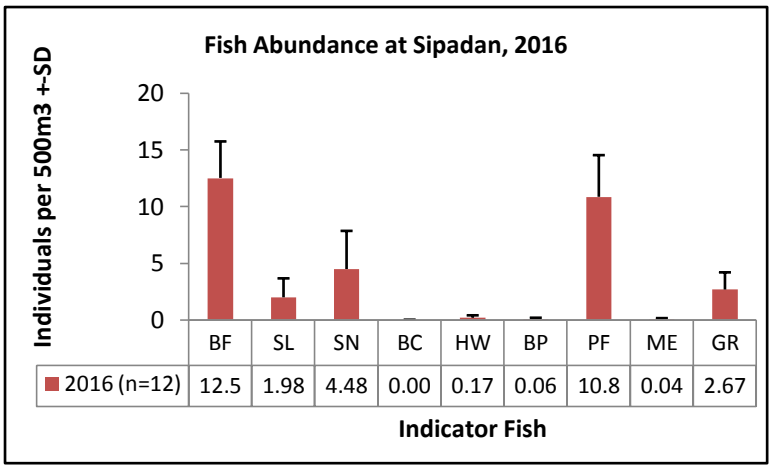
Substrate



Coral reefs within the Sipadan were considered to be in 'Fair' condition with 43.49% live coral cover and above the average (36.57%) of reefs within the North Borneo region.

High amount of RB was recorded and the level has increased from 13.18% in 2015 to 18.49% in 2016. This may be due to the high number of tourists visiting the island and is a cause for concern and need to be monitored closely.

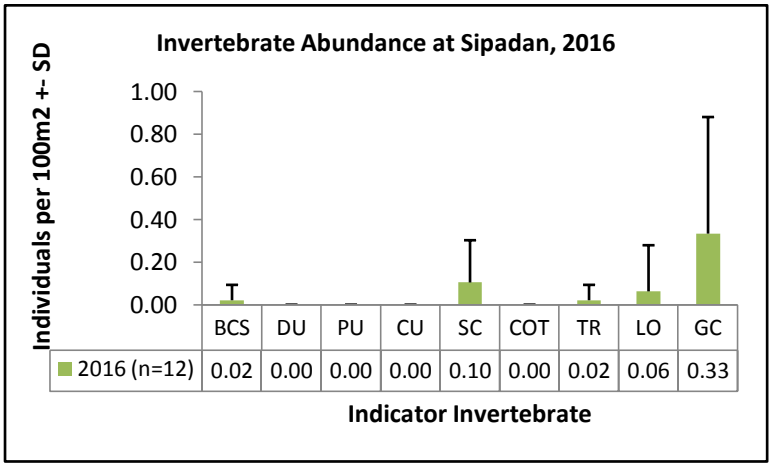
Fish



Butterflyfish was the most abundant indicator recorded during surveys, followed by Parrotfish and Snapper. Sipadan recorded the highest number of Butterflyfish, Parrotfish and Grouper of all islands surveyed in the North Borneo region.

Humphead Wrasse, Bumphead Parrotfish and Moray Eel were present in low number.

Invertebrate



All indicator invertebrate were recorded in low abundance, less than 1 ind./100m^2.

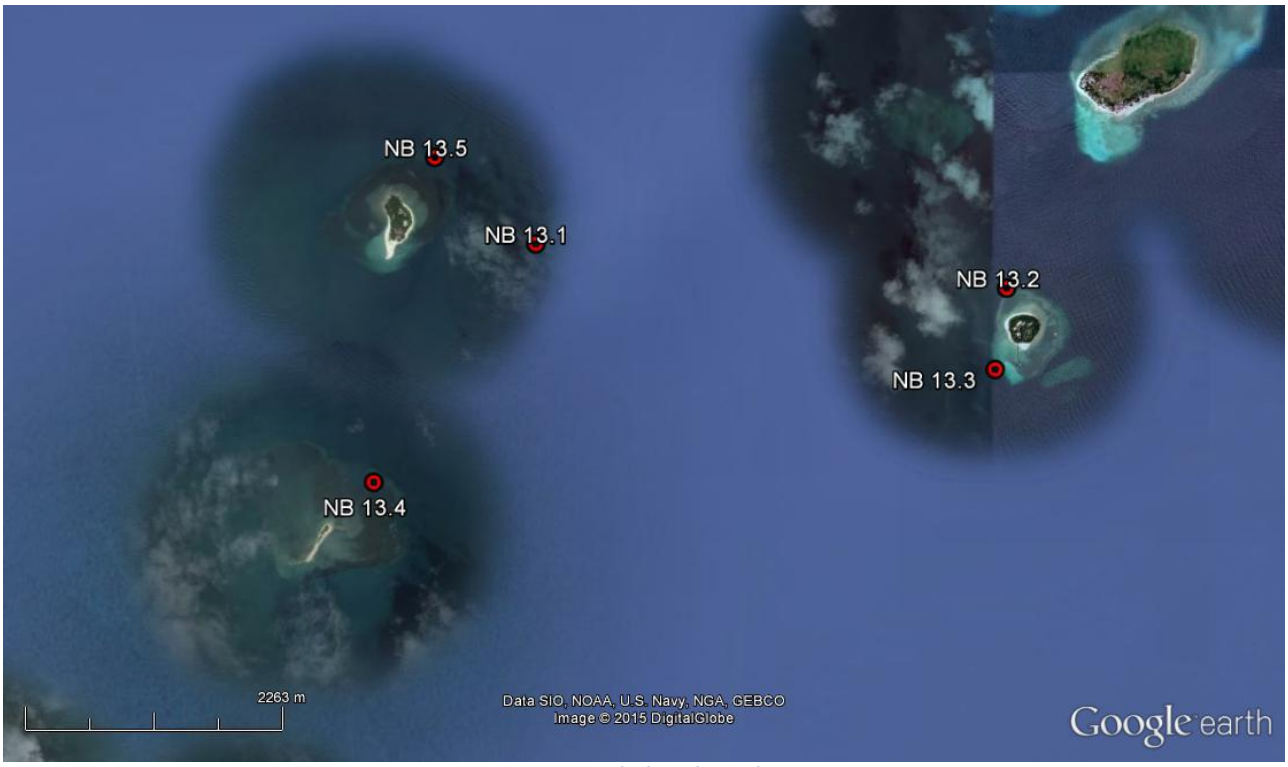
Sipadan is one of the three islands that recorded Triton during surveys.

Many turtles and sharks were recorded during surveys.

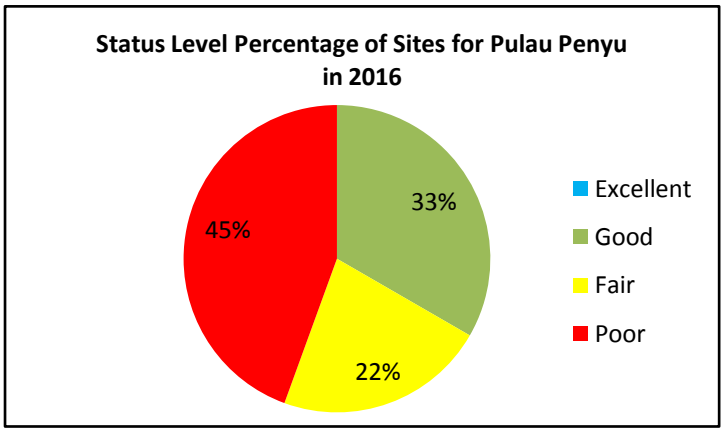
3.2.26 Pulau Penyu

Pulau Penyu lies in the Sulu Sea some 40km north of Sandakan, Sabah. It comprises of three islands; Pualau 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 eggmust 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.

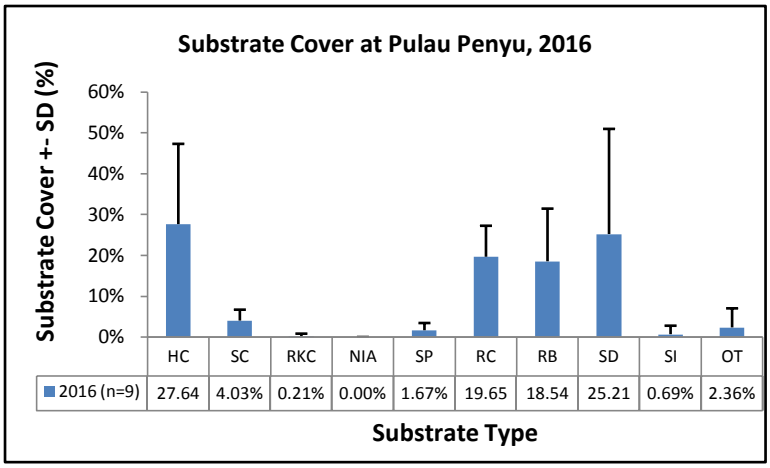


Map 30: Surveyed sites in Pulau Penyu



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

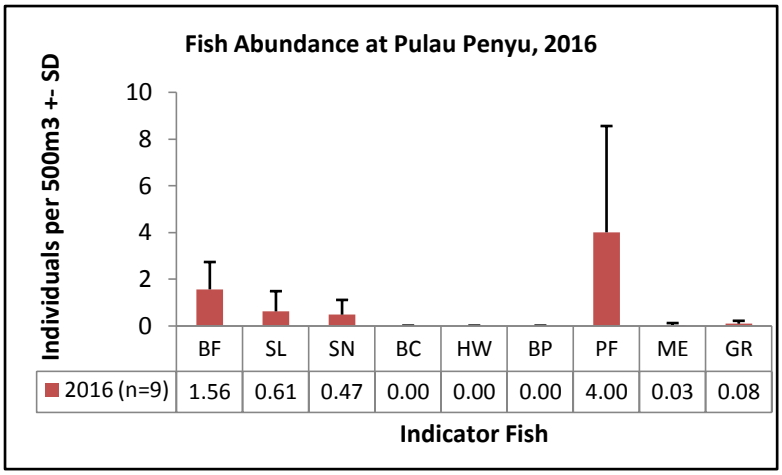
Substrate



Coral reefs in Pulau Penyu were considered to be in 'Fair' condition with 31.67% live coral cover and below the average (36.57%) of reefs within the North Borneo region.

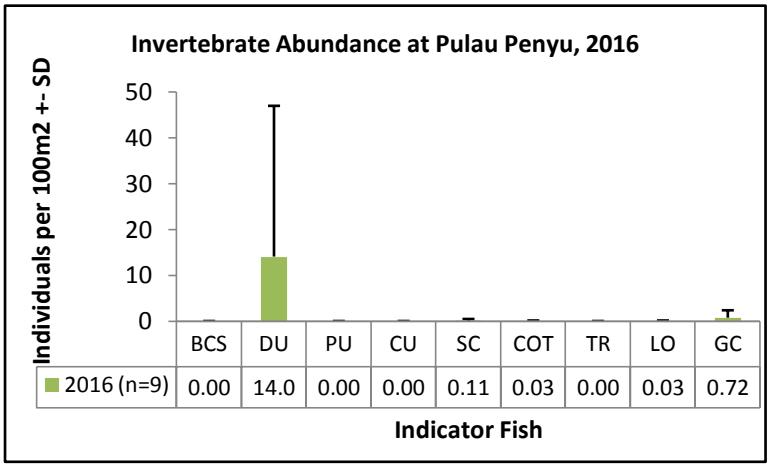
The islands in general have high level of SD. The level of RB has doubled, increased from 8.61% in 2015 to 18.54% in 2016. This indicates high level of recent disturbances in the area and is a cause for concern**.**

Fish



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

Invertebrate



Only five indicator invertebrates were observed during surveys, including Diadema Urchin, Sea Cucumber, Crown-of-Thorns, Lobster and Giant Clam. Their abundance were recorded in low number, less than 1 ind./100m^2, except for Diadema Urchin.

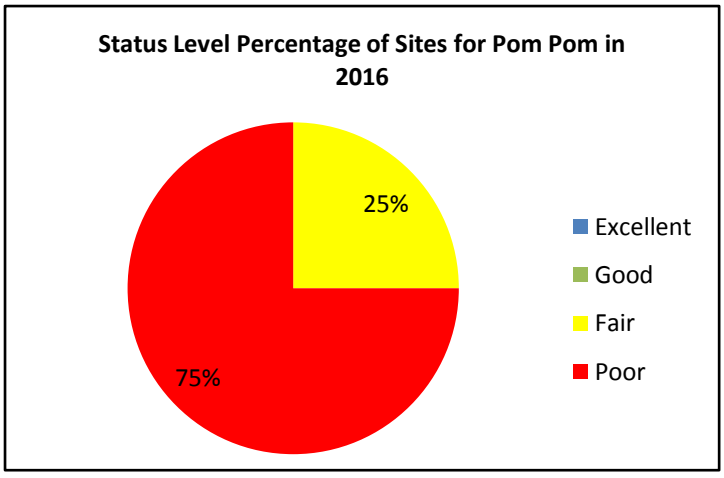
Turtle was observed during surveys at NB13.3 Pulau Bakungan 2 and NB13.4 Pulau Gulisan.

3.2.27 Pom Pom

Pom Pom Island is a small coral reef island approximately 30km North East of Semporna, Sabah. The island is 2.3km in circumference at the high tide line with a fringing coral reef 4km long. The island is flat sand with a maximum elevation of less than 2m above the high tide line. The reef flat is only 50-75m wide to the west and several hundred metres wide around most of the island. The island has a white sand coral beach and is a significant nesting location site for Green and Hawksbill turtles.

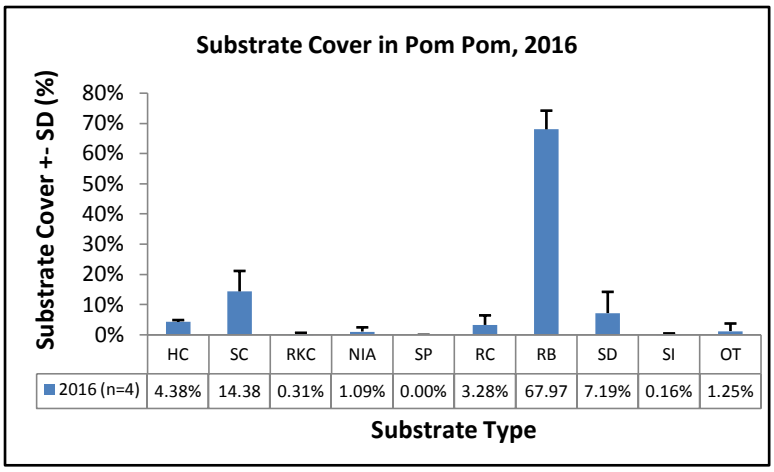
Pom Pom Island is one of the popular dive destinations in the Semporna district. The island has no village, only one resort and one research centre. There is no public transport to the island, the resorts carry their own guests and the research centre arranges transportation for its own students and volunteers. There are occasional day trips from dive centre in Semporna. The boat trip takes about 35–60 minutes using the speedboat.

Map 32: Surveyed sites in Pom Pom



A total of 4 coral reef sites were surveyed in Pom Pom and 25% of the reefs were in fair condition. The remaining 75% were in poor condition. No reefs were in excellent or good condition.

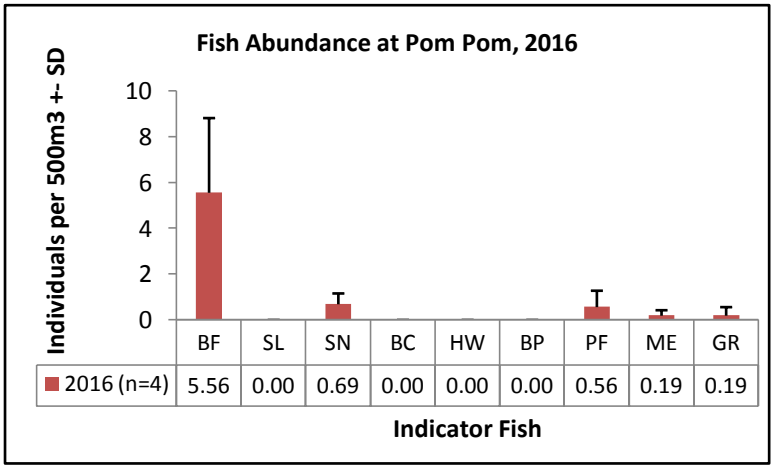
Substrate



Coral reefs in Pom Pom were considered to be in 'Poor' condition with 18.75% live coral cover and way below the average (36.57%) of reefs within the North Borneo region. The live coral cover was largely attributed to the high level of SC (14.38%).

The level RB was very high, indicating high level of recent disturbances in the area. This is confirmed with our impact surveys which recorded high level of damage from dynamite fishing.

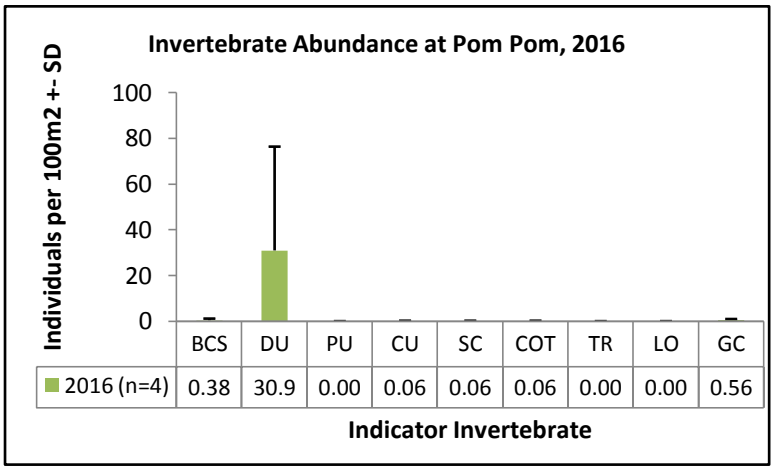
Fish



Butterflyfish was the most abundant indicator fish recorded during surveys.

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

Invertebrate



Five indicator invertebrates were observed during surveys. Diadema Urchin recorded the highest number. Other indicators were present low abundance, less than 1 ind./100m^2.

Pom Pom is one of the three islands recorded Collector Urchin during surveys. Crown-of-thorns abundance was within the healthy range.

Extensive damage by dynamite fishing was recorded at all sites. The severity of the damage recorded was the high. Damage due to warm water bleaching was also recorded at two sites however the severity is very low. On a positive note, turtles were observed at NB14.1 Lobster Lair and NB14.2 Mandarin House Reef.

4. Ten 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 10 years to assess changes to Malaysia's reefs over the period.

4.1 Peninsular versus East Malaysia over 10 years

The charts below show changing substrate cover, fish and invertebrate abundance over the last 10 years, separated into Peninsular Malaysia and East Malaysia.

4.1.1 Substrate

As stated in section 3.1.1, LCC can be used as a broad indicator of coral reef health. Data from surveys conducted around Peninsular Malaysia over the last 10 years show that there has been some variation in coral reef health.

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. In 2016, 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 5 few years NIA level increased gradually. Although slight, the levels of RB and SD have also been increasing steadily over the last 10 years and this needs to be monitored closely as the increase is an indication of disturbances.

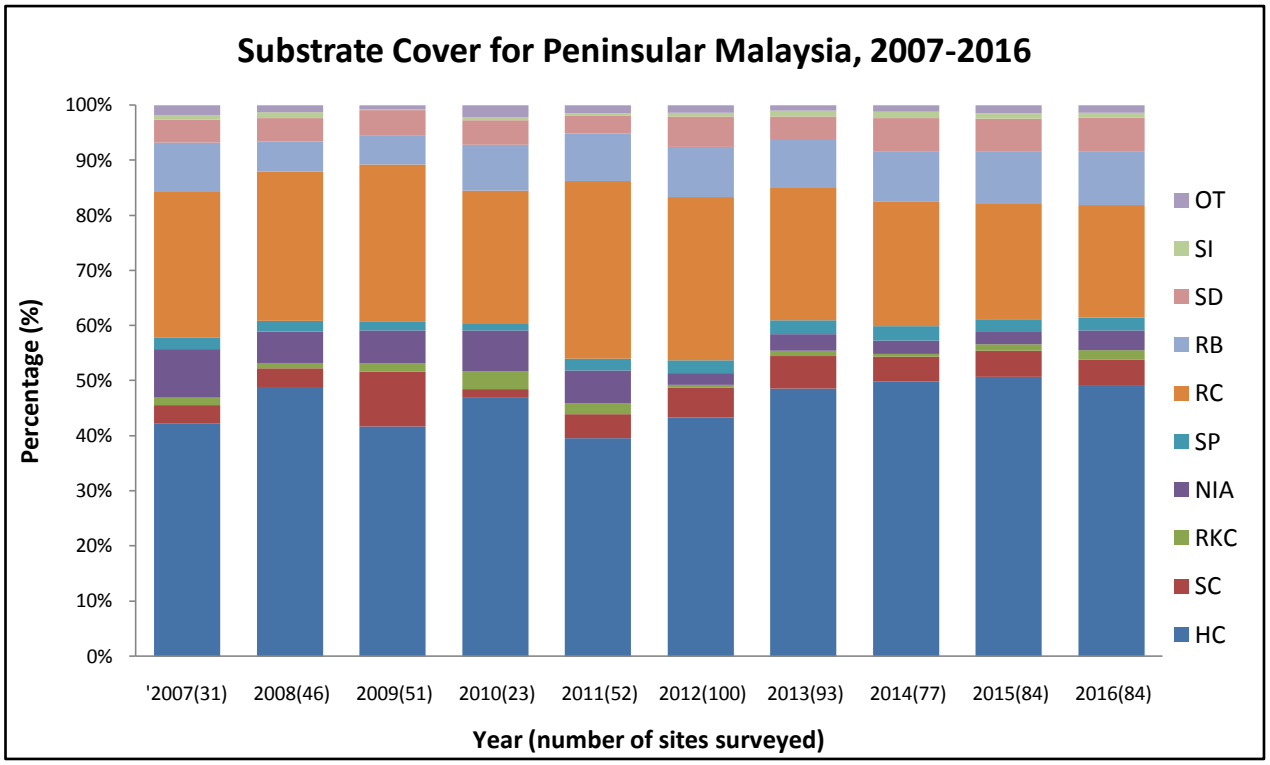


Chart 4: Substrate Cover in Peninsular Malaysia from 2006 to 2017

In East Malaysia, LCC has been consistently in fair condition (see chart 5). 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.

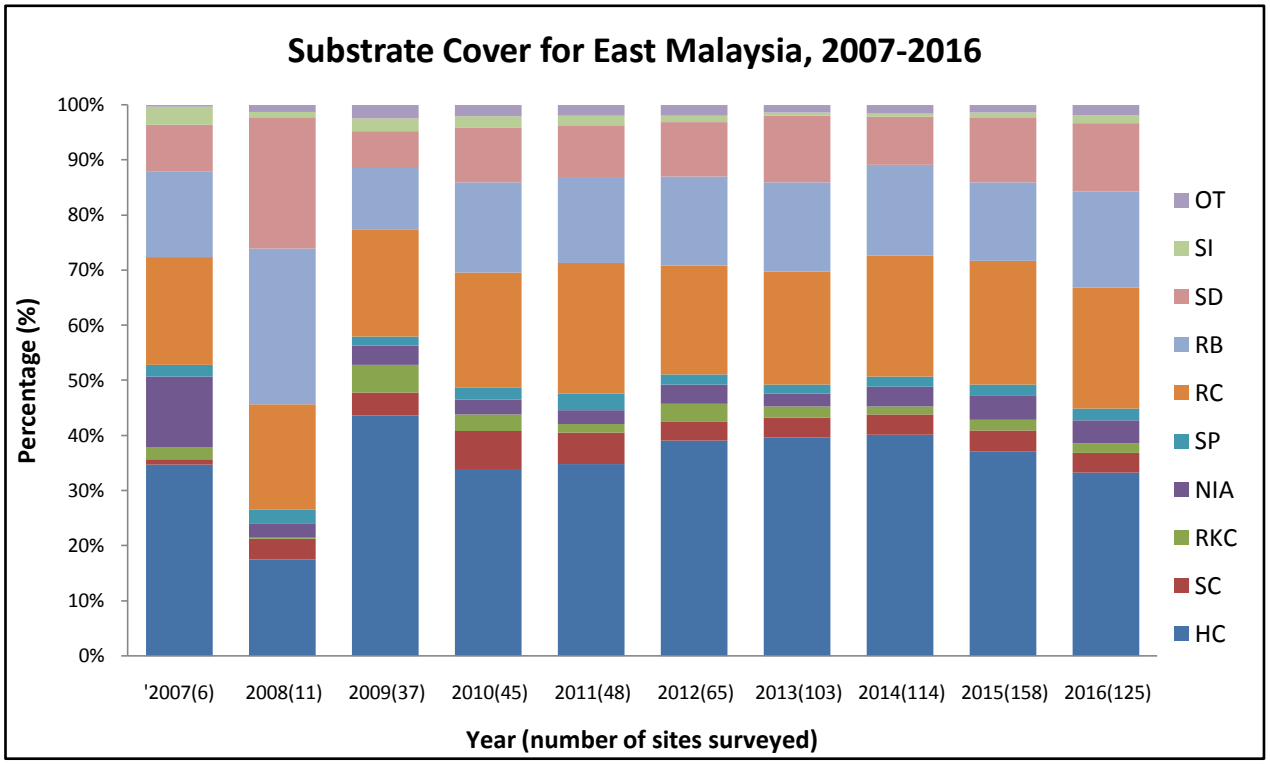


Chart 5: Substrate Cover in East Malaysia from 2006 to 2017

4.1.2 Fish

Over the last 10 years, fish abundances in both Peninsular and East Malaysia show little variation. 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.

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. In the last 2 years, no Barramundi Cod were recorded at all in both Peninsular and East Malaysia. 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.

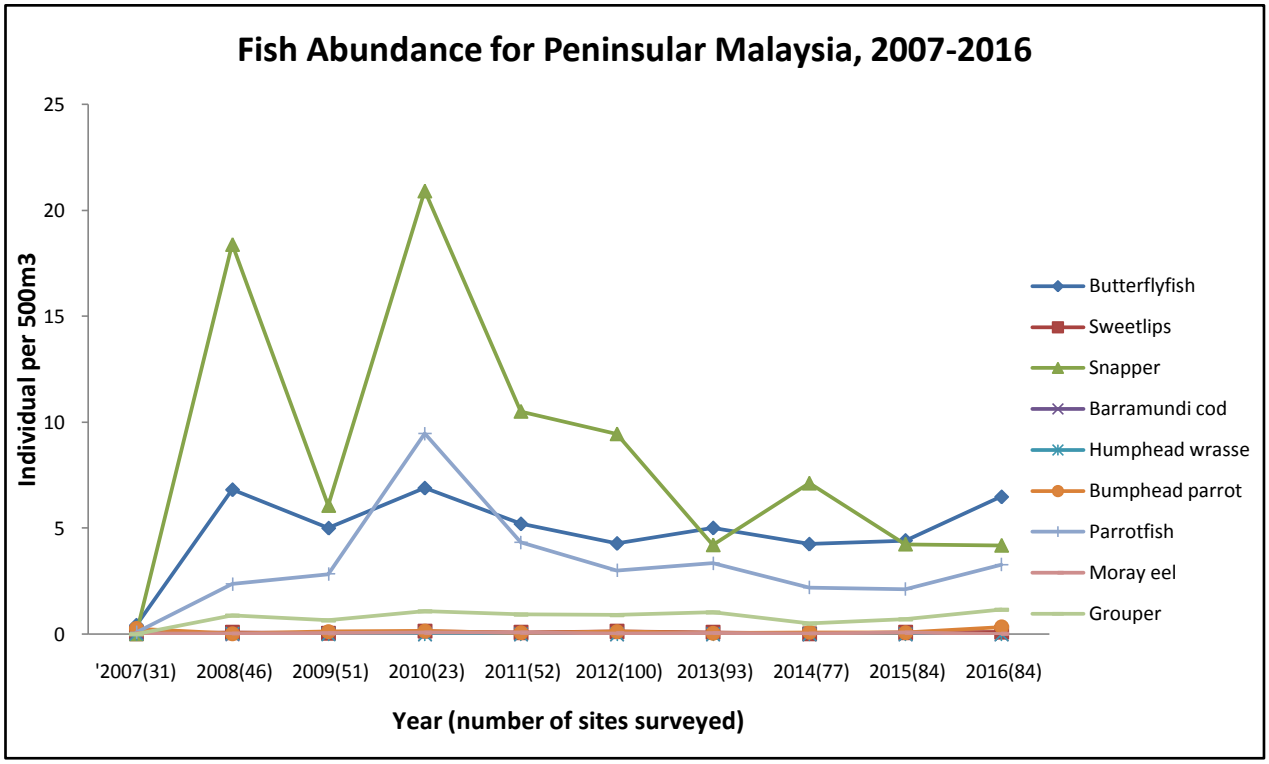


Chart 6: Fish Abundance in Peninsular Malaysia from 2006 to 2017

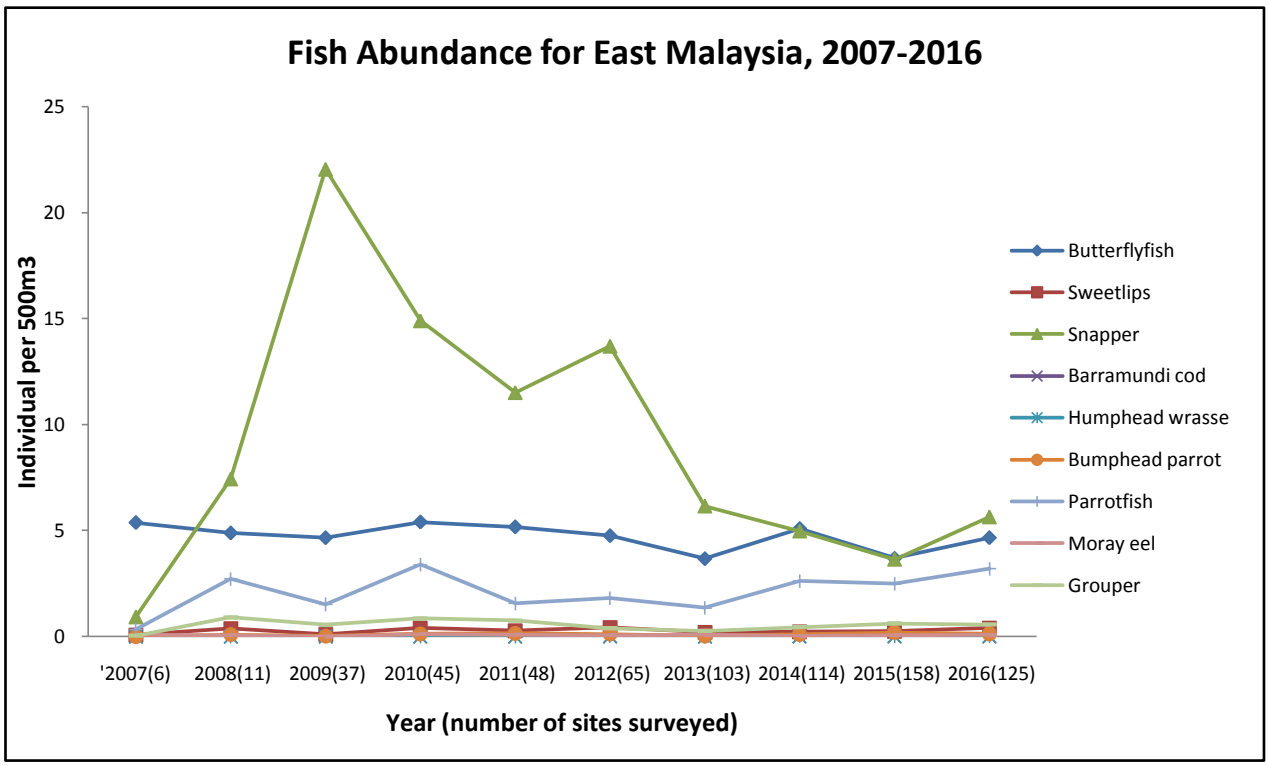


Chart 7: Fish Abundance in East Malaysia from 2007 to 2016

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. 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.

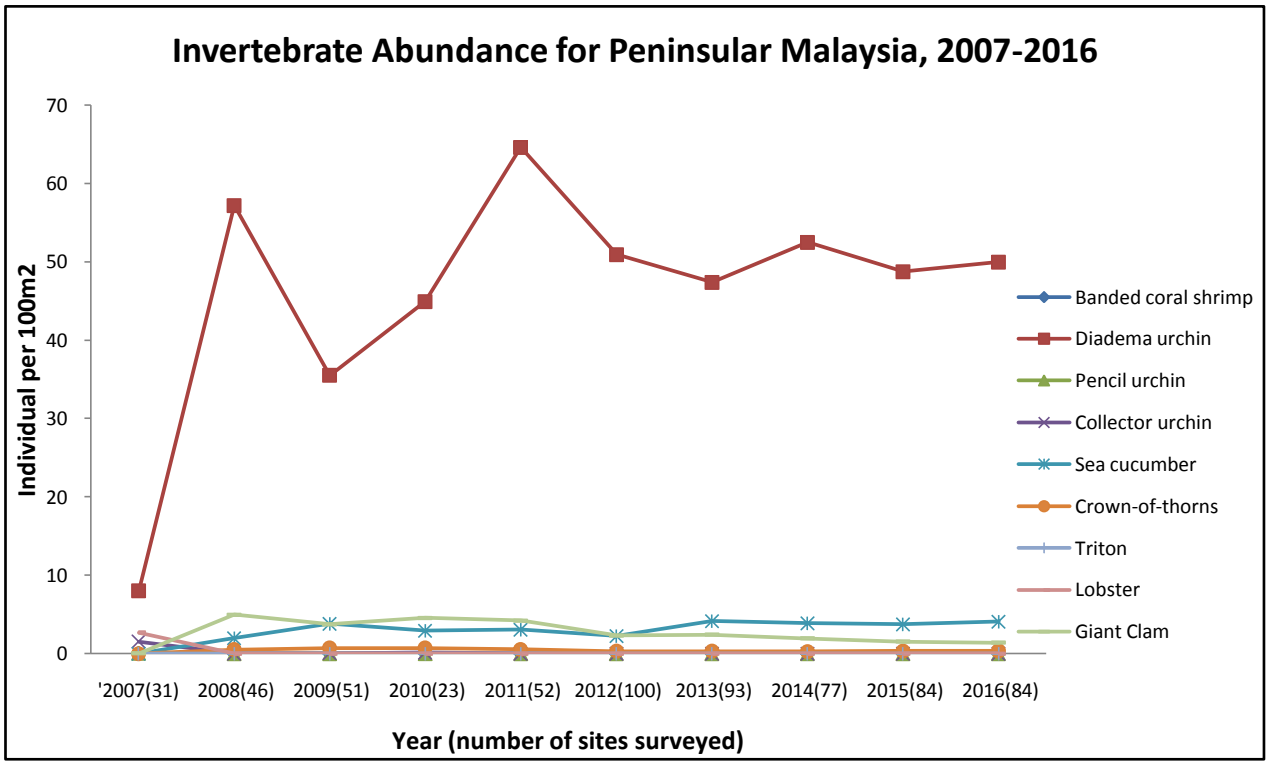


Chart 8: Invertebrate Abundance in Peninsular Malaysia from 2007 to 2016

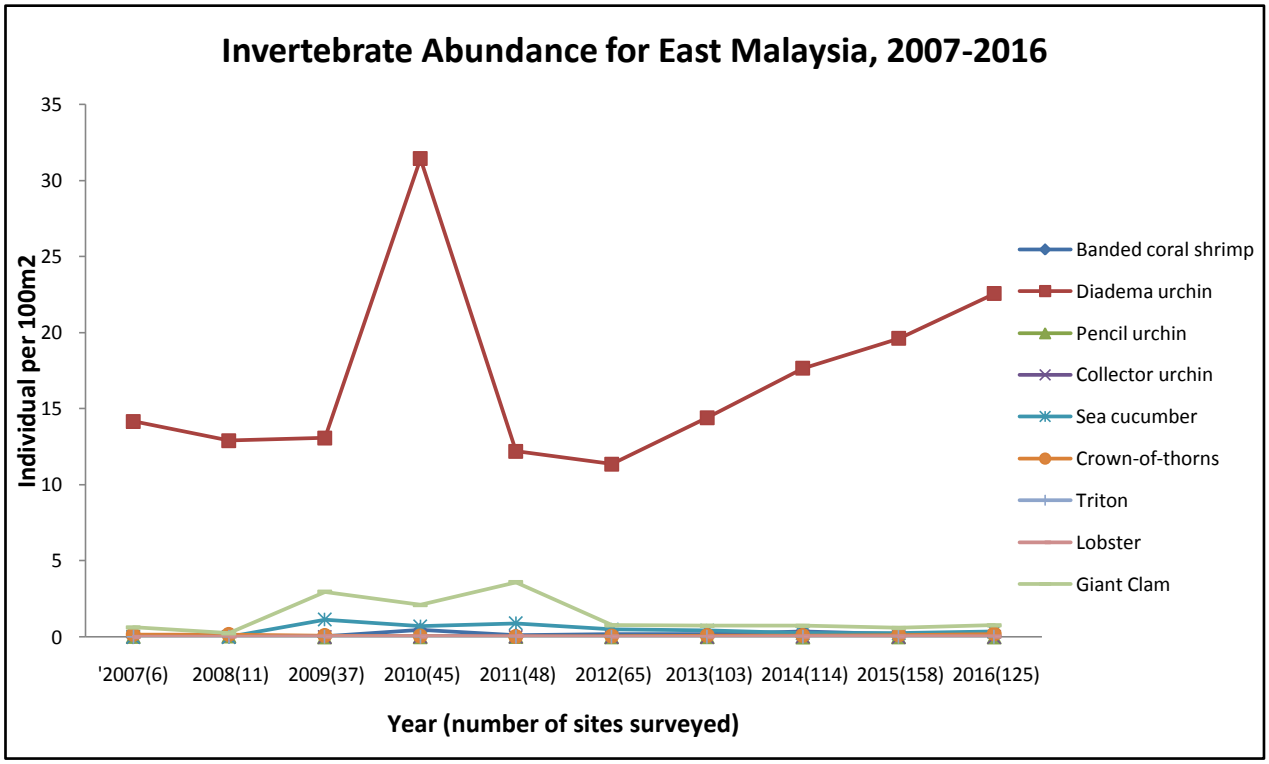


Chart 9: Invertebrate Abundance in East Malaysia from 2007 to 2016

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 six year period from 2011 to 2016. 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

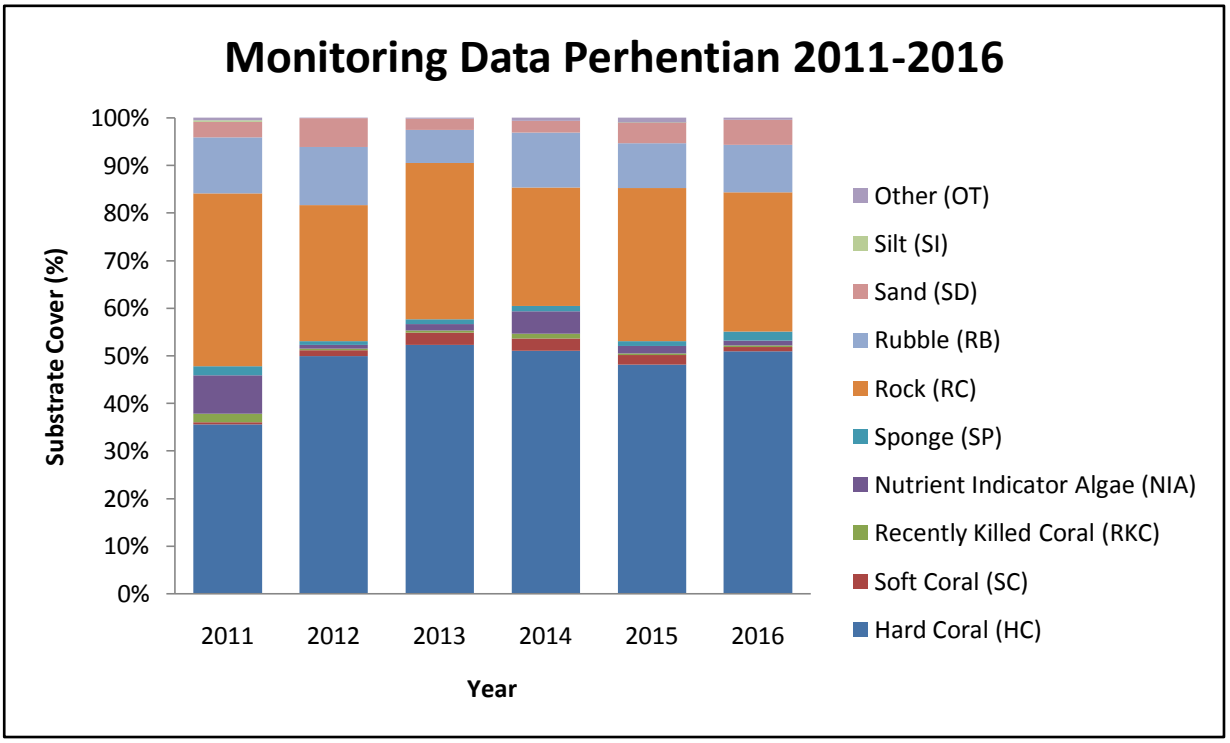
Mataking (6) Cahaya Way, Sting Ray City, Pandanan Bay, Coral Garden, Mataking House Reef and Sweetlips Rock

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 on Perhentian over the six years show that there has been some variation in reef health over that period of time. 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 ever since.



The level of SD had been increasing gradually over the last 4 years since 2012. Although the increase is very slight each year, over the 4 years the increase can be an indication of disturbance as dead coral breaks off and is eroded into sand by wave action.

The inconsistent factor is the level of NIA detected during surveys. In 2011 the level of NIA was high at 7.94%, followed by a substantial decrease in 2012 to 0.75% and increased again in 2013 and 2014 to 4.75% in 2014. In 2015 and 2016, NIA level decreased again to 1.5% and 1% respectively. 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.

From a management perspective, this wide variation presents some challenges as it suggests that the reefs, while being damaged by anthropogenic impacts (particularly sewage pollution) can recover quickly once stressors (e.g., bleaching) are removed. Control of development and improving sewage treatment could have significant benefits for coral reefs around the islands.

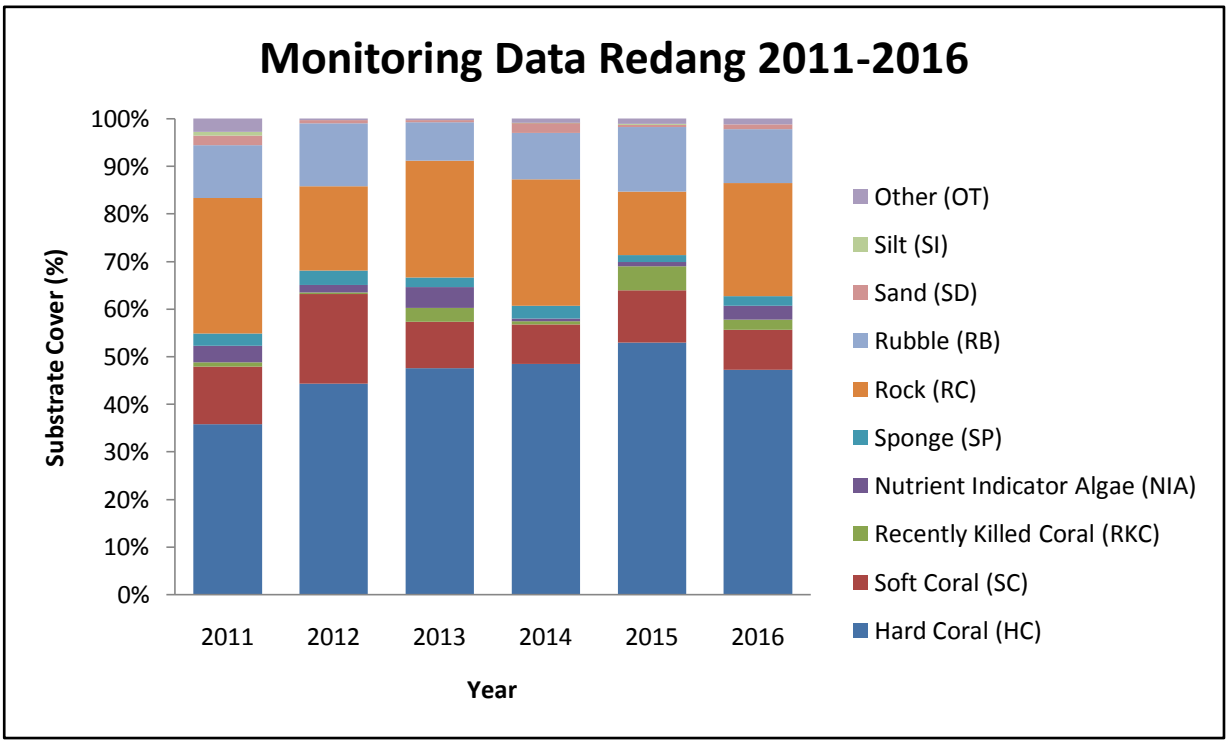
4.2.2 Redang

The overall condition of coral reefs around Redang Island has generally been good since 2011 with average LCC at or above 50% in most years. The low HC cover in 2010 and the increase by 2012 is similar to that for Perhentian, indicating recovery from the 2010 bleaching event. 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.

The level of RB in Redang has remained high in the range of 8 to 14% over the last 6 years. The sites of most concern are Pulau Kerengga Kecil, Pulau Lima Southern Tip and Pulau Paku Besar where RB level recorded during the 2016 survey recorded was more than 20%. Another cause for concern in Redang is the

increasing level of NIA over the last 3 years, albeit slight increase every year. This situation needs to be monitored as it could have a negative impact on the reefs over the long term.

There is only one significant anomaly in the data – the spike 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 surveys, the results showed some good recovery – decrease in RKC level to 2.13%. The data is indicative of the value of long term monitoring, which allows changes like this to be tracked and provides opportunities for intervention if necessary.



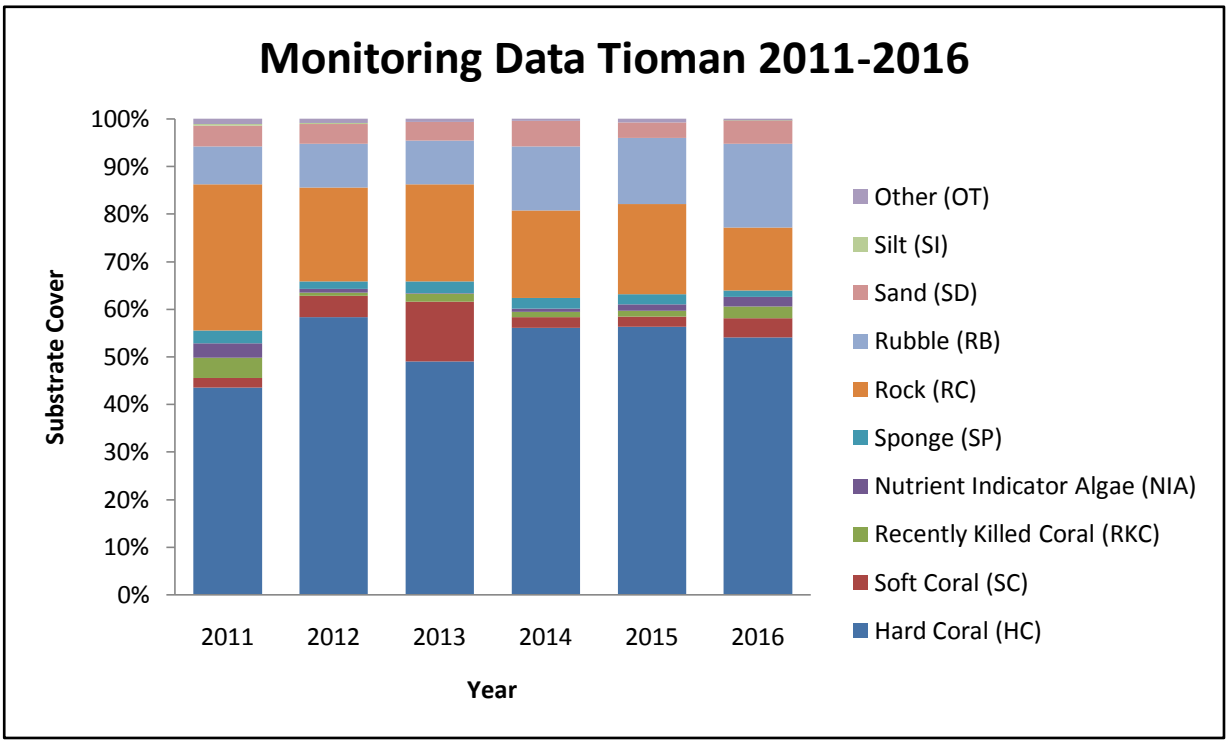
4.2.3 Tioman

The data from surveys conducted on Tioman over the last six years show that there has been some variation in LCC over that period of time. 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%.

The level of RB in Tioman is a cause for concern. The level remains in the range of 8 to 10% over the first three years of the survey period. However the average level has increased substantially in 2014 and 2015 to over 13%. In 2016, RB level increased further to 17.66%. The site of most concern is still Labas with RB level increased from 7.50% in 2012 to 50.63% in 2014 and subsequently to 71.88% in 2015. In 2016, the level had decreased considerably to 56.88%, but it is still critically high. Other sites which recorded worrisome increasing levels of RB are Soyak South, Tekek House Reef and Chebeh. As noted previously, RB can be an indicator of recent and long term disturbances.

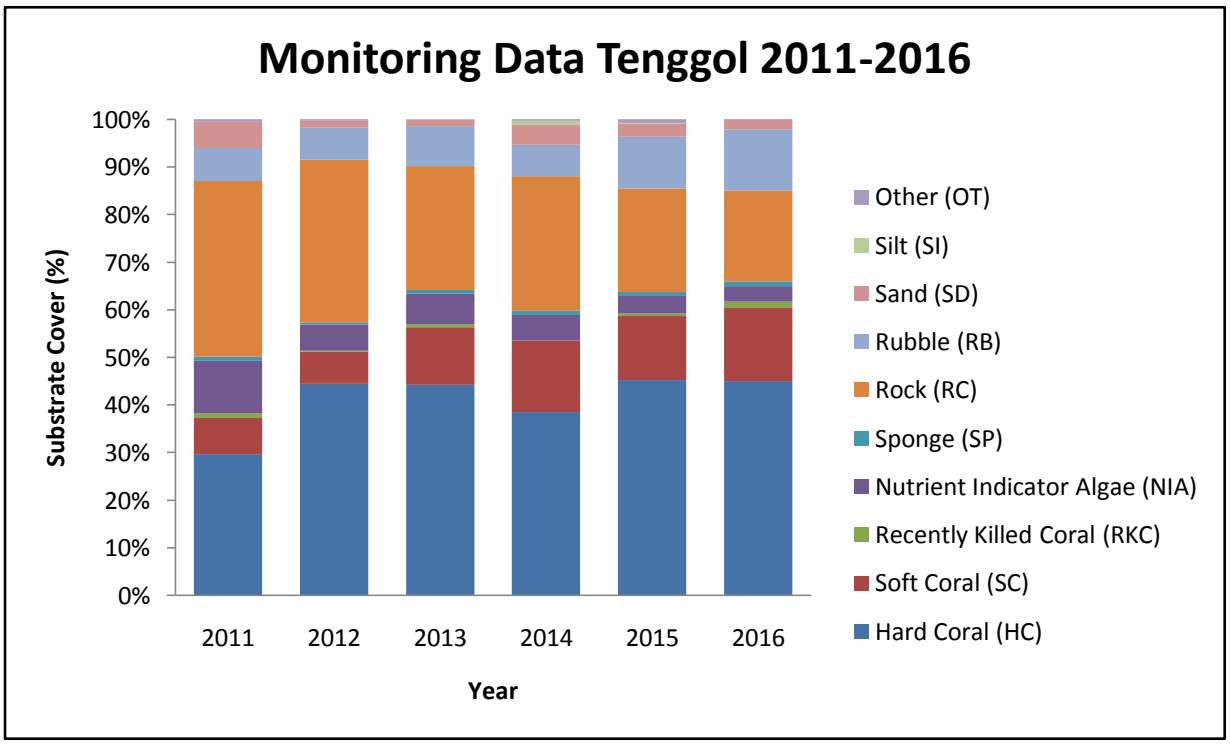
The levels of RKC and NIA in Tioman have also been increasing over the last 3 to 4 years, although the increase was very slight each year. In 2014, the level of RKC in Tioman was 1.09% and had increased to 2.5% in 2016. The level of NIA recorded 0.08% in 2013 and had steadily increased to 2.03% in 2016.

Combined, these indicators suggest there is a need for management intervention, to ascertain the cause of these changes and find solutions to reduce damage to these reefs.



4.2.4 Tenggol

The data from surveys conducted at Tenggol since 2011 show a similar pattern to other locations – recovery in LCC since the 2010 bleaching event followed by stabilisation at pre-bleaching levels. The overall condition of coral reefs around Tenggol Island since then has been good, with average LCC above 50%.



In the last 4 years there appears to have been a shift from RC to SC. 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 long 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. This needs to be reviewed after future surveys.

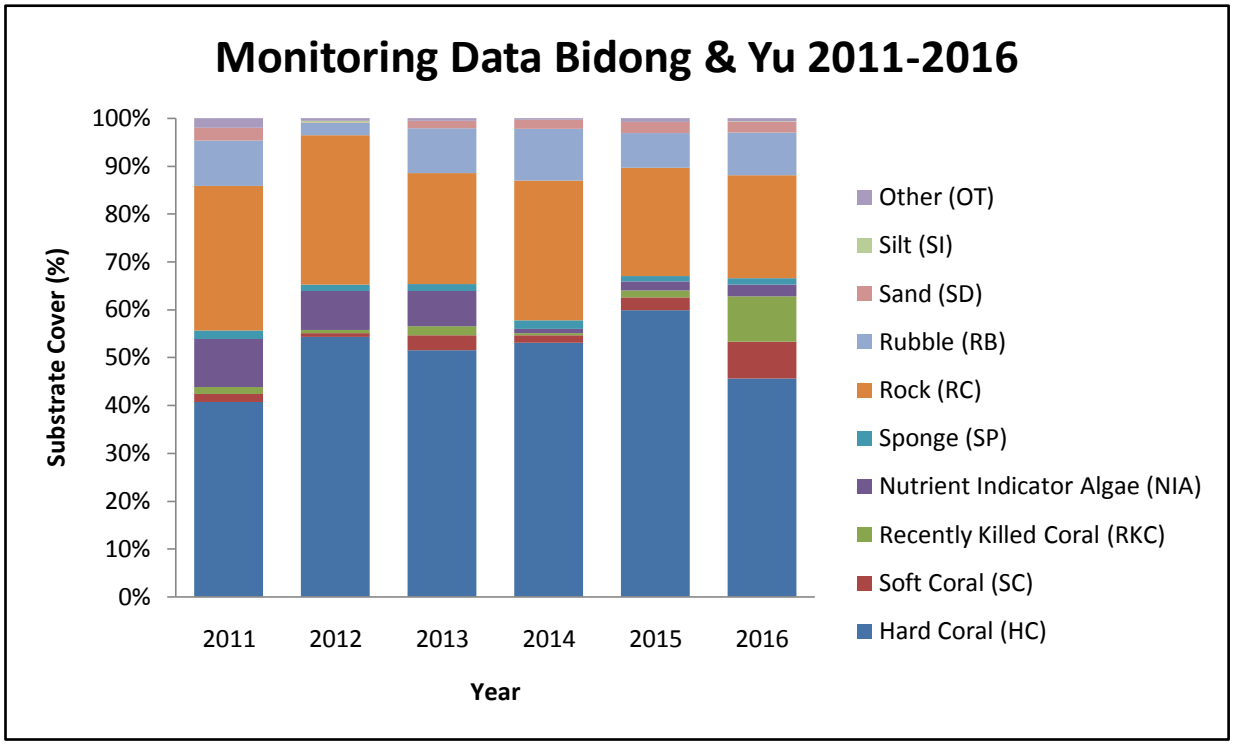
A further concern is the relatively high level of RB over the years. From 2011 to 2014, the level of RB remained in the range of 6.6 to 8.5%. In 2015, RB level increased to 10.94% from 6.56% in 2014. The level increased further to 12.92% in 2016 surveys. The site of most concern is Pasir Tenggara which recorded 3.75% RB in 2011 and substantially increased to 14.38% and 20.63% in 2012 and 2013 respectively. In 2015 and 2016, the level had increased further to 46.25% and 43.13% respectively.

NIA level on the other hand has improved over the last 4 years. In 2011, NIA in Tenggol recorded 10.94% which decreased to 5.52% in 2012. Although the level increased slightly in 2013 to 6.35%, it decreased the next year to 5.31% and had been decreasing gradually ever since and in 2016 surveys, the level of NIA is recorded at 3.23%.

4.2.5 Bidong & Yu

The sites around the two islands show a similar trend in LCC to other East coast sites, increasing from 2011-2012 after recovering from the 2010 bleaching event. Further recovery is apparent through to 2015. However, LCC level dropped considerably in 2016. This was highly likely due to the increase in COT abundance over the last four years. 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. Bidong and Yu also appear to be undergoing a shift from RC to SC where zoanthid is colonising dead corals. As a result, the level of SC and RKC increased considerably in 2016.

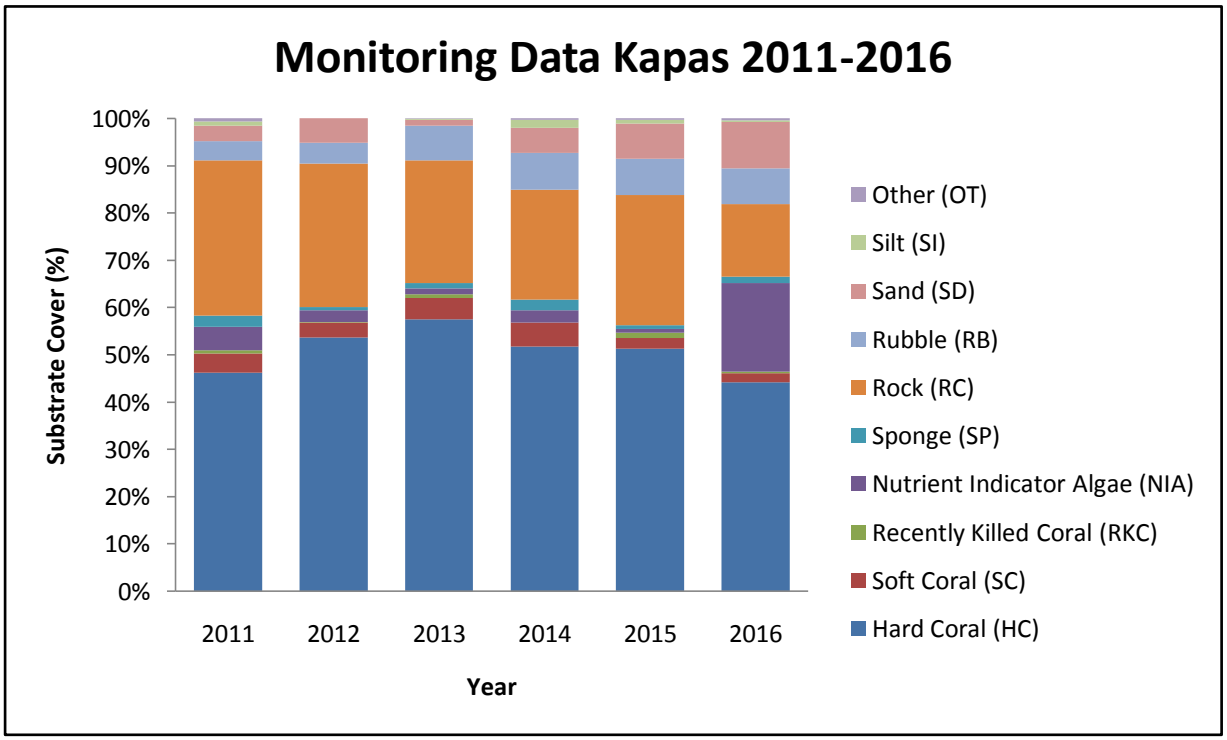
However, the data show some inconsistencies over the five year period, with varying levels of RB and NIA. These trends should be monitored to identify the cause and ensure reefs remain healthy.



4.2.6 Kapas

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

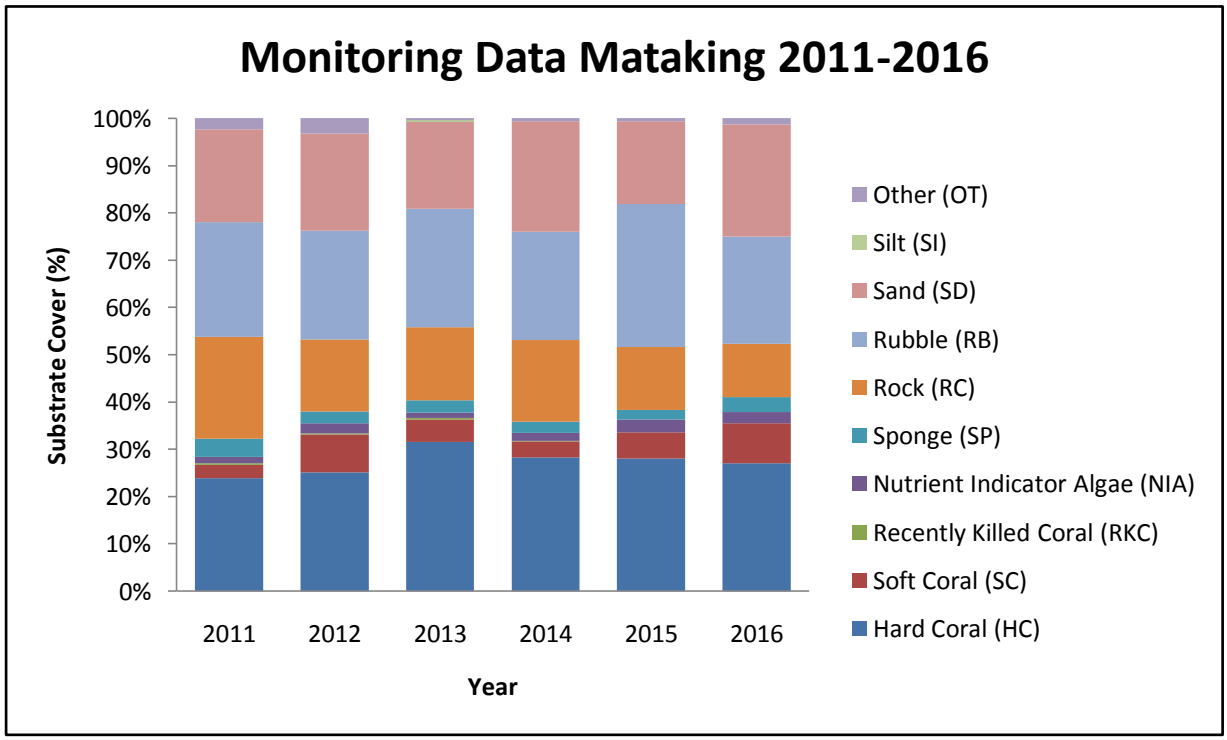
The other significant changes over the period are an increase in RB and NIA level. The level of RB increased considerably from around 4% in 2011-2012 to around 7-8% in 2013 and had maintained at that level through 2016. The level of NIA showed a gradual decline from 5% in 2011 to 0.78% in 2015, however in 2016 it showed a very significant increase to 18.75%. This perhaps indicates raised level of human impacts on Kapas (e.g. nutrient runoff). The cause of these changes needs to be determined so that preventive measure can be taken to ensure no continuing damage to the reefs around the island.



4.2.7 Mataking

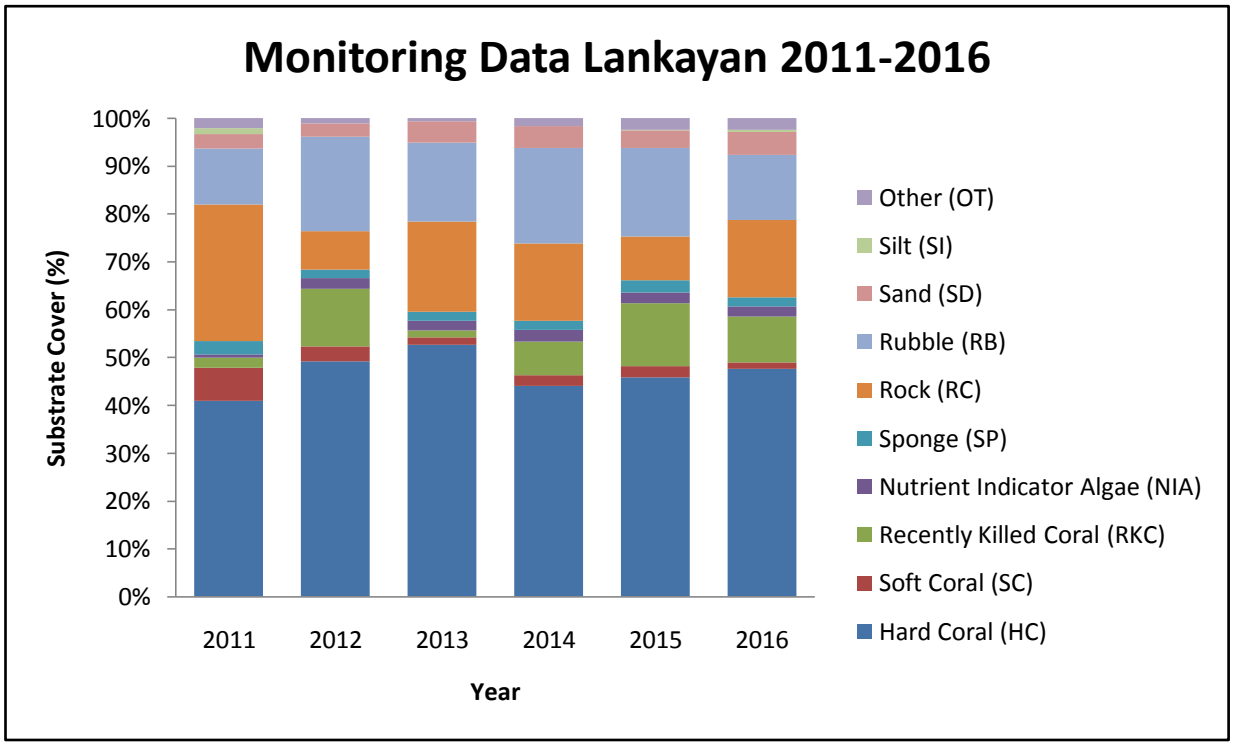
The data from surveys conducted on Mataking since 2011 show little significant change, with the overall condition of reefs around the Island remaining fair, with average LCC above 25%. The level of RB has remained very high in the range 22 to 31% in the last 6 years. Although some of the variability 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 Sweetlips Rock where RB level recorded during the 2016 survey was 51.88% and 41.88% 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.



4.2.8 Lankayan

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%. In the last two years, the reefs showed gradual recovery and recorded 47.58% in 2016. The other wide variation over the period is RKC level. In general, the level of RKC increases from 2.08% in 2011 to 9.63% in 2016, however in 2012 and 2015 the level increased sharply and recorded 12% and 13.13% respectively. Overall, reefs around Lankayan are healthier than other areas of Sabah (higher LCC), probably due to the presence of the SIMCA protected area.

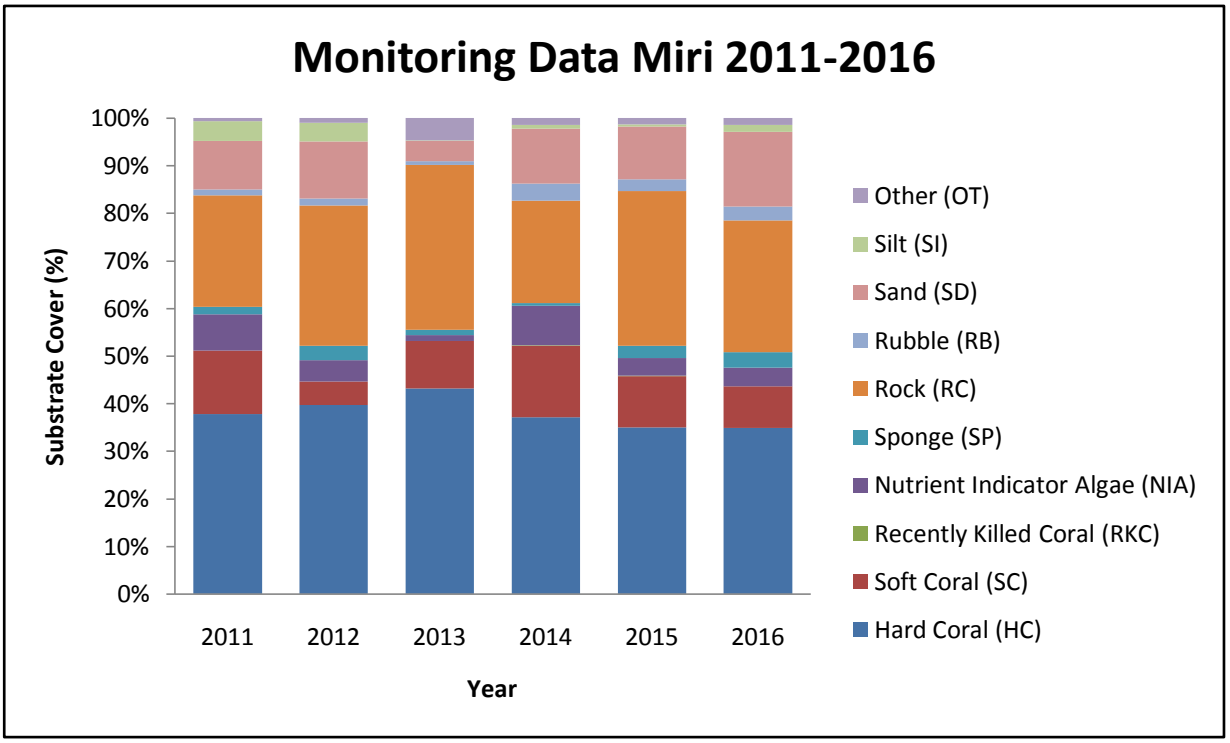


4.2.9 Miri

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, hence the variation in data.

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

5.1.1 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 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.

5.1.2 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.

5.1.3 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).

Table 3: Average and Maximum abundance of Indicator Species

Fish				**Invertebrates**			
Indicator	Abundance			Indicator	Abundance		
	Avg.	Max.	Max. Site		Avg.	Max.	Max. Site
Butterflyfish	5.40	23.5	Panglima, Mabul	Banded Coral Shrimp	0.04	3	Mataking House Reef, Mataking
Sweetlips	0.28	5	Drop Off, Sipadan	Diadema	33.58	425	Riza Garden, Mantanani
Snapper	5.06	115	Sunday Reef, Miri	Pencil Urchin	0	0.75	Scuba Junkie House Reef, Mabul
Barramundi Cod	0	0	n/a	Collector Urchin	0	0.25	Reef 77, Lankayan; Sweetlips Rock, Mataking; Mandarin House Reef, Pom Pom
Humphead Wrasse	0.01	0.75	South Point, Sipadan	Sea Cucumber	1.85	83	Soyak South, Tioman
Bumphead Parrotfish	0.22	10	Teluk Jawa, Kapas	Crown of Thorns	0.26	5	Pulau Tengkorak, Bidong
Parrotfish	3.24	61.25	Coral Garden, Payar	Triton	0	0.25	Small Reef, Lahad Datu; Sweetlips Rock, Mataking; Baracuda Point, Sipadan
Moray Eel	0.06	2	Ribbon Valley, Mabul	Lobster	0.02	0.75	White Tip, Sipadan
Grouper	0.81	20.75	Coral Garden, Payar	Giant Clam	1.02	20	Kerengga Besar, Redang

5.1.4 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.

5.1.5 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).

5.1.6 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).

5.1.7 The “snapshot” of reef health provided by the 2016 survey data suggests reefs in Malaysia are relatively healthy (“fair” LCC, high diversity of fish and invertebrate indicators). However, an analysis of 10 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 three 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

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 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.

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 2016 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 10 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.

Acknowledgements

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Yayasan Sime Darby: supporting a five year programme on Tioman island to build reef resilience and social resilience.

CIMB Foundation: funding a clean-up campaign and plastic recycling system on Mantanani Island, Sabah.

Vale Malaysia: providing support to local communities in Perak through alternative livelihoods and investments in social assets.

KPMG in Malaysia: donates funds to support a Corporate Reef Check team and education programmes in two schools in KL.

Murphy Oil Corporation: supporting reef rehabilitation and community awareness efforts in Mantanani island, Sabah.

YTL: Supporting efforts by RCM to improve coral reefs around Malaysia, including through its Pangkor Laut Resort which supports surveys at the Sembilan islands.

Yayasan Hasanah: supporting the development of a community managed marine area in Mantanani, Sabah

SGP: funding a programme of work in Sabah to raise awareness of the negative impacts of fish bombing, including education and public awareness campaigns.

La Mer: donates funds to support a Reef Check survey programme in Lahad Datu, Sabah.

Kose: supporting reef rehabilitation programmes.

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Shell Malaysia: supports Miri surveys under Shell Sustainable Development Grant

Biosphere Expedition: supports Tioman surveys

Department of Marine Park Malaysia: donates funds and assists Reef Check surveys on Marine Park islands, as well as supports Reef Check reef rehabilitations and island-based school programmes.

Sabah Parks: assists Reef Check surveys on Sabah Park islands.

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, 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.

Particular thanks go to:

- Reef Guardian, Lankayan, who have been conducting the survey programme around SIMCA for several years
- Tioman Dive Centre, Tioman, who provide RCM with facilities for EcoDiver training and also assist in other activities such as beach clean ups and rehabilitation programmes
- Scuba Junkie, Mabul, who promote Reef Check through their Eco Dive Master programme and also conduct school education and awareness programmes as well as clean-ups etc.

We work through a small network of dive centres and NGOs who continue to support our work:

Reef Check Certified Facilities

Bubbles Dive Centre, Perhentian
Scuba Explorers, Tenggol
Tioman Dive Centre, Tioman
Borneo Divers, KK
Reef Guardian, Lankayan
Mataking Reef & Dive Resort
Usukan Cove Lodge Dive Centre
Scuba Junkie, Mabul/KK

Other dive operators

Aqua Sports Divers, Kapas
Kapalai Resort
Scooba Tank and Mari Mari Dive Lodge, Mantanani
Darvel Bay Diving, Lahad Datu
Piasau Boat Club, Miri
Pelangi Resort, Redang

NGOs

MNS Miri Branch
Blue Temple Conservation, Perhentian
WWF
Juara Turtle Project, Tioman
Lang Tengah Turtle Watch
MENGO

Finally, thanks to the many EcoDivers who give up their time to help us with surveys. Our small team could not possibly manage all those surveys ourselves, and we really appreciate your efforts. To you, and the many other volunteers who have helped in our work, we are grateful.

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Jamadi Bin Hassan

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Appendix 1: Survey Sites (2016)

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 3.18	Batu Nipah	Tioman	2 43.928 N 104 08.125 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

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

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 3.2	Uban-Uban	Usukan Cove	6 23.442 N 116 19.342 E
NB 3.3	Pandan-Pandan	Usukan Cove	6 21.265 N 116 18.666 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 3.6	Keramat	Usukan Cove	6 23.635 N 116 19.637 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 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 58.433N 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 19.938 N 118 37.925 E
NB 9.1	Amoi Cantik, Rusukan Besar	Labuan	5 11.460 N 115 08.142 E
NB 9.2	Boya Jo, Rusukan Kecil	Labuan	5 12.112 N 115 08.558 E
NB 9.3	Takat Saripah, Kuraman	Labuan	5 13.079 N 115 07.516 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	Dead End Channel	TSMP, Semporna	4 34.408 N 118 45.507 E
NB 11.2	Kapikan Reef	TSMP, Semporna	4 37.698 N 118 50.112 E
NB 11.3	Mantabuan	TSMP, Semporna	4 37.933 N 118 47.798 E
NB 11.4	Ribbon Reef	TSMP, Semporna	4 36.135 N 118 46.090 E
NB 11.5	South Rim	TSMP, Semporna	4 34.078 N 118 45.498 E
NB 11.6	Sibuan	TSMP, Semporna	4 39.154 N 118 39.884 E
NB 11.7	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	Lobster Lair	Pom Pom	4 35.397 N 118 52.126 E
NB 14.2	Mandarin House Reef	Pom Pom	4 35.414 N 118 51.849 E
NB 14.3	New Life	Pom Pom	4 35.488 N 118 51.720 E
NB 14.4	TRACC House Reef	Pom Pom	4 35.883 N 115 51.717 E