Status of Coral Reefs in Malaysia, 2019

Reef Check Malaysia

Contents

Executive Summary

1. A total of 180 sites were surveyed in 2019 (2018: 212), 97 in Peninsular Malaysia and 83 in East Malaysia. The surveys are a continuation of a successful National Reef Check Survey Programme that has now run for thirteen years.

2. The surveys were carried out by trained volunteers as well as government officials from Marine Parks Malaysia, 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 (MPAs) and non-protected areas, and in various parts of East Malaysia, both Sabah and Sarawak.

3. The results indicate that the Malaysian coral reefs surveyed have a relatively high level of living coral, at 40.63% (2018: 42.42%). However, this has been declining slightly for the last few years and this trend is now considered a matter of increasing urgency for managers to address.

4. Low 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 improving management and encouraging local stakeholder participation to 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 strengthen local management (including local stakeholder participation in co-management) and to take steps to build resilience of coral reefs to enable them to withstand future bleaching and other climate-related events.

9. While tourism is a valuable source of income, the government is urged to consider carrying capacity of coral reef areas, and is asked to require hotels and dive facilities to follow best practices including paying careful attention to sewage treatment and discharge, and educating 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. 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: https://www.reefcheck.org.my/resources

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 alter 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 Marine Park of Malaysia, (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 reef areas around Peninsular Malaysia died. Reefs had barely recovered before the 2010 mass coral reef bleaching event occurred, which fortunately saw lower coral death rates.

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

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

Reef Check Malaysia (RCM) works with various stakeholders to conserve coral reefs. Since it was registered in 2007, RCM has established an annual, national coral reef monitoring programme. This report presents the results of coral reef surveys conducted in Malaysia during 2019, the thirteenth year of surveys.

2. Reef Check

2.1 Background

Reef Check Malaysia (RCM) 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.

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 thirteen years, RCM has trained over 1000 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 the Marine Park of Malaysia, 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 thirteenth annual Malaysia coral reef survey report and details the results of Reef Check surveys carried out during 2019. 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.org for 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 5 m, 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.

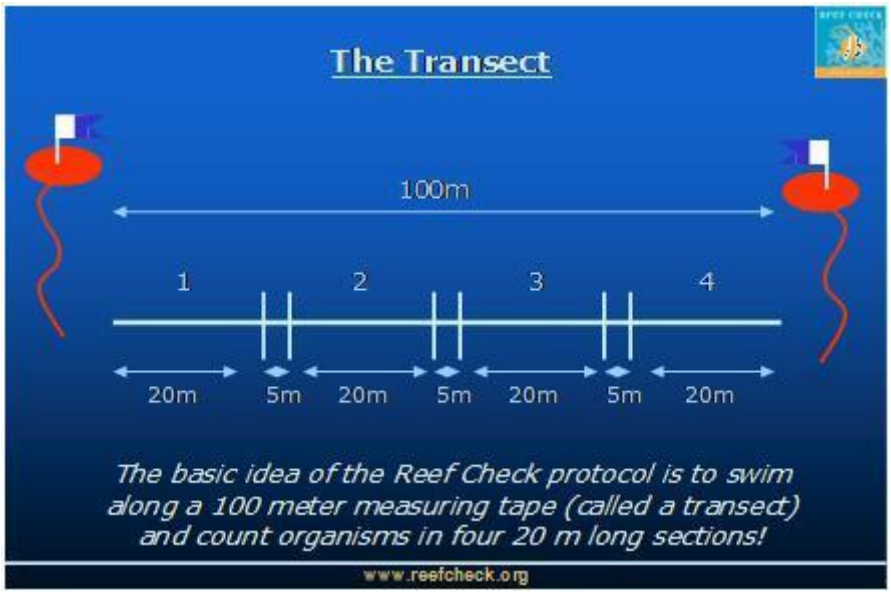


Figure 1: The Transect

2.3 Survey Sites

In 2019, a total of 180 sites were surveyed, 97 of which were in Peninsular Malaysia and the remaining 83 in East Malaysia. As far as possible, the same sites are visited each year to provide consistent data over time.

In Peninsular Malaysia, surveys were conducted at sites around several islands off the East coast (Bidong, Yu, Kapas, Pemanggil, Perhentian, Redang, Sibu, Tinggi, Tenggol, Tioman, Aur, Dayang and Rawa). 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, Mataking, Mabul and Kapalai in Sabah and Miri in Sarawak. 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.

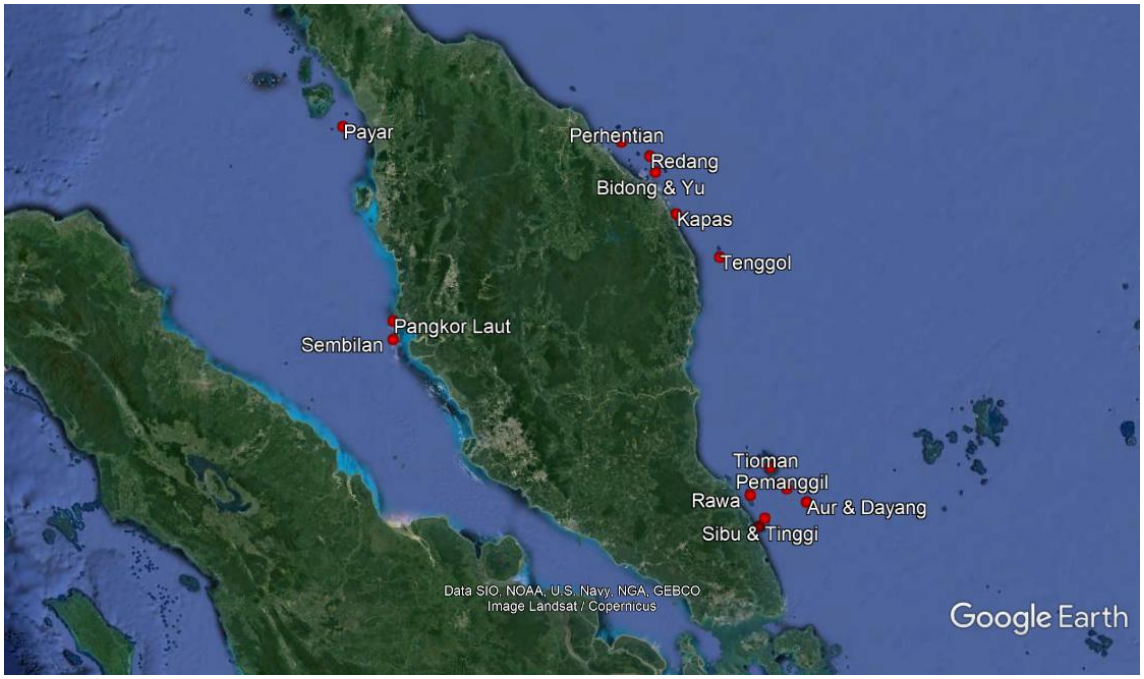
The list of sites surveyed is shown in appendix 1.

3. 2019 Survey Results and Analysis

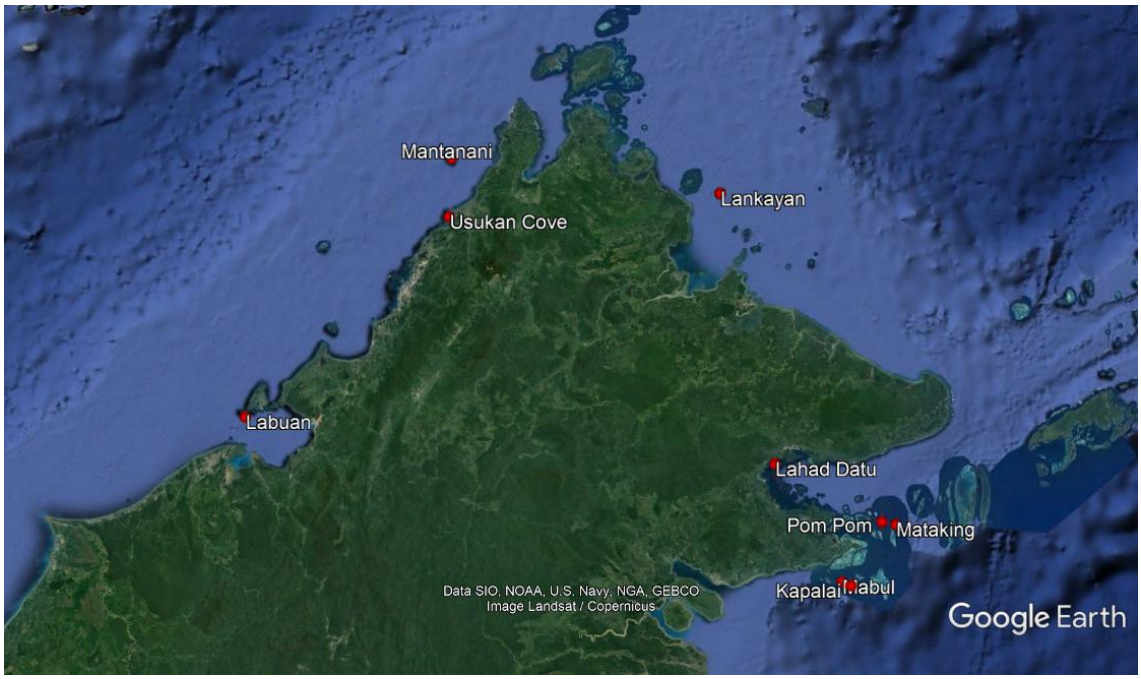
This section presents the results from surveys conducted in 2019, providing an overview of the condition of coral reefs in Malaysia as a whole, and a detailed analysis of the health of reefs in surveyed reef areas.

3.1 Status of Coral Reefs in Malaysia 2019

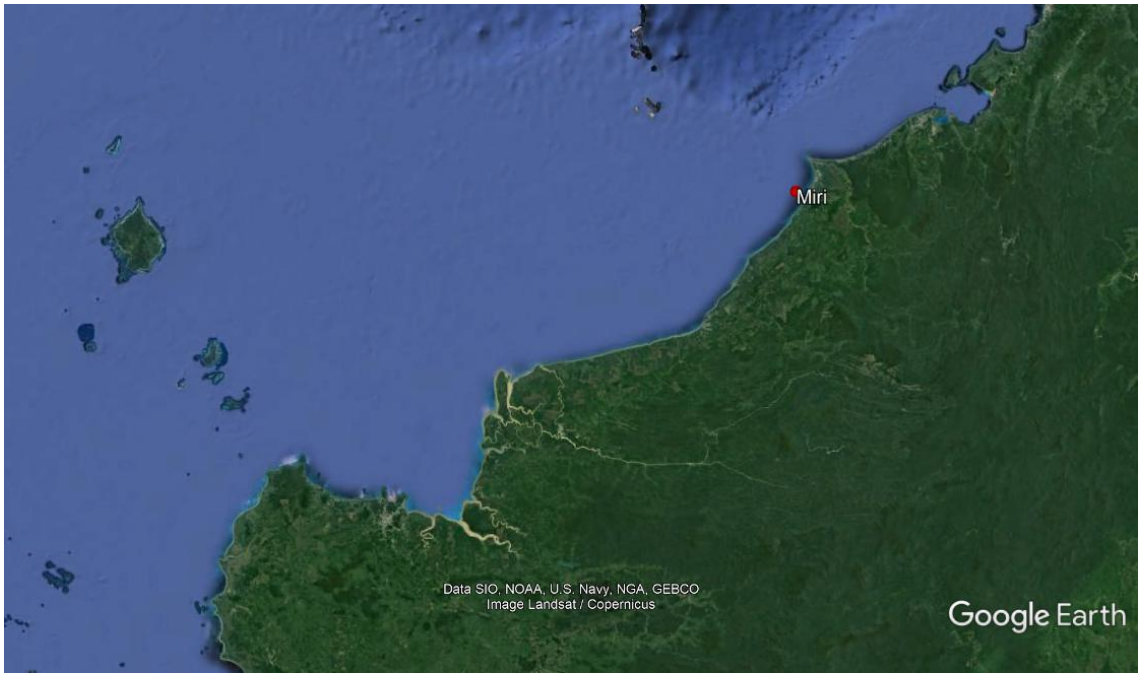
The results from all 180 surveys were compiled to provide an overview of the status of coral reefs around Malaysia. Sites surveyed off Peninsular Malaysia are mostly islands which are important tourist destinations while the islands and reefs off Sabah and Sarawak are less frequently visited but face other problems such as destructive fishing practices.



Map 1: Surveyed islands in Peninsular Malaysia



Map 2: Surveyed islands in Sabah



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 40.63% (42.42% in 2018). The reduction in LCC is a continuation of a trend that started in 2015. However, it should be noted that two other factors may have contributed to this decline:

- Tropical Storm Pabuk hit reefs in Terengganu in January and caused extensive damage, particularly to shallow reefs, resulting in a reduction in LCC of up to 30% in some sites
- Less sites were surveyed in Sabah in 2019 than in 2018, and this may have caused a reduction in average LCC for reefs in Sabah.

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 14.53% in 2019 and has increased from last year. Around 37% of reefs in Malaysia had RB in the range 10-29% of RB and 8.3% of reefs recorded RB in the range 30-49%. 5% of the reefs recorded as high as 50-90% RB. Sites of most concern were Mandarin House Reef (Pom Pom) 88.75%, Northern Valley (Pom Pom) 82.50%, New Life (Pom Pom) 62.50%, Coral Garden (Mataking) 66.25%, Ira's Reef (Lahad Datu (55.63%) and Riza Garden (Mantanani) 53.75%. Fish bombing is known to occur in these areas.

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, they 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 2019 was high at 6.13% (2018: 2.96%); a significant increase compared to last year. 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 attention. Nearly 17% of reefs in Malaysia recorded NIA in the range 10-24%. 6.1% of the reefs recorded as high as 25-50%. Sites of most concerned were Pulau Tengkorak (Bidong) 50%, Heritage Row (Bidong) 38.13%, Shark Point (Perhentian) and Freshwater Bay (Tenggol) 33.75%, Sea Bell (Perhentian) 33.13% and Pemanggil Village South (Pemanggil) 31.25%.

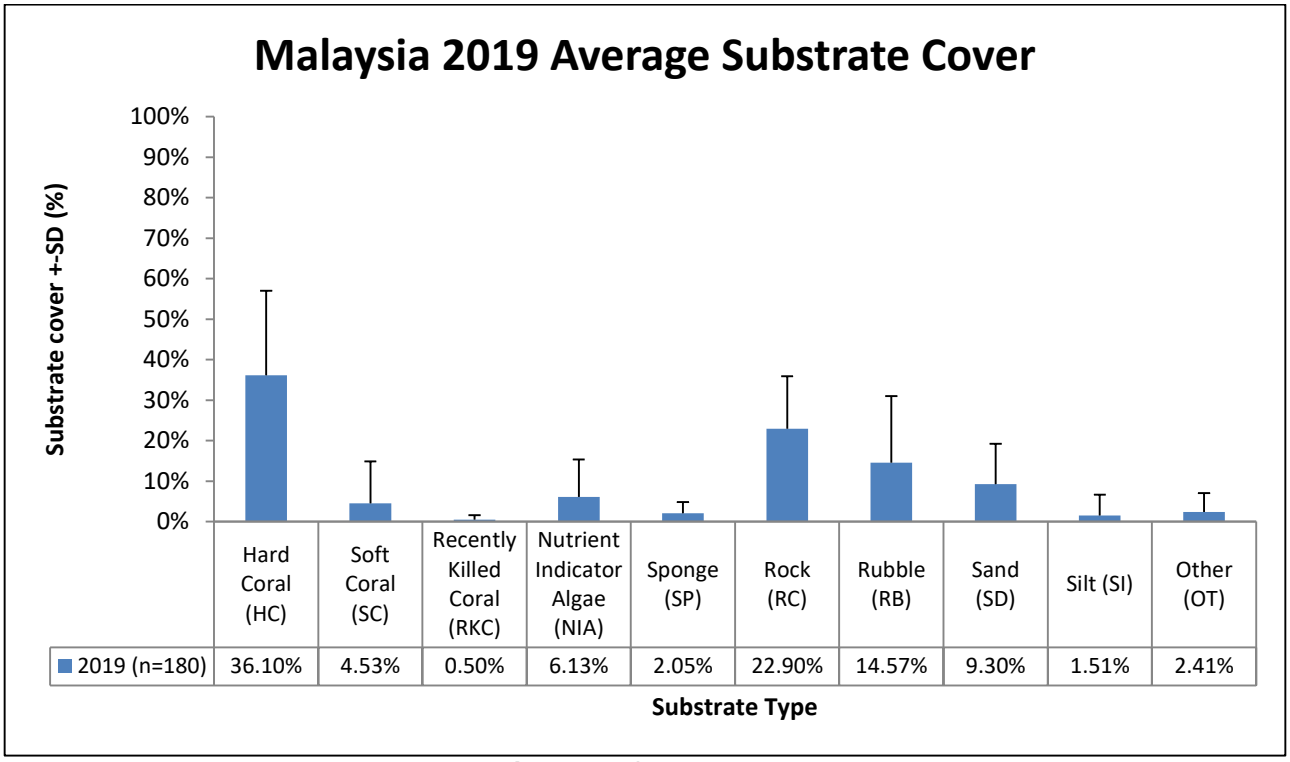


Chart 1: Substrate Cover

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 (0.5%) indicates there were few local impacts on Malaysian reefs.

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 1.51%. 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 (e.g. land use change) and it is this change that should be monitored.

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 2.05%, 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 2019 the average cover of RC on Malaysian reefs was 22.90%. 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 2.41% in 2019.

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 2019 surveys are shown below (Chart 2).

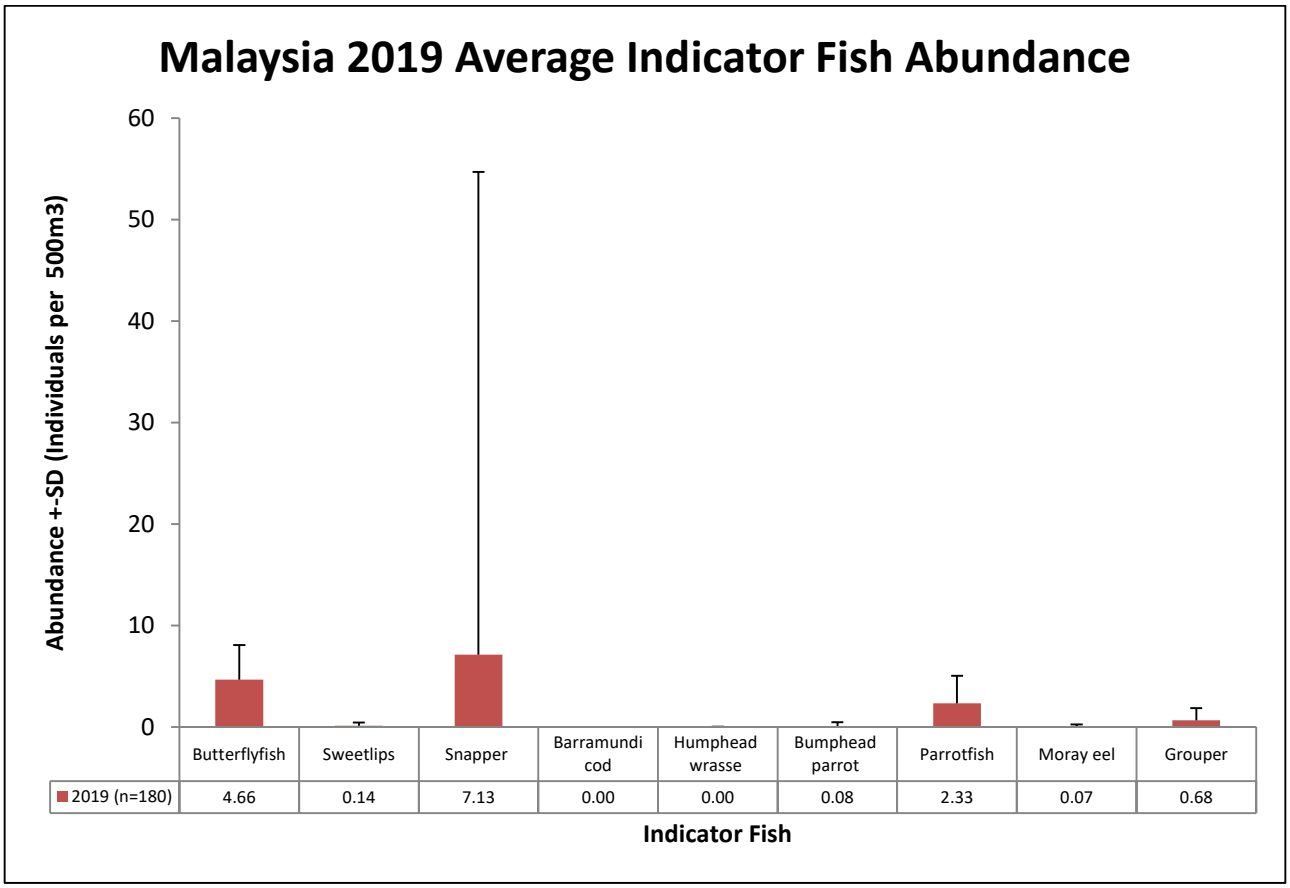


Chart 2: Indicator Fish Abundance

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. Barramundi Cod was not recorded at any survey sites.

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 4.66 individuals per 500m^3 in 2019 (2018: 4.18), showing a slight increase from previous year. 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 2019 was 2.33 individuals per 500m^3, a slight decrease from last year (2018: 2.4).

3.1.3 Invertebrates

The invertebrate indicators are targeted for different reasons:

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

The abundance of indicator invertebrates documented during the 2019 surveys is shown in Chart 3 below.

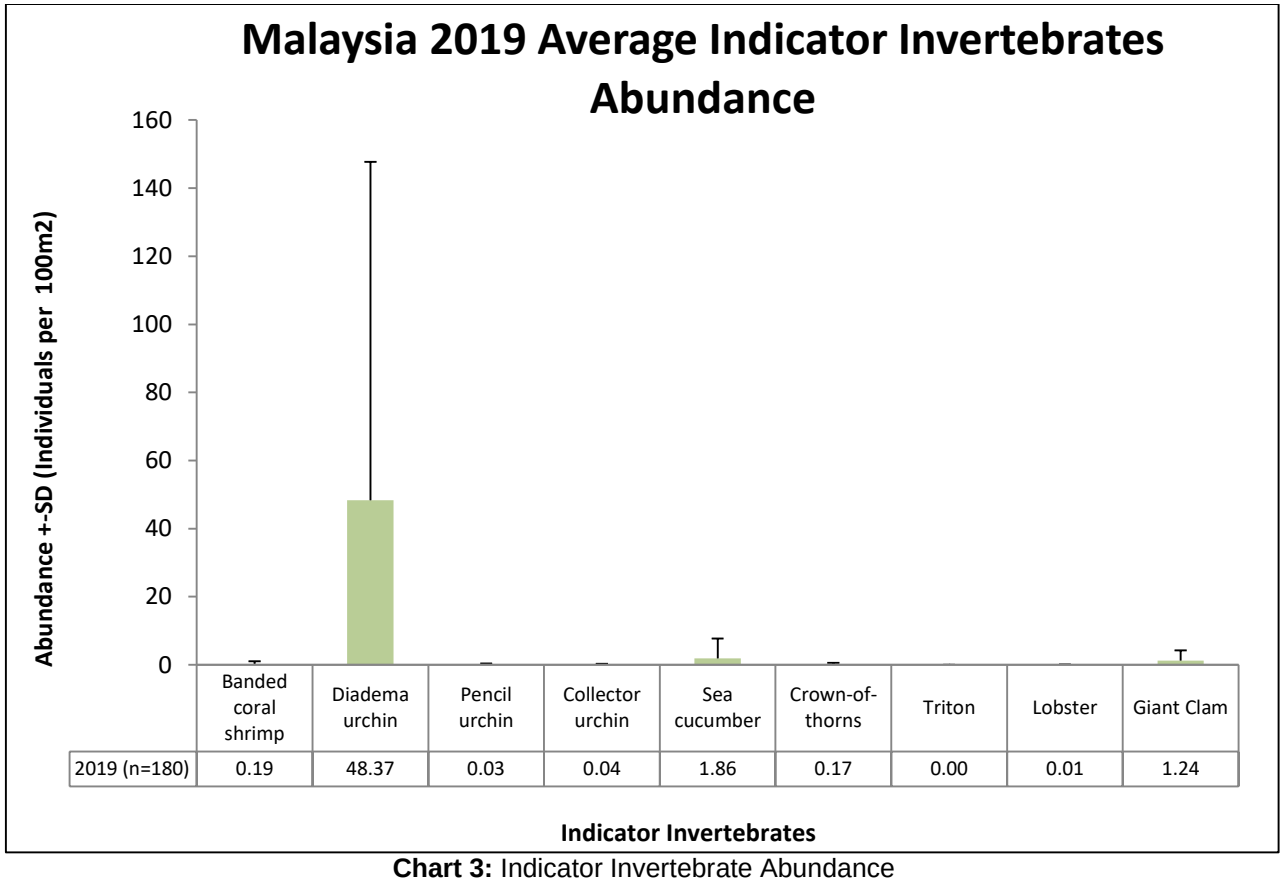


Chart 3: Indicator Invertebrate Abundance

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 0.01 individuals per 100m^2 survey transect; Collector Urchin – 0.04). The abundance of Sea Cucumber is low at 1.86 individuals per 100m^2. Giant Clam recorded an average of 1.24 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 herbivorous 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, 0.17 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 Kapas 1.3 individuals per 100m^2, Bidong and Yu 0.75, Aur 0.5, Tenggol 0.38 and Redang 0.33; 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 (LCC = HC + LC) 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) 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	35.50
Redang	12	Marine Park	28.49
Tioman	18	Marine Park	63.82
Kapas	5	Marine Park	47.38
Bidong and Yu	6	Marine Park	44.58
Tenggol	6	Marine Park	47.19
Pemanggil	4	Marine Park	52.03
Tinggi	4	Marine Park	58.59
Sibu	6	Marine Park	55.83
Pulau Aur and Dayang	6	Marine Park	40.21
Pulau Rawa	5	Marine Park	74.63
Miri	6	Miri-Sibuti Coral Reefs National Park	50.94
Malacca Strait			
Sembilan	9	No protection	26.88
Pangkor Laut	1	No protection	53.75
Payar	5	Marine Park	50.88
North Borneo			
Lankayan	15	SIMCA	
Mataking	6	No protection	33.23
Mabul	6	No protection	27.71
Kapalai	6	No protection	14.69
Mantanani	12	No protection	38.91
Usukan Cove	6	No protection	53.02
Lahad Datu	15	No protection	25.25
Labuan	4	Marine Park	29.53
Pom Pom	7	No protection	22.77
Total	**180**	**Average**	**40.63**

Sunda Shelf

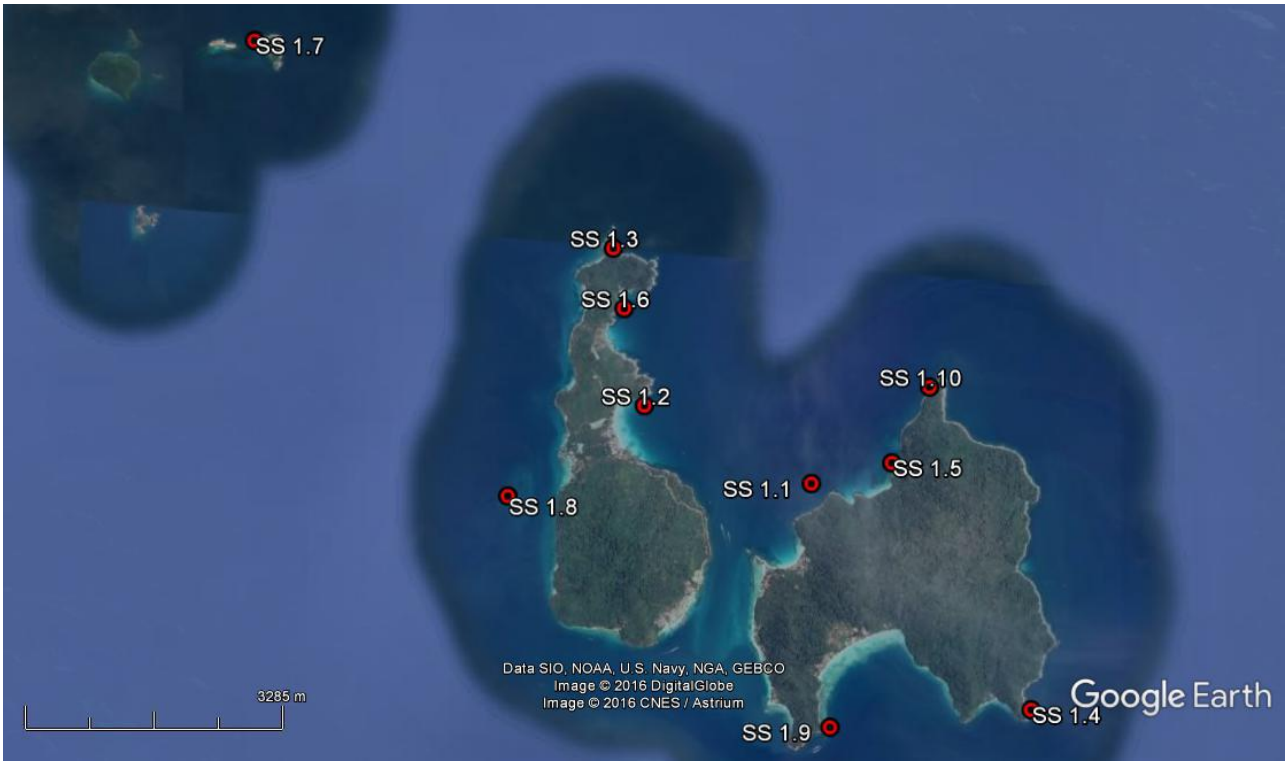
3.2.1 Perhentian

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 whom work in tourism, the main industry on the islands. The islands are gazetted as a Marine Park (since 1994).

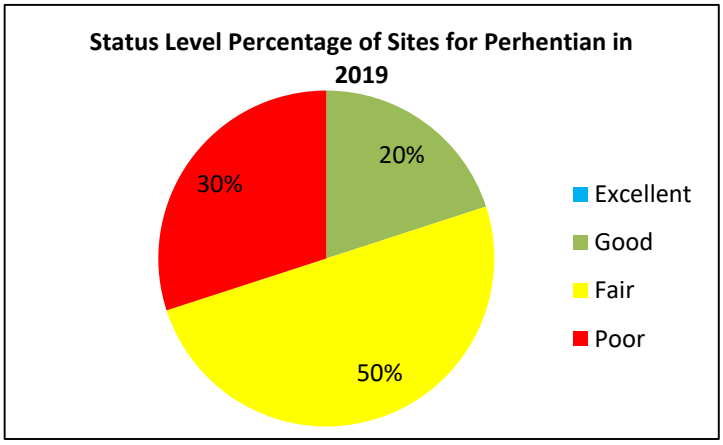
A popular tourist destination, particularly among backpackers, there are over 40 resorts, mainly small, family run chalets with a growing number of large resorts to cater for a changing tourist market. There are now over 20 dive operators, spread around the two main islands. Diving and snorkelling are the main tourist activities.

Growth in tourism has been rapid on the islands, and resort development continues. There is no grid-supplied electricity, nor centralised sewage treatment; groundwater supplies are limited in Perhentian and fresh water is supplied from the mainland.

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

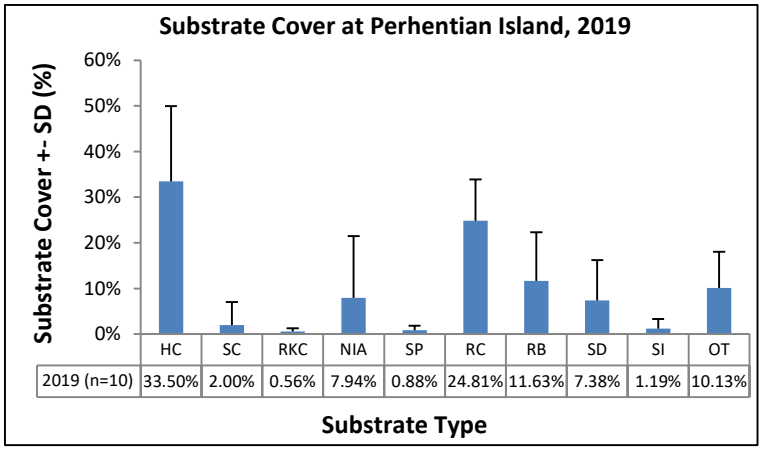


Map 4: Surveyed sites in Perhentian



A total of 10 coral reef sites were surveyed in Perhentian and 50% of the reefs were in fair condition. 20% were in good condition and the remaining 30% were in poor condition. No reefs were in excellent condition.

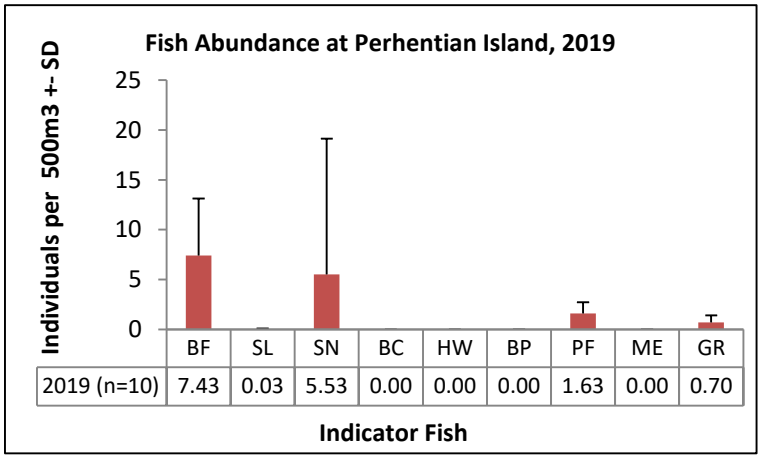
Substrate



Coral reefs around the Perhentian islands are considered to be in 'Fair' condition, with 35.5% live coral cover, below the average (49.21%) for reefs within the Sunda Shelf region.

HC cover has decreased significantly from 42.31% in 2018 to 33.5% in 2019. The level of RB has increased from 7.44% (2018) to 11.63% (2019). These changes are thought to be due to the impact of Tropical Storm Pabuk, which passed through the area in January 2019.

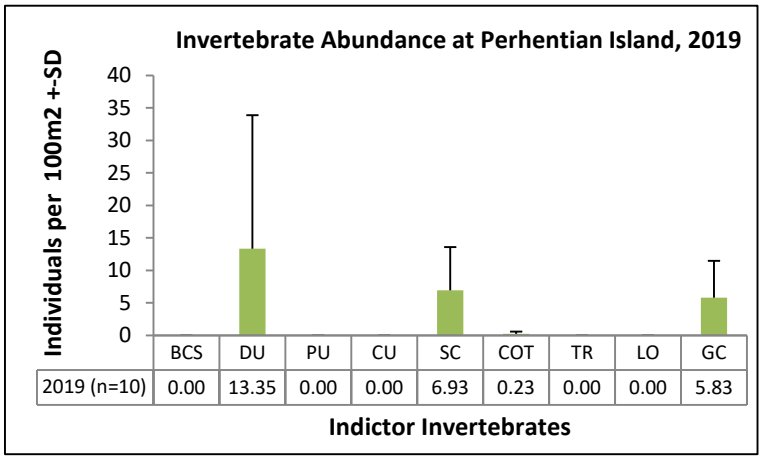
Fish



Five indicator fish were recorded during surveys. The most abundant fish recorded was Butterflyfish, followed by Snapper. Sweetlips, 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



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

Diadema Urchin, Sea Cucumber and Giant Clam were common on most reefs. The number of COT is within what a healthy reef can sustain (0.2-0.3 ind./100m^2).

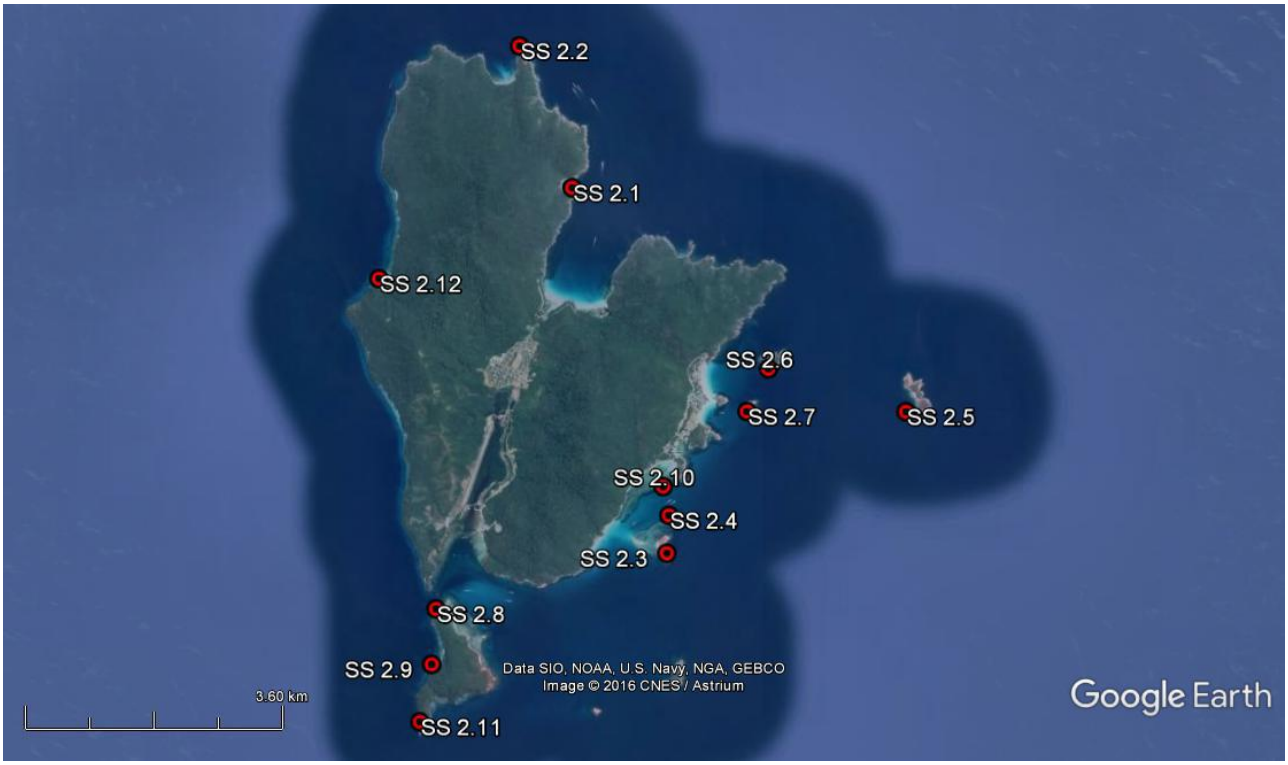
Human impacts such as boat anchor damage, discarded fishing nets, trash and bleaching due to sedimentation were recorded at many sites. Natural impacts such as COT and drupella predations were recorded at some sites. Many of the shallow reefs around Perhentian were badly damaged by Tropical Storm Pabuk which hit the island early in the year. On a positive note, turtle and sharks were recorded during surveys.

3.2.2 Redang

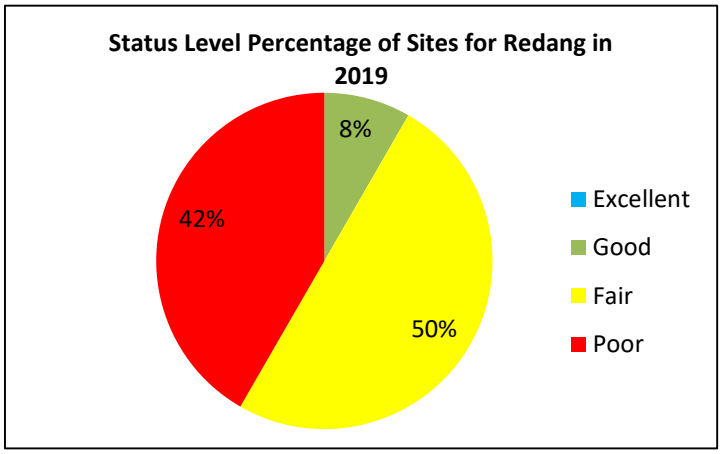
Redang Island is located some 25km from Merang, off the East coast of Terengganu, Malaysia. The island has a population of approximately 1,500, only a small proportion of whom work in tourism, the main industry on the islands. The islands are gazetted as a Marine Park (since 1994).

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 centralised electricity supply, resorts operate their own generators for power. Water is supplied by pipeline from the mainland and each resort has its own sewage treatment facilities. The island is served by an airport (flights to KL and Singapore) as well as boat services from the mainland.

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

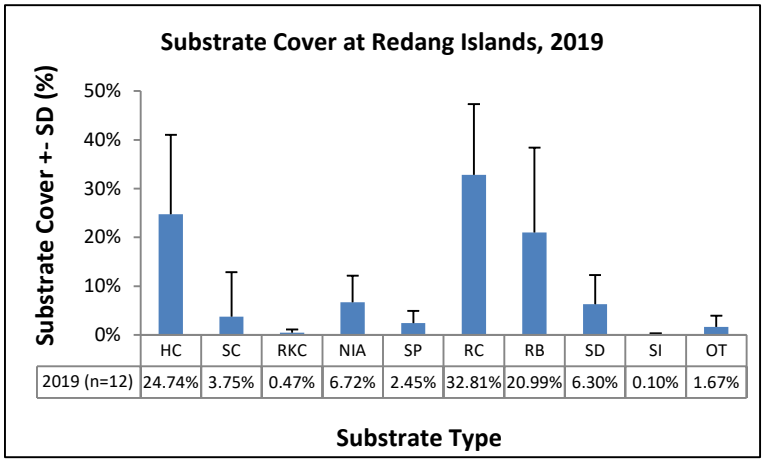


Map 5: Surveyed sites in Redang



A total of 12 coral reef sites were surveyed in Redang and 50% of the sites were in fair condition. 8% were in good condition and the remaining 42% were in poor condition. No reefs were in excellent condition.

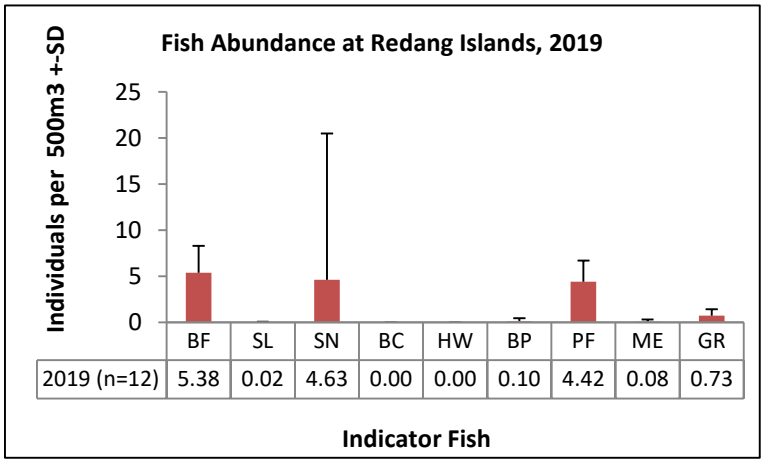
Substrate



The reefs around Redang islands are considered to be in 'Fair' condition, with live coral cover of 28.49% and way below the average (49.21%) for reefs within the Sunda Shelf region.

HC cover has decreased significantly from 38.49% in 2018 to 24.74% in 2019. The level of RB has increased from 6.25% (2018) to 20.99% (2019). These changes are thought to be due to the impact of Tropical Storm Pabuk, which passed through the area in January 2019, worsened by COT and drupella predation.

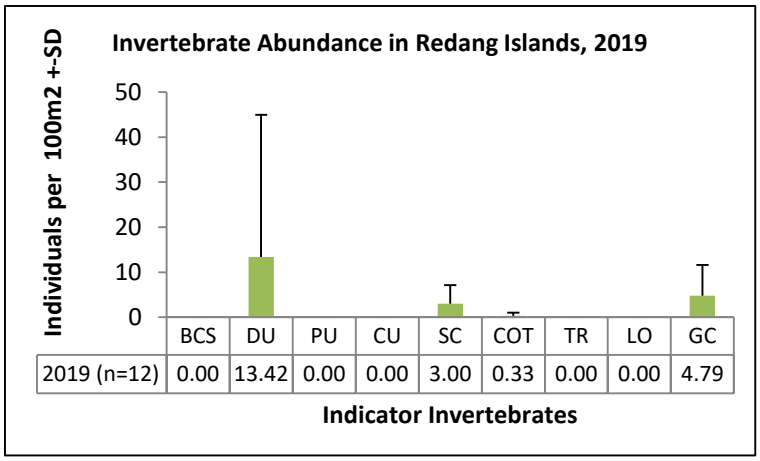
Fish



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

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

Invertebrates



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

Although the abundance of COT is still above what a healthy reef can sustain (0.2-0.3 ind./100m^2), it has decreased significantly from 1.67 ind./100m^2 in 2018 to 0.33 in 2019. The decrease is due to the continuous COT removal effort by Marine Park officers and dive centres in Redang, which has finally managed to contain a COT outbreak that has plagued Redang reefs for almost 7 years.

Human impacts such as boat anchor damage, discarded fishing nets and trash were recorded during surveys. Warm water bleaching was recorded at all sites. COT and drupella predations were also observed. Many of the shallow reefs around Redang were badly damaged by Tropical Storm Pabuk which hit the island early in the year. On a positive note, turtles and sharks were recorded during surveys.

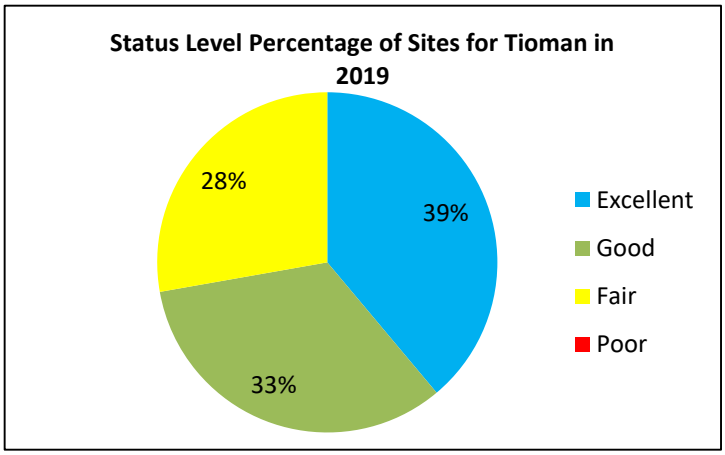
3.2.3 Tioman

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

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

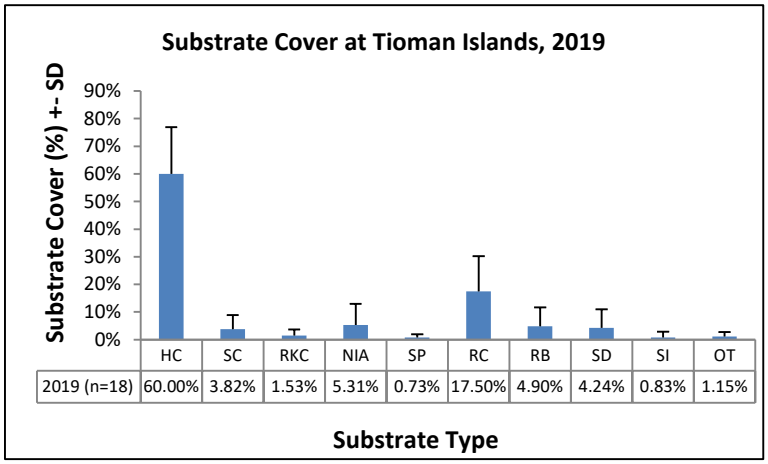
There is a small power generation station on the island, supplying electricity to all areas. Freshwater on the island depends mainly on several river systems coming from the hilly forested areas. A municipal incinerator was constructed some years ago. The island is served by an airport as well as ferry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

Map 6: Surveyed sites in Tioman



A total of 18 coral reef sites were surveyed in Tioman and 39% of the reefs were in excellent condition. 33% were in good condition, while the remaining 28% were in fair condition. No reefs were in poor condition.

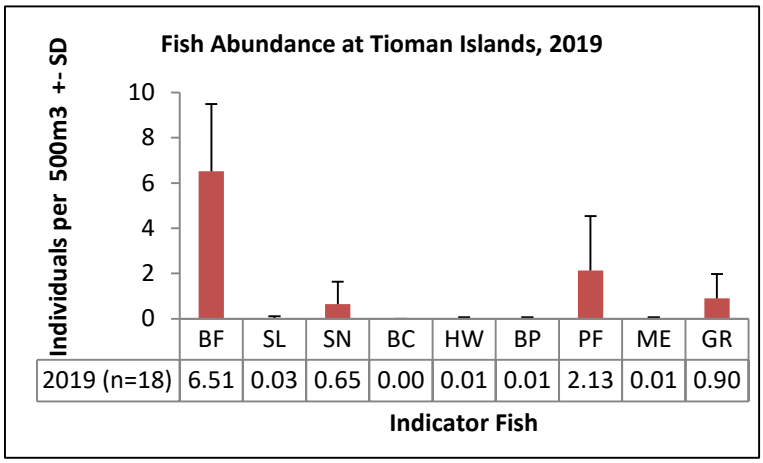
Substrate



The reefs in Tioman are considered to be in 'Good' condition, with 63.82% live coral cover, significantly above the average for reefs of the Sunda Shelf region (49.21%).

The level of RB has decreased considerably from 11.39% in 2018 to 4.9% in 2019. However, the level of NIA has increased from 1.67% in 2018 to 5.31% in 2019. NIA level is especially high at SS3.1 Pirate Reef and SS3.2 Renggis, both sites recorded over 20% NIA. This is a cause for concern and the level of NIA at these two sites need to be monitored closely.

Fish

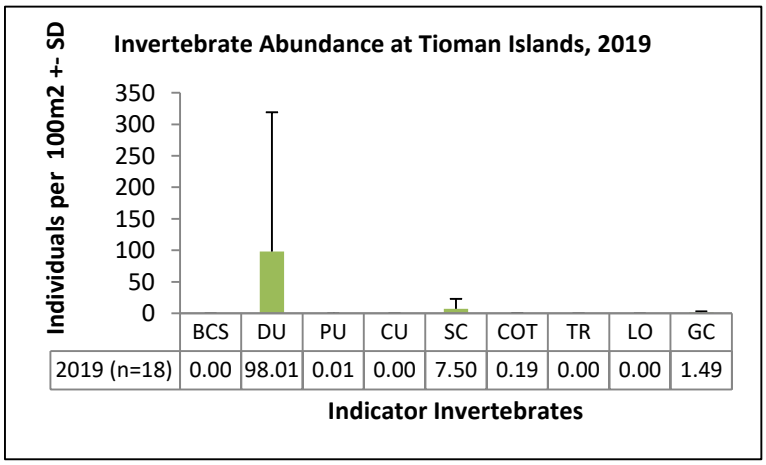


Only Barramundi Cod was not recorded during surveys.

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

Highly prized fish such as Humphead Wrasse and Bumphead Parrotfish were recorded during surveys.

Invertebrates



Indicator invertebrates targeted for the curio trade such as Triton shells were not recorded during surveys. Collector Urchin and Lobster which are targeted for food were also absent from the surveys.

The number of Diadema was the highest, followed by Sea Cucumber and Giant Clam. The number of COT is within what a healthy reef can sustain (0.2-0.3 ind./100m^2). Pencil Urchin which is targeted for curio trade was observed during surveys.

Boat anchor damage, discarded fishing nets and trash were recorded during surveys. Some reefs were impacted by bleaching and overgrown with NIA. On a positive note, shark and turtle were observed at many survey sites.

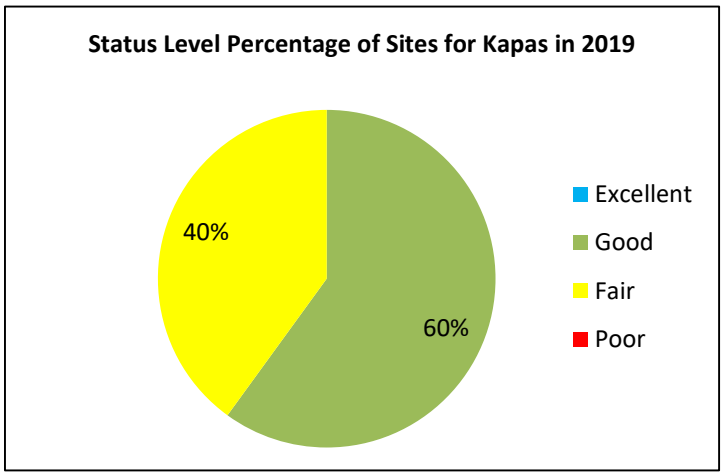
3.2.4 Kapas

Kapas is a small island located just 6km from Marang, off the East coast of Terengganu, Malaysia. There is no resident local population but several resorts provide accommodation for tourists. The island is gazetted as a Marine Park (since 1994).

The island is not a major tourism destination due to its small size, but does have an established tourist market, with less than ten resorts and one dive operator. Diving and snorkelling are the main tourist activities. There is no centralised electricity supply, resorts operate their own generators for power. Groundwater supplies are limited and there is no centralised sewage treatment, each resort having its own sewage treatment facilities.

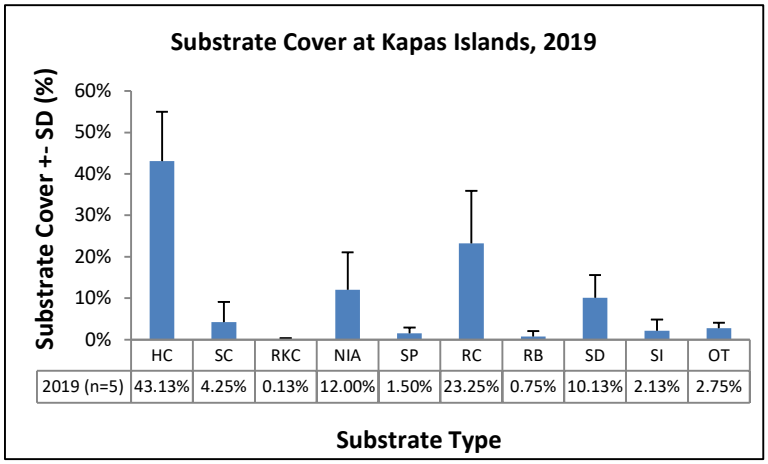
Reefs are mainly fringing off-shore reefs, with some submerged reefs.

Map 7: Surveyed sites in Kapas



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

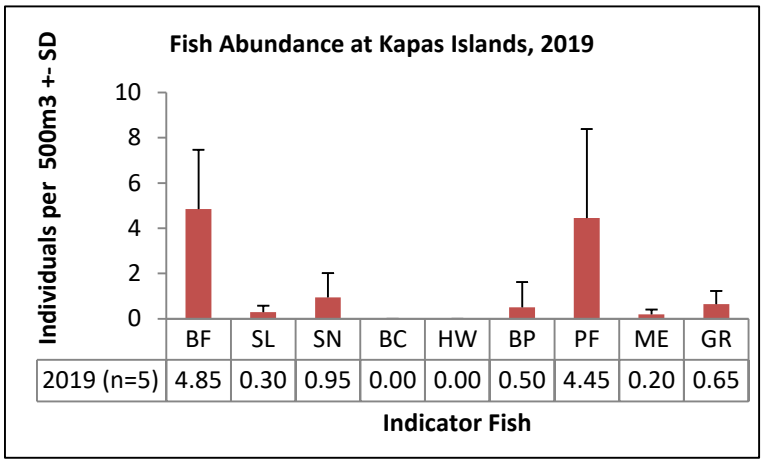
Substrate



Coral reefs around Kapas islands are considered to be in 'Fair' condition, with 47.38% live coral cover, slightly below the average (49.21%) for all islands surveyed in the Sunda Shelf region.

The level of NIA has increased significantly from 0.13% in 2018 to 12% in 2019. This is a cause for concern and need to be monitored closely. On the other hand, RB level has decreased from 5.5% (2018) to 0.75% (2019).

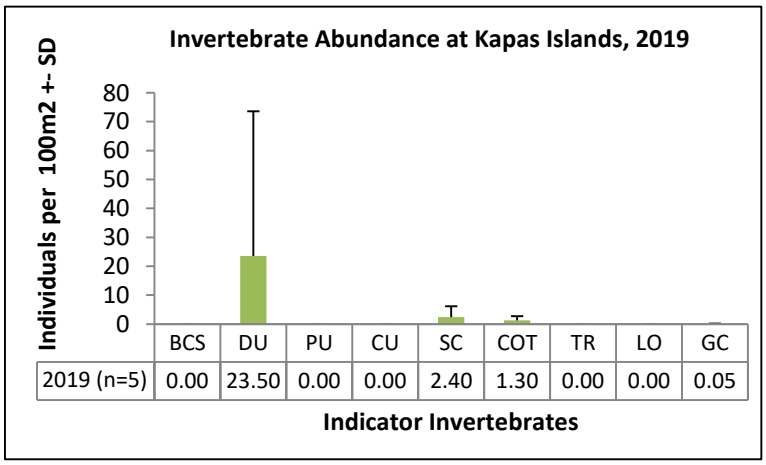
Fish



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

On a positive note, highly prized fish such as Bumphead Parrotfish was recorded during surveys.

Invertebrates



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

Abundance of Diadema Urchin was the highest. Sea Cucumber and Giant Clam were present in low numbers. The abundance of COT is way above what a healthy reef can sustain (0.2-0.3 ind./100m^2) and is the highest of all islands surveyed in the Sunda Shelf region.

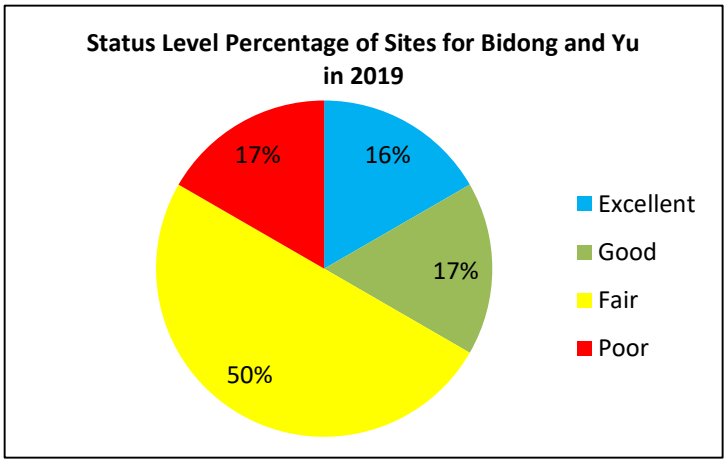
Human impacts such as discarded fishing nets and trash were recorded at many sites during surveys. Warm water bleaching was recorded at all sites. On a positive note, whaleshark and turtle were spotted during surveys.

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.

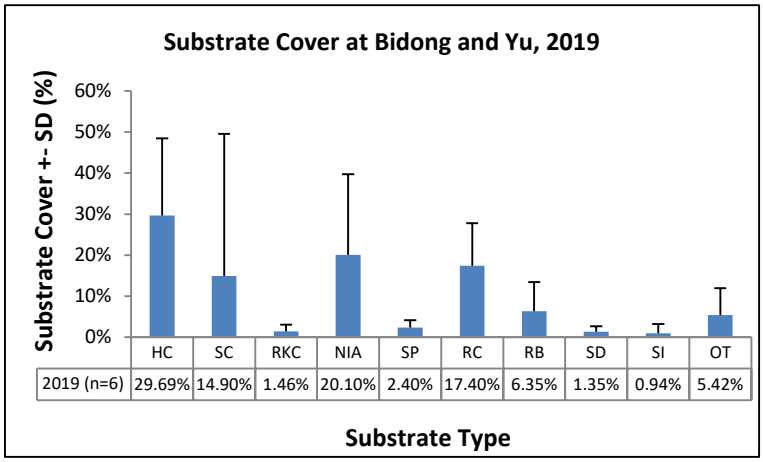
Bidong has mainly been used as a research base for University Malaysia Terengganu but has recently grown in popularity as a diving destination. Bidong has some sandy beaches and fringing reefs while Pulau Yu Besar and Kecil are mainly small rocky islands, with boulder slopes dropping to 25-30m, with 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 reefs were in fair condition. The remaining 16% were in excellent condition, 17% in good condition and 17% in poor condition.

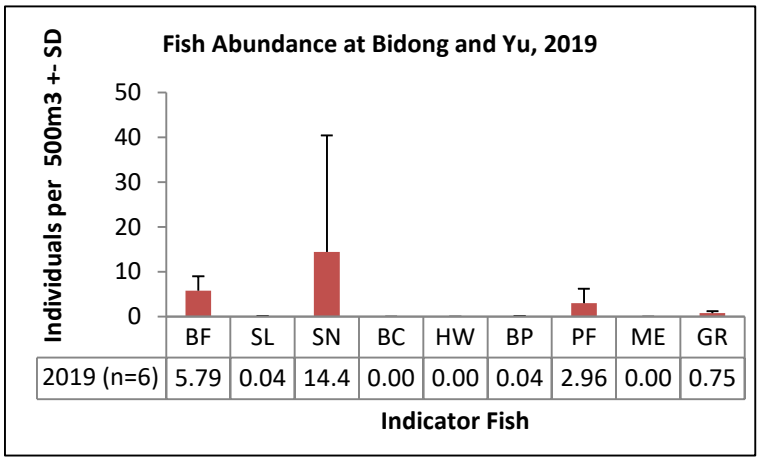
Substrate



Coral reefs around Bidong and Yu islands are considered to be in 'Fair' condition, with 44.58% live coral cover, slightly below the average (49.21%) for reefs in Sunda Shelf region.

HC cover decreased significantly from 38.13% in 2018 to 29.69% in 2019. NIA level increased significantly from 6.56% (2018) to 20.10% (2019). These changes are likely due to damaged caused by Tropical Storm Pabuk which passed through the area in January 2019, worsened by COT and drupella predation.

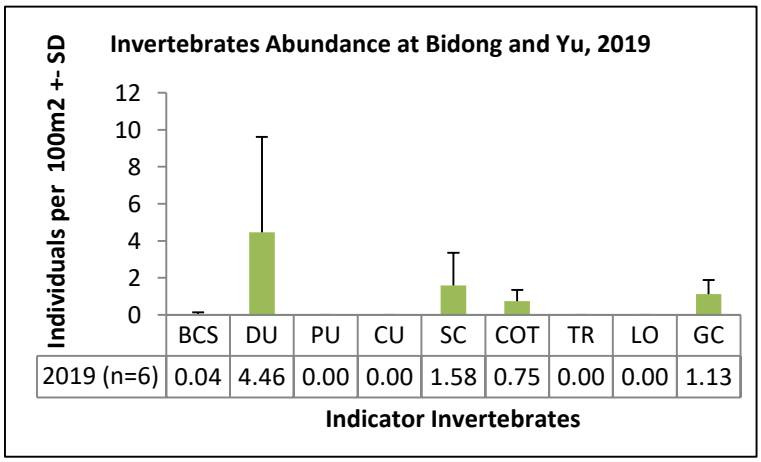
Fish



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

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

Invertebrates



As in most sites, indicator invertebrate targeted for curio trade such as Pencil Urchin and Triton were absent during surveys. However, Banded Coral Shrimp was observed. Collector Urchin and Lobster which are targeted for food were also absent from the surveys.

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

Human impacts were generally low, with discarded fishing nets and trash only recorded at some sites. The reefs at Bidong and Yu were highly affected by natural impacts. Many of the shallow reefs were badly damaged by Tropical Storm Pabuk which hit the island early in the year. To make recovery harder, many sites were affected by warm water bleaching and predation by COT and drupella. On a positive note, turtle was recorded during surveys.

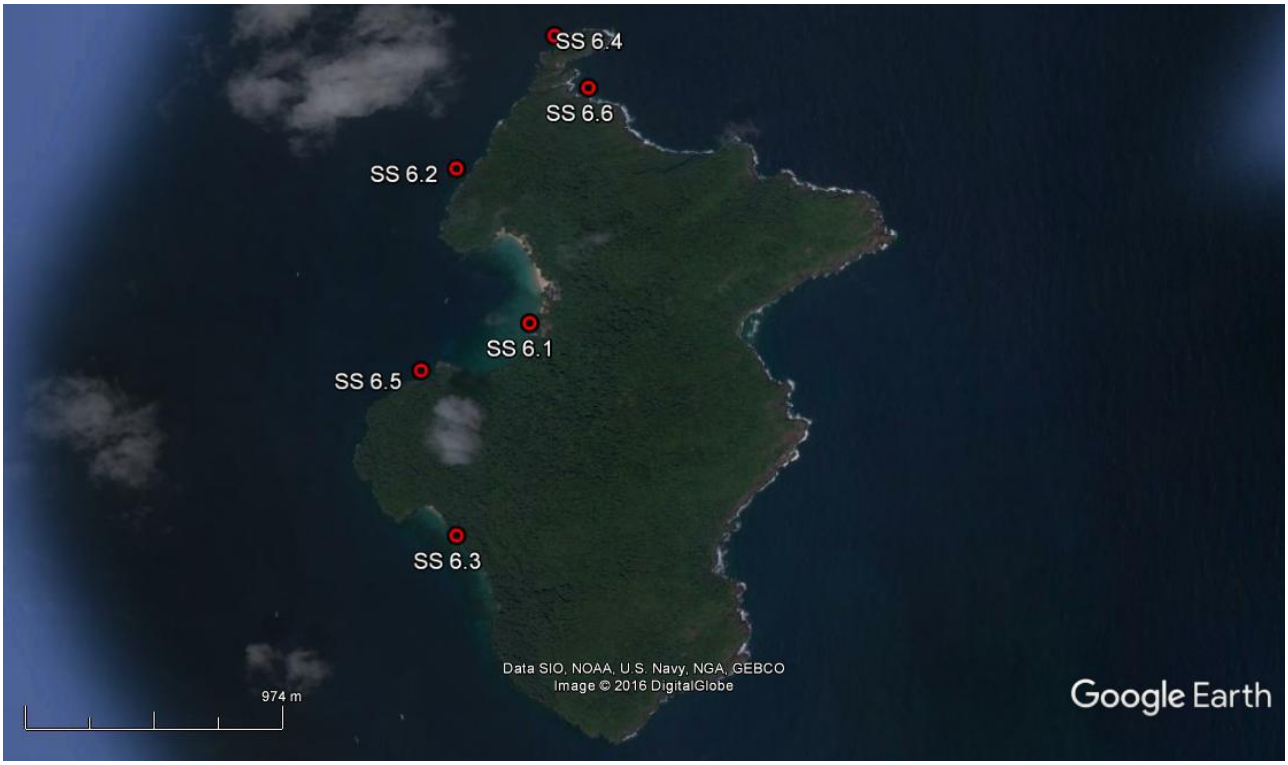
3.2.6 Tenggol

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).

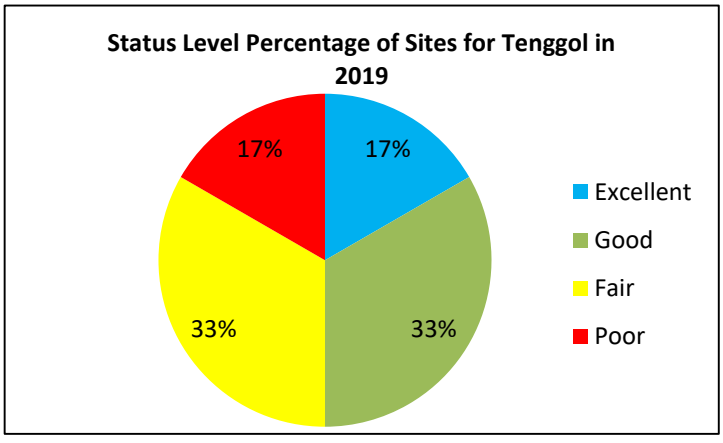
The island is a popular diving destination due to the surrounding deep water which attracts more mega fauna than other islands (whale sharks are common around the island). There are four resorts on the island, each with its own dive operator. There is no centralised electricity supply, resorts operate their own generators for power. Groundwater supplies are limited and there is no centralised sewage treatment, each resort having its own sewage treatment facility.

Tenggol Island has gained in popularity over the last few years and a number of dive and snorkel operators have started to operate from Dungun, the nearest town on the mainland, offering day trip packages to divers and snorkelers alike.

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

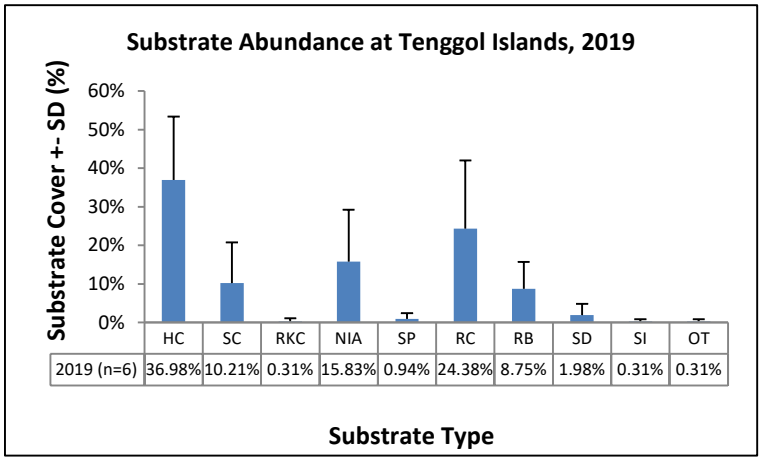


Map 9: Surveyed sites in Tenggol



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

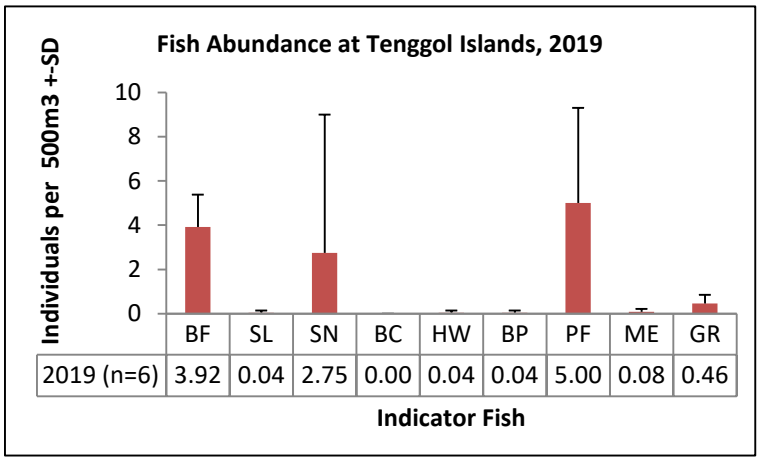
Substrate



The reefs in Tenggol were considered to be in 'Good' condition, with 47.19% live coral cover, slightly below the average (49.21%) for reefs of the Sunda Shelf region.

HC cover has decreased from 41.04% in 2018 to 36.98% in 2019. RB level on the other hand has increased from 5.73% (2018) to 8.75% (2019). NIA level has increased from 7.71% (2018) to 15.83% (2019). The decrease in HC cover and increase in RB and NIA level may be due to damage caused by Tropical Storm Pabuk.

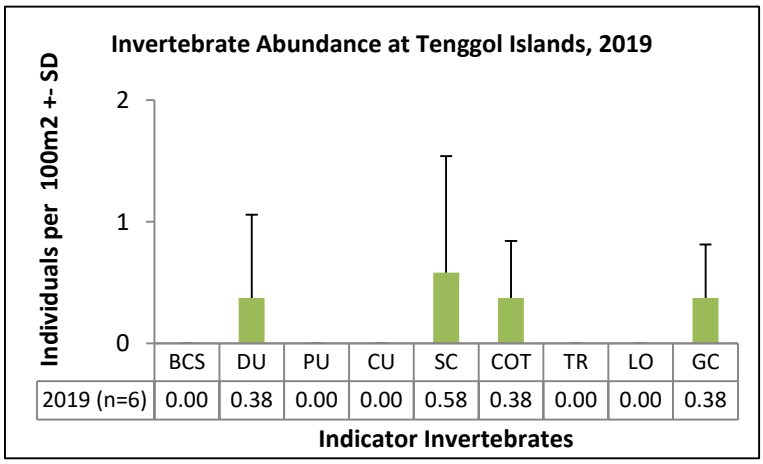
Fish



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

Highly prized fish such as Bumphead Parrotfish and Humphead Wrasse were also recorded in low number. Barramundi Cod was absent.

Invertebrates



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

Abundance of other indicator species was very low. The abundance of COT is above what a healthy reef can support (0.2-0.3 ind./100m^2).

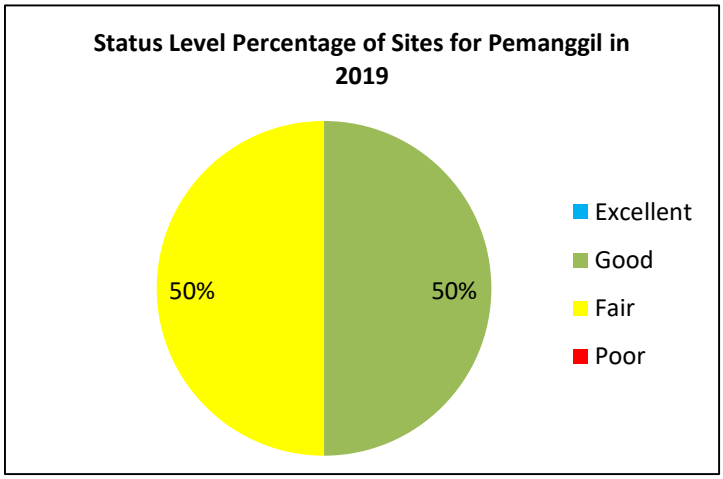
Human impacts such as boat anchor damage, discarded fishing nets and trash were recorded at a few sites during surveys. Many of the shallow reefs around Tenggol were probably damaged by Tropical Storm Pabuk which hit the island early in the year. To make recovery harder, warm water bleaching was recorded at all sites. No rare animals were sighted during surveys.

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).

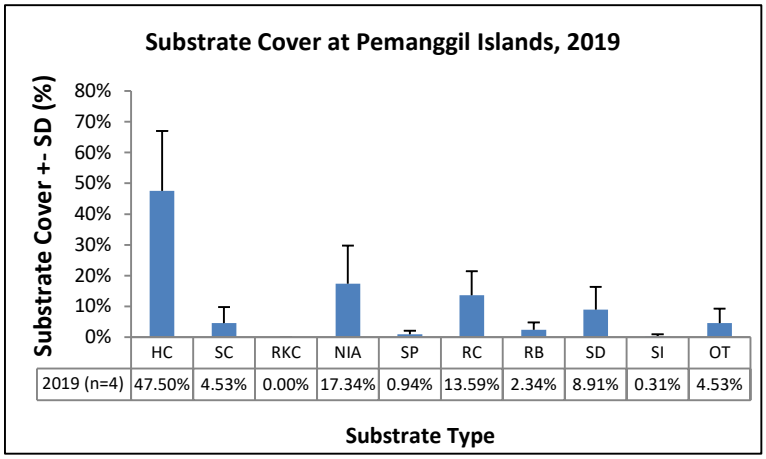
The island is sparsely populated and has for many years been a frequent stopover point for fishermen.

Map 10: Surveyed sites in Pemanggil



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

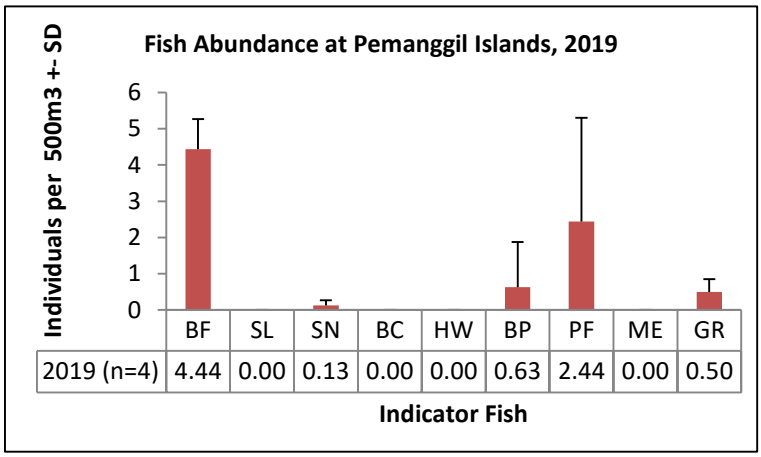
Substrate



The reefs in Pemanggil are considered to be in 'Good' condition, with 52.03% live coral cover, above the average (49.21%) for reefs of the Sunda Shelf region.

HC cover has decreased slightly from 51.41% in 2018 to 47.5% in 2019 while NIA level has increased significantly (10%). RB level has decreased significantly from 20.31% in 2018 to 2.34% in 2019. The level of SD on the other hand has increased considerably from 1.72% in 2018 to 8.91% in 2019.

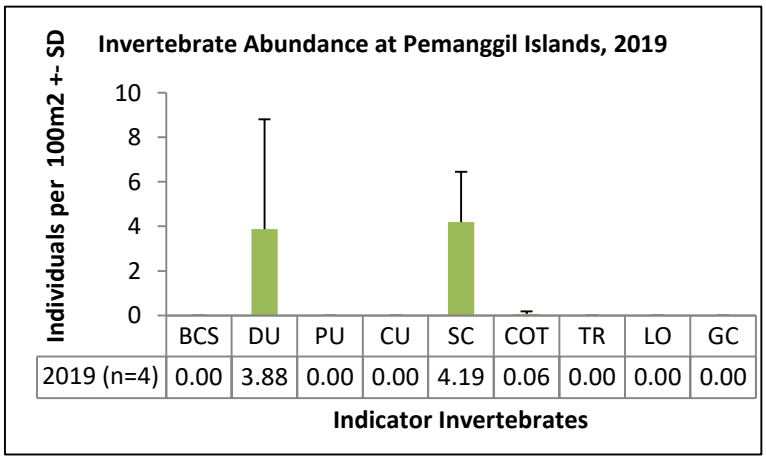
Fish



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

The most abundant fish was Butterflyfish, followed by Parrotfish. Snapper and Grouper were present in low number. Bumphead Parrotfish was recorded during surveys.

Invertebrates



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

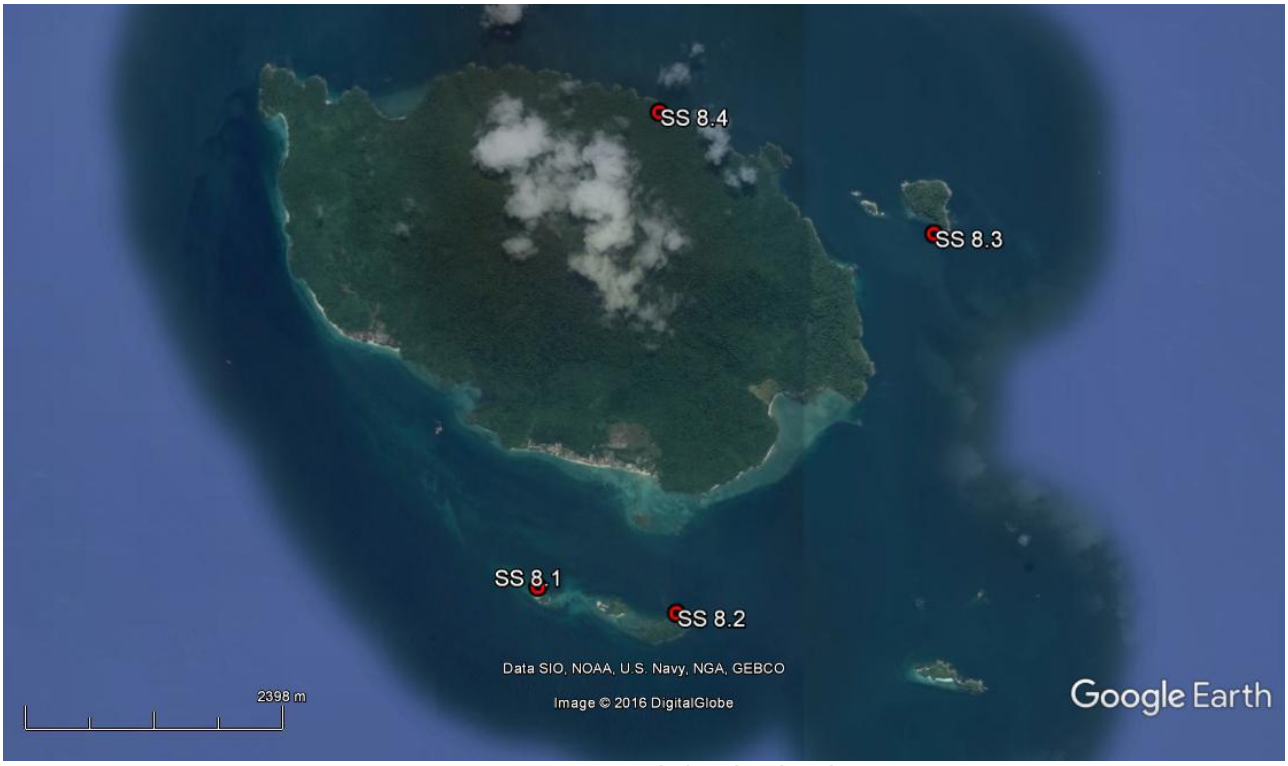
Sea Cucumber recorded the highest number, followed by Diadema Urchin. COT does not seem to pose any dangers as the abundance was within the healthy range.

Neither human nor natural impacts were recorded during surveys. No rare animals were sighted during surveys. High amounts of NIA are causing damage to reefs, and the cause must be determined.

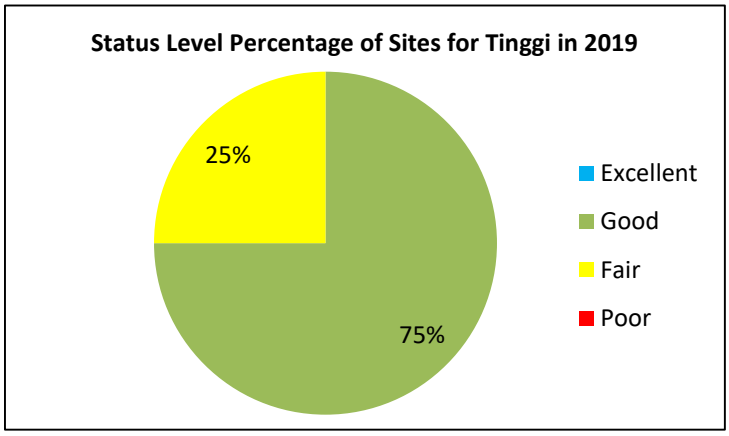
3.2.8 Tinggi

Tinggi Island is located less than 15km off the East coast of mainland Peninsular Malaysia. The island and its surrounding waters were gazetted as a Marine Park 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.

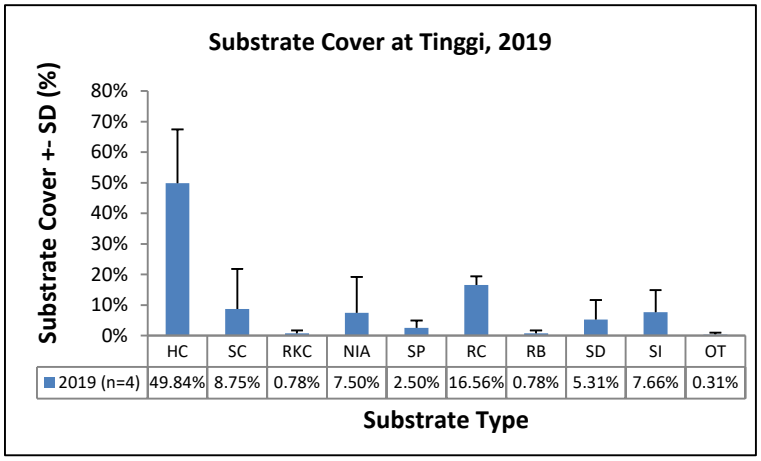


Map 11: Surveyed sites in Tinggi



A total of 4 coral reef sites were surveyed in Tinggi and 75% of the reefs were in good condition. The remaining 25% were in fair condition.

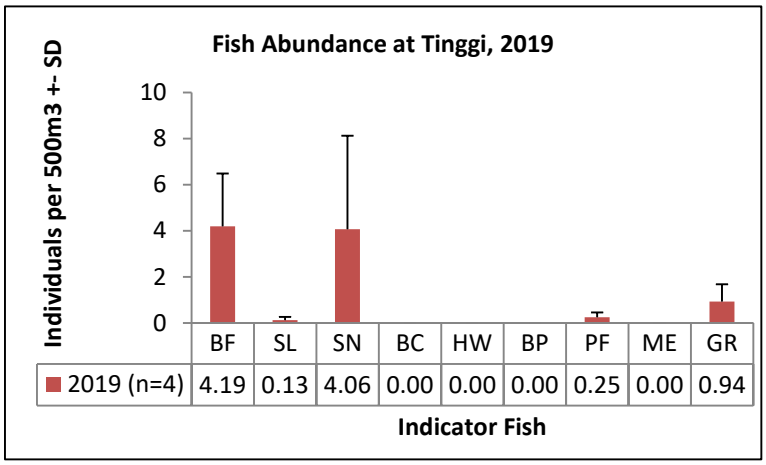
Substrate



Coral reefs around Tinggi Island were in 'Good' condition, with 58.59% live coral cover, above the average (49.21%) for reefs in the Sunda Shelf region.

The level of NIA and SI has increased considerably, from 2.03% in 2018 to 7.5% in 2019 for NIA level and from 1.41% in 2018 to 7.66% in 2019 for SI level. This is a cause for concern and the levels need to be monitored closely.

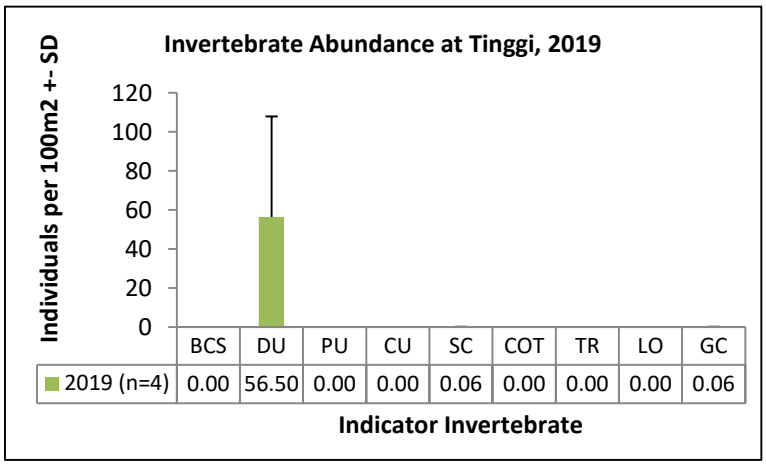
Fish



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

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

Invertebrates



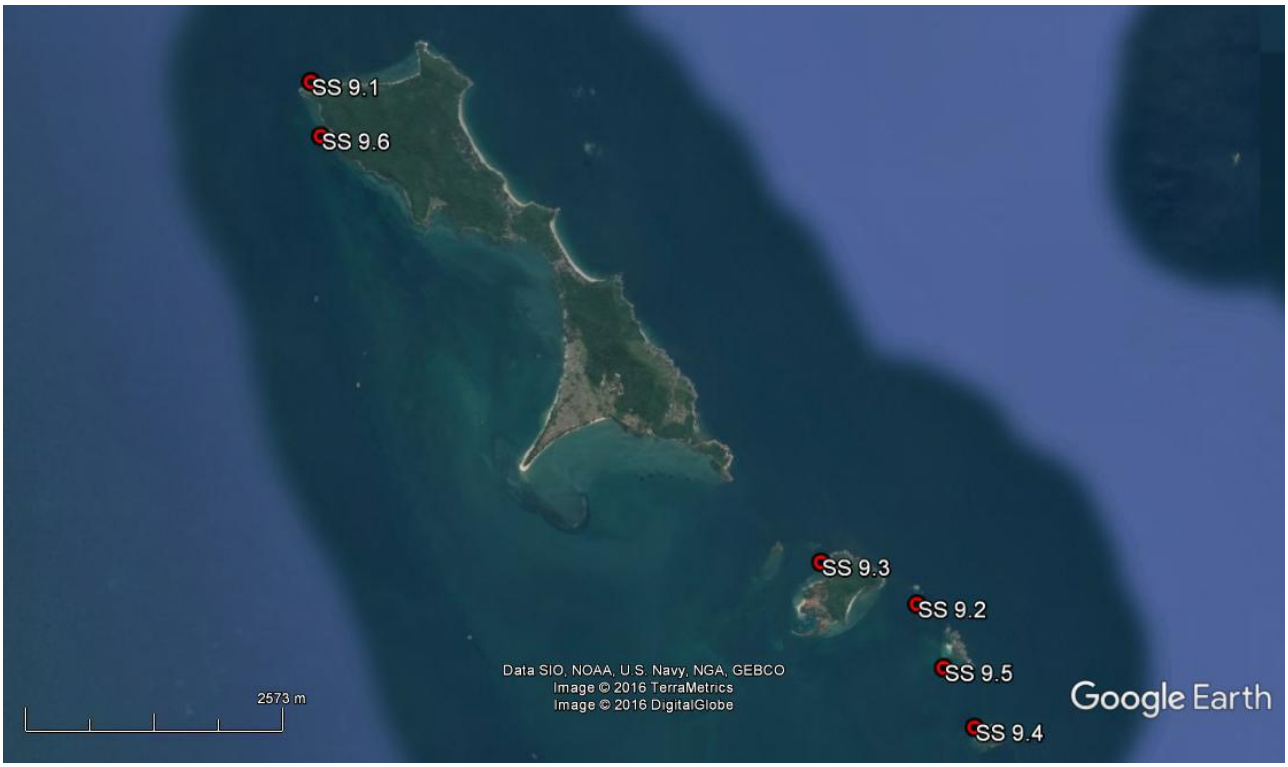
Only Diadema Urchin, Sea Cucumber and Giant Clam were recorded during surveys. The abundance of Diadema Urchin was high at 56.50 ind./100m^2 while the abundance of Sea Cucumber and Giant Clam was very low, less than 1 ind./100m^2.

Discarded fishing net and trash were seen during surveys. Bleaching was recorded at SS8.2 P. Nanga and Drupella predation was observed at SS8.1 P. Mentinggi.

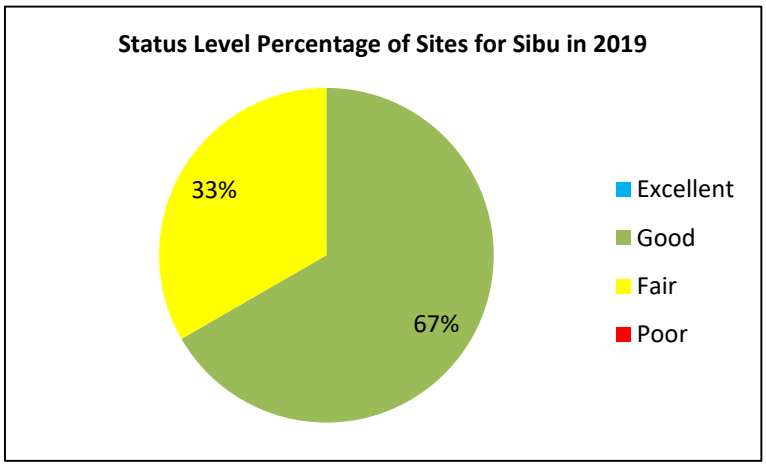
3.2.9 Sibu

The Sibu archipelago, known locally by the name of the largest island, Sibu, is located less than 10km off the East coast of mainland Peninsular Malaysia. The waters surrounding the island group were gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1993).

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

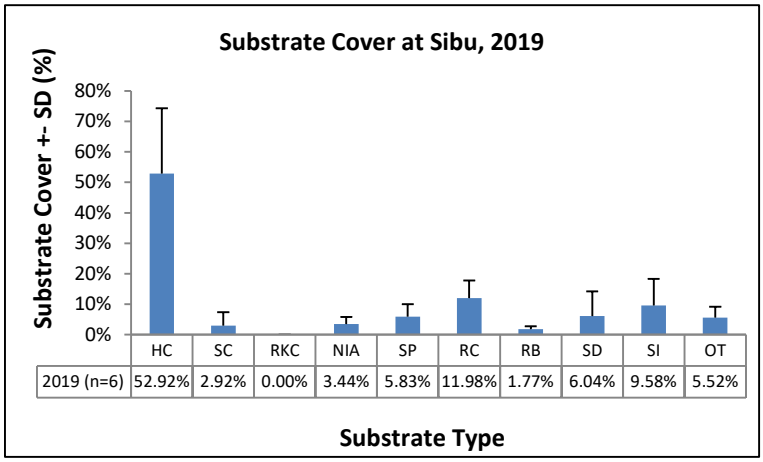


Map 12: Surveyed sites in Sibu



A total of 6 coral reef sites were surveyed in Sibu Island. 67% of the reefs were in good condition and 33% were in fair condition.

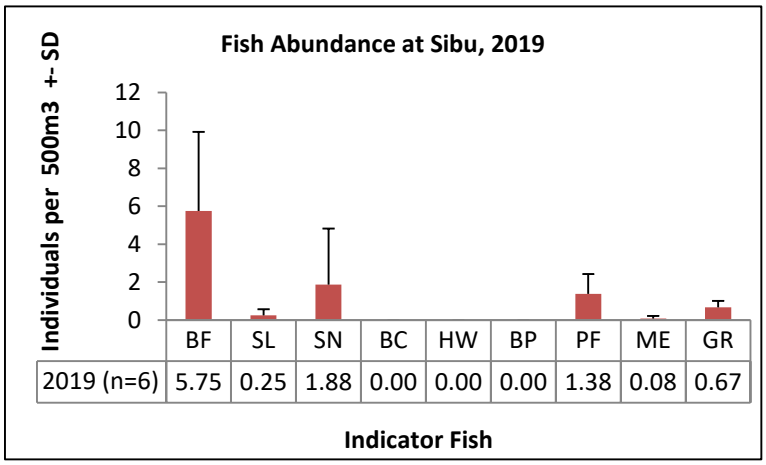
Substrate



Coral reefs around Sibu were in 'Good' condition, with 55.83% live coral cover, above the average (49.21%) for reefs in the Sunda Shelf region.

The levels of RB and SI have increased slightly. This shows that there are some disturbances on reefs around the Sibu Islands.

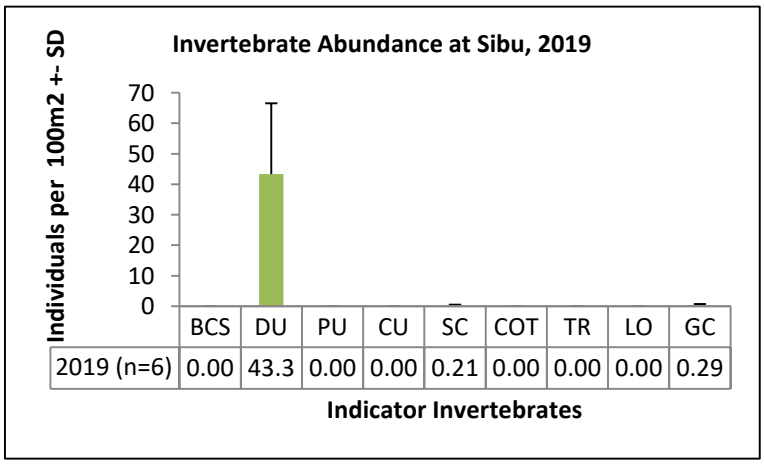
Fish



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

Butterflyfish was the most abundant targeted fish recorded, followed by Snapper and Parrotfish. Abundance of other indicators was very low, including Sweetlips, Moray Eel and Grouper.

Invertebrates



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

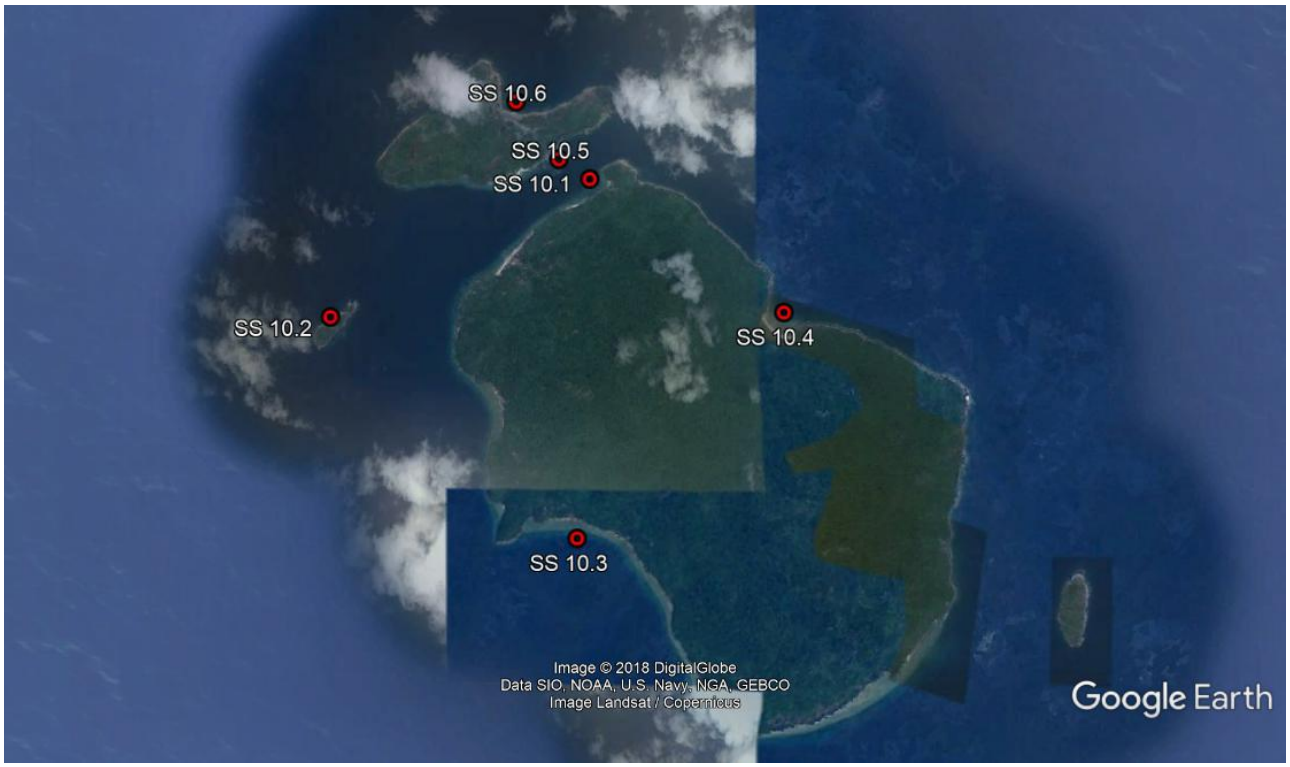
The abundance of Diadema Urchin was high while the abundance of Sea Cucumber and Giant Clam was very low.

Human impacts such as discarded fishing net and fish trap were recorded during surveys. Trash was also observed. Warm water bleaching was recorded at many sites.

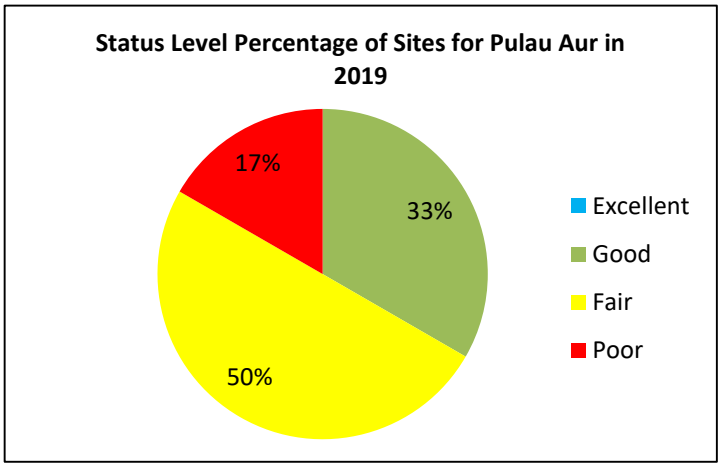
3.2.10 Pulau Aur and Pulau Dayang

Pulau Aur and Pulau Dayang are adjacent islands in Mersing District, Johor. They lie about 76km east of Mersing off the East coast of Peninsular Malaysia and were gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1993).

Their corals, lagoons and offshore pools make these islands a tourist attraction. The islands are sparsely populated with few villages and have for many years been a frequent stopover point for fishermen. Pulau Aur and Pulau Dayang used to be a popular diving destination among tourists from Singapore.

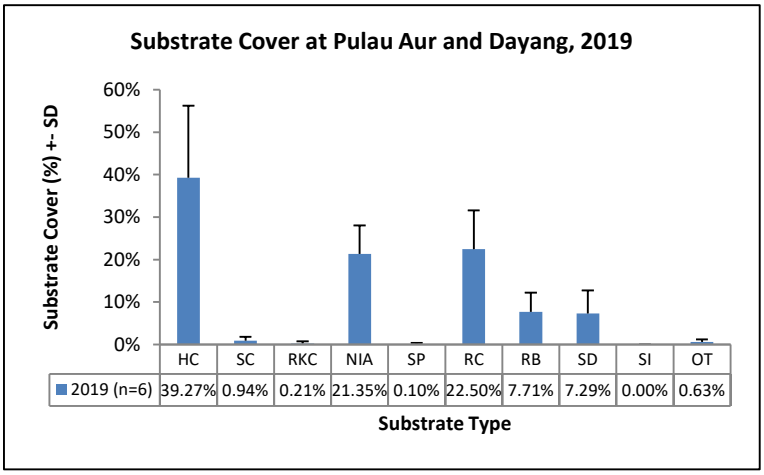


Map 13: Surveyed sites in Pulau Aur and Dayang



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

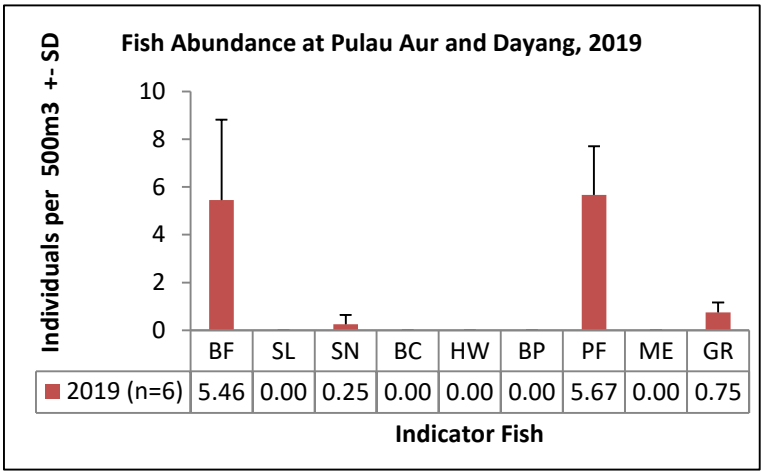
Substrate



Coral reefs around Pulau Aur and Dayang are considered to be in 'Fair' condition, with 40.21% live coral cover, lower than the average (49.21%) for reefs of the Sunda Shelf region.

HC cover has decreased slightly from 43.23% in 2018 to 39.27% in 2019 while NIA level has increased significantly from 8.96% in 2018 to 21.35% in 2019

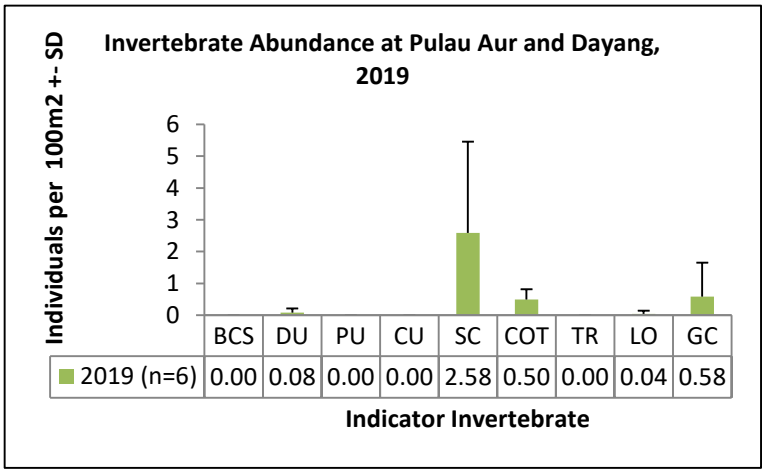
Fish



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

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

Invertebrate



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

Four indicator invertebrates were recorded during surveys but all were present in low number, except for Sea Cucumber. The abundance of COT was above the range of what a healthy reef can support (0.2-0.3 ind./100m^2).

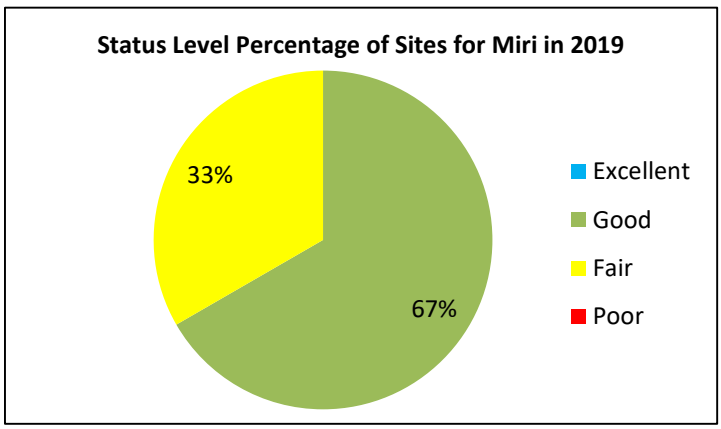
Human impacts such as fish nets and trash were recorded during surveys. On a positive note, turtles were sighted during surveys.

3.2.11 Miri

Miri is located in the north 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.

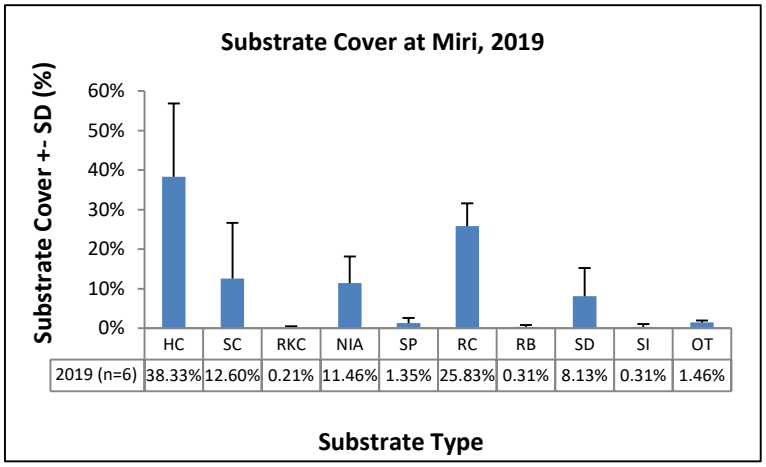
Miri has extensive submerged offshore reefs, generally flat in profile, in depths ranging from 7 to 30m. The reefs and surrounding waters cover an area of 186,930 hectare areas in the Miri and Sibuti districts, were gazetted as the Miri-Sibuti Coral Reef National Park in 2007 under the National Parks 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 14: Surveyed sites in Miri



A total of 6 coral reef sites were surveyed in Miri and 67% of the sites were in good condition. The remaining 33% were in fair condition.

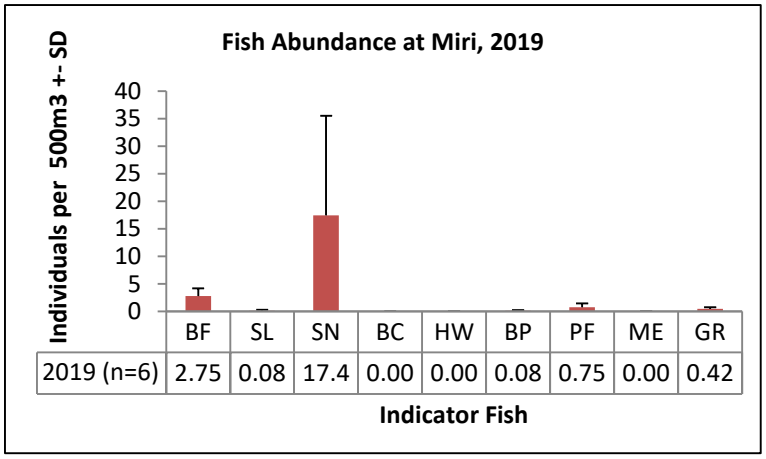
Substrate



Coral reefs around Miri were in 'Good' condition with 50.94% of live coral cover, slightly above the average (49.21%) for the Sunda Shelf region.

The level of NIA has increased from 8.54% in 2018 to 11.46% in 2019.

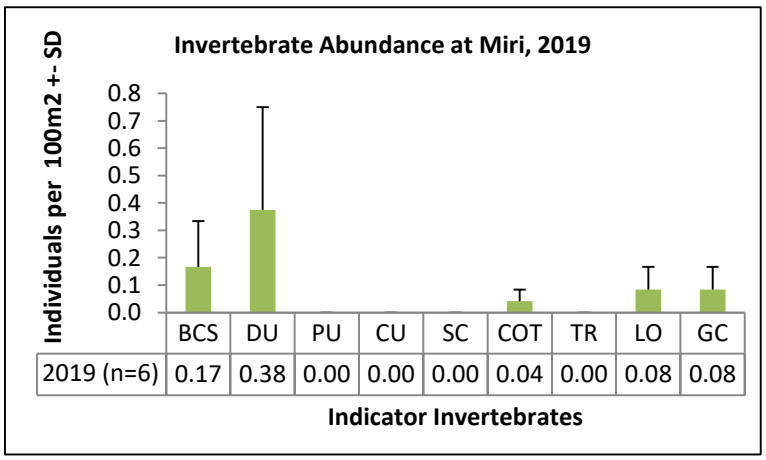
Fish



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

The abundance of Snapper was the highest, followed by Butterflyfish. Others indicators were recorded in low abundance. Bumphead Parrotfish was also recorded during surveys.

Invertebrates



Five indicators were observed during surveys, which are Banded Coral Shrimp, Diadema Urchin, Crown-of Thorns, Lobster and Giant Clam. All indicators were present in very low number.

The abundance of COT was within the range of what a healthy reef can support (0.2-0.3 ind./100m^2).

Human impacts such as boat anchor damage and discarded fishing net were observed during surveys. Warm water bleaching and storm damage were also observed. On a positive note, turtle and school of jacks and fusiliers were observed.

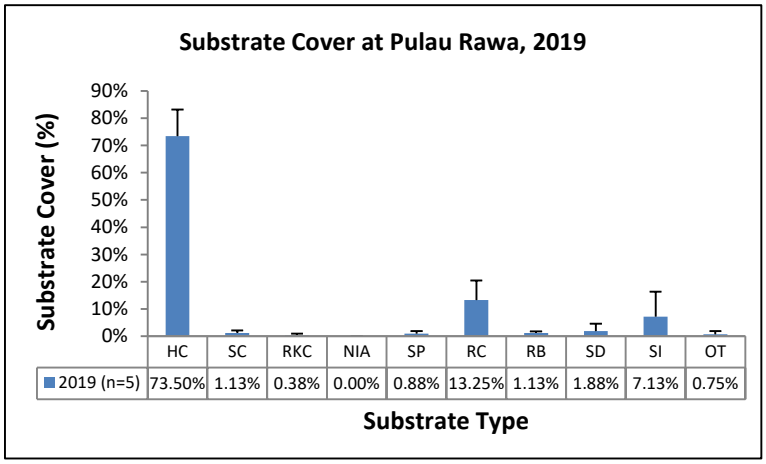
3.2.12 Pulau Rawa

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

Only one site has been surveyed at Pulau Rawa, a very limited sample. Further sites will be added in the future.

Map 15: Surveyed site in Pulau Rawa

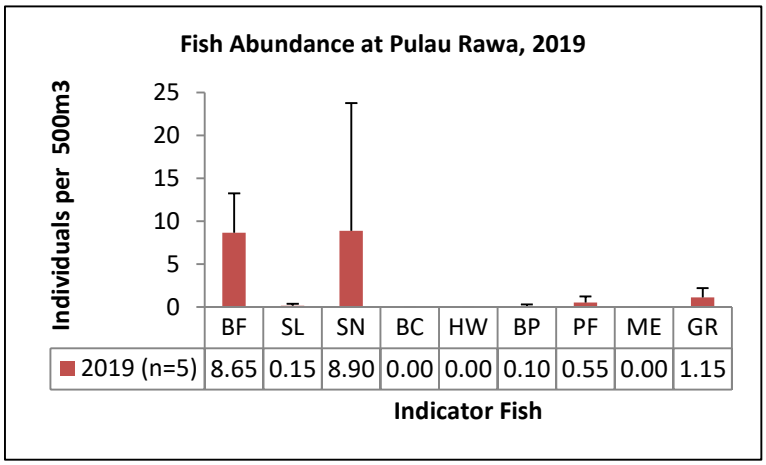
Substrate



The coral reef surveyed at Pulau Rawa was in 'Good' condition with 74.63% of live coral cover, way above the average (49.21%) for the Sunda Shelf region.

The level of SI is high at 7.13%. The high SI level is probably due to the close proximity of Pulau Rawa to the mainland and a likely source of this high SI level is terrestrial runoff from the Mersing River.

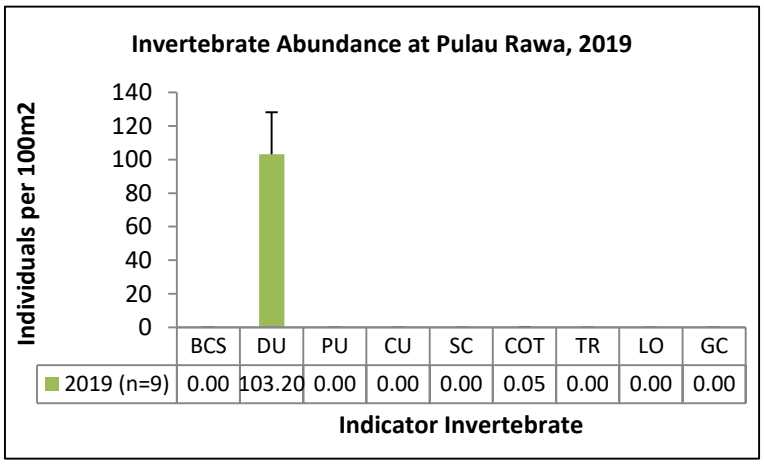
Fish



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

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

Invertebrate



Only Diadema Urchin and Crowns-of-thorns were recorded. The abundance of Diadema Urchin was high at 235.25 ind./100m^2.

The abundance of COT was within the range of what a healthy reef can support (0.2-0.3 ind./100m^2).

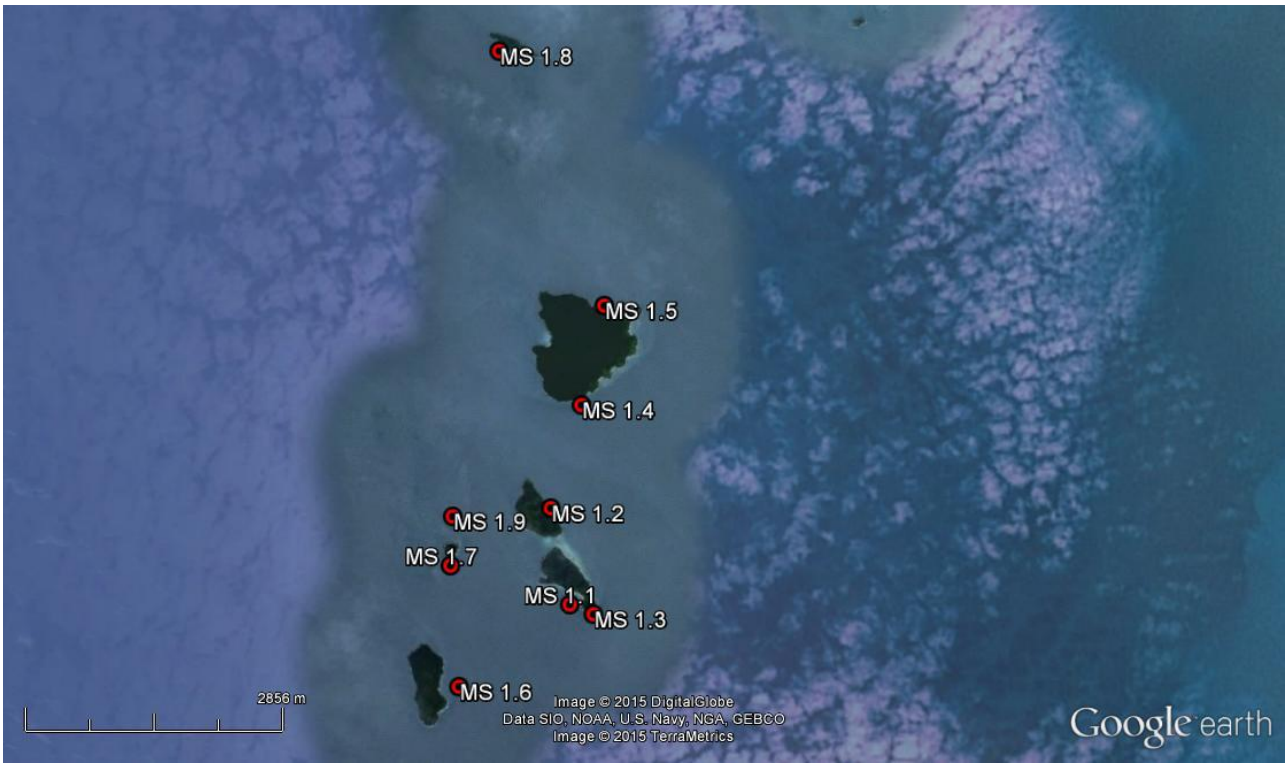
Human impacts such as trash and discarded fishing nets were recorded at many sites. Warm water bleaching was recorded at all sites. A turtle was also recorded during survey.

Malacca Strait

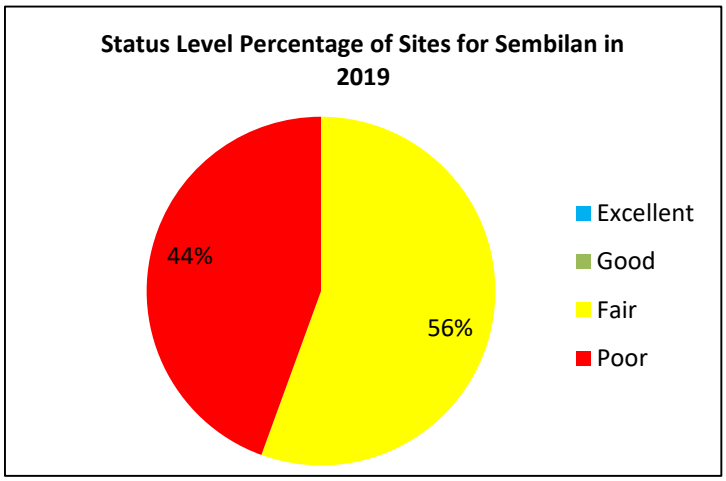
3.2.13 Sembilan Islands

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

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

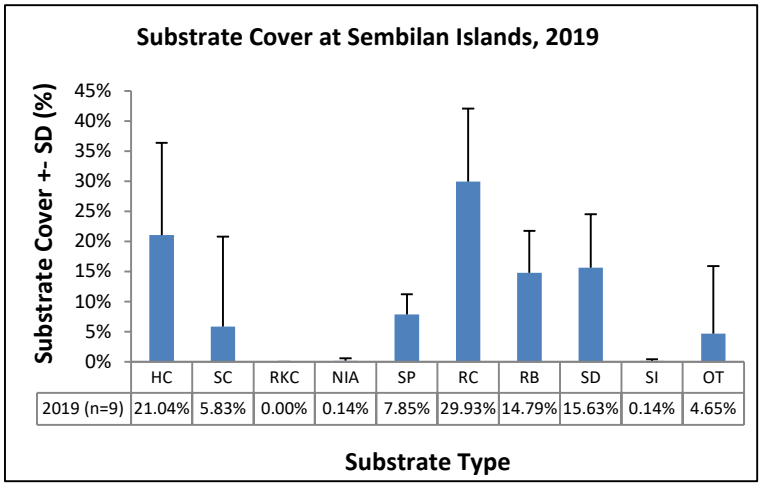


Map 16: Surveyed sites in Sembilan



A total of 9 coral reef sites were surveyed in Sembilan islands and 56% of the reefs were in fair condition. The remaining 44% were in poor condition. No reefs were in excellent or good condition.

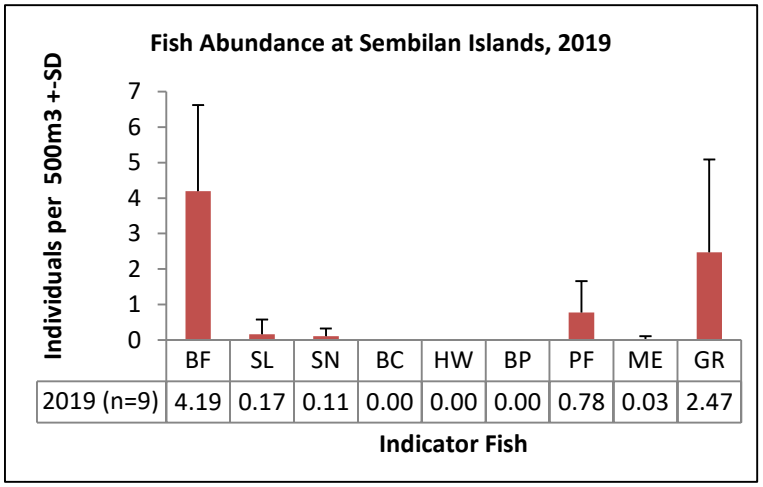
Substrate



Coral reefs around Sembilan islands are considered to be in 'Fair' condition, with 26.88% live coral cover, lower than the average (36.67%) for reefs of the Malacca Strait region.

The level of RB has increased from 8.33% in 2018 to 14.79% in 2019 while the level of SD has decreased significantly from 24.10% in 2018 to 15.63%

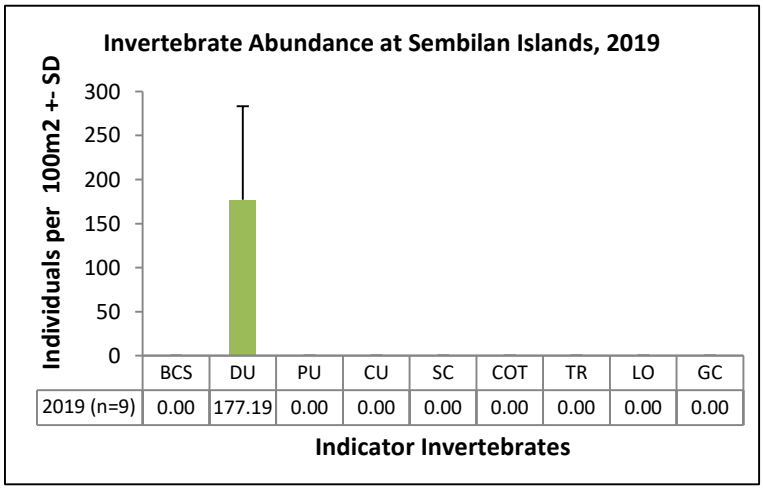
Fish



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

Abundance of Butterflyfish was the highest, followed by Grouper. Other indicator species were present in very low numbers such as Sweetlips, Snapper, Parrotfish and Moray Eel.

Invertebrates



As in previous years, only Diadema Urchin was recorded during surveys and the abundance was high, the highest within the Malacca Strait region.

Discarded fishing nets and trash were recorded at many surveyed sites. On a positive note, seahorses were observed during surveys.

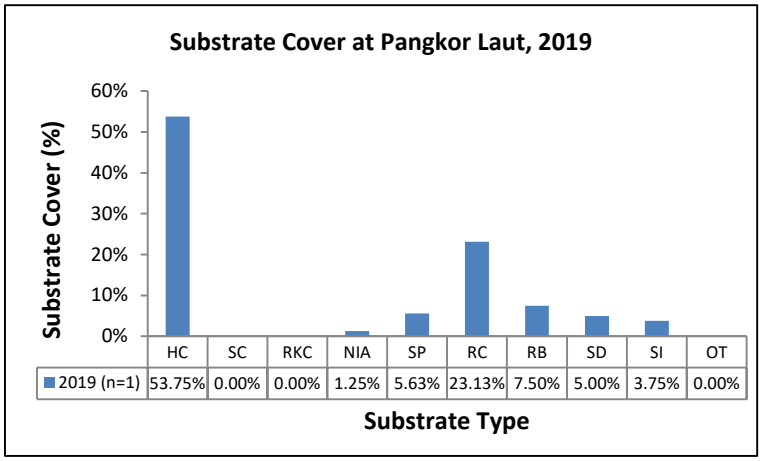
3.2.14 Pangkor Laut Island

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

Only one site has been surveyed at Pulau Pangkor Laut, a very limited sample. Further sites will be added in future.

Map 17: Surveyed site in Pangkor Laut

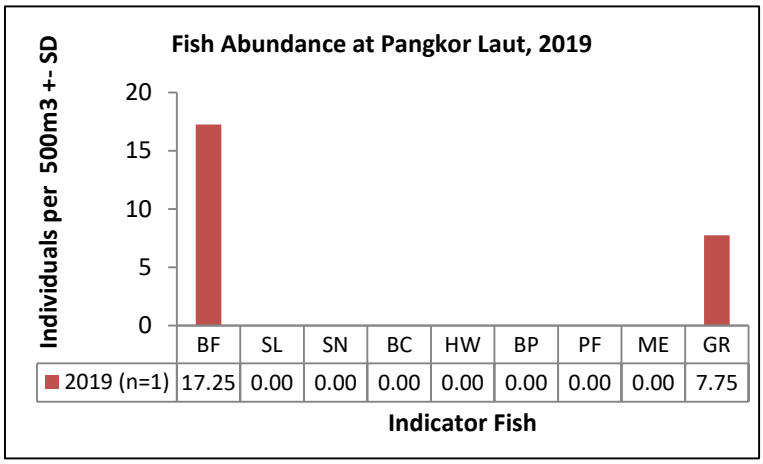
Substrate



Reef at Pangkor Laut is considered to be in 'Good' condition, with 53.75%% live coral cover, above the average (36.67%) for reefs of the Malacca Strait region.

HC cover has increased significantly from 28.75% in 2018 to 53.75% in 2019 while RC cover decreased significantly from 61.25% (2018) to 23.13% (2019). SD and SI levels have also increased considerably; from 0.63% (2018) to 5% (2019) and 1.88% (2018) to 3.75% (2019), respectively.

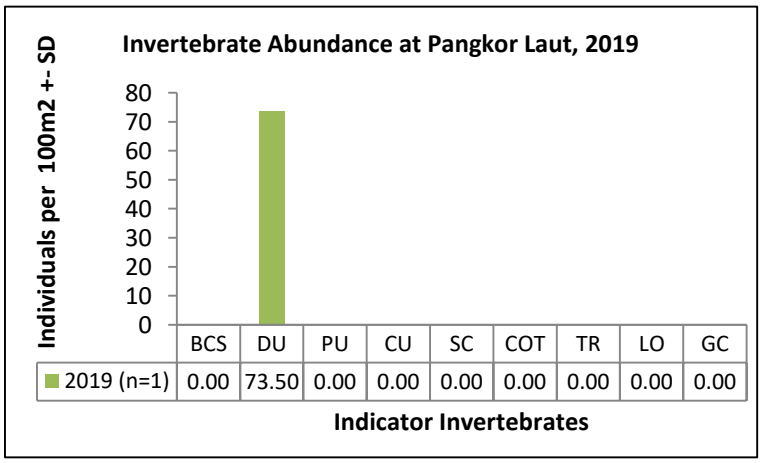
Fish



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

The abundance of Butterflyfish and Grouper were high.

Invertebrates



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

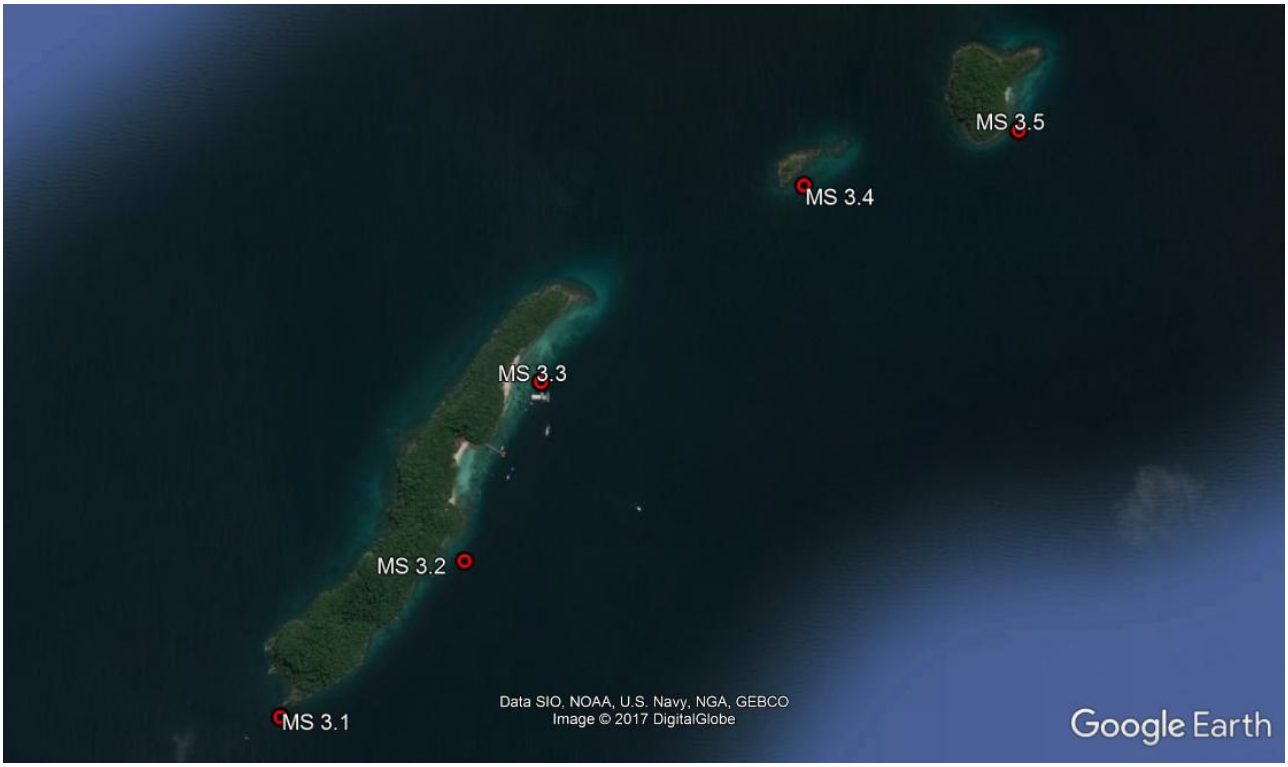
Discarded fishing net and trash were recorded during the survey. Three seahorses were also observed.

3.3.15 Payar

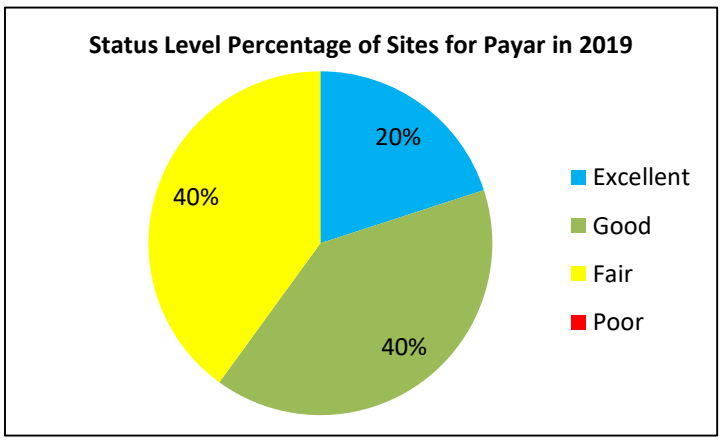
Payar is one of many islands off the West coast of mainland Kedah in the Straits of Malacca. It is situated 35km south of Langkawi, 59km north of Penang and 28km west of Kuala Kedah. It was gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1991).

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

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

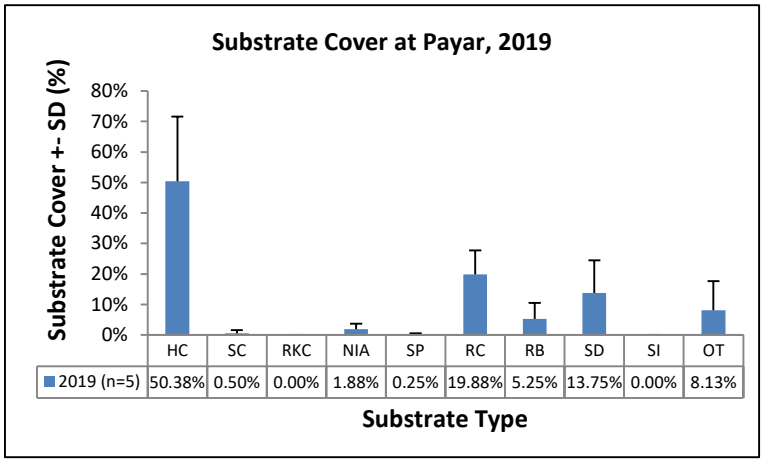


Map 18: Surveyed sites in Payar



A total of 5 coral reef sites were surveyed in Payar and 20% of the reefs were in excellent condition. 40% were in good condition and the remaining 40% were in fair condition.

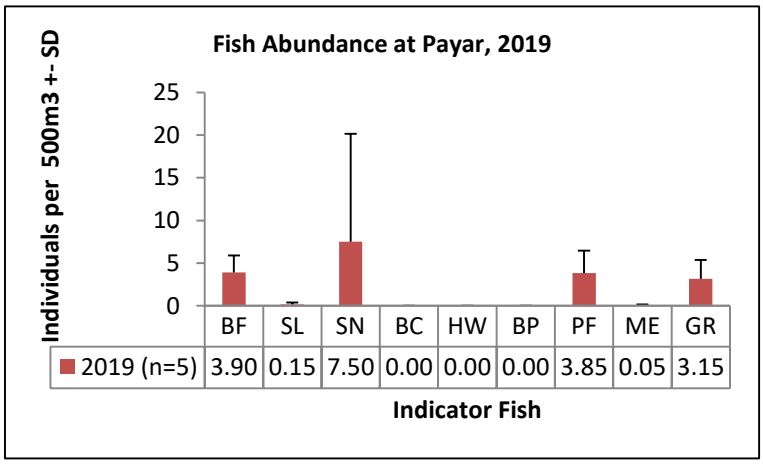
Substrate



Coral reefs around Payar are considered to be in 'Good' condition, with 50.88% live coral cover, above the average (36.67%) for reefs of the Malacca Strait region.

The island in general has high level of RC and SD.

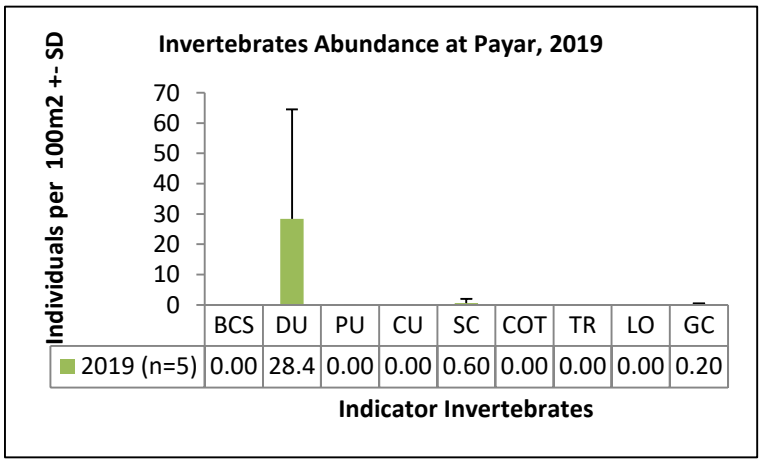
Fish



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

The abundance of Snapper was the highest, followed by Butterflyfish, Parrotfish and Grouper.

Invertebrates



Only three indicator invertebrates were recorded; 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, less than 1 ind./100m^2.

Discarded fishing net was recorded during surveys. On a positive note, blacktip sharks were observed during surveys.

North Borneo

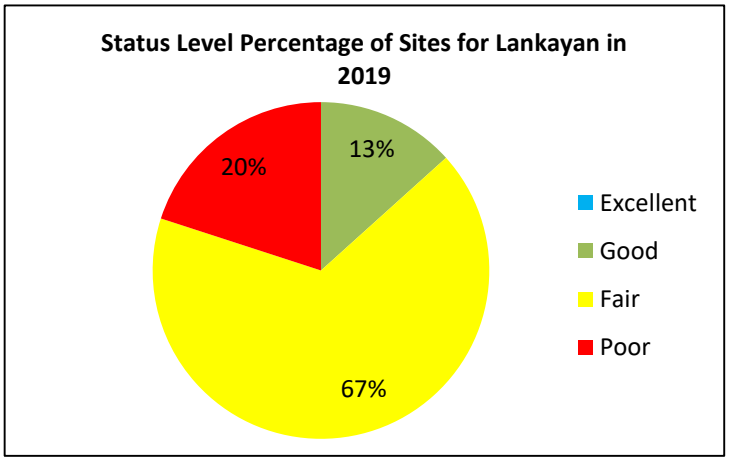
3.2.16 Lankayan

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

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

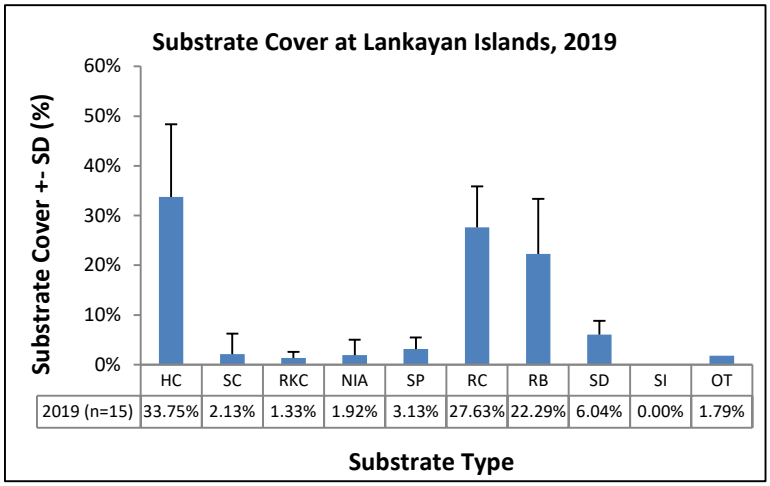
Before the creation of SIMCA, blast fishing was a constant problem, and turtle eggs were poached on a regular basis. Lankayan Island is the only developed island within SIMCA. The 0.05 km^2 island is the site of the Lankayan Island Dive Resort (LIDR), which is the only structure on the otherwise uninhabited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

Map 19: Surveyed sites in Lankayan



A total of 15 coral reef sites were surveyed in Lankayan islands and 13% of the reefs were in good condition. 67% of the reefs were in fair condition and the remaining 20% were in poor condition.

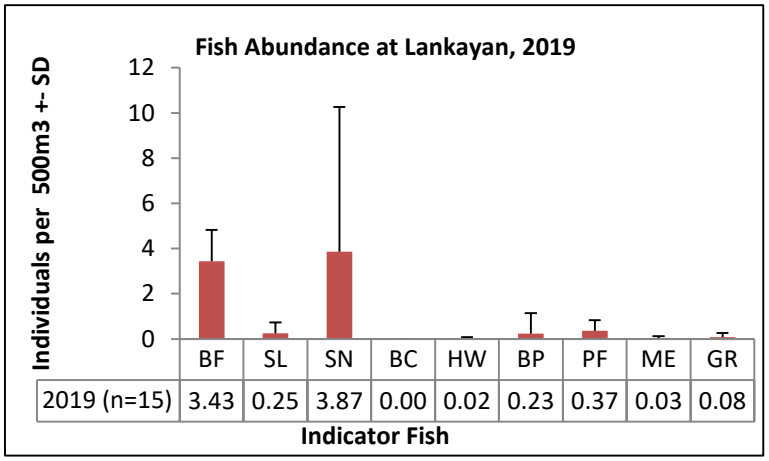
Substrate



The reefs in Lankayan islands are considered to be in 'Fair' condition, with 35.88% live coral cover, above the average (31.60%) for reefs within the North Borneo region.

HC cover has decreased significantly from 41.38% in 2018 to 33.75% in 2019 while the level of RB has increased significantly from 3.96% in 2018 to 22.29% in 2019. These indicate disturbances on the reefs and the situation need to be monitored closely.

Fish

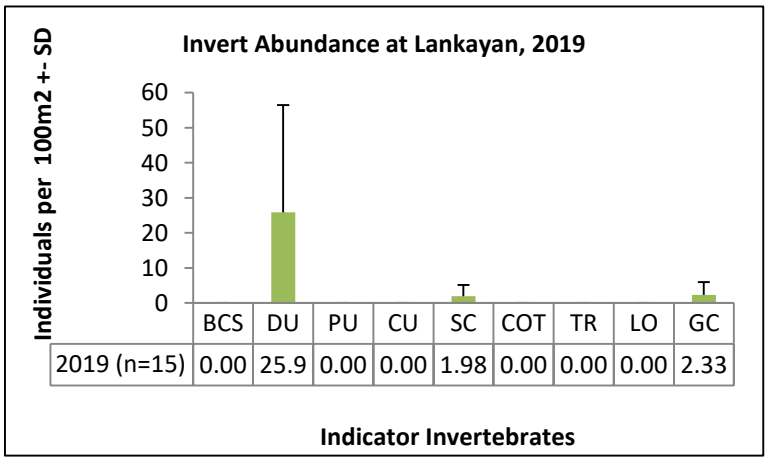


Only Barramundi Cod was absent during surveys.

The abundance of Snapper was highest, followed by Butterflyfish. The abundance of Snapper was the second highest of all islands surveyed in North Borneo region. The abundance of other indicators was low, less 1 ind./500m^3.

Highly prized fish such as Humphead Wrasse and Bumphead Parrotfish were recorded during surveys.

Invertebrates



Only three indicator invertebrates were present during surveys, they were Diadema Urchin, Sea Cucumber and Giant Clam (the highest of all islands surveyed in North Borneo region).

The abundance of Diadema Urchin was the highest. Other indicators were present in low number.

Warm water bleaching was recorded at almost all survey sites. On a positive note, sharks were observed during surveys at a few sites.

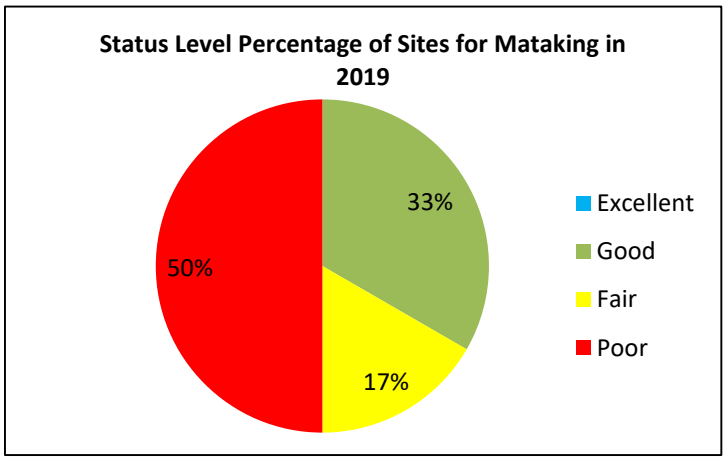
3.2.17 Mataking

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

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

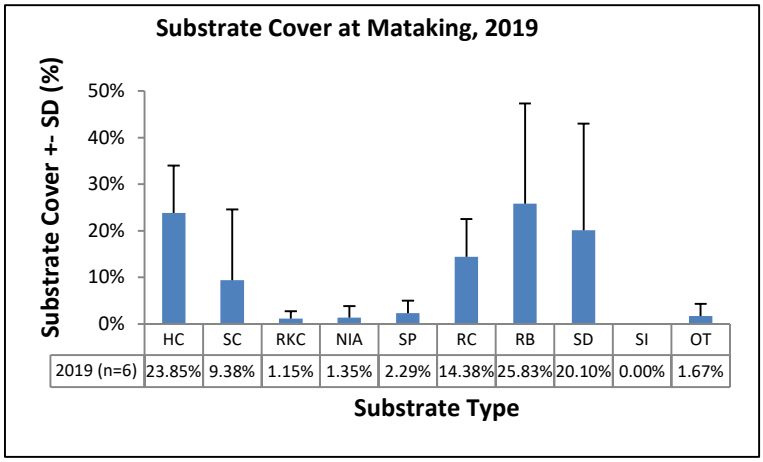
The island has fringing reefs, and coral extends down to almost 30m. Coral reefs around this, and surrounding islands have been extensively damaged by fish bombing in the past, and fish bombing continues in some areas nearby.

Map 20: Surveyed sites in Mataking



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

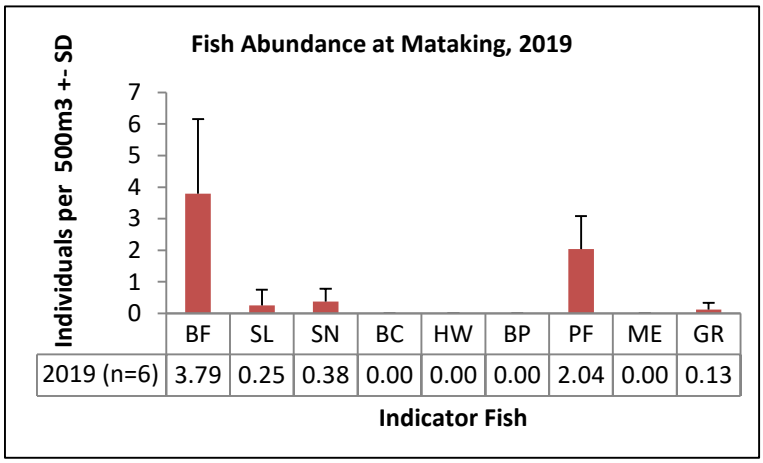
Substrate



The reefs around the island were considered to be in 'Fair' condition, with 33.23% live coral cover, above the average (31.60%) in the North Borneo region.

While the level of SD has decreased significantly (31.35% in 2018 to 20.1% in 2019), the level of RB has increased significantly (14.17% in 2018 to 25.83% in 2019). NIA level has decreased slightly.

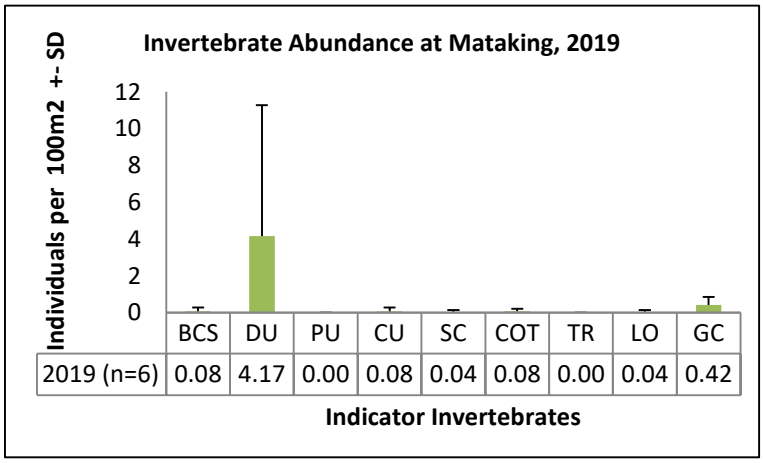
Fish



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

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

Invertebrates



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

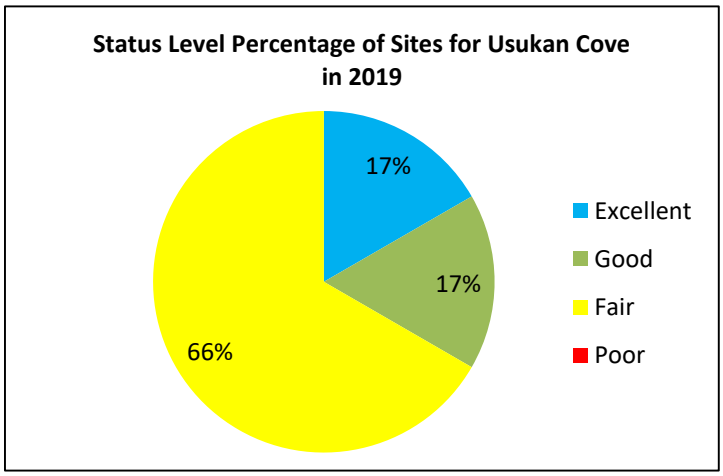
The abundance of Diadema was the highest. Abundance of other indicator was very low, less than 1 ind./100m^2.

Boat anchor damage, trash and storm damages were recorded during surveys. No rare animals were sighted during surveys.

3.2.18 Usukan Cove

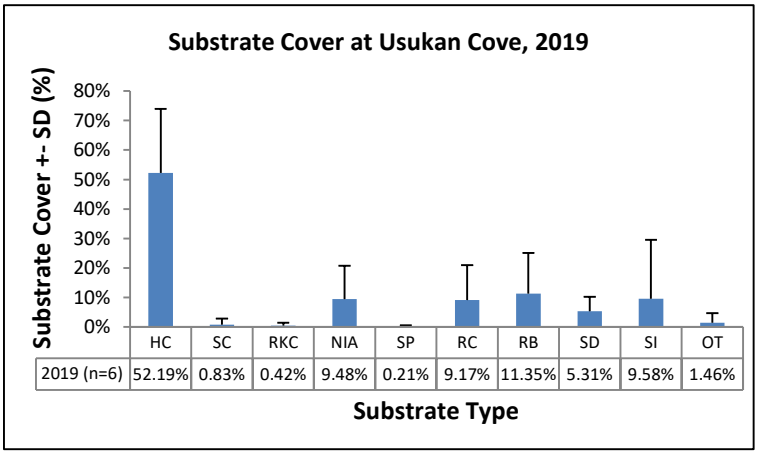
Usukan Cove is located on the North West coast of Sabah approximately half way between Kota Kinabalu and Kudat, in a district called Kota Belud, just beside Kampung Kuala Abai where the jetty to Mantanani Island is situated. Diving and snorkelling as well as fishing are the main activities offered in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

Map 21: Surveyed sites in Usukan Cove



A total of 6 coral reef sites were surveyed in Usukan Cove and 66% of the reefs were in fair condition. 17% of were in excellent condition and the remaining 17% were in good condition.

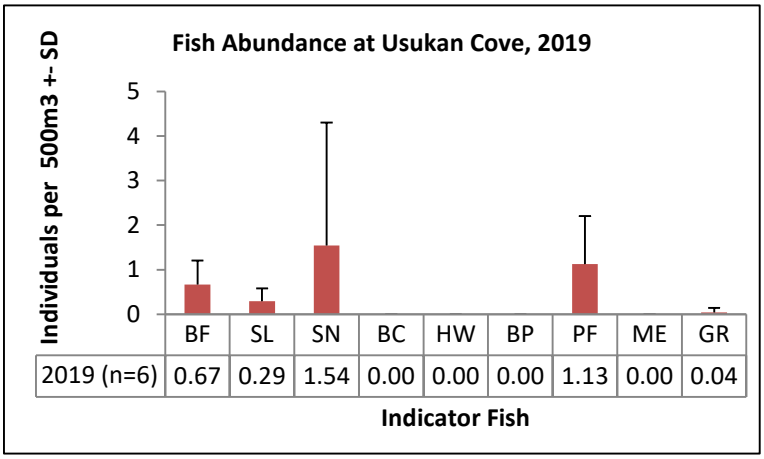
Substrate



Reefs in Usukan Cove are considered to be in 'Good' condition with 53.02% live coral cover, way above the average (31.60%) for North Borneo region.

HC cover has increased significantly from 33.75% in 2018 to 52.19% in 2019 while RC level has decreased significantly from 29.27% (2018) to 9.17% (2019). SI has increased significantly from 0.10% in 2018 to 9.58% in 2019 while SD has decreased significantly from 15.63% (2018) to 5.31% (2019). NIA level has also increased considerably from 5.31% to 9.48%

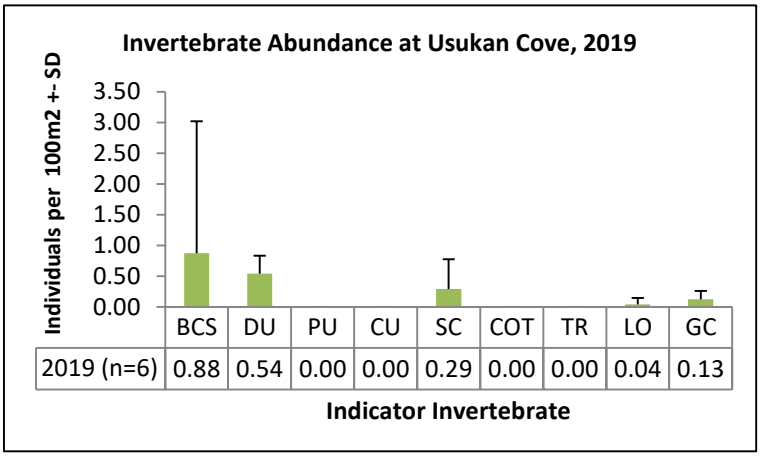
Fish



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

Other indicator fish were present in low abundance.

Invertebrates



Five indicator invertebrates were observed during surveys (Banded Coral Shrimp, Diadema, Urchin, Sea Cucumber, Lobster and Giant Clam) and their abundance was low.

Trash, siltation and warm water bleaching were observed at some sites. No rare animal was sighted during surveys.

3.2.19 Mantanani

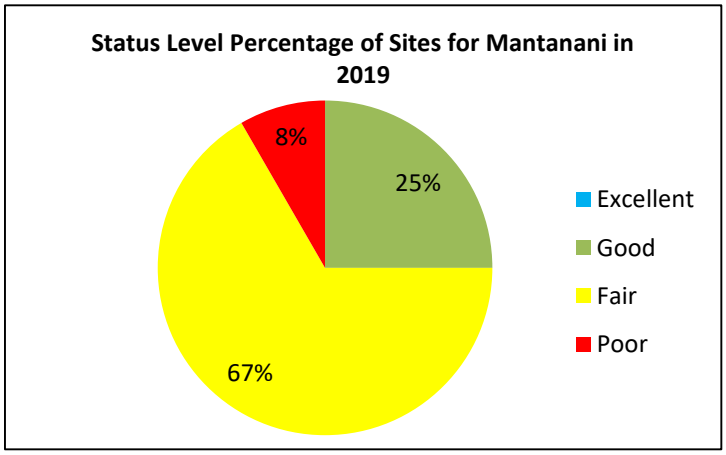
The Mantanani archipelago is located some 30km off the north-west coast of the state of Sabah, off the town of Kota Belud. The largest island is Mantanani Besar; the other two are Mantanani Kecil and Linggisan.

Mantanani is mainly populated by Bajau Ubian, with a small population of about 1,000 in two villages. The two main economic activities are fisheries and tourism.

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

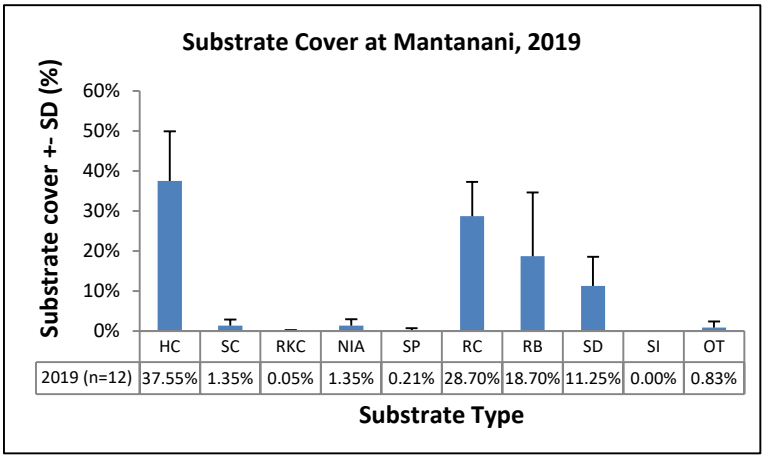
Fish bombing is a major problem in the area. This destructive fishing method has damaged large areas of reef around the islands. Recent blast detector data showed that a total of 371 blasts were recorded from November 2018 until July 2019. The blasts were recorded within 5km radius of Mantanani.

Map 22: Surveyed sites in Mantanani



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

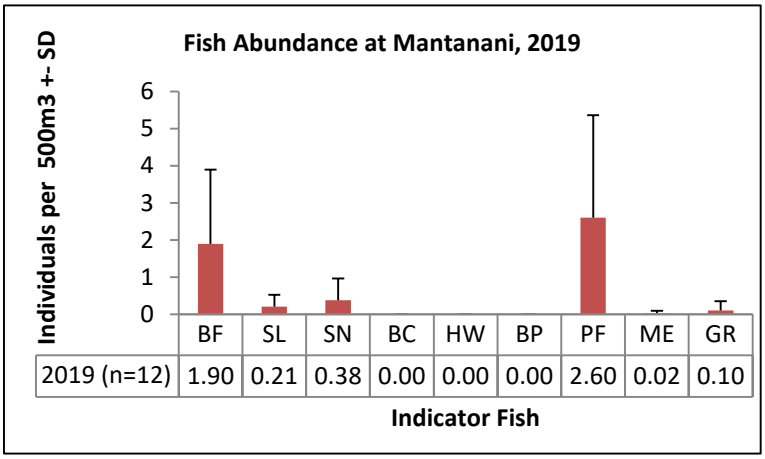
Substrate



Coral reefs around Mantanani islands are considered to be in 'Fair' condition, with 38.91% live coral cover, above the average (31.60%) for reefs in the North Borneo region.

The level of HC has increased from 30.26% in 2018 to 37.55% in 2019 while the level of RC has decreased from 41.72% in 2018 to 28.70% in 2019. The level of SD has increased considerably from 4.79% in 2018 to 11.25% in 2019.

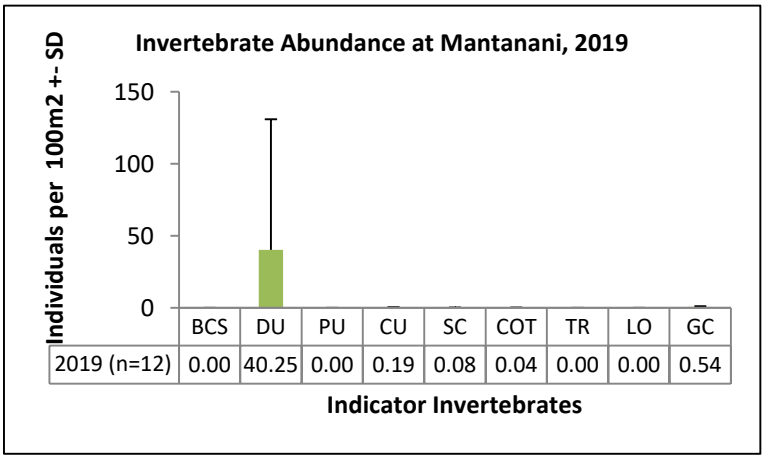
Fish



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

The abundance of Parrotfish was the highest, followed by Butterflyfish. Other 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



Banded Coral Shrimp, Pencil Urchin and Triton which are targeted for curio trade were not recorded during surveys. Lobster which is targeted for food was also absent from the surveys.

Abundance of Diadema Urchin was high. Collector Urchin, Sea Cucumber and Giant Clam was present in very low numbers, less than 1 ind./100m^2. The abundance of COT was within what a healthy reef can support (0.2-0.3 ind./100m^2).

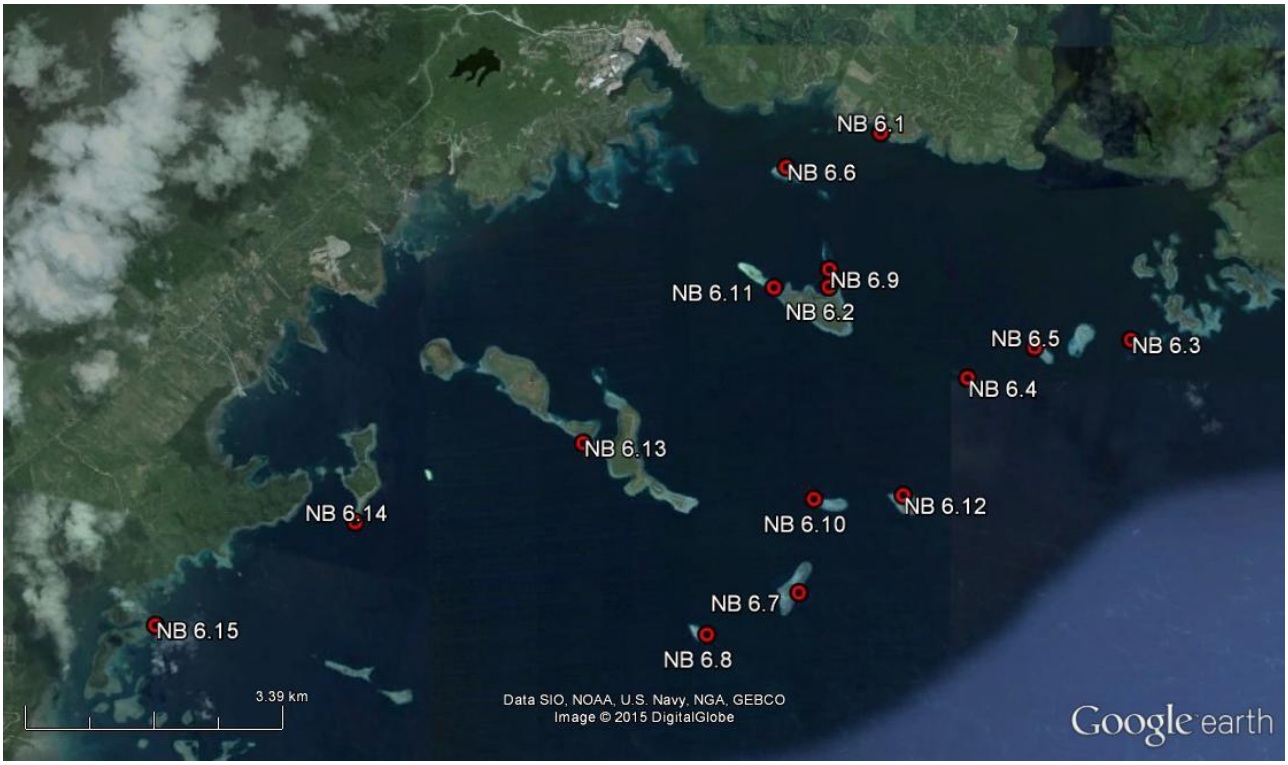
Extensive human impacts were seen on most of the reefs; boat anchor damage, dynamite fishing impact, discarded fishing nets and trash. Warm water bleaching was also observed on most of the reefs. No rare animals were observed during surveys.

3.2.20 Lahad Datu

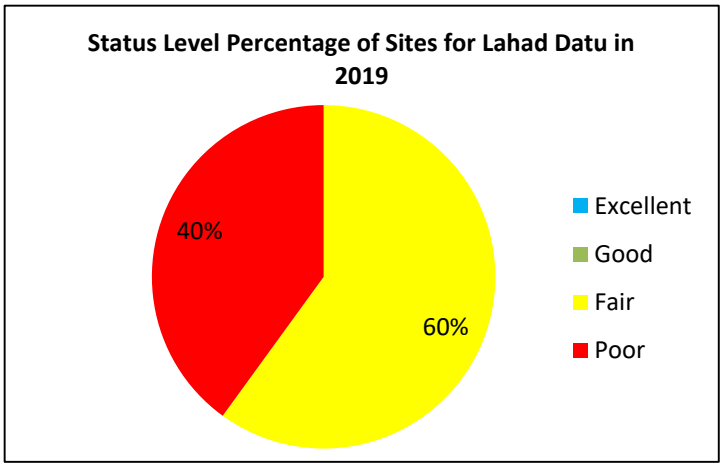
Lahad Datu is a town located in the east of Sabah, Malaysia, on the island of Borneo. It occupies the peninsula on the north side of Darvel Bay – the largest semi-enclosed bay on the east coast of Borneo islands. Administratively, it falls within the Tawau Division and is estimated to have a population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

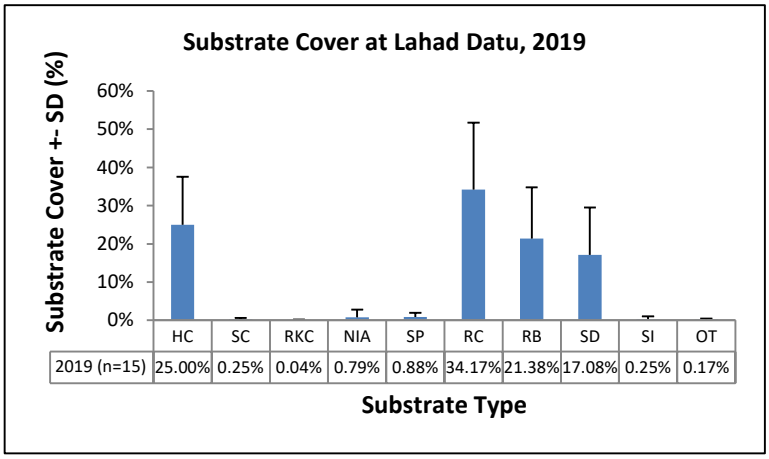


Map 23: Surveyed sites in Lahad Datu



A total of 15 coral reef sites were surveyed in Lahad Datu and 60% of the reefs were in fair condition. The remaining 40% were in poor condition. No reefs were in excellent and good condition.

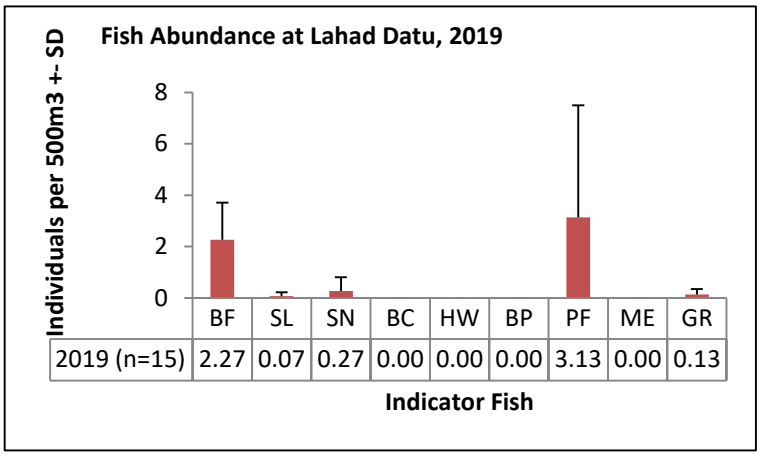
Substrate



Reefs in Lahad Datu are considered to be in 'Poor' condition with live coral cover of 25.25%, below the average (31.60%) for reefs in the North Borneo region.

The level of RB has increased from 15.79% in 2018 to 21.38% in 2019. The level of SD has increased from 13.25% in 2018 to 17.08% in 2019. Both SD and RB are indicators of disturbance on reefs.

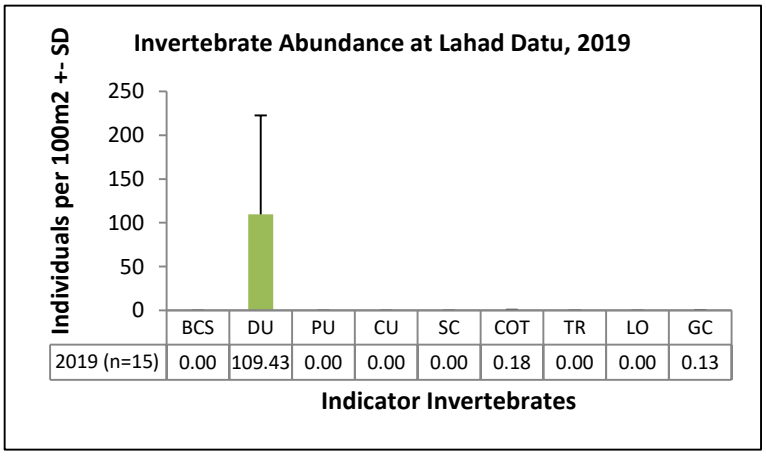
Fish



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

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

Invertebrates



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

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

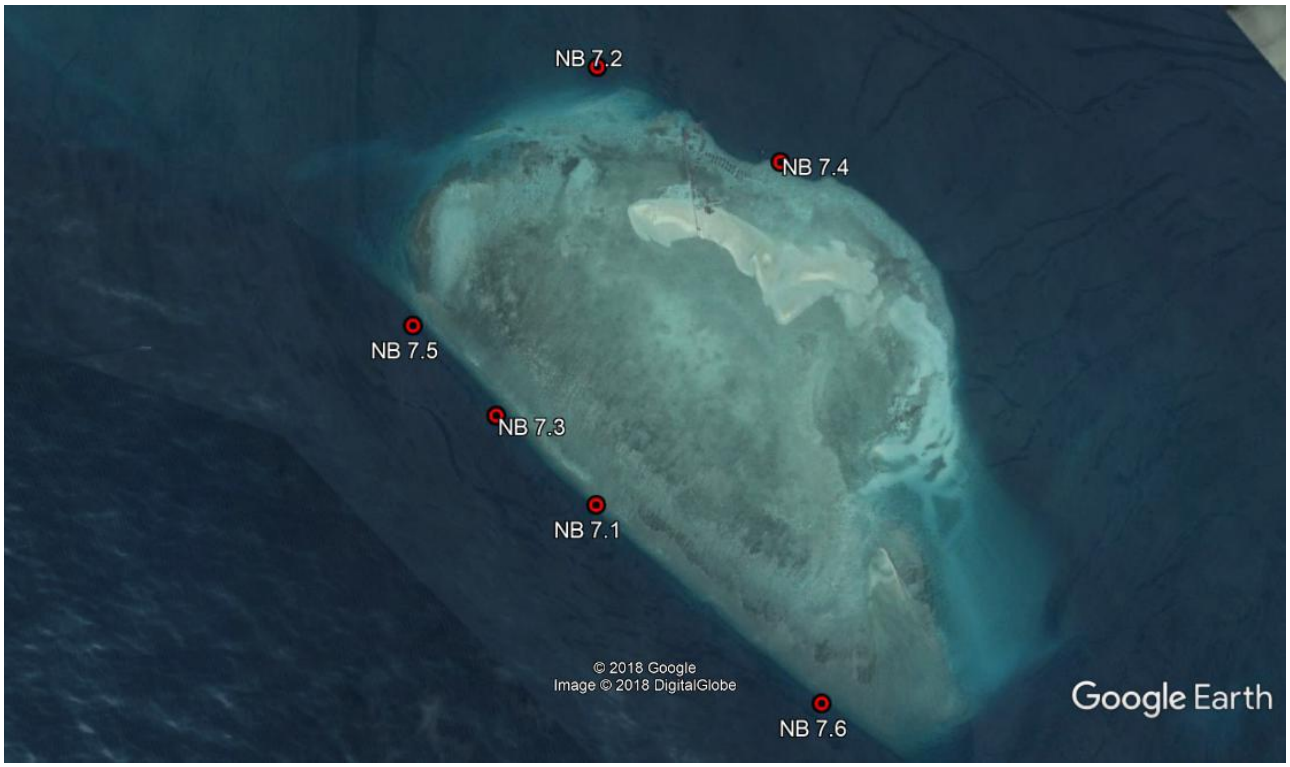
The abundance of Crown-of-thorns was within what a healthy reef can sustain (0.2-0.3 ind./100m^2).

Discarded fishing nets, fish cages, trash, pollution and high amount of sediments in the water column were recorded on many of the survey sites.

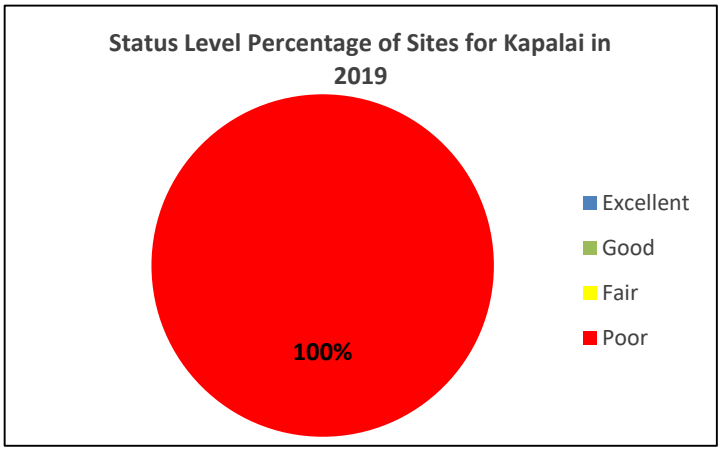
3.2.21 Kapalai

Kapalai Island is located near Semporna, Sabah and is 15 kilometres from Sipadan Island. Though it is called an island, it is actually a sandbar situated on Ligitan Reef. Kapalai used to be a real island with vegetation but erosion over the last few hundred years has reduced the island to sea level. All of the buildings are on stilts resting on the reef.

Kapalai is mostly known for its scuba diving. There is only one private resort on the island while the rest of the island is uninhabited.

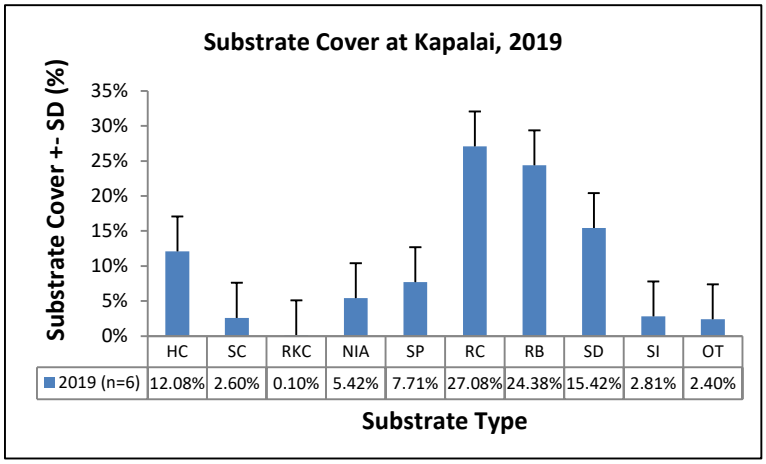


Map 24: Surveyed sites in Kapalai Island



A total of 6 coral reef sites were surveyed in Kapalai Island and 100% of the reefs were in poor condition.

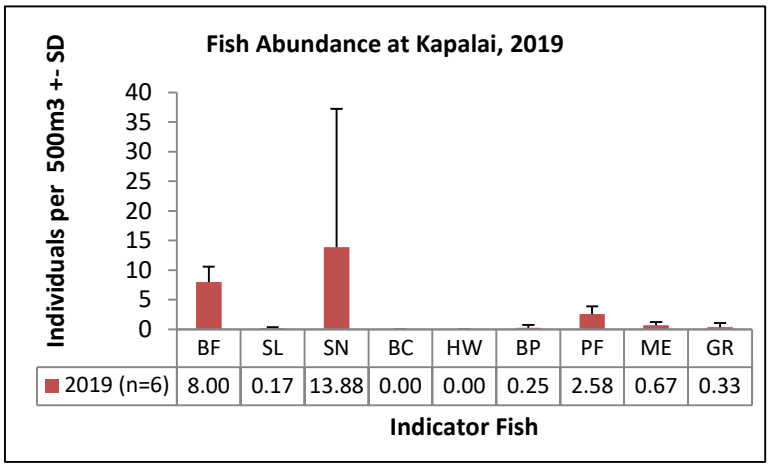
Substrate



Reefs in Kapalai were considered to be in 'Poor' condition with 12.08% live coral cover and were way below the average (31.60%) for North Borneo Region.

Both the levels of NIA and SI have increased slightly compared to last year (NIA – 4.69% in 2018 to 5.42% in 2019; SI – 0.10% in 2018 to 2.81% in 2019). This indicates recent disturbances in the area.

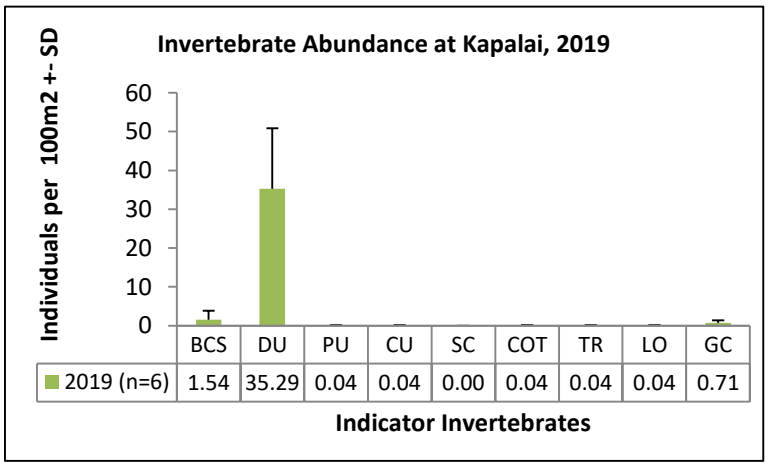
Fish



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

The most abundant fish was Snapper, followed by Butterflyfish (the highest of all islands surveyed in North Borneo region) and Parrotfish. Other indicators such as Sweetlips, Bumphead Parrotfish, Moray Eel and Grouper were present in low numbers.

Invertebrates



All indicators were present during surveys except for Sea Cucumber. The abundance of Diadema Urchin was the highest.

The abundance of other indicators was very low, less than 1 ind./100m^2, except for Banded Coral Shrimp.

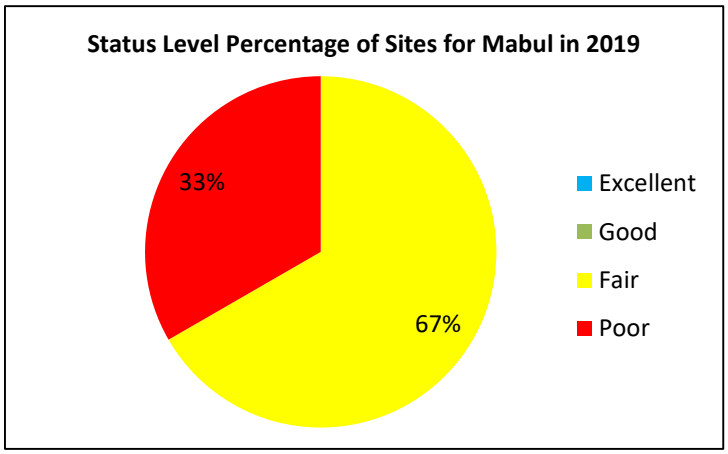
Human impacts such as boat anchor damage and trash were recorded at many sites. Warm water bleaching was also recorded. On a positive note, turtles were recorded at many sites during surveys. A killer whale was also sighted during surveys.

3.2.22 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, 15km away. This 20-hectare piece of land surfaces 2–3 m above sea level, consists mostly of flat ground 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.

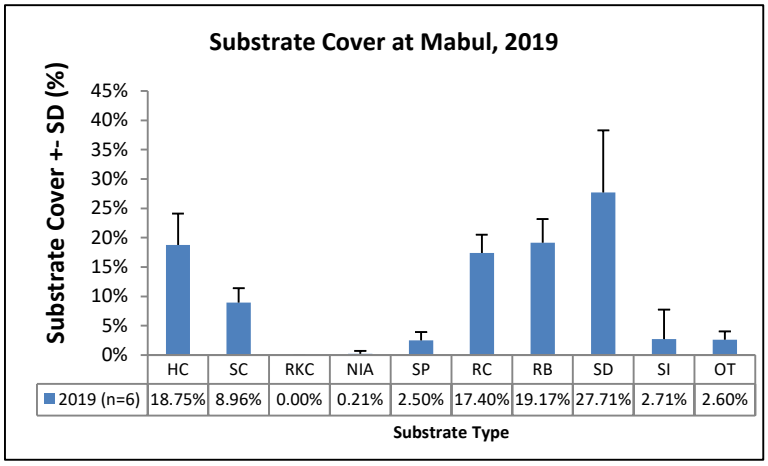
There are several dive resorts operating on Mabul Island, which provide accommodation for scuba divers – most are located on the island or on stilts over the water, while one is on a converted oil platform about 500 meters from the beach. There are also several home stay and backpacker accommodations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

Map 25: Surveyed sites in Mabul



A total of 6 coral reef sites were surveyed in Mabul and 67% of the reefs were in fair condition. The remaining 33% were in poor condition.

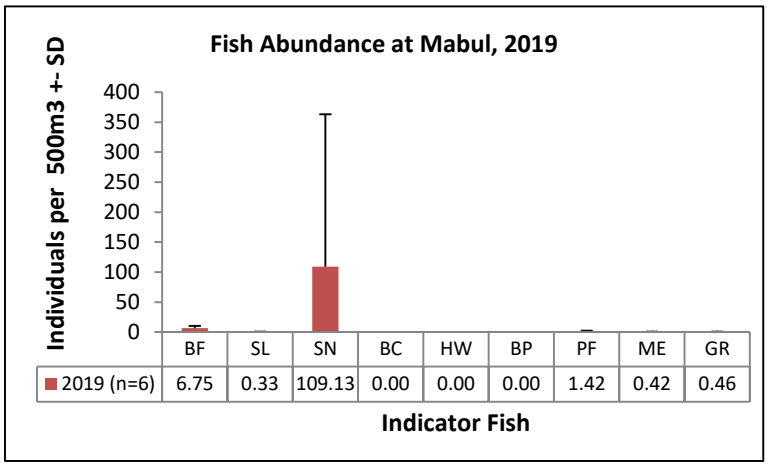
Substrate



Reefs in Mabul were considered to be in 'Fair' condition with 27.71% live coral cover and were below the average (31.60%) for North Borneo Region.

The high level of RB was likely due to the ongoing practice of fish bombing within the region. Half of the sites surveyed recorded more than 10% RB while the other half recorded more than 20%.

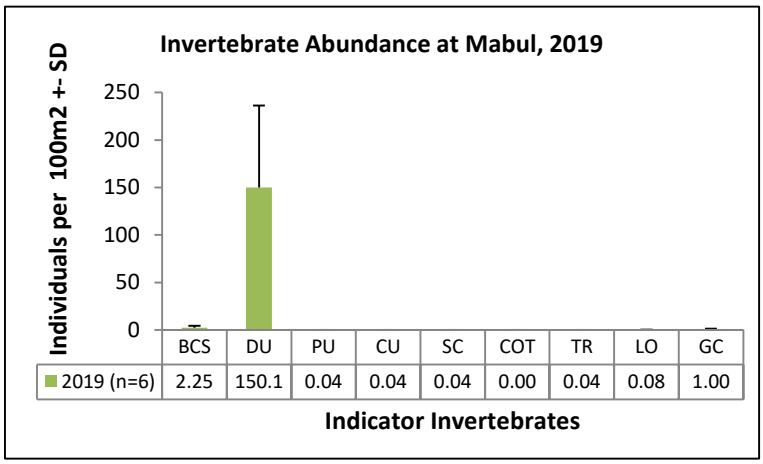
Fish



The abundance of Snapper was the highest and the highest of all islands surveyed in North Borneo region. The abundance of Butterflyfish was the second highest followed by Parrotfish. Sweetlips, Moray Eel and Grouper were recorded in low number.

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

Invertebrate



All indicator invertebrates were observed during surveys except for Crown-of-thorns. The abundance of Diadema Urchin was high and the highest of all islands surveyed in North Borneo region. The abundance of other indicators was very low.

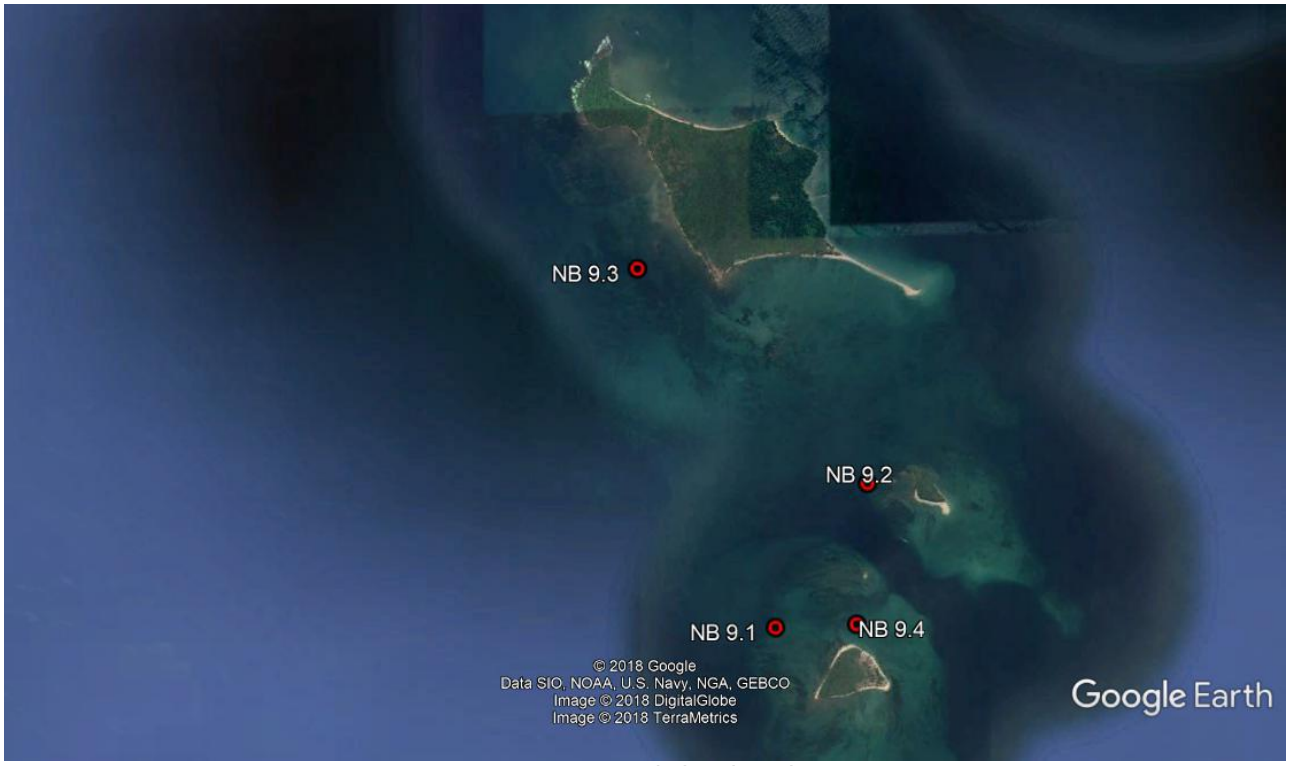
Mabul recorded the highest number of Banded Coral Shrimp of all islands surveyed in North Borneo region.

Damage by human and natural impacts was observed during surveys. Signs of coral damage due to boat anchor, trash and discarded fishing nets were seen at many sites. Warm water bleaching was recorded at many sites. On a positive note, turtles were recorded at many sites during surveys. Eagle ray was also spotted during surveys.

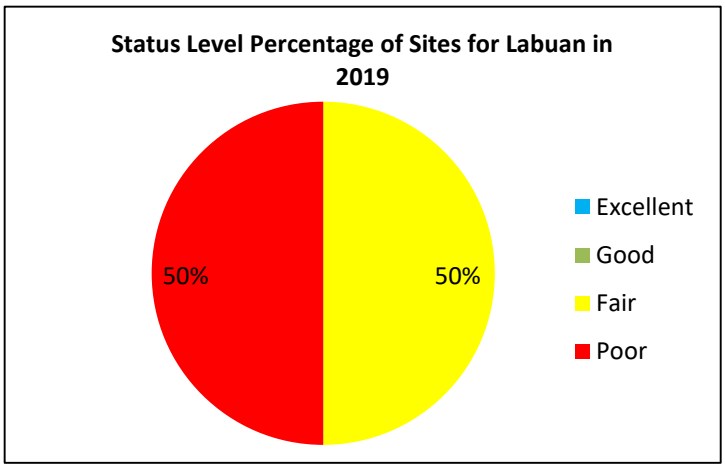
3.23 Labuan

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.

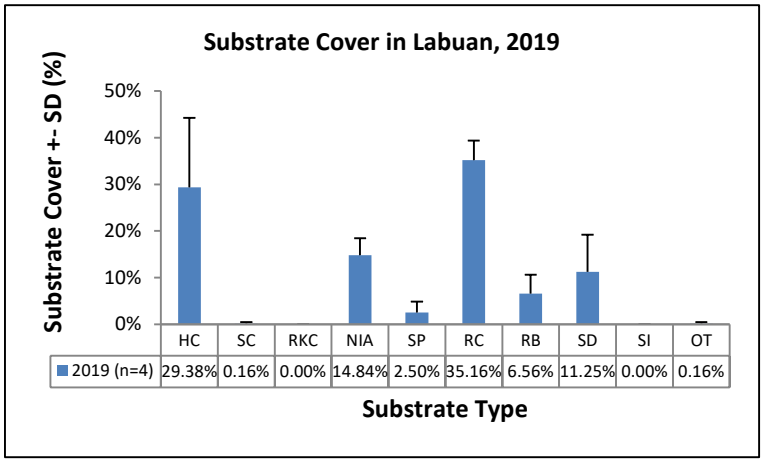


Map 26: Surveyed sites in Labuan



A total of 4 coral reef sites were surveyed in Labuan and 50% of the reefs were in fair condition. The remaining 50% were in poor condition.

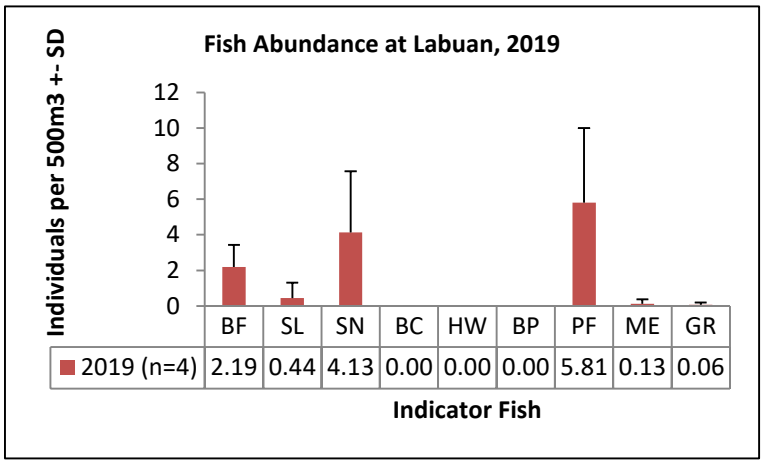
Substrate



Coral reefs in Labuan were considered to be in 'Fair' condition with 29.53% live coral cover and below the average (31.60%) of reefs within the North Borneo region.

The level of NIA has increased significantly from 7.66% in 2018 to 14.84% in 2019. This is a cause for concern and NIA level need to be monitored closely.

Fish

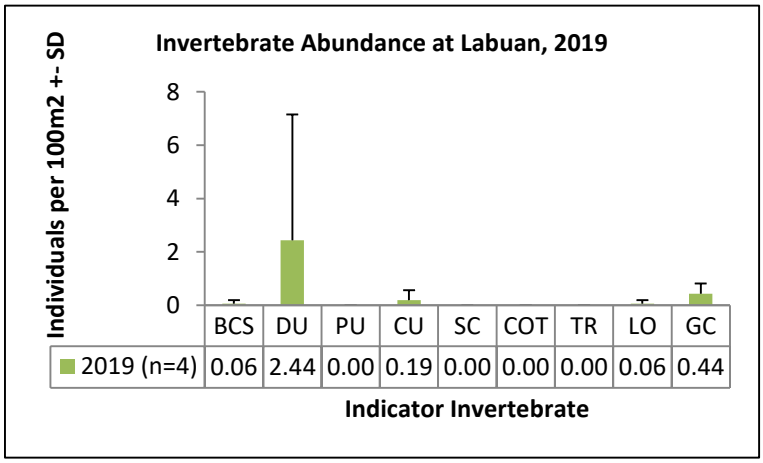


Parrotfish was the most abundant indicator recorded during surveys, followed by Snapper and Butterflyfish.

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

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

Invertebrate



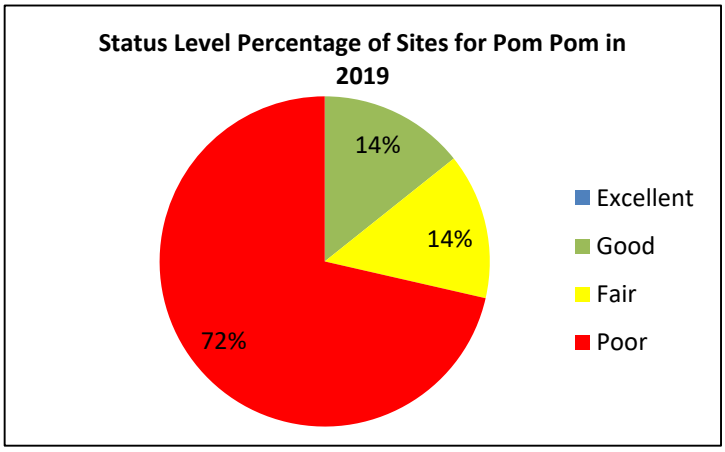
Diadema Urchin was the most abundant indicator recorded. The abundance of Banded Coral Shrimp, Collector Urchin, Lobster and Giant Clam was low.

3.2.24 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 white sand coral beaches and is a significant nesting location site for Green and Hawksbill turtles.

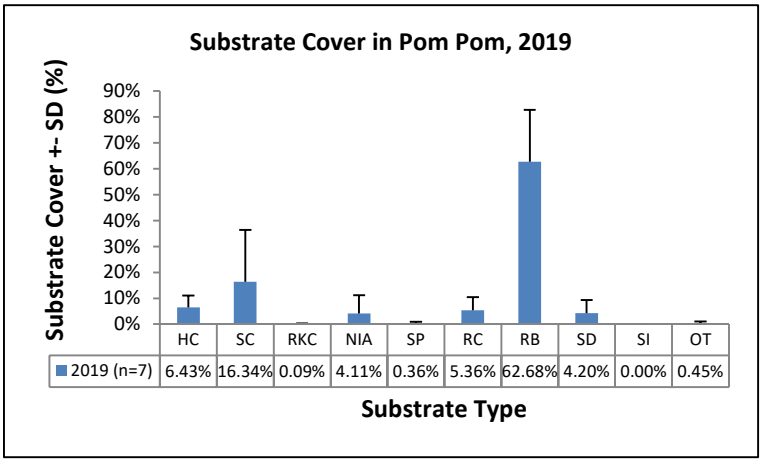
Pom Pom Island is one of the popular dive destinations in the Semporna district. The island has no village, only one resort and one research centre. There is no public transport to the island, the resorts transport their own guests and the research centre arranges transportation for its own students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

Map 27: Surveyed sites in Pom Pom



A total of 7 coral reef sites were surveyed in Pom Pom and 72% of the reefs were in poor condition. 14% of the reefs were in good condition and the remaining 14% were in fair condition.

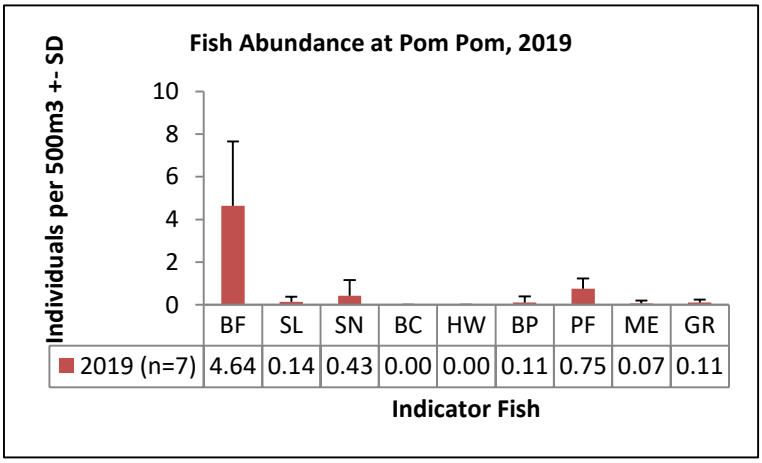
Substrate



Coral reefs in Pom Pom were considered to be in 'Poor' condition with 22.77% live coral cover and below the average (31.60%) of reefs within the North Borneo region.

The island has very high level of RB: all sites except one recorded more than 50% RB. Some sites recorded over 80% RB. The island has been extensively damaged by fish bombing in the past, and fish bombing continues in some areas nearby.

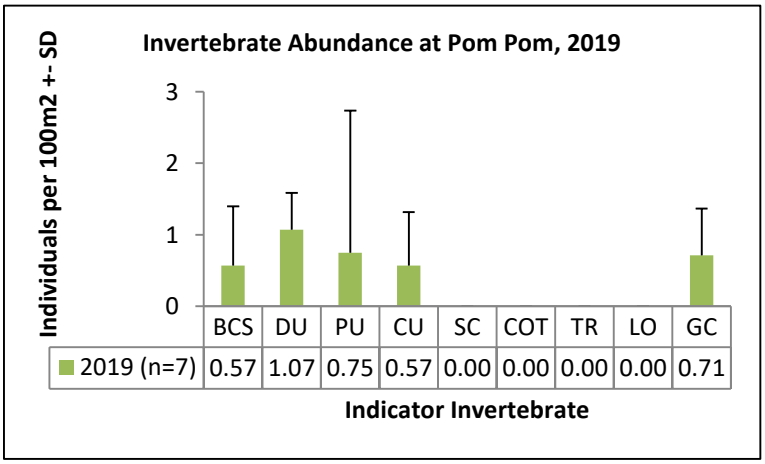
Fish



Butterflyfish was the most abundant indicator recorded during surveys.

Sweetlips, Snapper, Parrotfish, Moray Eel and Grouper were present in low number, less than 1 ind./500m^3. Bumphead Parrotfish was recorded during surveys too.

Invertebrate



Five indicator invertebrates were observed during surveys: Banded Coral Shrimp, Diadema Urchin, Pencil Urchin, Collector Urchin and Giant Clam. Their abundance was recorded in low number.

Dynamite fishing, trash, discarded fishing nets and warm water bleaching were recorded during surveys. On a positive note, turtles were recorded at many sites.

4. Reef Check Data Over the Years

Reef Check data are primarily used for monitoring coral reef health and comparisons of data over time can highlight significant changes and indicate problems and emerging issues. This section reviews data collected over the last 13 years to assess changes to Malaysia's reefs over the period.

4.1 Peninsular versus East Malaysia over 13 years

The charts below show changing substrate cover, fish and invertebrate abundance over the last 13 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 13 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. From 2015 to 2018, 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. In 2019, the drop in LCC was at least partly due to Tropical Storm Pabuk which struck reefs in Terengganu in January.

From 2007 to 2012, the level of NIA showed a large decline. However, in the last eight years NIA level has been increasing gradually. In 2019, the increase in NIA level was high, from 3.84% in 2018 to 8.16% in 2019. Although slight, the levels of RB and SD have also been increasing steadily over the last 13 years, especially for RB level which has increased from 9.79% in 2016 to 13.50% in 2017. In 2018 and 2019, RB level had dropped to around 8%, however this still needs to be monitored closely.

In summary, although some explanations for the changes can be identified, the five-year decline in reef health is a major concern and further studies are required to better understand impacts and possible solutions.

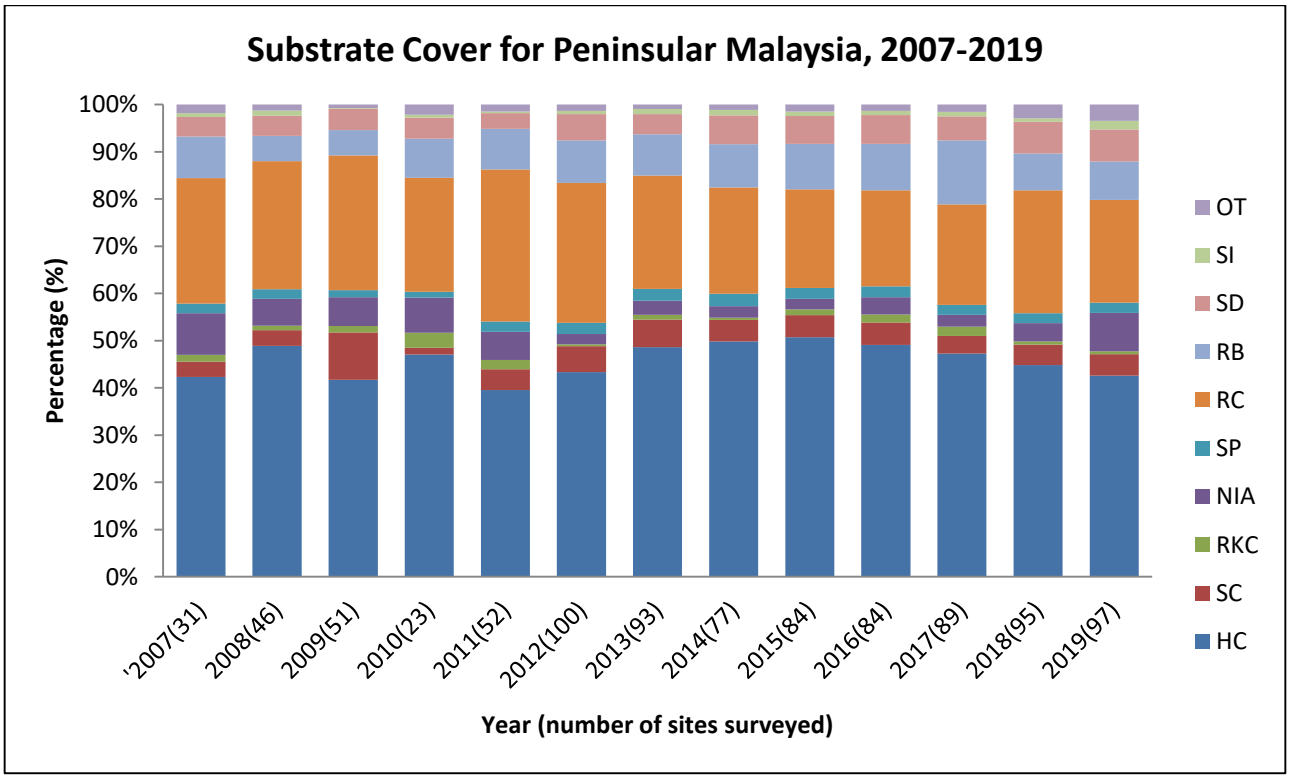


Chart 4: Substrate Cover in Peninsular Malaysia from 2007 to 2019

In East Malaysia, LCC has been consistently in fair condition (see chart 5). The low LCC data point in 2007 and 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 five 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. In 2019, the reduction in LCC was due to a major reduction in number of survey sites (almost 37%). However, the increased levels of NIA and RB (negative indicators) suggesting recent disturbances to reefs, is perhaps more indicative of declining reef health.

The level of NIA in Sabah gradually increased from 2013 to 2016, and in 2017 it showed some reduction. However, in 2018 and 2019, NIA level has gradually increased again. The level of RB has been consistently high over the last 13 years. These indicators support the argument that the level of disturbances on reef in Sabah is high and that greater attention to reef health, and management of impacts, is required if ecosystem services are to be maintained, particularly important to local communities that rely on them.

Low fish and invertebrate populations also support this.

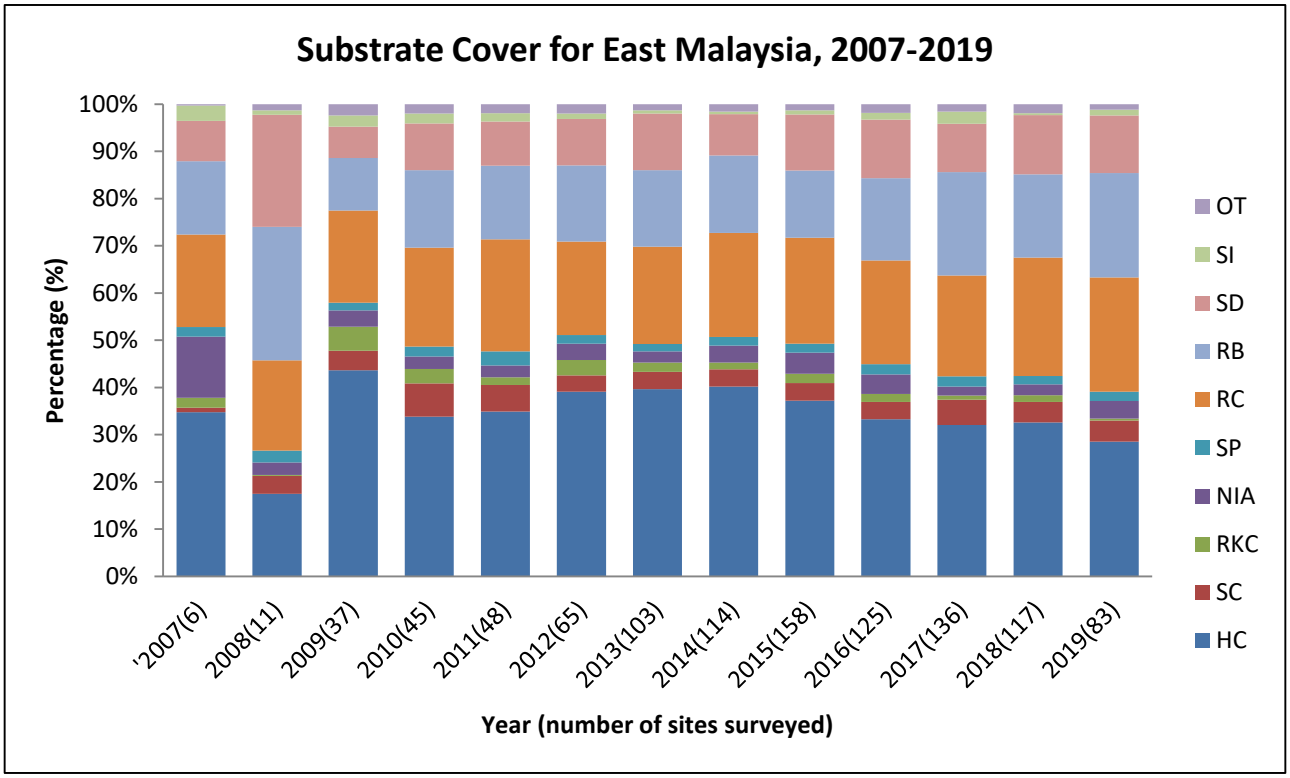


Chart 5: Substrate Cover in East Malaysia from 2007 to 2019

Reefs in East Malaysia show a similar multi-year decline in reef health, small on a year-on-year basis but more significant over the extended time for which data are available.

This slow decline in reef health indicators in both Peninsular and East Malaysia raises concerns over the long term health of coral reefs, particularly given future climate change scenarios which predict warmer oceans and stronger storms. There is growing urgency to address reef resilience and adaptation strategies to ensure that coral reefs continue to provide essential eco-system services to communities around Malaysia.

4.1.2 Fish

Over the last 13 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) are 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. Snapper, Butterflyfish and Parrotfish were the most abundant fish recorded in both Peninsular and East Malaysia.

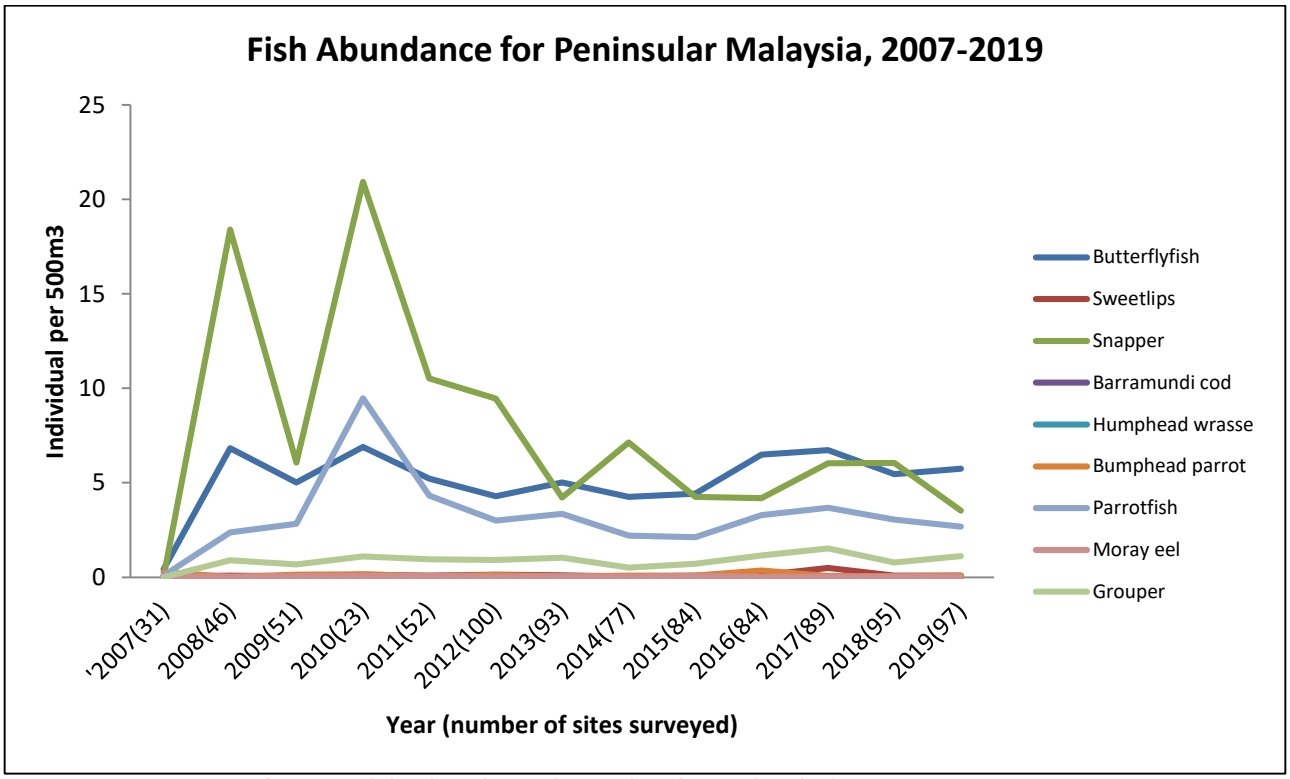


Chart 6: Fish Abundance in Peninsular Malaysia from 2007 to 2019

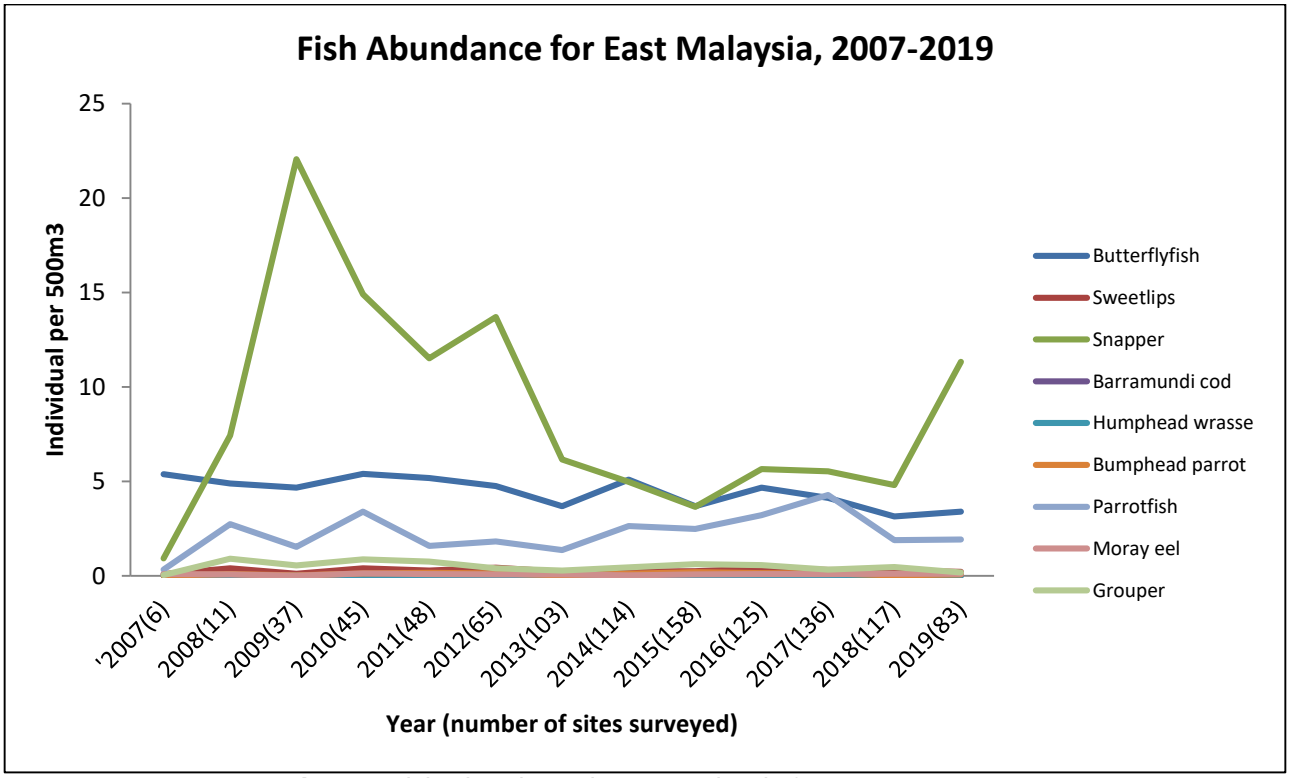


Chart 7: Fish Abundance in East Malaysia from 2007 to 2019

4.1.3 Invertebrates

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 (except for Lobster for Peninsular Malaysia in 2007 which recorded 2.71 individual per 100m^2).

Diadema Urchin was the most abundant invertebrate indicator recorded in both Peninsular and East Malaysia with East Malaysia showing an increase over the last eight years, 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. From 2008 to 2018, Crown-of-Thorns population was above what a healthy coral reef can support. In 2019, their population finally was not a threat to the reefs. However, the population of Crown-of-Thorns in Peninsular Malaysia still needs to be monitored closely and continuous efforts should be taken to ensure that populations remain within the healthy range. Collector Urchin was not recorded in Peninsular Malaysia over the last 8 years whereas in East Malaysia, it was recorded every year since 2009. Pencil Urchin and Lobster were only occasionally observed in Peninsular Malaysia over the last 12 years whereas in East Malaysia, it was recorded yearly. Triton was only recorded three times in Peninsular Malaysia (2007, 2008 and 2013), in East Malaysia it is recorded yearly since 2013.

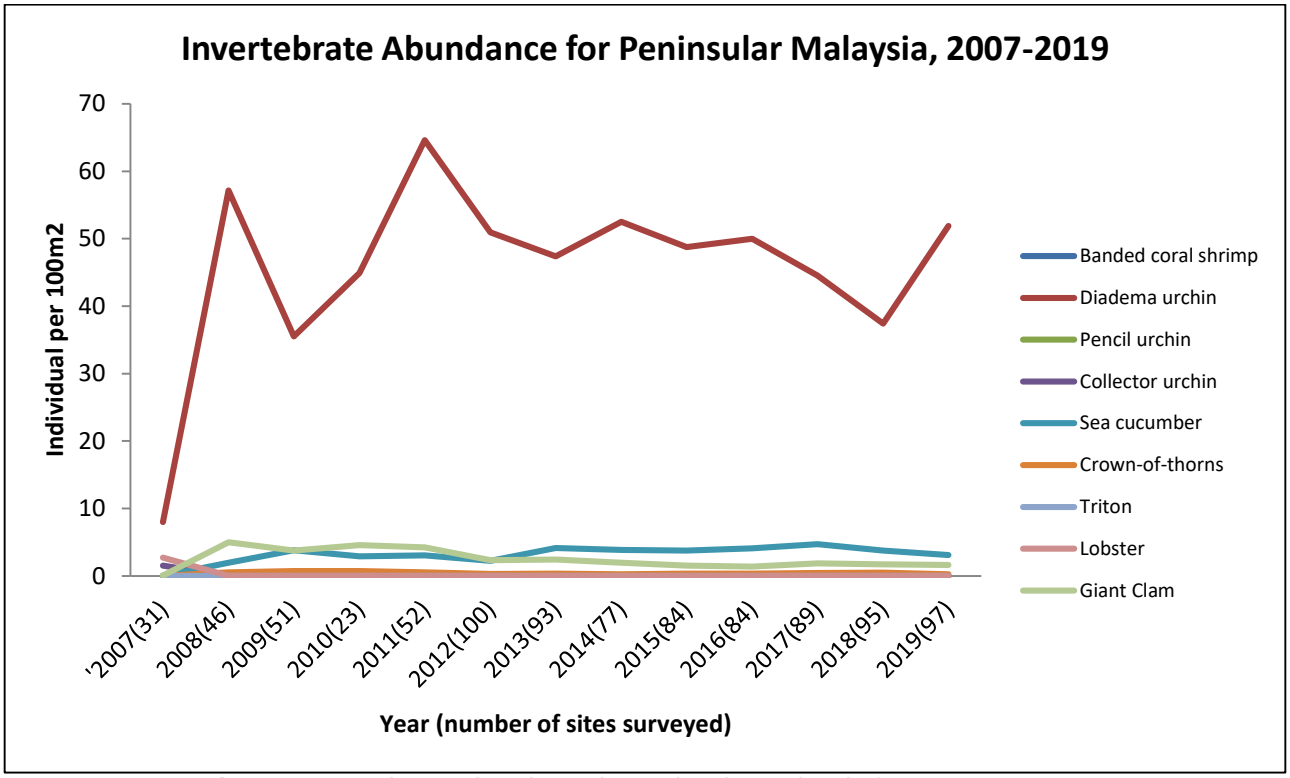


Chart 8: Invertebrate Abundance in Peninsular Malaysia from 2007 to 2019

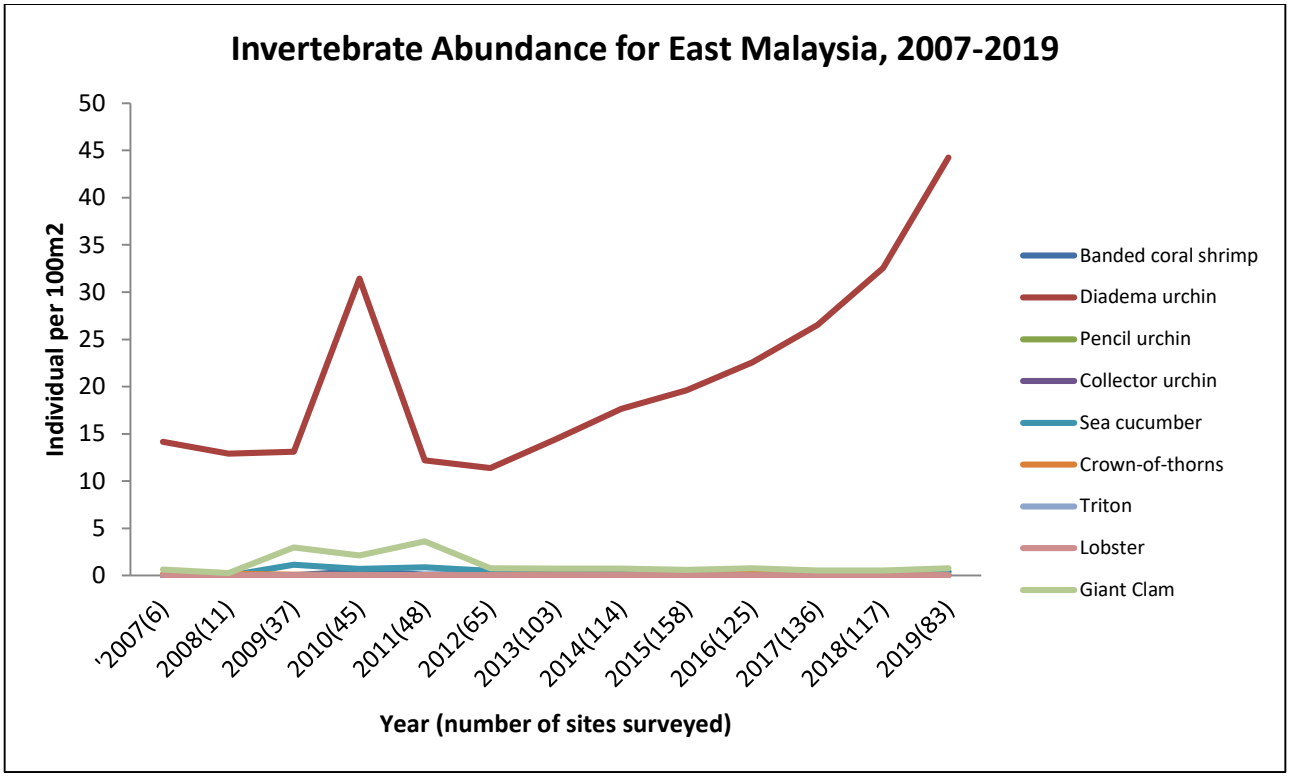


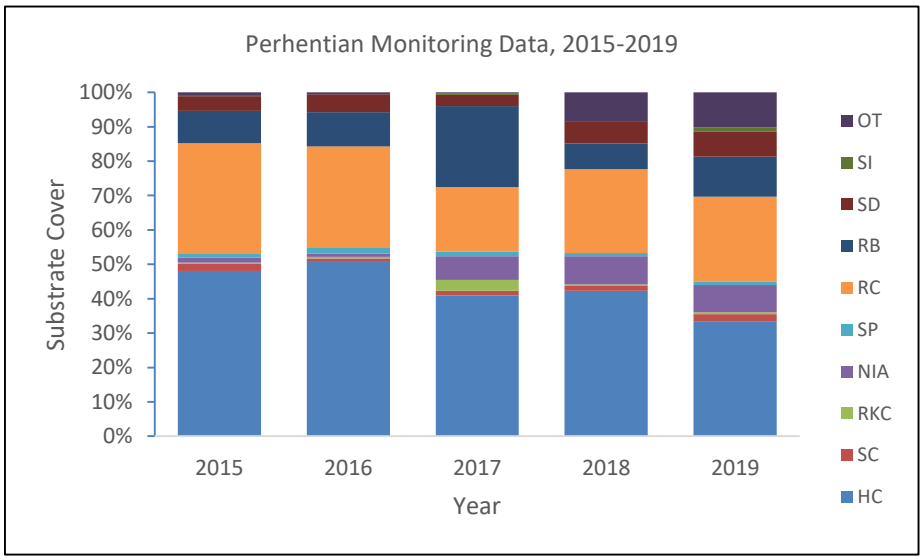
Chart 9: Invertebrate Abundance in East Malaysia from 2007 to 2019

4.2 Local Changes in Reef Health

This section provides details of the health of coral reefs around Malaysia over the last 5 years, from 2015 to 2019. Only islands with permanent sites that were surveyed every year over the period are included in this section.

4.2.1 Terengganu

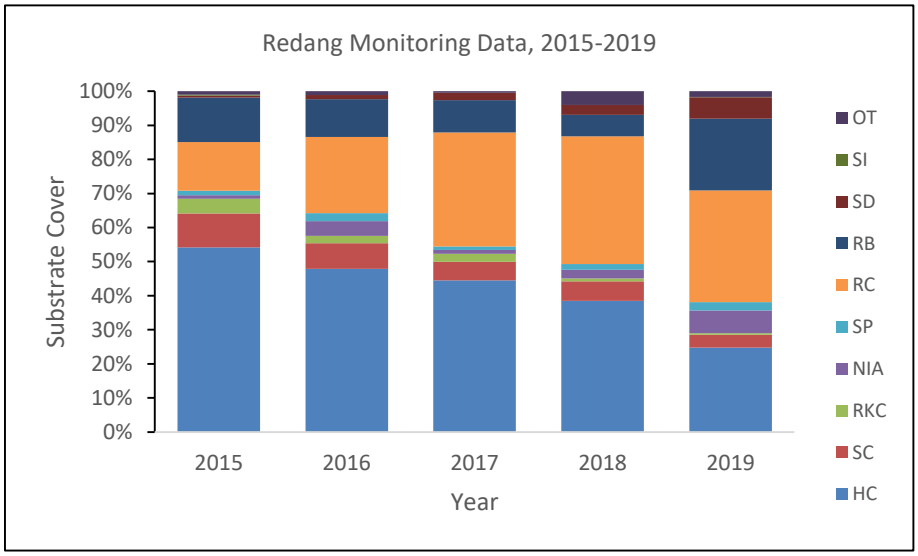
Perhentian



Data from surveys conducted on Perhentian over the last five years show that there has been a steady decline in reef health over that period of time. The overall condition has deteriorated from 'good' with average LCC slightly above 50% to 'fair' with average LCC 35%. In both 2017 and 2019, HC cover decreased by 10% on the previous year. In 2017, this was most likely due to physical damage caused by human activities. In 2019 the decrease was probably due to Tropical Storm Pabuk which struck Perhentian in January that year, causing major physical damage to shallow reefs. Both these changes were reflected in RB level, which increased from 9.94% in 2016 to 23.56% in 2017 and from 7.44% in 2018 to 11.63% in 2019. The level of NIA has increased considerably over the last three years, recording only ~1% in 2015 and 2016 to 7-8% in the last three years. 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

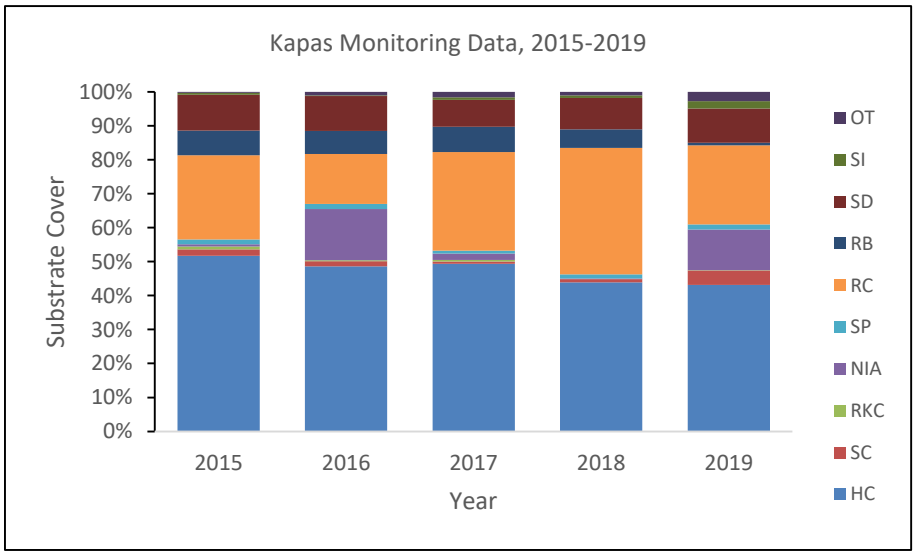
testing data (2009) that indicate the presence of sewage pollution around Perhentian, and a review of sewage treatment systems (2011) that highlighted the inadequate sewage treatment systems at many resorts.

Redang



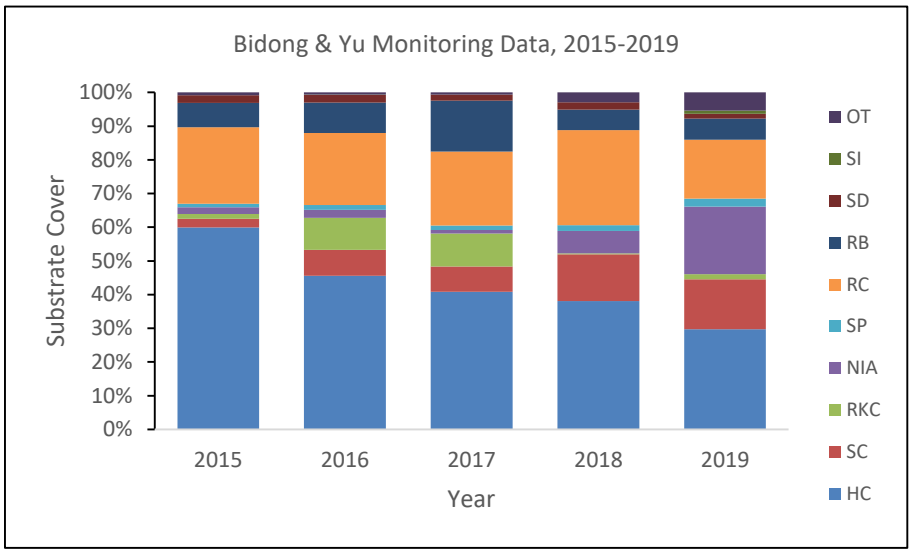
Data from surveys conducted on Redang over the last five years show that there has been a sharp decline in HC and SC cover. The overall condition has deteriorated from 'good' with average LCC above 60% to almost 'poor' with average LCC just above 25% to make it into 'fair'. A particularly steep decline in HC cover was recorded in 2019 surveys. The decline was likely due to Tropical Storm Pabuk which struck Redang in January, causing major physical damage to shallow reefs. The damage was reflected in 2019 data with RB level increasing from 6.25% in 2018 to 20.99% in 2019. The level of NIA and SD were doubled in 2019 as compared to 2018. SD is an indicator of physical disturbance while NIA is an indicator of nutrient pollution. However, the increase in NIA level in 2019 was more likely due to damage caused by the storm rather than nutrient pollution.

Kapas



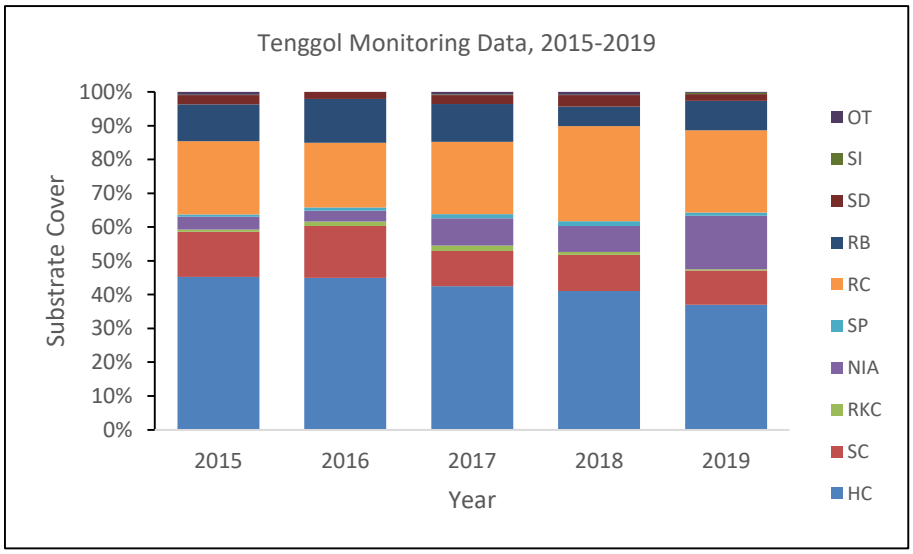
Data from surveys conducted on Kapas over the last five years show that HC cover has declined only slightly over the period. The overall condition has deteriorated from 'good' with average LCC slightly above 50% to 'fair' with average LCC slightly below 50%. Kapas was the only island in Terengganu not affected by Tropical Storm Pabuk which struck Terengganu in January 2019, causing major physical damage to shallow reefs. NIA level has been inconsistent, showing significant increases in 2016 (0.63% in 2015 to 15.13% in 2016) and 2019 (0.13% in 2018 to 12% in 2019).

Bidong & Yu



Data from surveys conducted on Bidong & Yu over the last five years show that the overall condition of Bidong & Yu reefs has deteriorated from 'good' with average LCC above 60% to 'fair'. HC cover has decreased from 59.90% in 2015 to 38.13% in 2018. The decrease was highly likely due to the increase in COT abundance over the period, which was above what a healthy reef can sustain. Since 2016 surveys, damage due to COT and Drupella predation was recorded. The steep decline in HC cover recorded in 2019 surveys was probably due to Tropical Storm Pabuk which struck Bidong & Yu in January, causing major physical damage to shallow reefs. The damage was reflected in 2019 data where NIA level has increased from 6.56% in 2018 to 20.10% in 2019. A sharp increase in NIA level is common following a perturbation such as storm damage which happened to Bidong & Yu reefs. Bidong & Yu appear to be undergoing a shift from RC to SC where zoanthid is colonising dead corals. As a result, the level of SC increased considerably in 2018 and 2019. At Pasir Tenggara, 85.63% of the reefs were SC which was mostly zoanthid and only 3.75% of the reefs were HC.

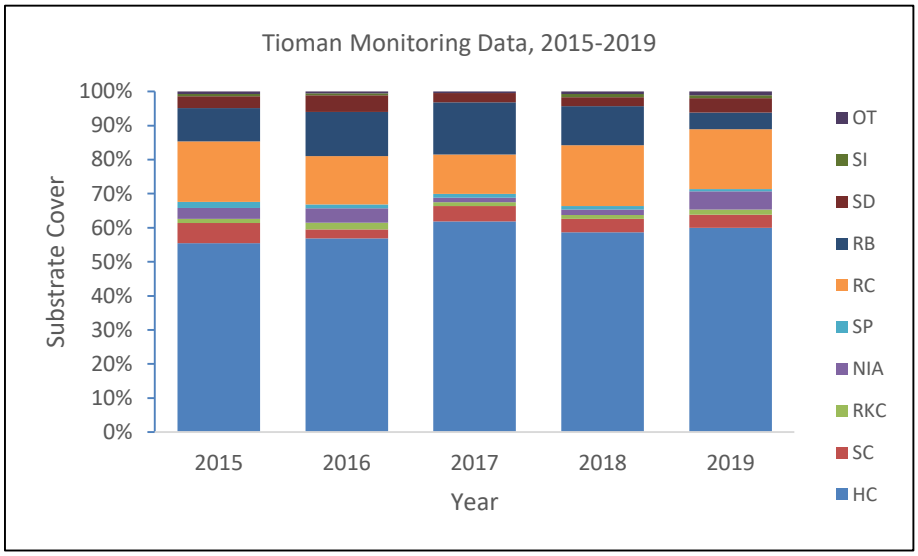
Tenggol



Data from surveys conducted on Tenggol over the last five years show that LCC has declined over the period. The overall condition has deteriorated from 'good' with average LCC above 50% to 'fair' with average LCC below 50%. A steep decline in HC cover was recorded during 2019 surveys, probably due to Tropical Storm Pabuk which struck Tenggol in January, causing major physical damage to shallow reefs. The damage was also reflected in increased NIA level (7.71% in 2018 increasing to 15.83% in 2019). A sharp increase in NIA level is common following a perturbation such as storm damage which happened to Tenggol reefs. However, NIA level in Tenggol has been increasing steadily since 2017, before the storm damage, indicating increased levels of nutrient in the waters around the islands. In the last 5 years there appears to have been a shift from RC to SC. In some reefs zoanthid soft corals were 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.

4.2.2 Pahang

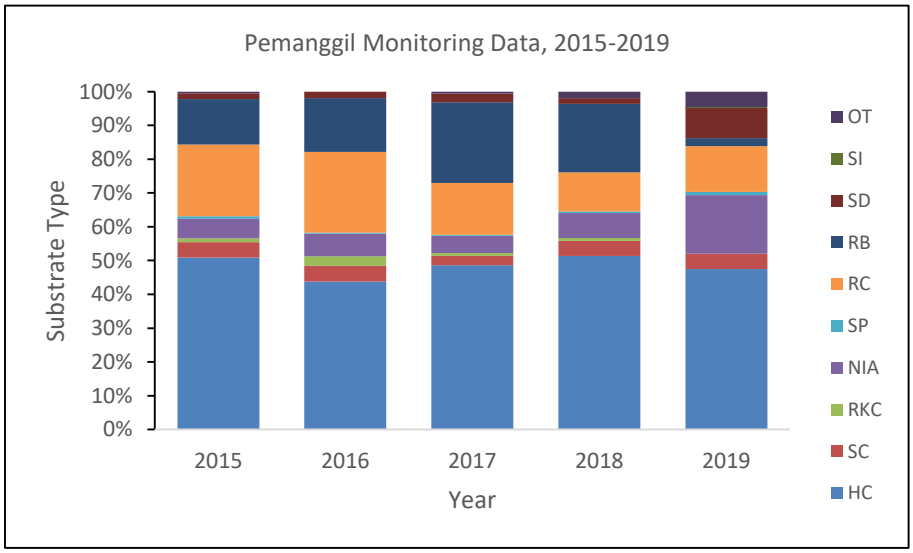
Tioman



Data from surveys conducted on Tioman over the last five years show that LCC has increased slightly over the years. (The spike in 2017 is considered to reflect the elimination of one site that year, rather than an actual increase in HC cover). The overall condition of the coral reefs surveyed around the island has been consistently good over the years, with LCC above 50%. The level of RB finally saw a dip in 2019 after recording high levels (9-16%) from 2015 to 2018. RB can be an indicator of recent and long term disturbances. Continuous increase in RB level suggests there is a need for management intervention, to ascertain the cause and find solutions to reduce damage to these reefs. As a result, RB level in Tioman still need to be monitored closely. The level of NIA in Tioman has increased considerably in 2019, especially in Renggis and Pirate Reef. Both sites recorded less than 5% in 2018 and this has increased to over 20% in 2019. This is a cause for concern and the level of NIA at these two sites need to be monitored closely.

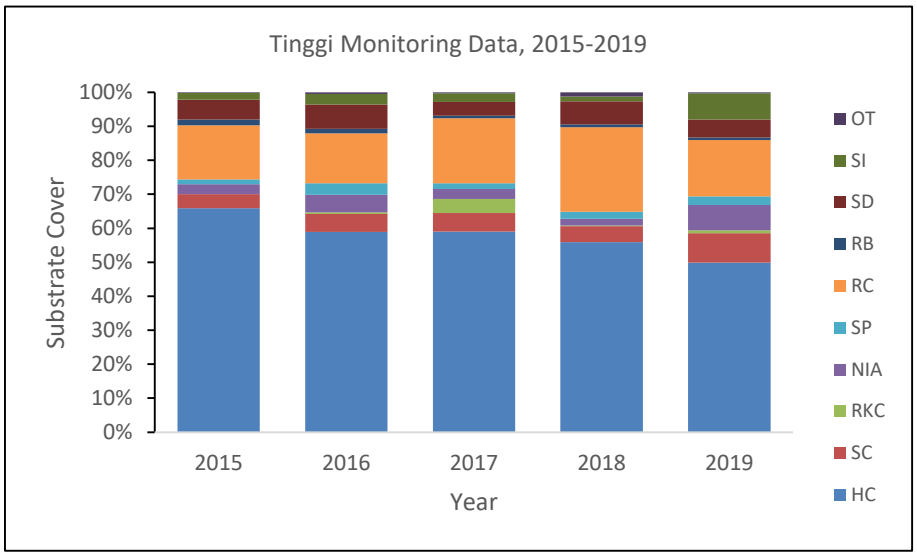
4.2.3 Johor

Pemanggil



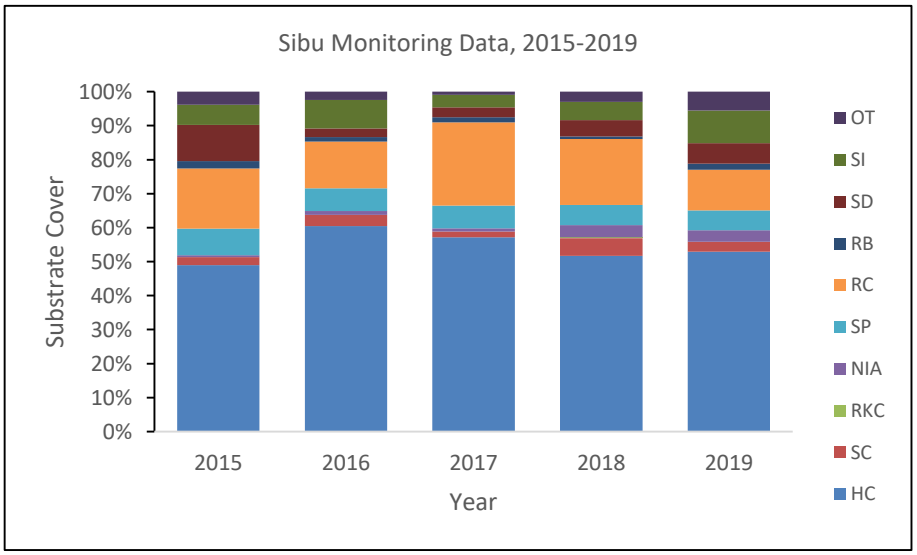
Data from surveys conducted on Pemanggil over the last five years show that reefs health over that period of time did not change much. The overall condition of the reefs has maintained more or less the same. The level of RB recorded between 2015 until 2018 was high, ranging from 13 to 24%. In 2019, the level has dropped significantly to 2.34%. On the other hand, the level of NIA has increased significantly in 2019, from 7.34% in 2018 to 17.34% in 2019 (recording 5 to 7% from 2015 to 2018). This increase in the level of NIA is probably indicative of raised levels of nutrient in the waters around the islands.

Tinggi



Data from surveys conducted on Tinggi over the last five years show that there has been a steady decline in reef health over that period of time. While the overall condition has maintained in the 'good' category, average LCC has decreased from 70% in 2015 to 58.59% in 2019. The level of NIA has been inconsistent over the last five years with the highest increase recorded in 2019 surveys an increase from 2.03% in 2018 to 7.50% in 2019. This high level of NIA is probably indicative of raised levels of nutrient in the waters around the islands. The level of SI also has been inconsistent, showing significant increase during 2019 surveys, up from 1.41% in 2018 to 7.66% in 2019. The increase in SI level can indicate a local impact and this change should be monitored.

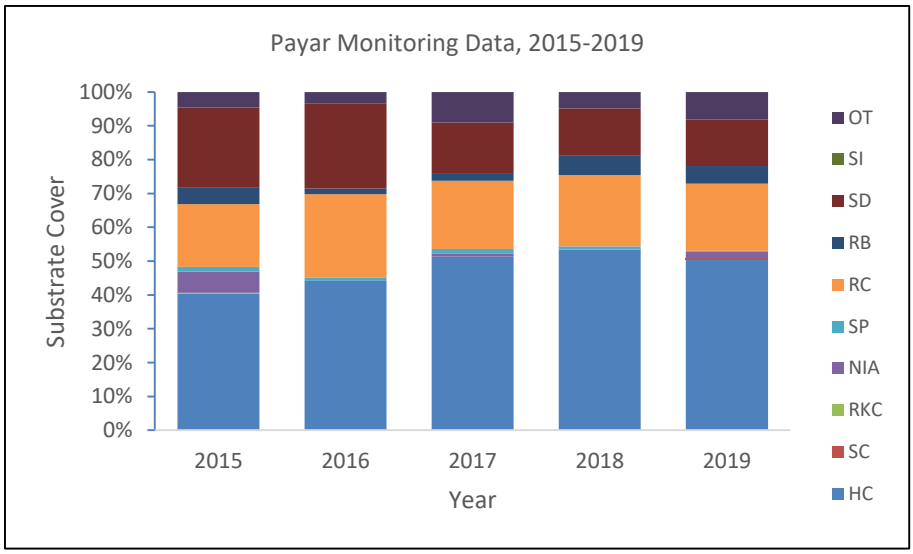
Sibu



Data from surveys conducted on Sibu over the last five years show that there was an improvement in reef health during the first two years of surveys after which reef health has been steadily deteriorating. The worsening condition was reflected in NIA, SD and SI level; all have steadily increased over the last three years. The increase in NIA level is indicative of raised levels of nutrient in the waters around the islands, SD is possibly an indication of disturbance as dead coral breaks off and is eroded into fine particles (sand) by wave action and SI is an indication of a local impact. These increases should be monitored closely and measures should be taken to prevent further deterioration of reef health on Sibu.

4.2.4 Kedah

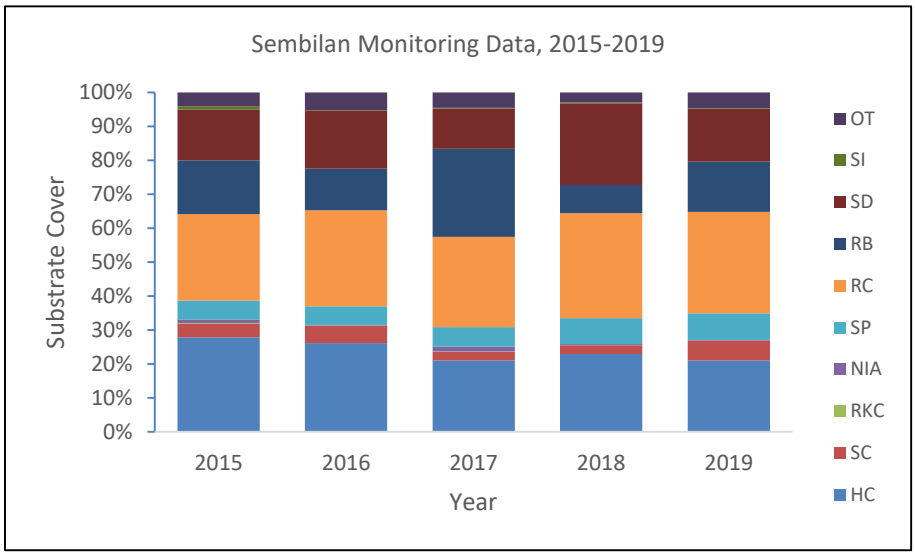
Payar



Data from surveys conducted on Payar over the last five years show that there has been an increase in HC cover from 2017 to 2019. However, it is probable that the increase is due to the addition of two permanent survey sites rather than an improvement in reef health. Overall reef condition has remained more or less the same without much variation except for an increase in RB level over the last two years. RB is created by a number of factors, some natural such as wave action and storms, while others result from human activities, including anchoring, fishing and SCUBA diving. RB level on Payar should be monitored closely in future surveys.

4.2.5 Perak

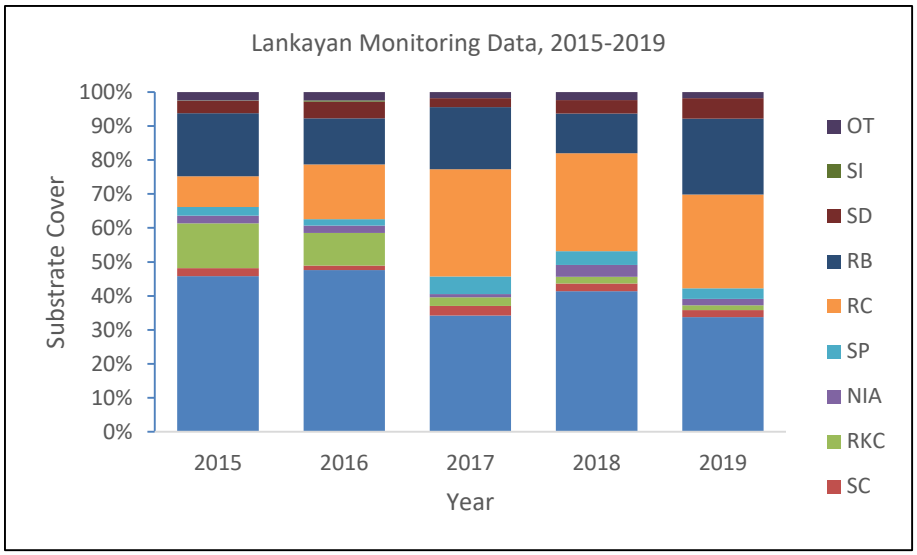
Sembilan



Data from surveys conducted on Sembilan over the last five years show that HC cover has declined over the period. Overall, reef condition has remained in the 'fair' category with the exception of 2017 when reef health dropped to 'poor' category. The decline in 2017 was reflected in RB, showing a significant increase from the previous year. RB level on Sembilan is generally high; over 10%. The level of SP has been showing a steady increase over the period although the increase was very slight. SP is a normal component of coral reefs, however it can proliferate in the presence of high levels of nutrients.

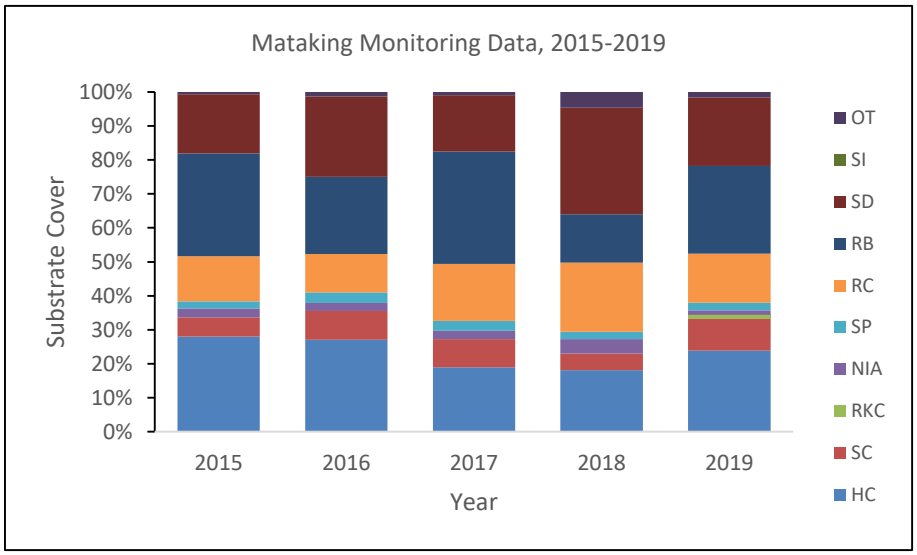
4.2.6 Sabah

Lankayan



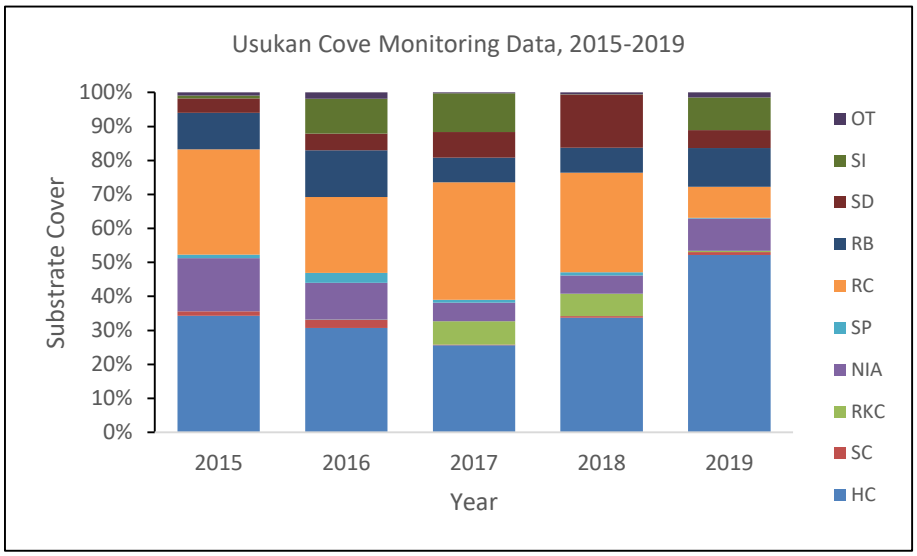
Data from surveys conducted around Lankayan island over the last five years show that there has been an overall decline in reef health. HC recorded 48-49% in 2015 and 2016 but decreased to 35-37% thereafter, except for 2018 where it increased to around 41%. RKC level has decreased significantly from 9-13% in 2015 and 2016 to below 3% thereafter. RB on the other hand maintained high at 11-22% over the period. 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. RB level at Lankayan should be monitored closely in future surveys.

Mataking



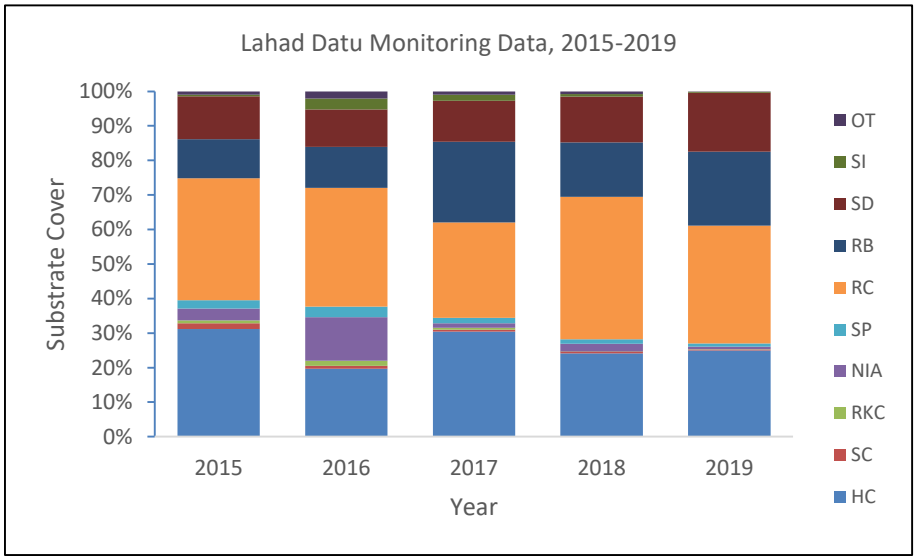
Data from surveys conducted on Mataking over the last five years show that there has been a decline in reef health in 2017 and 2018. Data from 2019 surveys showed that HC cover has recovered to level recorded in 2015 and 2016. Overall reef condition has remained in the 'fair' category with the exception of 2018 when reef health dropped to the 'poor' category. The level of RB and SD on Mataking was very high. 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. 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.

Usukan Cove



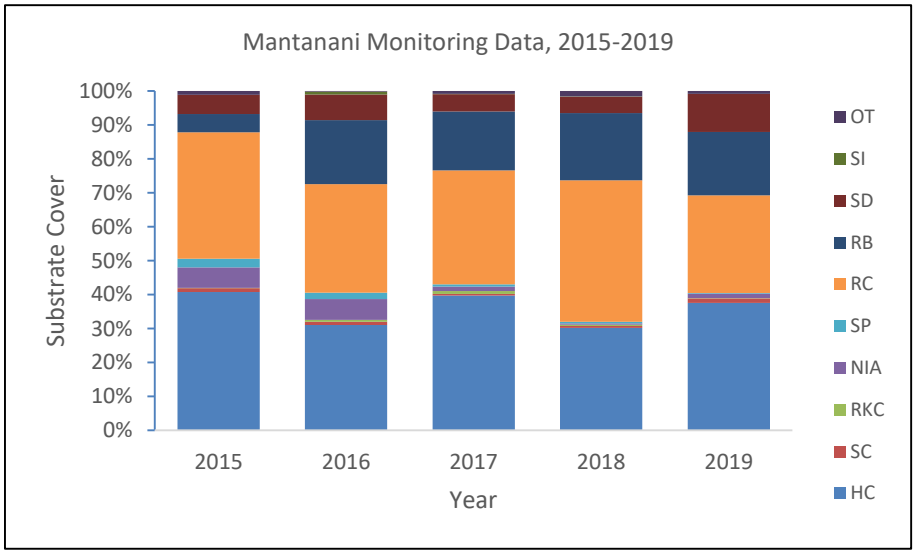
Data from surveys conducted at Usukan over the last five years show that HC cover declined during the first three years but subsequently recovered, with 2019 surveys recording the highest HC cover. The level of NIA and RB on Usukan Cove is high. The high level of NIA is indicative of raised levels of nutrient in the waters around the islands while high level of 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. Fish bombing is a problem on Usukan Cove and the damage was recorded in our surveys. Usukan Cove also recorded a high level of SI which is indicative of local impacts.

Lahad Datu



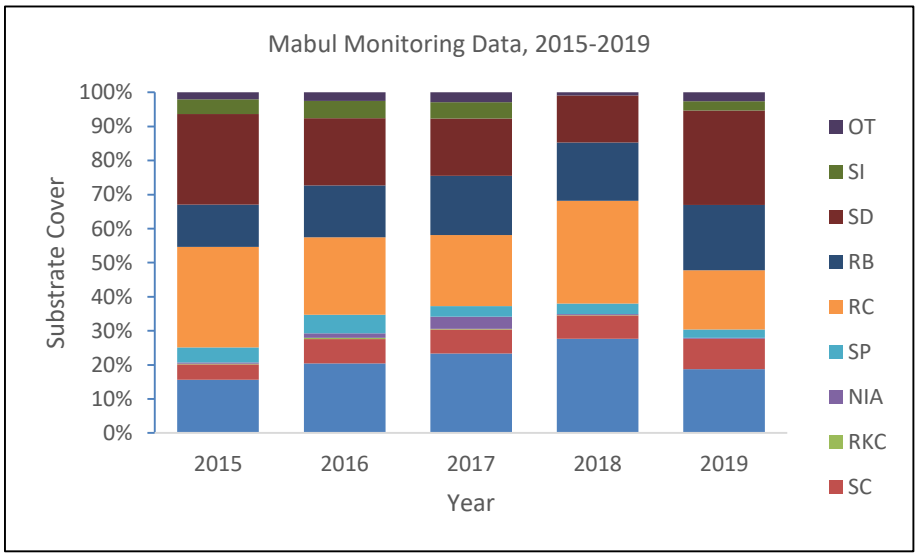
Surveys conducted in Lahad Datu show that the health of reefs varied between fair and poor, with a decline over the last three years. It is thought that some of the variability in data is a result of not having fixed transects. Although GPS coordinates are used to identify reef areas, locating specific start points can be challenging, hence the variation in data. Both RC and RB level also varied over the period; the level of RC varied between 24% and 42%, while the level of RB varied between 14% and 24%. Bare RC can be re-colonised by coral recruits and is critical for reef recovery, regeneration and extension while RB on the other hand slows down coral regeneration 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.

Mantanani



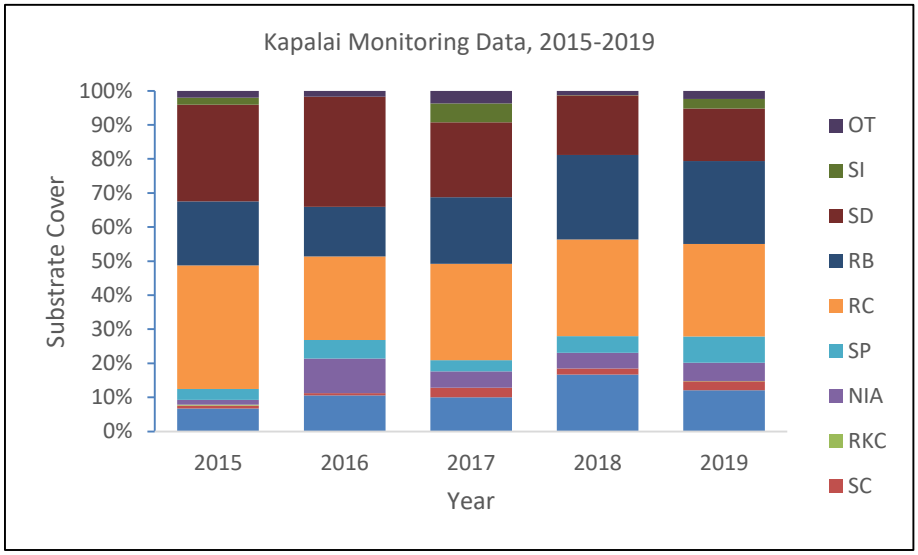
Data from surveys conducted on Mantanani over the last five years show that HC cover varied substantially, showing a decrease and increase pattern yearly. Mantanani recorded a high level of RB. RB is created by a number of factors, some natural such as wave action and storms, while others result from human activities, including fish bombing, anchoring and SCUBA diving. Fish bombing is known to be a big problem on Mantanani and bomb damage was recorded every year during surveys. The number of visitors entering the island has increased yearly and storms are very frequent on Mantanani. While nothing can be done to reduce storm frequency and intensity, fish bombing and damage contributed by tourism activities should be controlled and managed to prevent further reefs deterioration.

Mabul



Data from surveys conducted on Mabul over the last five years show that HC cover increased for the first four years but decreased sharply in 2019 (from 27.63% in 2018 to 18.75% in 2019). The level of SD on the other hand decreased for the first four years and increased sharply in 2019 (from 13.88% in 2018 to 27.71% in 2019). SD can be an indicator of disturbance as dead coral breaks off and is eroded into fine particles (sand) by wave action. Mabul recorded a high level of RB throughout the period and the level is showing an increasing trend. 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. Fish bombing is a big problem around Mabul and bomb damage was recorded during surveys.

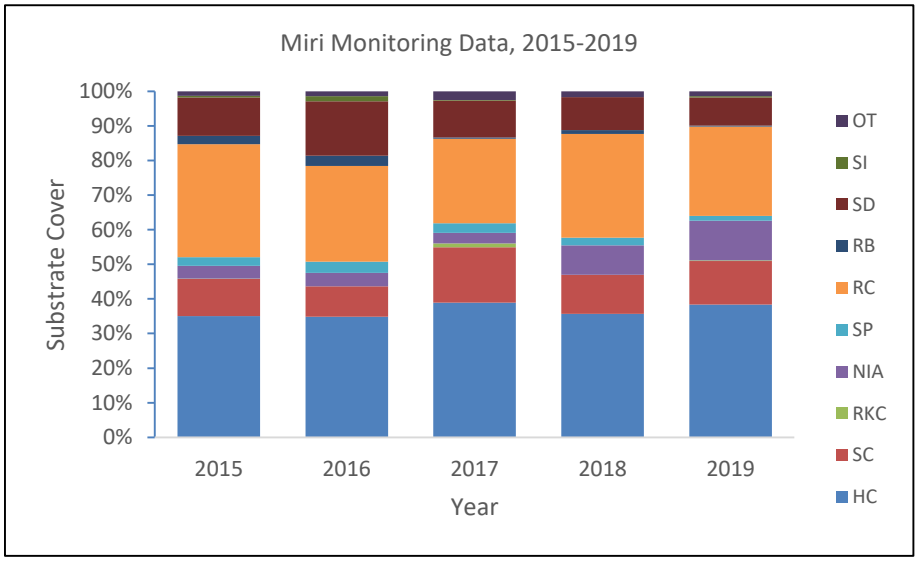
Kapalai



Data from surveys conducted on Kapalai over the last five years show that HC cover varied substantially. It is thought that the variability in data is a result of variation in number of survey sites over the period. Kapalai recorded high levels of RB. 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. Fish bombing is a big problem around Kapalai and bomb damage was recorded during surveys. The level of NIA has increased over the last five years. The increase in the level of NIA is an indicative of raised levels of nutrient in the waters around the island.

4.2.7 Sarawak

Miri



Data from surveys conducted in Miri over the last five years show that the health of reefs varied 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. NIA level has increased significantly over the last two years; recording 3 to 4% from 2015 to 2017, increasing to 8.54% in 2018 and further increasing to 11.46% in 2019. This increase in the level of NIA is probably indicative of raised levels of nutrient in the water. RC, which comprises both natural rock and dead coral also varied over the period time (between 24% to 33%). Bare RC can be re-colonised by coral recruits and is critical for reef recovery, regeneration and extension.

5. Summary and Recommendations

5.1 Summary

5.1.1 The ***decline*** in coral reef health (as measured by Live Coral Cover, LCC) that has been evident for several years has now ***extended into a fifth consecutive year*** in 2019 and is now considered to be a significant ***cause for alarm***.

5.1.2 ***Abundance*** of both fish and invertebrate indicators ***continues to be low***, and in some areas is declining. This is despite the fact that many survey sites, particularly in Peninsular Malaysia, are in protected areas where extraction is forbidden and thus abundance should be increasing. This appears not to be happening, raising questions about the commitment of stakeholders to conserve marine resources and the effectiveness of management.

5.1.3 There are a number of indications that human impacts to reefs continue to increase, particularly:

- The level of rubble (RB) is ***high***. The average for Malaysia is 15%, an increase on last year. One third of survey sites have RB in the range 10-29%; 8% of sites have RB in the range 30-49% and 5% of sites have RB over 50%.

- The amount of nutrient indicator algae (NIA) has increased since 2018 and is ***high*** in many areas. 17% of sites have NIA in the range 10-24% and 6% have NIA in the range 25-50%.

5.1.4 Climate change-related impacts are increasing:

- Tropical storm Pabuk, which hit the Terengganu coastline in January 2019, caused ***significant damage*** to shallow reefs in both Redang and Perhentian islands, as reflected in the precipitous declines in LCC at some sites around those islands. Given that scientists are predicting that such storms will increase in both frequency and strength, we can only expect greater impacts on reefs in the future.

- Malaysia was once again affected by region-wide high sea temperatures in mid-2019 and ***coral bleaching*** was observed around all coastal areas.

5.1.5 Observations made while conducting surveys highlight the following trends that are potentially damaging to reefs:

- On many islands the ***number of resorts and tourists is increasing***. There appears to be little regard to carrying capacity of the islands and development is not well regulated.

- There are few visible improvements in sewage treatment facilities to cater for the increasing numbers of visitors. This observation is supported by the data on ***increasing level of NIA*** on reefs and low numbers of herbivorous fishes.

- Data from the International Coastal Clean-up strongly indicate that ***waste management – locally, nationally and regionally – is poor***. This is likely to have a negative impact on reef health.

- Data from other surveys (e.g. resilience surveys, reef mapping) that could be used to inform decisions on, for example, resort development proposals, is not widely distributed. There is a ***dearth of Management Plans*** for Marine Parks that could utilise such data to better control tourism impacts.

- Proposals for further growth in tourism numbers, and the related infrastructure development that would be required, seem to be taken in isolation from international commitments to conserve biodiversity. For example, the ***proposed airport in Tioman Island will have significant negative consequences for biodiversity*** and this should be a key determinant in the decision to proceed with the project.

5.2 Recommendations

The continuing decline in reef health revealed by the 2019 surveys – for a fifth successive year – highlights an urgent need to strengthen marine resource management and reduce impacts to coral reefs.

5.2.1 Improve resource management

Action is needed in three areas, as outlined below.

Fix the problems. There is an urgent need to address key impacts to reefs. Programmes should be implemented to:

- Improve supervision of marine tourism to reduce physical impacts to reefs including contact by tourists (both snorkelers and divers), boat damage, anchor damage, etc. Training and awareness programmes should be targeted at all stakeholders. As an incentive, a requirement to participate in relevant environmental training/programmes could be included into business licensing procedures.

- Enforce strict waste management systems for all stakeholders in coral reef areas, to reduce the amount of trash entering the sea. At the same time, urban municipalities must improve rates of collection to reduce the release of waste into the environment.

- Reduce sewage pollution through a programme to improve existing sewage treatment systems (e.g. desludging programme for septic tanks, as conducted on Tioman in 2016) and gradually invest in new sewage treatment installations.

- Eliminate illegal fishing, including by local communities, tourists and encroachment by fishing vessels from outside Marine Parks. This will help to increase the numbers of important herbivores, which play an important role in managing the level of algae on reefs.

Fix management. Some data from the surveys, as well as observations on the Marine Park islands, indicate that some aspects of coral reef management need to be improved. In particular:

- There is a need to localise management, rather than rely on institutions and personnel who are geographically distant from Marine Parks and local stakeholders. It is strongly recommended that more resources are deployed onto Marine Park islands to strengthen local management capacity and provide greater visibility to management efforts. Appropriate stakeholder programmes should be introduced to engage local stakeholders in management and gain their support. Where possible, local stakeholders should be employed by management agencies.

- Involve local stakeholders in decision making. Our co-management programme in Pulau Sibu, and the Tioman Marine Conservation Group, are two examples of successful collaboration between government management agencies and local stakeholders. Such programmes should be vigorously extended, using schemes such as the recently launched Reef Care initiative.

- Prepare Management Plans for all Marine Parks as a matter of urgency. Plans should explain to stakeholders the need to conserve marine ecosystems, empower them to participate by detailing their role in marine conservation and state the resources that will be deployed locally and the conservation programmes to be implemented.

- Introduce mechanisms to finance conservation efforts from the Conservation Charge collected from tourists. This will have two impacts: first, it will increase the budget available to invest on the islands; and second it will demonstrate to stakeholders that funds collected for conservation will be used for conservation.

Plan for the future. As noted, climate change is expected to have increasing impacts on coral reefs. It is essential to start now to prepare for more extreme climate events (storms, bleaching, etc.) and develop programmes to protect and conserve reefs under likely future scenarios. This will require developing capacity in reef resilience, specifically:

- Build resilience concepts into management. Coral reef management currently focuses on enforcement and patrolling to conserve reefs. More attention should be given to viewing reefs holistically and to reduce impacts to optimise reef health. Two key components of resilience – water quality and herbivore populations – are mutually self-reinforcing if correctly balanced: good water quality reduces algal growth on reefs; and healthy herbivore populations ensure that algae growth does not impact corals. It is strongly recommended that two programmes are introduced at the earliest opportunity to optimise both factors:
    - Improve sewage treatment systems to reduce nutrient pollution and improve water quality
    - Enforce no-fishing rules in reef areas to allow herbivore populations to recover to ensure a natural control mechanism of algal growth.

- Introduce MPA networking concepts and approaches to address broader conservation issues and further enhance reef resilience. In Peninsular Malaysia, for example, the current system of individual MPAs around islands successfully serves to establish no-take zones. However, it does not address wider issues such as: biological connectivity corridors between distant reef systems; management of other ecosystems outside Marine Parks that are important linked ecosystems (e.g. coastal ecosystems including mangrove forests and inter-tidal seagrass meadows); and integrating fisheries management into marine resource management. Visualising the entire coastal zone as one large managed area would overcome these limitations and allow more comprehensive management.

5.2.2 Improve collaboration.

In addition to these specific recommendations, it is clear that there is a need to improve collaboration between relevant Ministries and other agencies that have different impacts on marine resources. Management of Malaysia's Marine Parks comes under the jurisdiction of three agencies:

- Peninsular Malaysia - Marine Parks Section of Department of Fisheries
- Sabah - Sabah Parks
- Sarawak - Sarawak Forestry Corporation.

While these bodies are responsible for "day to day" management, other Ministries and agencies have functions that, in part, overlap with the management agencies:

- KATS: enhance biodiversity conservation
- MESTECC: environmental protection and climate change adaptation
- MOTAC: maximise tourist visitors
- MOA: maximise fisheries production
- State governments: economic development of land resources.

In some cases, these responsibilities are contradictory:

- Maximising tourist numbers increases the chances of biodiversity degradation
- Maximising fisheries production increases the chances of over-fishing which can have negative impacts on coral reef health
- State governments are responsible for land matters and might encourage activities that damage ecosystems (e.g. resort development).

Experience shows that coordination between these agencies could be improved:

- Numbers of tourists in Mantanani Island, Sabah, have increased more than 10 fold over a seven-year period; this is now putting pressure on the island's ecosystems
- New airports proposed for Tioman and Redang Islands will result not only in damage to ecosystems in the short term from construction-related activities, but will likely lead to long term biodiversity loss as increasing numbers of tourist arrivals are encouraged by ease of travel to the island, resulting in construction of more resorts, more waste generated, water extracted and sewage generated.

It is strongly recommended that the Marine Parks Advisory Council act as a liaison between these various bodies, to ensure that resource management and economic development needs are adequately balanced.

5.3 Conclusion

The 2019 review of the health of coral reefs around Malaysia indicates that, while reefs are generally in “fair” condition, there has been a five-year decline in coral reef health. The monitoring data, combined with observations made during survey trips and our knowledge of other factors such as governance and pressure from tourism growth, suggest that if this decline is not addressed, the long term prognosis for reef health is extremely poor.

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 13 years of monitoring data highlights some potentially worrying trends. Management authorities and other government agencies are urged 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

Reef Check Malaysia cannot work in isolation. We continue to maintain a close working relationship with the **Marine Parks section of Department of Fisheries,** Ministry of Agriculture, and **Sabah Parks,** both of whom make significant contributions to this annual survey programme by conducting surveys at some of the sites, as well as assisting in reef rehabilitation programmes and school education projects.

We are grateful to the following sponsors for supporting the survey programme during 2019:

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

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

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

Royal Bank of Canada: collaborating with RCM on a long term programme to address impacts to coral reefs in Tioman island.

Estee Lauder Malaysia donates funds to support a Reef Check survey programme in Lahad Datu, 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.

Russell Bedford LC & Company: provides *pro bono* company secretarial services for RCM.

Accenture: donates funds to support Reef Check survey programme Tinggi Island and address impacts to coral reefs in Sibu Island, Johor

Yinson Holdings Bhd: sponsors nationwide beach clean-ups for International Coastal Clean Up Day 2019

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** (Lim Jit Cheng, Kevin Hiew, Ruth Yeoh and Datuk Hiswani Harun) 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 many years
- **Mataking Reef & Dive Resort**, Mataking, who organise and conduct a survey programme around Mataking

- **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.
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- **Sea Voice Divers,** Perhentian, who sponsored 2019 surveys for Perhentian Kecil
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- **Redang Bay**, Redang, who partially sponsored 2019 Redang surveys
- **DM Scuba**, Redang, who partially sponsored 2019 Redang surveys
- **Rimba Resort,** Sibu, who fully sponsored 2019 Sibu survey

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- EIG Haircare
- Oh Ying Ying
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- Politeknik Sultan Ibrahim
- UKM students
- DM Scuba Dive Team
- SMK Saint Mary's School
- Sri Sempurna International School.

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 Junkie, Mabul/KK
Tioman Dive Centre, Tioman
DM Scuba, KL
Reef Guardian, Lankayan
Mataking Reef & Dive Resort
Usukan Cove Lodge Dive Centre
Sea Voice Divers, Perhentian

Other dive operators

Aqua Sports Divers, Kapas
Kapalai Resort
Scooba Tank and Mari Mari Dive Lodge, Mantanani
Pom Pom Dive Resort
Darvel Bay Diving, Lahad Datu
Pelangi Resort, Redang
Orca Scuba, Rawa

NGOs

Juara Turtle Project, Tioman

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Hamka Bin Juhuri
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Diana Majetova
Carina Lau
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Lim Wei Kang
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Mabel Tan
Adam Buligis
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Smita Jairam
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Appendix 1: Survey Sites (2019)

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	Tioman	2 48.594 N 104 08.161 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 52.558 N 104 08.828 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 10.1	Atlantis Bay	Aur	2 28.271 N 104 30.633 E
SS 10.2	Pulau Lang	Aur	2 27.594 N 104 29.358 E
SS 10.3	Teluk Meriam	Aur	2 26.509 N 104 30.571 E
SS 10.4	Teluk Teluran	Aur	2 27.617 N 104 31.587 E
SS 10.5	Teluk Batu Kapal	Dayang	2 28.368 N 104 30.481 E
SS 10.6	Teluk Jawa	Dayang	2 28.651 N 104 30.271 E
SS 11.1	Siwa 4A	Miri	4 16.383 N 113 48.883 E
SS 11.2	Siwa Penyu	Miri	4 16.583 N 113 49.050 E
SS 11.3	Anemone Centre	Miri	4 17.550 N 113 49.550 E
SS 11.4	Anemone North	Miri	4 17.616 N 113 49.566 E
SS 11.5	Eve's Garden	Miri	4 20.583 N 113 53.900 E
SS 11.6	Sunday Reef	Miri	4 17.217 N 113 49.167 E
SS 14.1	House Reef	Pulau Rawa	2 31.178 N 103 58.460 E
SS 14.2	South House Reef	Pulau Rawa	2 31.057 N 103 58.528 E
SS 14.3	Dragon Rock	Pulau Rawa	2 30.978 N 103 58.578 E
SS 14.4	Northern Garden	Pulau Rawa	2 31.392 N 103 58.377 E
SS 14.5	Rocky Island	Pulau Rawa	2 31.465 N 103 58.410 E

Malacca Strait

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

North Borneo

No.	Site Name	Island	Coordinate
NB 1.1	Bimbo Rock	Lankayan	6 31.240 N 117 55.763 E
NB 1.2	Edwin Rock	Lankayan	6 30.806 N 117 55.499 E
NB 1.3	Froggie Fort	Lankayan	6 30.806 N 117 54.337 E
NB 1.4	Goby Rock	Lankayan	6 28.745 N 117 53.448 E
NB 1.5	Jawfish	Lankayan	6 29.182 N 117 54.670 E
NB 1.6	Ken's Rock	Lankayan	6 30.393 N 117 55.651 E
NB 1.7	Lycia Garden	Lankayan	6 29.895 N 117 55.634 E
NB 1.8	Mel's Rock	Lankayan	6 29.140 N 117 53.584 E
NB 1.9	Moray Reef	Lankayan	6 33.125 N 117 56.141 E
NB 1.10	Pegaso	Lankayan	6 33.726 N 117 55.210 E
NB 1.11	Reef 38	Lankayan	6 32.619 N 117 55.201 E
NB 1.12	Reef 77	Lankayan	6 33.124 N 117 55.482 E
NB 1.13	Sandbar S	Lankayan	6 29.900 N 117 54.681 E
NB 1.14	Veron	Lankayan	6 31.259 N 117 54.944 E
NB 1.15	Zorro	Lankayan	6 30.470 N 117 55.218 E
NB 2.1	Cahaya Way	Mataking	4 30.252 N 118 56.504 E
NB 2.2	Coral Garden	Mataking	4 34.212 N 118 57.415 E
NB 2.3	Mataking House Reef	Mataking	4 34.758 N 118 56.415 E
NB 2.4	Pandanan Bay	Mataking	4 34.907 N 118 54.795 E
NB 2.5	Stingray City	Mataking	4 33.359 N 118 55.627 E
NB 2.6	Sweetlips Rock	Mataking	4 35.960 N 118 56.454 E
NB 3.1	Usukan Cove Lodge	Usukan Cove	6 22.455 N 116 20.586 E
NB 3.2	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 4.12	South East Point	Mantanani	6 42.454 N 116 22.329 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 7.5	Siu Siu Point	Kapalai	4 13.087 N 118 40.313 E
NB 7.6	Lost World	Kapalai	4 12.093 N 118 41.392 E
NB 8.1	Eel Garden	Mabul	4 13.883 N 118 38.017 E
NB 8.2	Ribbon Valley	Mabul	4 14.046 N 118 38.255 E
NB 8.3	Stingray City	Mabul	4 14.222 N 118 37.641 E
NB 8.4	Panglima	Mabul	4 14.922 N 118 37.529 E
NB 8.5	Paradise	Mabul	4 14.989 N 118 37.830 E
NB 8.6	Scuba Junkie House Reef	Mabul	4 14.938 N 118 37.925 E
NB 14.1	Mandarin House Reef	Pom Pom	4 35.414 N 118 51.849 E
NB 14.2	New Life	Pom Pom	4 35.503 N 118 51.688 E
NB 14.3	Northern Valley	Pom Pom	4 35.775 N 118 52.158 E