Status of Coral Reefs in Malaysia, 2013

Reef Check Malaysia

Contents

Executive Summary

1. A total of 196 sites were surveyed in 2013 (2012: 165), 93 in Peninsular Malaysia and 103 in East Malaysia. The surveys are a continuation of a successful National Reef Check Survey Programme that has now run for seven years.

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

3. The results indicate that Malaysian reefs surveyed have a relatively high level of living coral, at 48.33% (2012: 46.37%). The level of recently killed corals indicates continuing recovery from the 2010 bleaching event that killed coral reefs around South East Asia.

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

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

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

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

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

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

10. Coral reefs are a valuable economic and biological resource in Malaysia, where they are a major attraction for the tourism industry, serve as a protein source for millions of people and are a major source of biodiversity. One estimate puts the economic value of well-managed coral reefs in Malaysia at RM 150 billion per annum. Coral reefs are threatened by global warming, overfishing, pollution and sedimentation.

11. Reef Check is a coral reef monitoring methodology used worldwide to assess the health of coral reefs in over 90 countries and territories worldwide, and in Malaysia since 2001. The non-profit Reef Check Malaysia (RCM) is available to oversee training and surveys in Malaysia.

This report is available for download at:
http://www.reefcheck.org.my/media-information/annual-survey-reports

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

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

1. Introduction

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

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

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

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

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

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

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

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

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

Reef Check Malaysia Bhd (RCM) works with various stakeholders to conserve coral reefs. Since it was registered in 2007, RCM has established an annual, national coral reef monitoring programme. This report presents the results of coral reef surveys conducted in Malaysia during 2013, the seventh year of surveys.

2. Reef Check

2.1 Background

RCM is part of the world wide Reef Check network. Established in 1997 in the USA, Reef Check now has Coordinators in over 80 countries worldwide. Reef Check was established by a group of scientists who developed a simple, rapid method of surveying coral reefs. It is the name both of the organisation and the survey methodology.

Reef Check Malaysia Bhd 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 six years RCM has trained over 380 divers to conduct reef surveys at over 100 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 addition, we have been working with stakeholders in the Perhentian islands and in Pangkor to involve local communities in coral reef management.

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 2013 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.

This report is the seventh annual report, and details the results of Reef Check surveys carried out during 2013. 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.

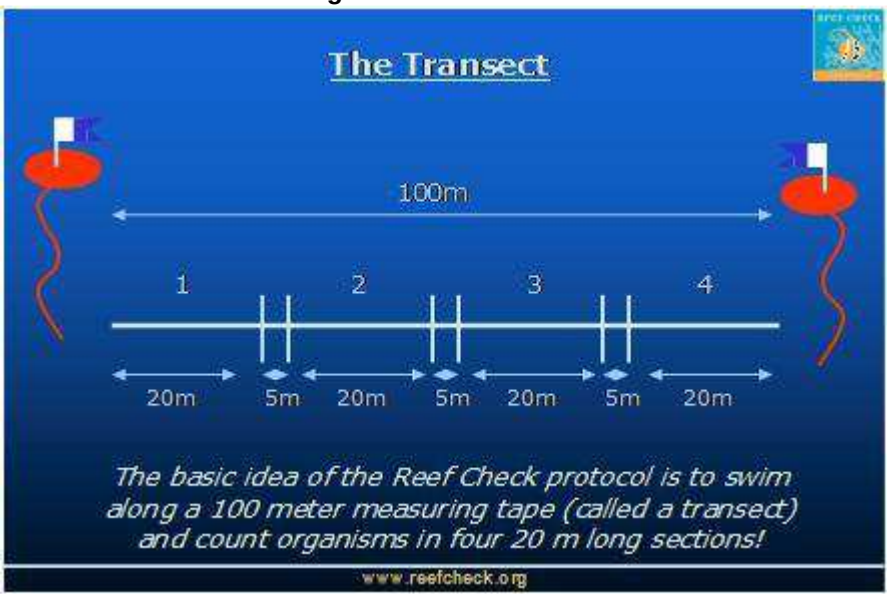
Reef Check surveys are conducted along two depth contours (3 m to 6 m and 6 m to 12 m depth). A 100 m transect line is deployed and along it four 20 m transects are surveyed, each separated by 5m, which provides four replicates per transect (8 per complete survey) for statistical analysis (see Figure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

Four types of data are collected:

- Fish abundance: the fish survey is carried out by swimming slowly along the transect line counting the indicator fish within each of the four 20 m long x 5 m wide x 5 m high corridors
- Invertebrate abundance: divers count the indicator invertebrates along the same four 20 m x 5 m belts

- Substrate cover: collected by the Point Intercept method whereby the substrate category such as live coral is noted every 0.5 m.
- Impact: the impact survey involves the assessment of damage to coral from bleaching, anchoring, destructive fishing, corallivores such as *Drupella* snails or crown-of-thorns starfish, and trash.

Figure 1: The Transect



2.3 Survey Sites

In 2013, a total of 196 sites were surveyed, 93 of which were in Peninsular Malaysia and the remaining 103 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, Perhentian, Redang, Tenggol, and Tioman). Numerous new sites were also surveyed around islands off the East coast (Tioman, Sibu and Pemanggil). In East Malaysia, a large percentage of the surveys were conducted by a number of dive operators, notably in Lankayan and Mataking in Sabah as well as Kuching, in Sarawak. This is one of the success stories of getting local stakeholders, especially dive operators and local community, to be involved in monitoring and management of their own local reefs.

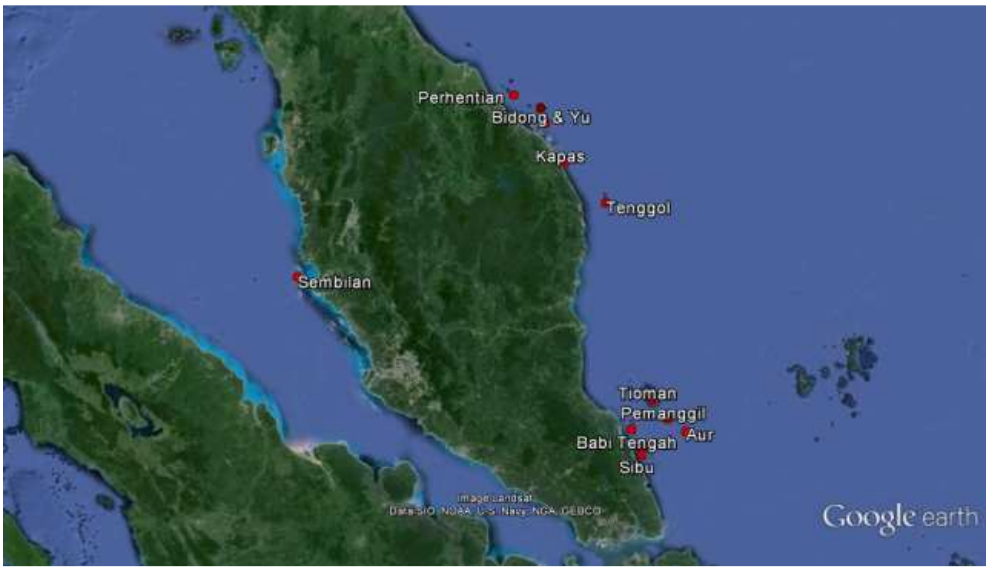
The list of sites surveyed is shown in appendix 1.

3. 2013 Survey Results and Analysis

This section details the results from surveys conducted in 2013, providing an overview of the condition of coral reefs in Malaysia as a whole, and a more detailed analysis of surveyed reef areas.

3.1 Status of Coral Reefs in Malaysia 2013

The results from all 196 surveys were compiled to provide a general idea of the status of coral reefs around Malaysia. Sites surveyed off peninsular Malaysia are mostly developed 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: Survey Locations in Peninsular Malaysia

Map 2: Surveyed islands in East Malaysia

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

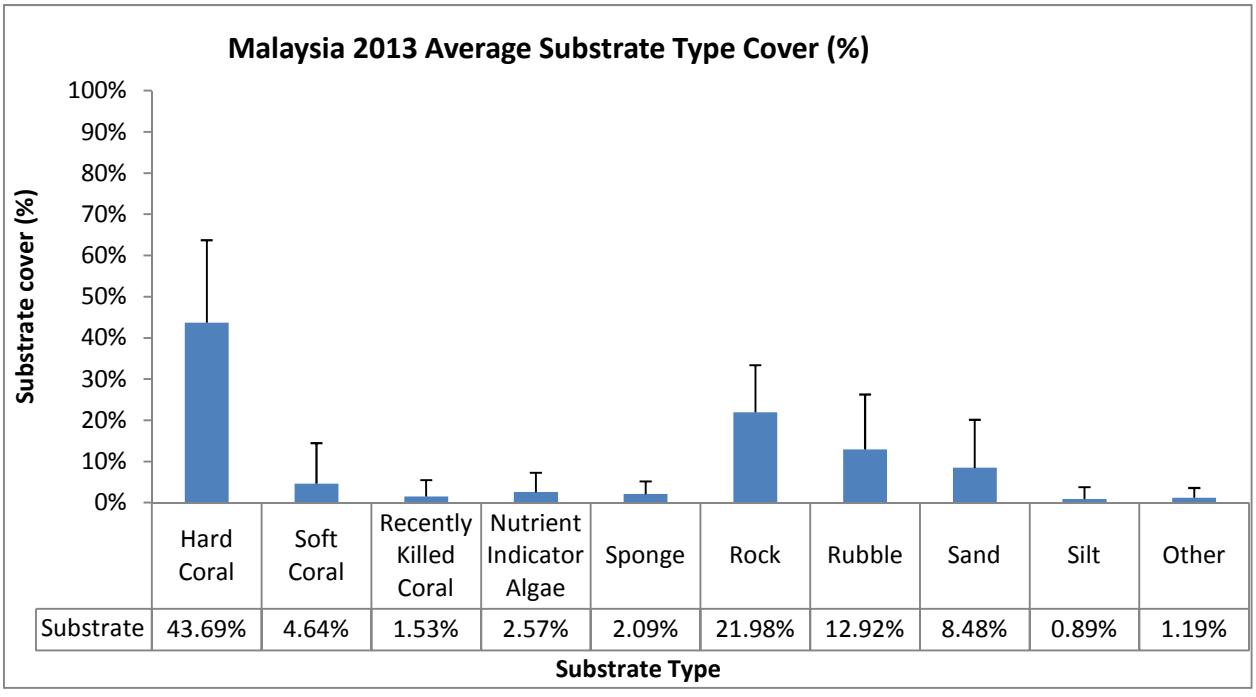
Percentage of live coral cover	Rating
0-25	Poor
26-50	Fair
51-75	Good
76-100	Excellent

According to these ratings Malaysian reefs are considered to be in "Fair" condition, with an average live coral cover of 48.33% (Hard Coral + Soft Coral – see Chart 1).

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 and Drupella snails) and other local stressors (e.g. sedimentation and disease). The low level of RKC (1.53%) in 2013 mirrored that of 2012.

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 populations on reefs and of the level of nutrient input to reefs. Algae is a natural and essential part of the coral reef, but if allowed to grow un-checked, algae can smother corals, shading them from the sunlight they need for photosynthesis 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. At 2.71% (4.34% in 2011), NIA does not appear to be a threat.

Chart 1



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 2.13%, (2.57% in 2011) the level of SP does not appear to be a threat.

Rock (RC) comprises both natural rock and dead coral. Bare RC can be recolonised by coral recruits and is critical for reef recovery, regeneration and extension. In 2013 the average cover of RC on Malaysian reefs was 21.98%. 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.

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 fishing, boating and SCUBA diving. High levels of RB indicate damage, and on such reefs, coral regeneration is slow due to the difficulty of corals recruiting onto a mobile substrate. Coral recruits are easily damaged or displaced from mobile substrate moving around on the seabed. The average cover of RB on reefs around Malaysia was 12.92% in 2013 and this amount has not changed much over the last 3 years.

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.

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 0.89% and mirrors the average of 2012. 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 levels of SI in a specific area can indicate a local impact.

The category Others (OT) includes all other sessile organisms that do not indicate any impacts, but are natural components of coral reefs. The average level of OT in Malaysia was 1.19% in 2013.

3.1.2 Fish

Reef Check indicator fish species were chosen because of their desirability for various types of fishing, for example:

- Butterfly fish (BF): targeted for the aquarium trade
- Sweetlips (SL), Snapper (SN), Barramundi Cod (BC), Parrotfish (PF), Moray Eel (ME), Grouper (GR): targeted as food fish
- Humphead Wrasse (HW), Bumphead Parrotfish (BP): targeted for the live-food fish trade.

The average abundances of indicator fish counted during the 2013 surveys are shown below (Chart 2).

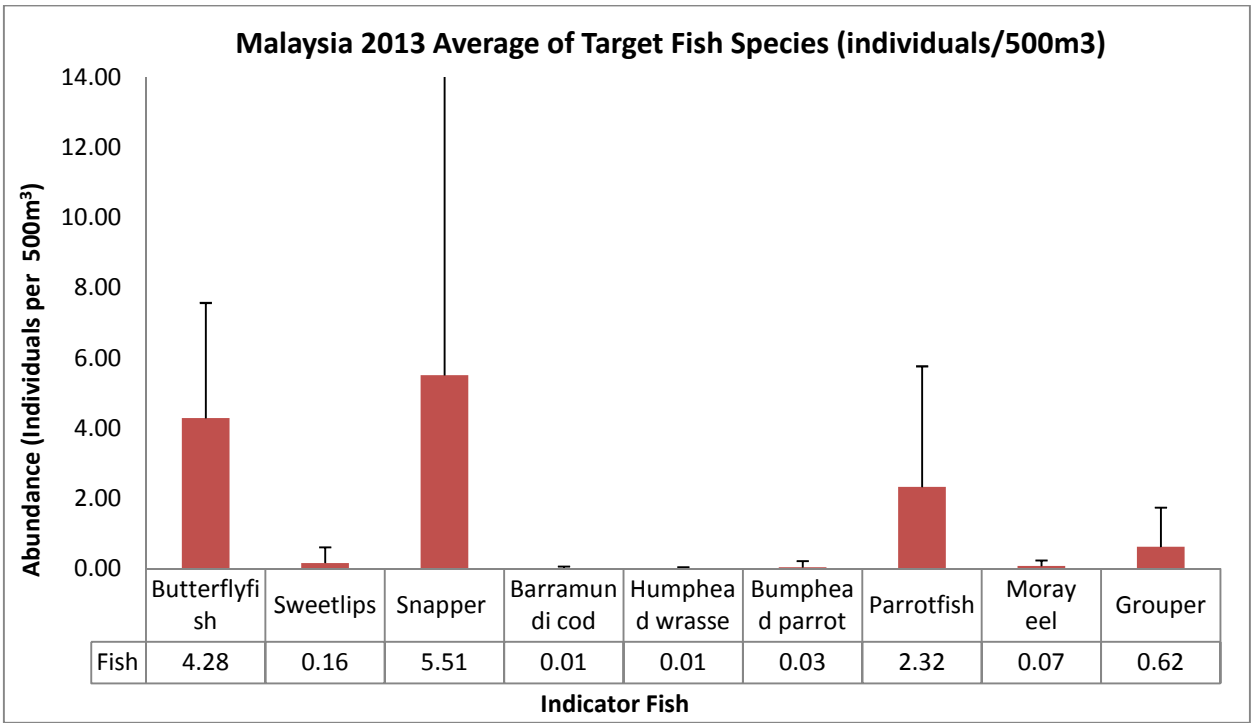
Barramundi cod, Humphead wrasse, Bumphead parrotfish, Groupers, Sweetlips, and Moray eels recorded an average abundance of less than 1 individual per 500m^3 survey transect. High value fish such as these, which are specially targeted for the international live food trade, recorded the lowest average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

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

Butterflyfish recorded a national average of 4.28 individuals per 500m^3 in 2013 and this mirrored the average abundance of 2012. 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 2013 was 2.32 individuals per 500m^3 and is similar to that of 2012.

Chart 2



3.1.3 Invertebrates

The invertebrate indicators are targeted for differing reasons:

- Curio trade: Pencil Urchin (PU), Triton Shell (TR)
- Food: Banded Coral Shrimp (BCS), Collector Urchin (CU), Sea Cucumber (SC), Lobster (LO), Giant Clam (GC)
- Imbalance/predator: Diadema Urchin (DU), Crown of Thorns (COT).

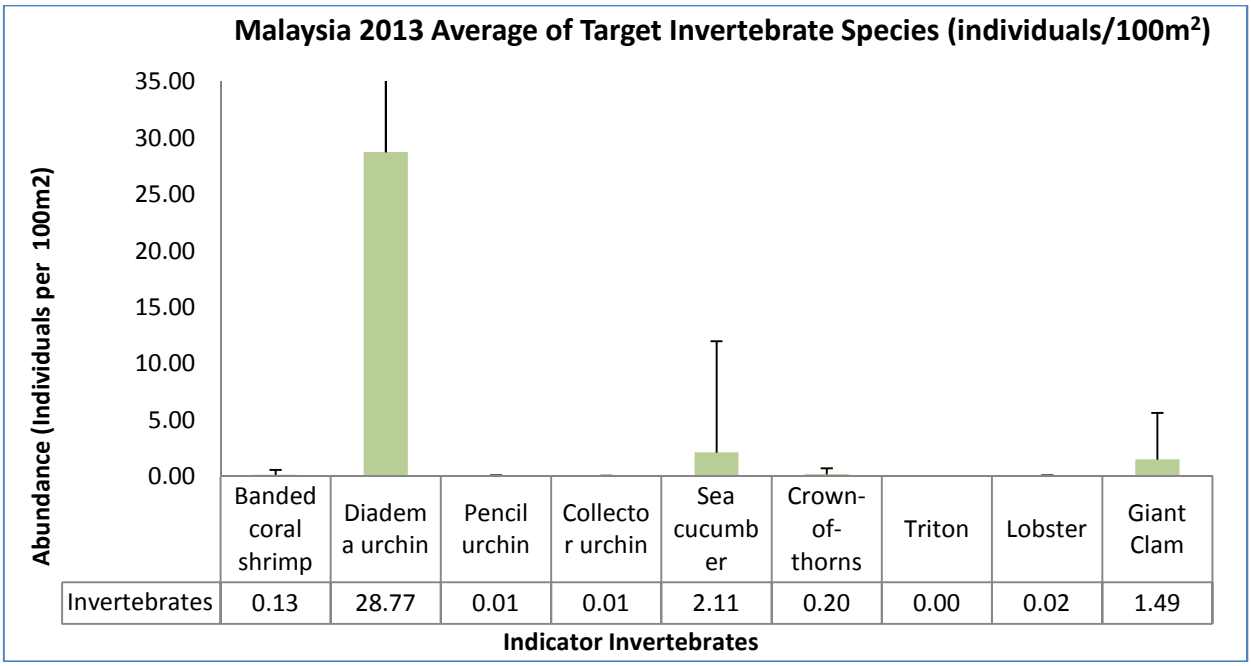
The abundance of indicator invertebrates counted during the 2013 surveys is shown in Chart 3 below.

National abundance average 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, the overexploitation of invertebrates such as Tritons and Pencil urchins has had a significant impact on their populations.

Similarly, several species targeted for the food trade are at or near zero (Lobster 0.02 individuals per 100m^2 survey transect; Collector Urchin – only observed at one site). Giant Clams recorded an average of 1.49 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-spined sea urchins *(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* urchins, 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 macroalgae, which proliferate in nutrient rich water) is abundant. Thus, high numbers of *Diadema* could indicate nitrification or overfishing of herbivores.

Chart 3



In high numbers, Diadema can have two 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 bioerosion exceeds the rate of coral growth. Controlling nutrient pollution s well as maintaining a healthy population of herbivores fish can contribute to reducing 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 COT per hectare (10,000m^2), or 0.2-0.3 per 100m^2 (Harriott et al., 2003) The abundance of COTs found during surveys (0.2 per 100m^2) is at the low end of this range, suggesting that COT numbers are within acceptable limits. On some of the islands off the East coast of Peninsular Malaysia, considerable efforts have been made by Marine Park authorities and local dive centres to control COT numbers by organising annual COT extractions to reduce the threats posed by these creatures. Continued monitoring is essential to track and help to manage significant outbreaks of this coralivore.

3.2 Status of Coral Reefs in Key Ecoregions in Malaysia

The sections below provide details of the health of coral reefs surveyed in three Ecoregions in Malaysia. An Ecoregion is defined as an area of relatively identical species composition, clearly distinct from adjacent regions (Spalding et al, 2007).

The Ecoregions for Malaysia are based on the “Marine Ecoregions of the World” system (Spalding et al, 2007). They are:

- Malacca Strait (West coast of Peninsular Malaysia, Ecoregion 118)
- Sunda Shelf (East coast of Peninsular Malaysia and West coast Sabah and Sarawak, Ecoregion 117)
- North Borneo (East coast of Sabah, Ecoregion 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: Ecoregions 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 below.

Table 2: Site Coverage by Ecoregion

Islands/Areas	No. of sites	Protection Status
Sunda Shelf		
Perhentian	11	Marine Park
Redang	12	Marine Park
Tioman	27	Marine Park
Kapas	5	Marine Park
Bidong/Yu	6	Marine Park
Tenggol	6	Marine Park
Pemanggil	6	Marine Park
Sibu/Tinggi	10	Marine Park
Miri	5	No protection
Kuching	6	No protection
Babi Tengah	1	Marine Park
Malacca Strait		
Sembilan	9	No protection
North Borneo		
Lankayan	15	SIMCA
Mataking	6	No protection
Semporna	14	No protection
Mantanani	13	No protection
Kota Belud	2	No protection
Tunku Abdul Rahman Park	18	Tunku Abdul Rahman Park
Labuan	3	Marine Park
Tun Sakaran Marine Park	12	Tun Sakaran Marine Park
Lahad Datu	9	No protection

Sunda Shelf Region

3.2.1 Perhentian

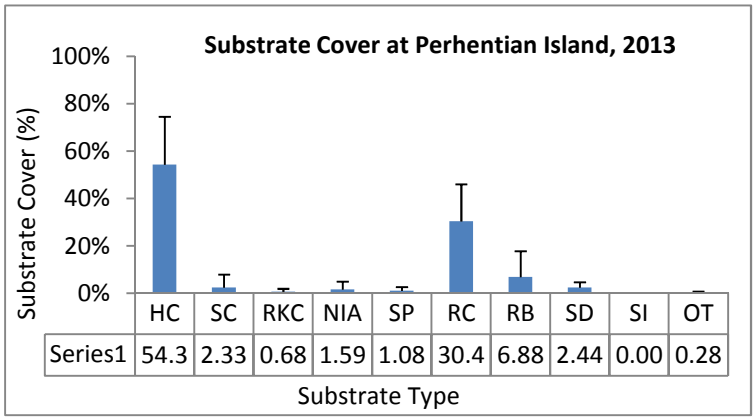
The Perhentian islands are located some 20km from Kuala Besut off the East coast of Terengganu, Malaysia. The islands have one village with a population of approximately 1,500, most of who work in tourism, the main industry on the islands. The islands are gazetted as a Marine Park (since 1994).

A popular tourist destination, particularly among backpackers, there are some 40 resorts, mainly small, family run chalets with a couple of large resorts, and 15 dive operators, spread around the two main islands. Diving and snorkelling are the main tourist activities. Growth in tourism has been rapid on the islands, and resort development continues. There is no mains electricity, groundwater supplies are limited and there is no centralised sewage treatment.

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

Map 3: Surveyed sites in Perhentian

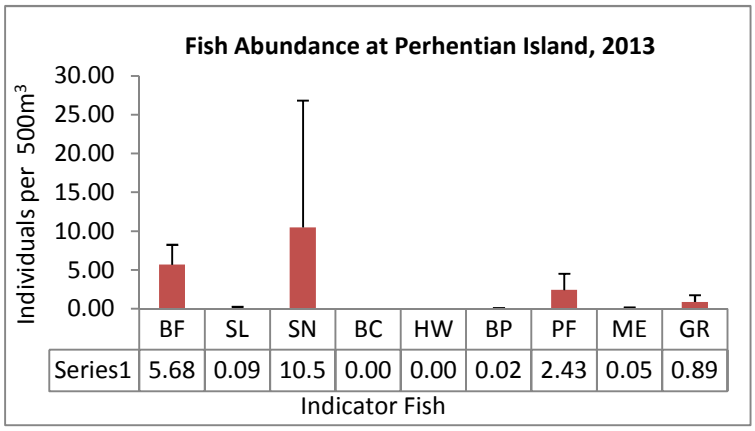
Substrate



Coral reefs around the islands are considered to be in 'Good' condition, with 56.63% (47.92% in 2012) live coral cover, near the average (56.65%) for reefs within the Sunda Shelf region.

The proportion of RC is high (30.40%), a significant proportion of which is dead coral. Although the average level of NIA is acceptable for Perhentian island (1.59%), the level is exceptionally high at SS 1.9 Shark Point (11.25%).

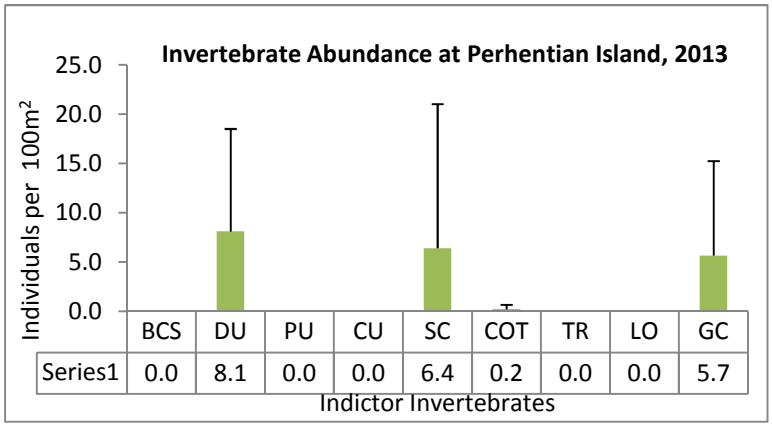
Fish



Abundance of indicator fish in Perhentian resembled the average abundance of indicators around the Sunda Shelf. Fish targeted for food showed low abundance, with some species absent entirely.

The most abundant fish were Snappers (10.50 individuals/500m^3), followed by Butterflyfish (5.68) and their abundance around Perhentian was higher than the average for Sunda Shelf (snapper 6.0 and Butterfly 4.7 individuals/500m^3). Only one Bumphead Parrotfish was seen during surveys.

Invertebrates



Diadema urchins (8.11), Sea Cucumbers (6.41) and Giant Clam (5.66) were common on most reefs and the abundance of sea cucumbers and giant clams were higher than the average for Sunda Shelf (Sea cucumber 4.1, Giant clams 2.4). The abundance of COT (0.23) was low and this is probably due to the annual removal of these organisms.

Banded Coral Shrimp, Pencil Urchin, Collector Urchin, Triton and Lobsters were absent at all sites.

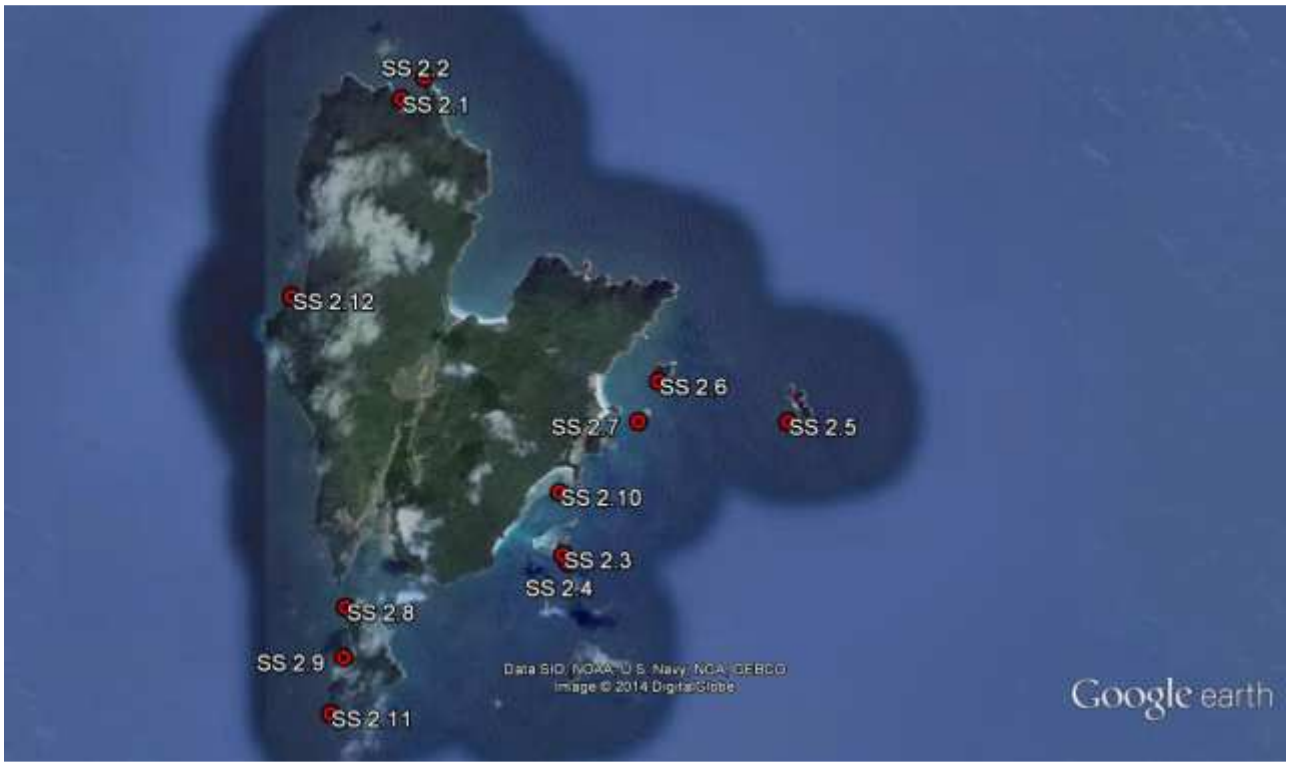
Damage to the reefs observed during the surveys was minor, such damage was most likely due to natural processes such as storms, predation and bleaching. Fish nets were also found on the reef at Shark Point and Sea Bell. Although the scale of the damage is considered low, it is evidence that illegal fishing is present inside the Marine Park. Blacktip sharks were observed at D' Lagoon and Tiga Ruang. One dead turtle was also found floating on the surface, which had scars resembling propeller damage.

3.2.2 Redang

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

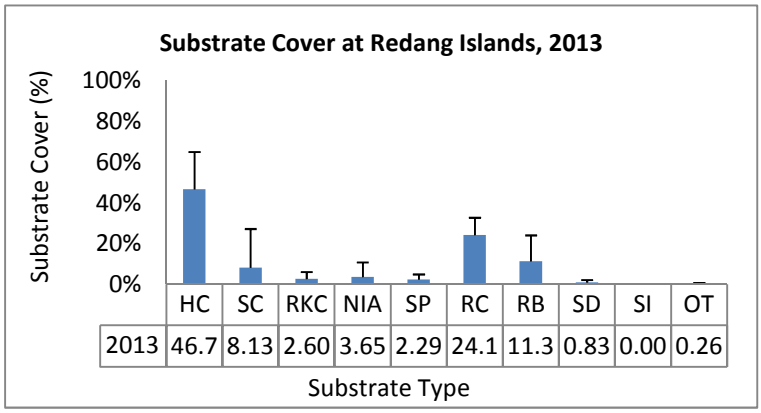
The island is a popular resort destination, with a more upmarket image than nearby Perhentian. Diving and snorkelling are the main tourist activities. There are 10 medium-large size resorts, mainly on Pasir Panjang. Most resorts have an in-house dive operator. There is no mains electricity, water is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

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



Map 4: Surveyed sites in Redang

Substrate

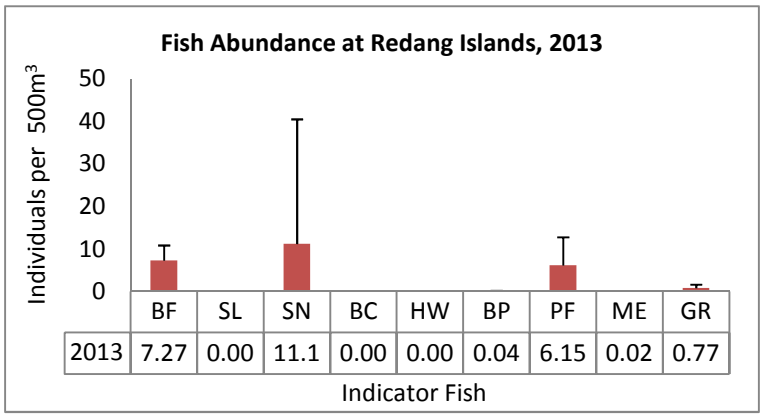


Although the reefs around the island are considered to be in 'Good' condition, with live coral cover of 54.83%, this represents a significant reduction compared to the 60.97% recorded in 2012.

The reason for this change is attributed to the drop in SC cover from 17.16% in 2012 to 8.13% in 2013.

Redang recorded the highest amount of RB within the Sunda Shelf, at 11.35%. Much of this was on shallow reefs which may have been damaged by the large number of snorkelers visiting the island.

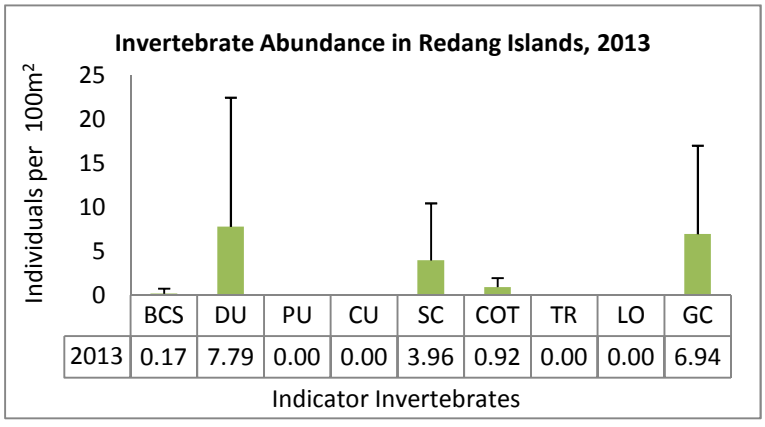
Fish



Similarly to Perhentian, Butterfly fish, Snappers, and Parrotfish were the most common indicators seen during surveys. Only two Bumphead Parrotfish were seen while Barramundi Cod, Sweetlips and Humphead Wrasse were completely absent.

Groupers were also recorded in low abundance with an average of only 0.77 individuals per 500m^3, perhaps suggesting that illegal fishing is still a problem around Redang

Invertebrates



Numerous targeted species were absent, including, Pencil and Collector Urchins, Triton and Lobster.

Banded Coral Shrimp were rare (0.17 ind/100m^2). Even though DMPM conducts annual COT cleanups around the island, COT abundance was high (0.92 ind/100m^2), and way above what a healthy reef can sustain (0.2-0.3 ind/100m^2). Their population must be closely monitored and nutrient runoff into the sea must be managed to avoid COT blooms in the future.

Trash on the reef was one of the main visible impacts along with damage cause by natural processes, discarded fishing nets and physical damage typical of that caused by snorkelers. One blacktip reef shark and a green turtle were seen during surveys.

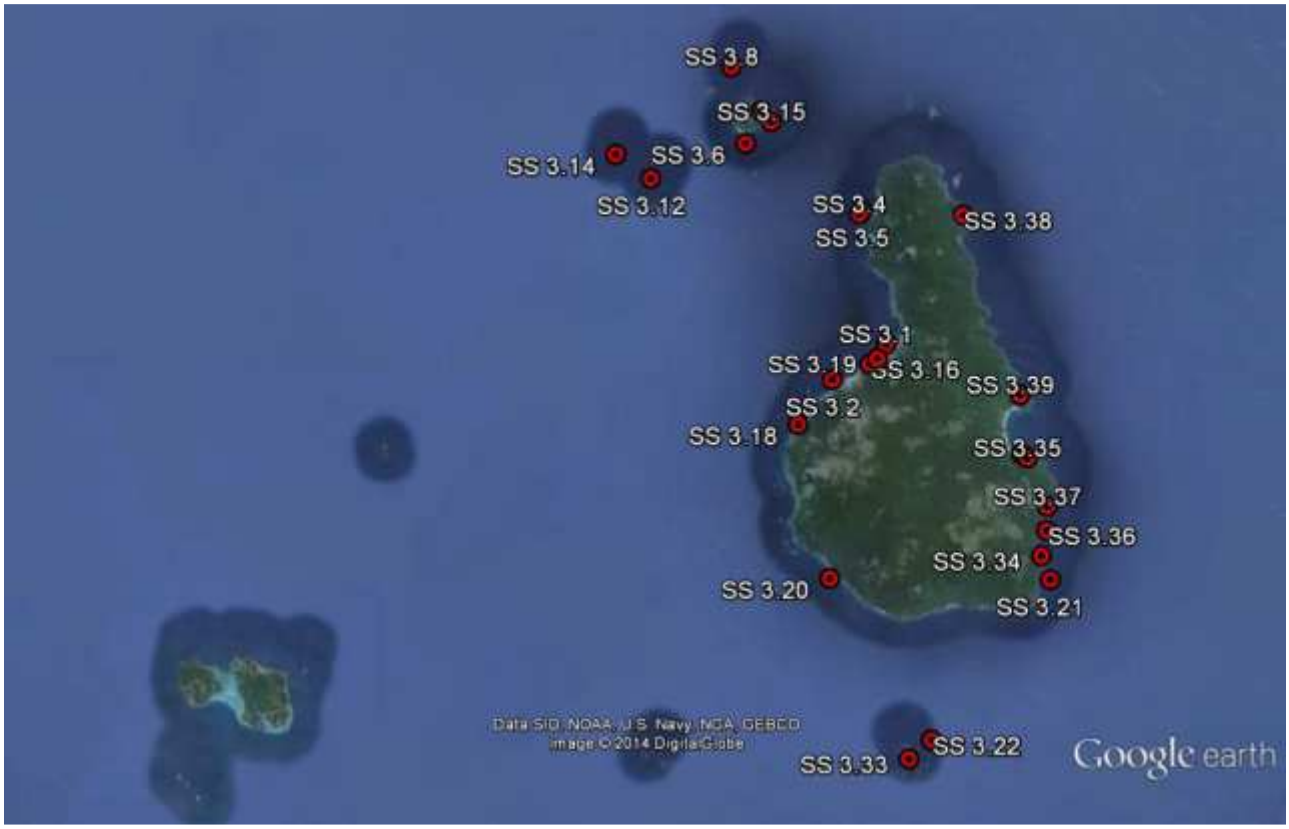
3.2.3 Tioman

Tioman island is located some 50km from Mersing, off the East coast of Pahang, Malaysia. It is the largest island off the East coast of Peninsular Malaysia. The island has five villages, with a total population of approximately 3,000, most of whom work in the tourism industry, the main industry on the islands. The island has been gazetted as a Marine Park since 1994.

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

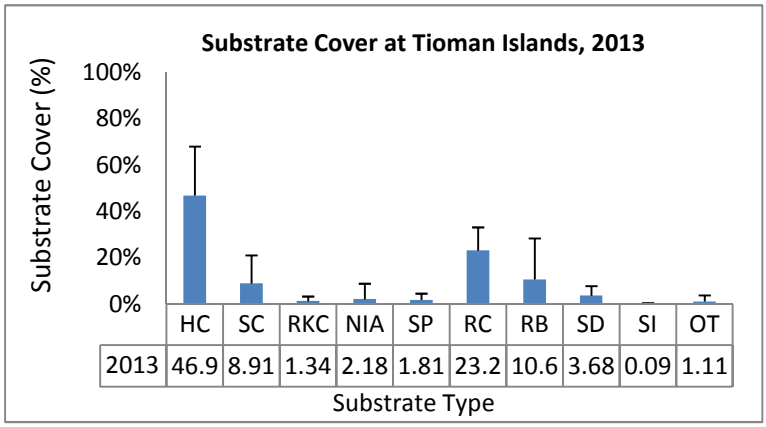
There is a small power generation station on the island, supplying electricity to all areas. The island has abundant fresh water, and a municipal incinerator was constructed some years ago. The island is served by an airport as well as boat services.

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



Map 5: Surveyed sites in Tioman

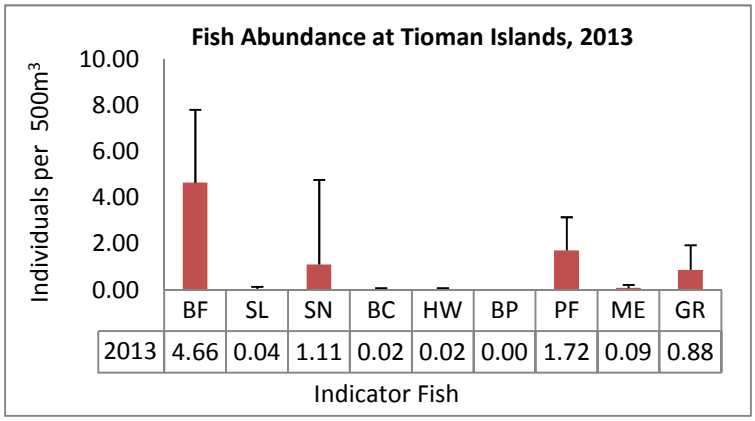
Substrate



The site is considered to be in 'Good' condition, with 55.81% live coral cover (48.82% in 2012), slightly below the average for reefs of the Sunda Shelf region (56.65%). The increase compared to 2012 is probably due to the introduction of 9 new survey sites not included in previous surveys.

Levels of RKC (1.34%), NIA (2.18%) and RB (10.69%) increased from 2012 (RKC 0.67%, NIA 1.55%, and RB 7.63), reflecting recent damage caused by storms in Tioman.

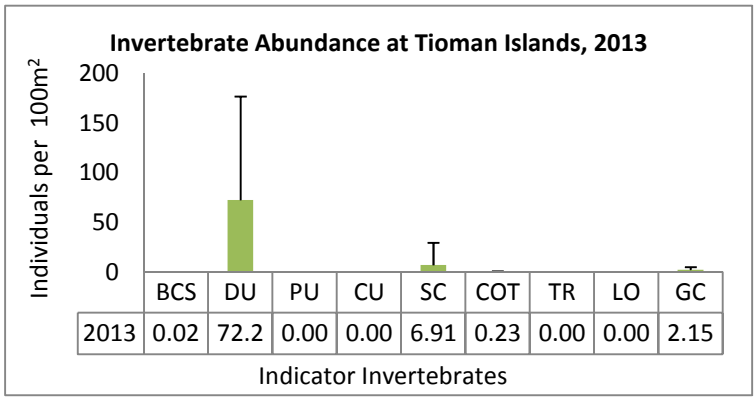
Fish



Only Bumphead Parrot were completely absent from the surveys. Butterflyfish (4.66 individuals/500m^3) were the most abundant indicators, followed by Parrotfish (1.72) and Snappers (1.11). The abundance of other indicators was less than 1 ind/500m^3.

Of all islands surveyed in the Sunda Shelf region, only Tioman recorded the presence of Barramundi Cod and Humphead Wrasse.

Invertebrates



Several targeted species were absent, including Pencil urchins, Collector Urchins, Triton and Lobster. The number of Diadema (72.20 individual/100m^2) in Tioman is the highest of all islands surveyed in the Sunda Shelf region. The exceptionally high number is due to the high abundance of Diadema urchins at two survey sites.

Annual COT cleanups organised by Marine Parks Department seem to be keeping their numbers inside the natural limit.

Some natural damage to the reefs was observed during the surveys, such as storms and predation by COTs. Fish nets, trash and boat and anchor damage were also observed at a number of surveyed sites. Although the scale of the damage is considered low, it is evidence that illegal fishing is present inside the Marine Park. Rare animals such as black tip reef sharks and turtles (both green and hawksbill) were observed at a number of sites in Tioman.

3.2.4 Kapas

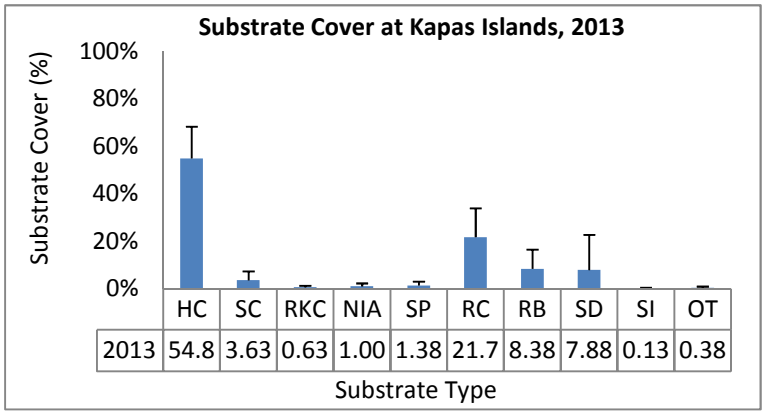
Kapas island is located just 6km from Marang, off the East coast of Terengganu, Malaysia. This small island has no local population. The islands are gazetted as a Marine Park (since 1994).

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

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

Map 6: Surveyed sites in Kapas

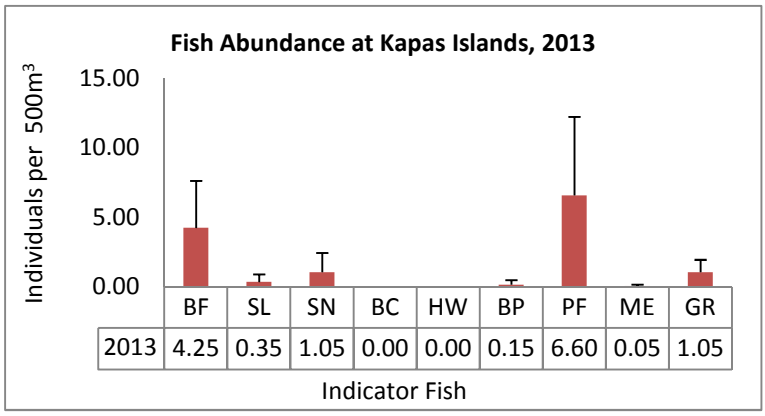
Substrate



Coral reefs around the island are considered to be in 'Good' condition, with 58.50% (56.72% in 2012) live coral cover, above the average for islands surveyed in the Sunda Shelf region.

Although the level of NIA (1%) has decreased compared to 2012 (2.50%), the levels of RKC (0.63%), RB (8.38%) and SI (0.13%) have increased (RKC 0.16%, RB 4.38% and SI 0% in 2012), indicating some recent disturbances in Kapas.

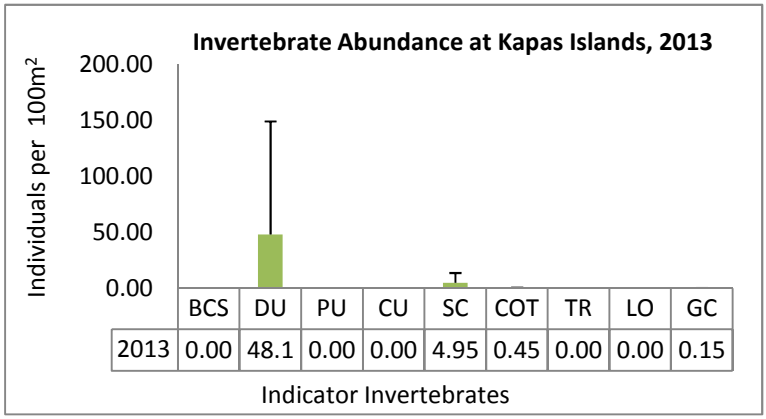
Fish



Two indicator species were completely absent from surveys (Barramundi Cod and Humphead Wrasse).

Parrotfish (6.60 individuals/500m^3) was the most abundant targeted fish, with lower populations of Butterflyfish (4.25). Abundance of several other fish was low (Sweetlips 0.35, Snapper 1.05, Bumphead Parrot 0.15 and Grouper 1.05).

Invertebrates



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

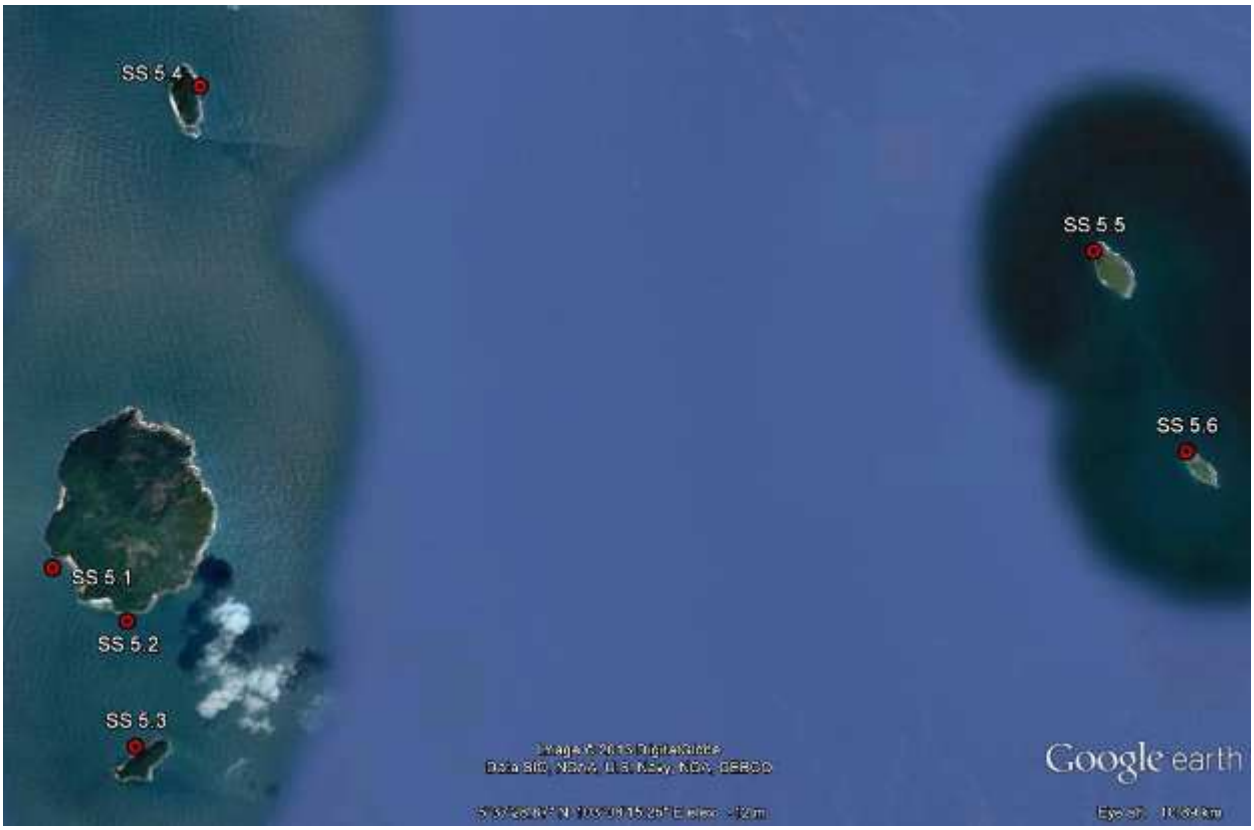
Abundance of Diadema Urchin was the highest (48.10 individuals/100m^2) of all targeted invertebrates recorded and has increased significantly compared to the past few years. This is due to the introduction of a new survey site in Kapas at which most of the Diadema Urchins were recorded. Sea Cucumber (4.95), Crown-of-thorns (0.45) and Giant Clam (0.15) are present in low number.

Fish nets or traps were found at 3 out of the 5 sites surveyed. Although the scale of the damage is considered low, it is evidence that illegal fishing is widely present inside the Marine Park. A green turtle was observed at Teluk Jawa during the survey..

3.2.5 Bidong/Yu

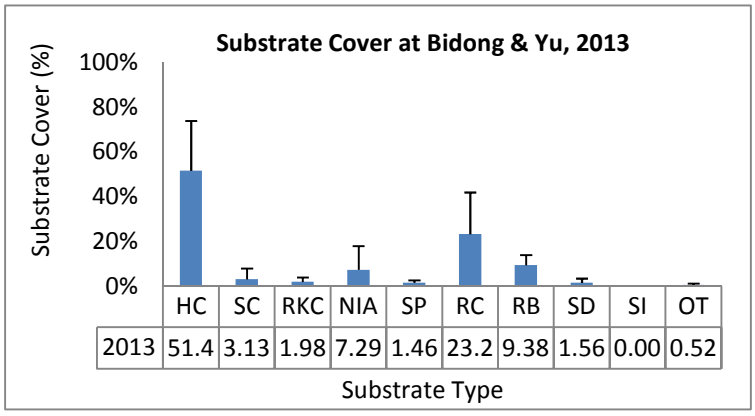
The Bidong and Yu archipelago comprises several small islands, located 15-25km from Marang, off the East coast of Terengganu, Malaysia. The islands are unpopulated, though from 1978 to 1991 Bidong was a centre for Vietnamese refugees. The islands are now gazetted as a Marine Park.

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



Map 7: Surveyed sites in Bidong & Yu

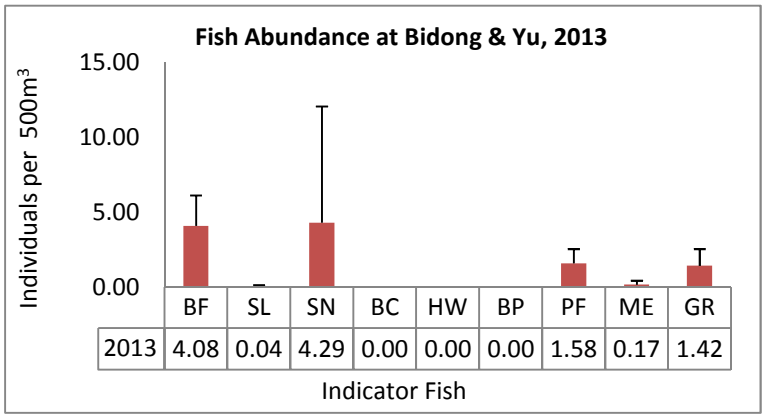
Substrate



Coral reefs around the islands are considered to be in 'Good' condition, with 54.58% (55.10% in 2012) live coral cover, just below the average for reefs in Sunda Shelf region.

Although the level of NIA (7.29%) has decreased slightly compared to 2012 (8.13%), it stills need to be monitored closely. The moderately high level of RC (23.23%) reflects the rocky nature of much of the coastline of the islands, particularly the Yu islands.

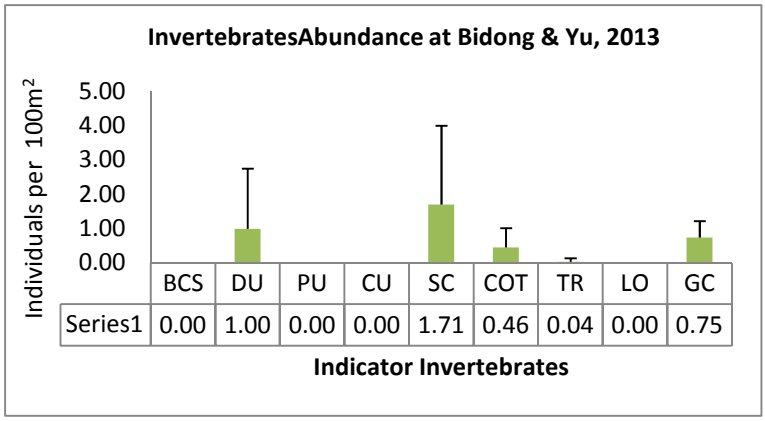
Fish



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

Abundance of Snapper (4.29 individuals/500m^3) is the highest, followed by Butterflyfish (4.08). Other fish indicators were all present in low numbers (Sweetlips 0.04, Parrotfish 1.58, Moray Eel 0.17 and Grouper 1.42).

Invertebrates



As in most other sites several targeted species are absent, including Banded Coral Shrimp, Pencil and Collector Urchins, and Lobster.

Abundance of most other indicators is low, including Diadema (0.38 individuals/100m^2), Sea Cucumber (0.46), Crown of Thorns (0.08) and Giant Clam (1.38). However a single juvenile Triton was recorded during one of the surveys.

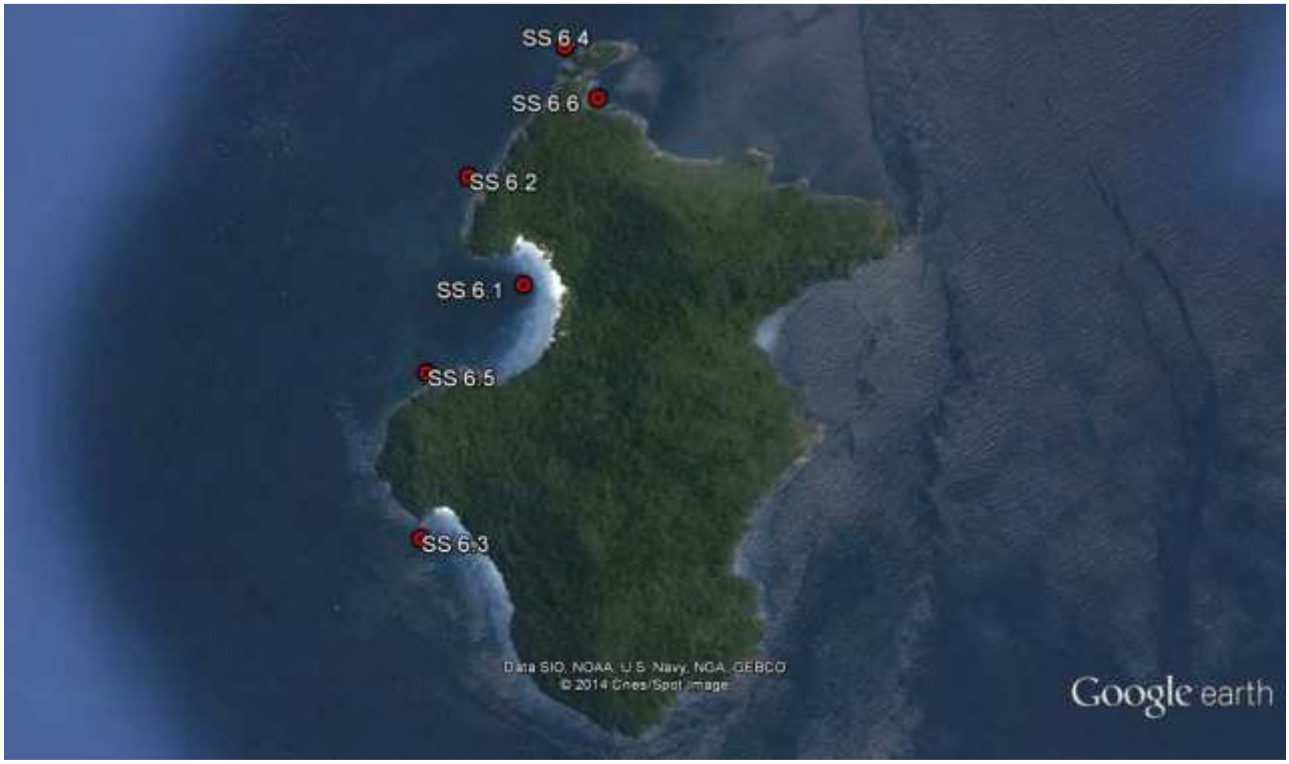
Little natural damage to the reefs was observed during the surveys, such as storms and predation. Boat and anchor damages were observed at almost all of the sites surveyed, while fish nets, fish traps and trash were recorded at a couple of sites. Fishermen were also commonly seen fishing inside the Marine Park during our 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).

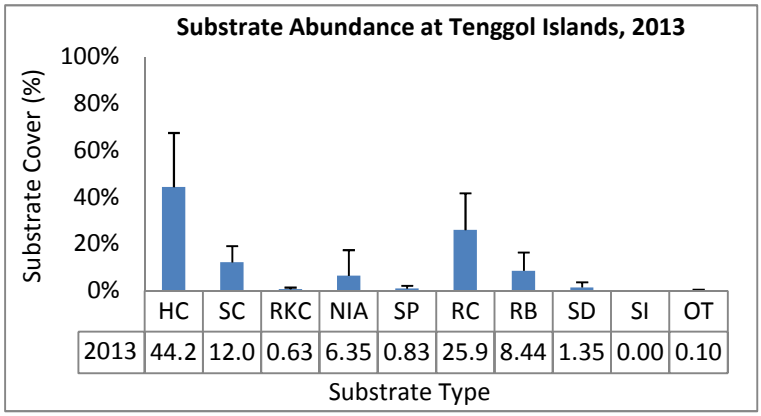
The island is a popular diving destination, due to the surrounding deep water which attracts more mega fauna than other islands (whale sharks are common around the island). There are three resorts on the island, each with its own dive operator. There is no mains electricity, groundwater supplies are limited and there is no centralised sewage treatment.

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



Map 8: Surveyed sites in Tenggol

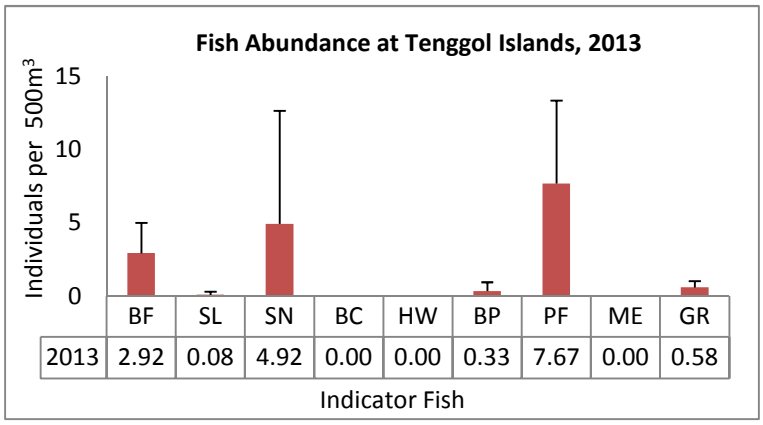
Substrate



The site is considered to be in 'Good' condition, with 56.35% (51.15% in 2012) live coral cover, just below the average (56.65%) for reefs of the Sunda Shelf region.

The level of NIA has increased slightly from 5.52% in 2012 to 6.35% in 2013. A very large proportion of this is recorded at Fresh Water Bay (28.13%), where three resorts are located. This may indicate a source of sewage pollution and needs to be monitored closely.

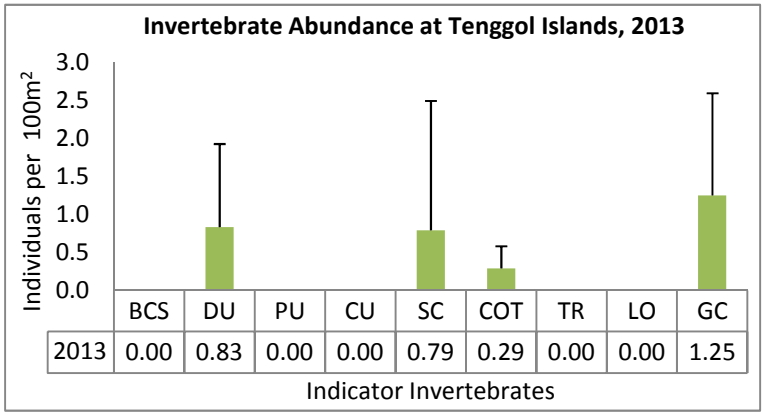
Fish



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

Abundance of Parrotfish (7.67 individuals/500m^3) is the highest, followed by Snapper (4.92) and Butterflyfish (2.92). Other indicators are present in low numbers (Sweetlips 0.08, Bumphead Parrotfish 0.33 and Grouper 0.58). However, the abundance of Bumphead Parrotfish recorded in Tenggol, while low, was the highest of all islands surveyed in the Sunda Shelf region.

Invertebrates



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

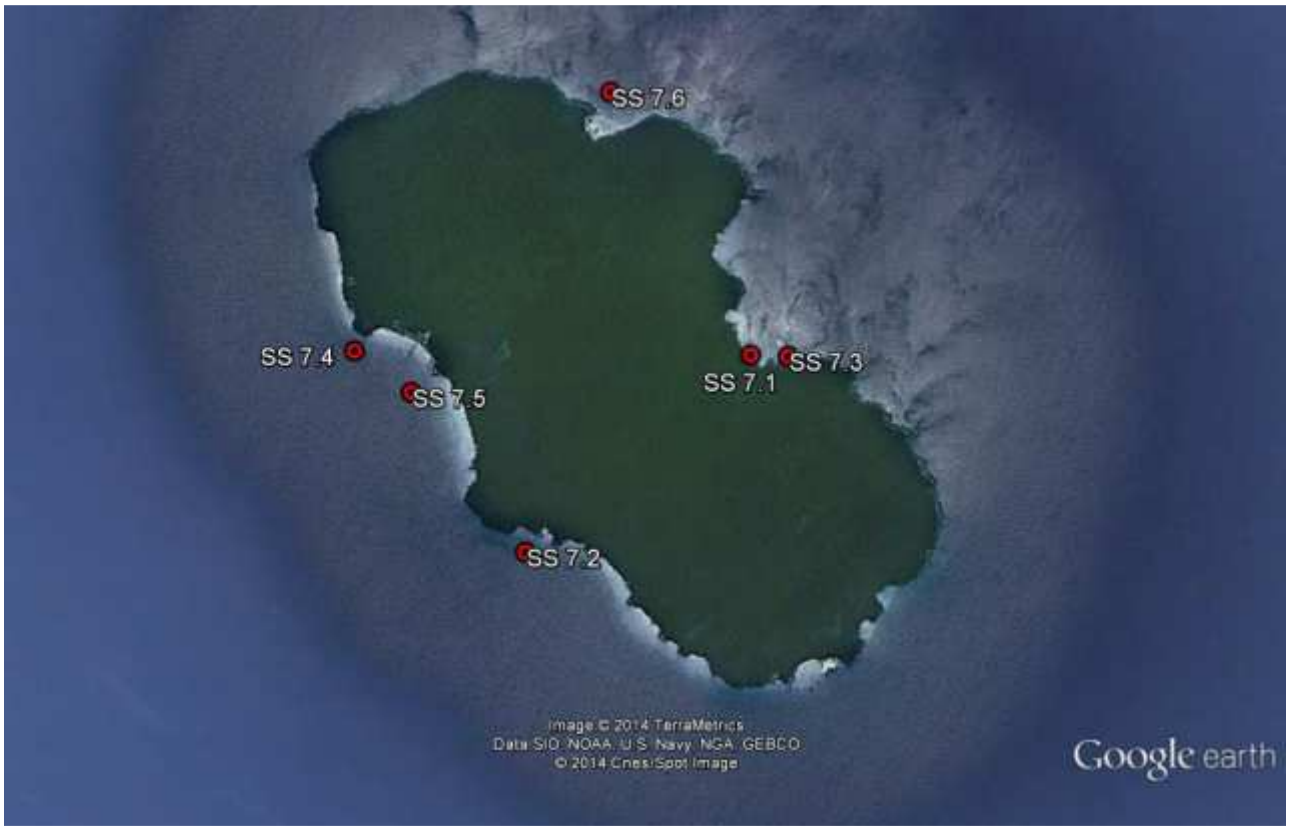
Abundance of most other indicators is low, including Diadema (0.83 individuals/100m^2), Sea Cucumber (0.79), Crown of Thorns (0.29) and Giant Clam (1.25).

Few natural disturbances to the reefs were observed during the surveys, such as storms and predation. Fish nets were found on the reefs at Gua Rajawali, Pasir Tenggara, and Teluk Rajawali. Although the scale of the damage is considered low, it is evidence that illegal fishing is present inside the Marine Park.

3.2.7 Pemanggil

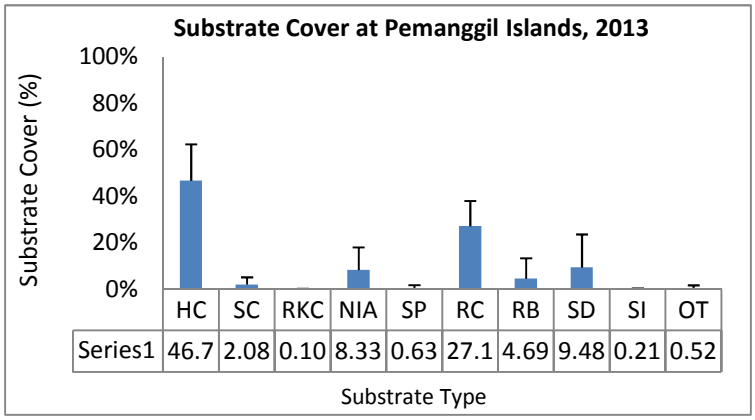
Pemanggil island is approximately 45 km east of Mersing off the East coast of Peninsular Malaysia. The island and its surrounding waters were gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1993).

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



Map 9: Surveyed sites in Pemanggil

Substrate

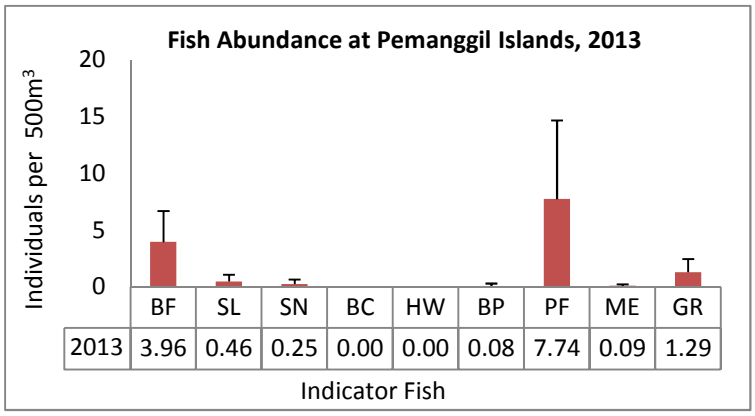


The site is considered to be in 'Fair' condition, with 47.13% live coral cover, below the average for reefs of the Sunda Shelf region.

Levels of other substrate categories were low (e.g. RKC 0.19%, NIA 4.31% and SI 0%), indicating little recent disturbances at Pemaggil.

The moderately high level of RC (26%) reflects the rocky nature of much of the coastline of the island.

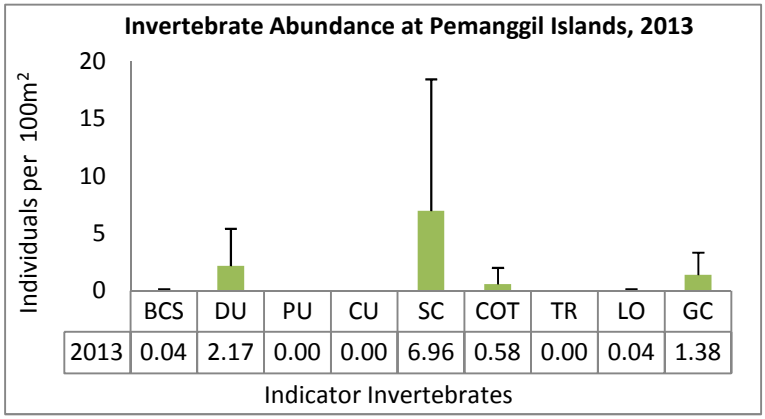
Fish



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

Abundance of most other indicators is low, including Butterflyfish (3.0 ind/500m^3), Snapper (0.20), Baramundi Cod (0.03), Bumphead Parrotfish (0.03), Parrotfish (3.50), and Grouper (0.33). Fishing around the island is widespread as there is no Presence of Marine Park officers on the island.

Invertebrates



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

Other indicators were present in low numbers, including Banded Coral Shrimp (0.05 individuals/100m^2), Diadema Urchin (0.28), Sea Cucumber (1.25), Crown-of-thorns (0.05), and Giant Clam (1.10).

Nets, fish traps and discarded fishing line were seen on the reefs and are evidence of fishing activities within the protected area. The survey team also witnessed turtle egg poachers dig up a turtle nest and remove all the eggs from it in broad daylight. The lack of Marine Park officials and the absence of enforcement have caused villagers to ignore all rules. One hawksbill and one green turtle were seen during surveys around Pemanggil.

3.2.8 Sibu and Tinggi

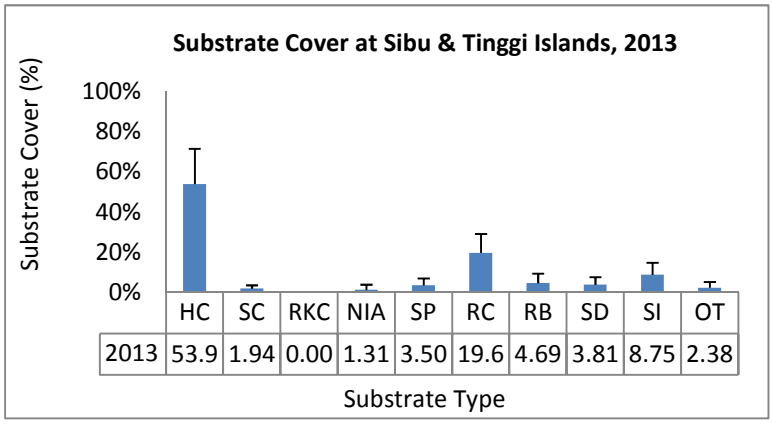
Sibu island is located less than 10km off the East coast of mainland Peninsular Malaysia and Tinggi island less than 15km. Both islands and their surrounding waters were gazetted as Marine Parks in 1994 under the Fisheries Act 1985 (Amended 1993).

These islands are not as popular among tourists as other islands off the East coast, but the tourism industry here is growing. There are only two dive operators on Sibu and none on Tinggi.

The islands are sparsely populated with few villages and a number of small resorts, typically used as a weekend or short vacation destination from Singapore.

Map 10: Surveyed sites in Sibu and Tinggi

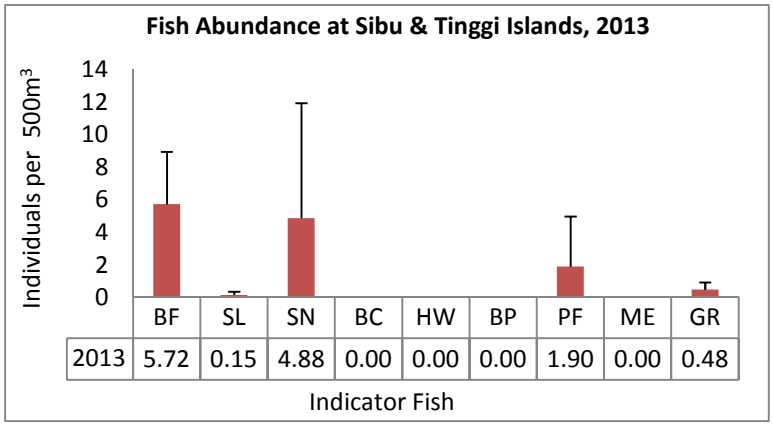
Substrate



Coral reefs around the islands were in 'Good' condition, with 55.88% live coral cover, slightly below the average for reefs in the Sunda Shelf region. The increase compared to 2012 (50.73%) is probably due to the introduction of 4 new survey sites. The 4 new sites were scattered around Sibu and were surveyed during the Sibu Expedition organised by Johor Parks.

Sibu/Tinggi has the highest level of SI (8.44%) of all islands surveyed in Malaysia. This probably reflects the close proximity of these islands to the mainland and a likely source of this high SI level is the rivers and other terrestrial runoff from Tanjung Leman.

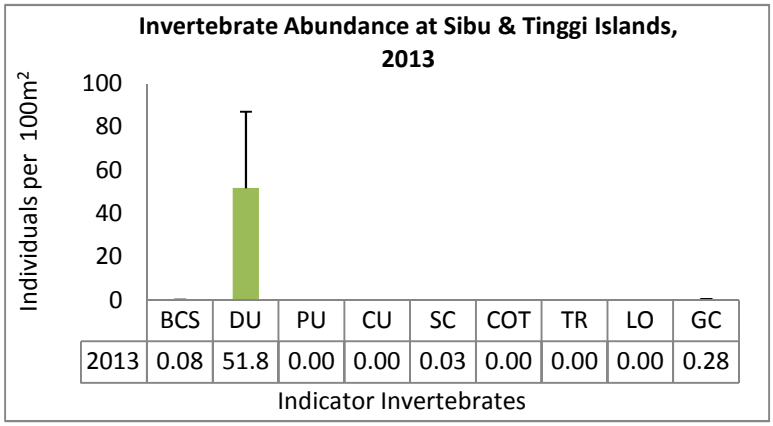
Fish



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

Butterflyfish (5.73 individuals/500m^3) are the most abundant targeted fish, with lower populations of Snapper (4.88). Abundance of other indicators is low, including Sweetlips (0.15), Parrotfish (1.90), and Grouper (0.48). On a positive note, many juvenile parrotfish were observed thus indicating a possible recovery in population abundance.

Invertebrates



Most of the indicators were absent from all surveys (Pencil and Collector Urchin, Crown-of-thorns, Triton and Lobster).

Abundance of Diadema Urchin (51.80 individuals/100m^2) is high. For the remaining indicators, abundance is very low (Banded Coral Shrimp 0.08, Sea Cucumber 0.03 and Giant Clam 0.28).

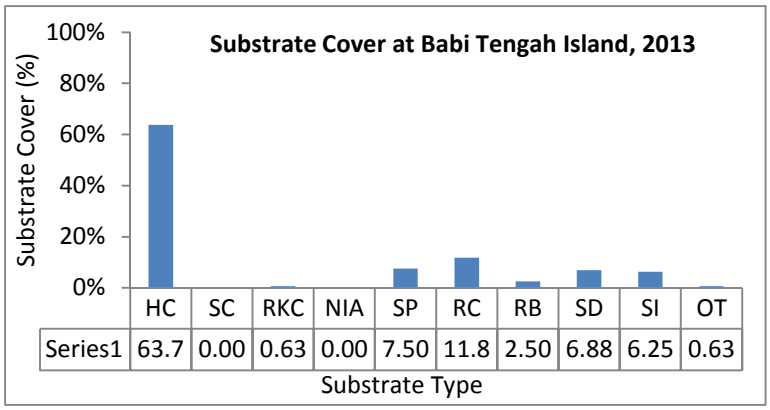
Hardly any natural or human impacts were observed during the surveys. Only one site was impacted by fish nets while at another site a fish trap was found. Fishing around these islands is very common due to the lack of enforcement of Marine Park regulations. One Green Turtle was recorded at one of the survey sites.

3.2.9 Babi Tengah

Pulau Babi Tengah is an small island located South West of Tioman and only 13 km off the coast of Mersing. There is one resort on the island and no local village. Around the islands there are patches of shallow fringing reefs.

Map 11: Surveyed site in Babi Tengah

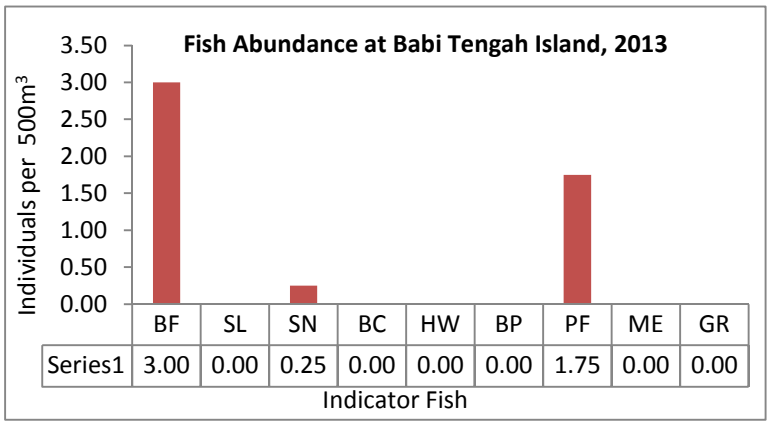
Substrate



2013 was the first time any survey had been done by RCM on Babi Tangah. We did one survey as part of a certification course for resort staff. The reef surveyed was in 'Good' condition with 63.7% HC cover.

No SC or NIA was recorded and there was very little RKC and RB indicting there has been no recent damage. SI levels were high (6.25%) and this is probably mainly due to the sedimentation from rivers and runoff from mainland.

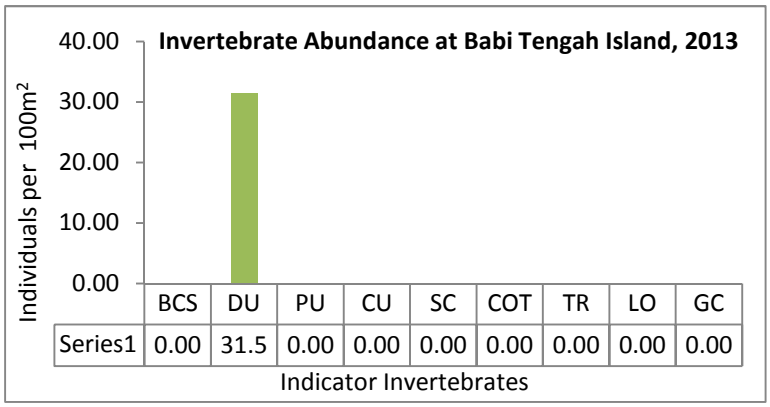
Fish



Fish abundance at Babi Tengah was low with most indicators such as Sweetlips, Bumphead Parrotfish, Barramundi Cod, Humphead Wrasse, Bumphead Parrotfish, Moray Eels and Groupers being absent.

Butterfly fish were present but only 3ind/500m^2 while Parrotfish and Snappers were in even lower abundance (1.75 and 0.25 respectively).

Invertebrates



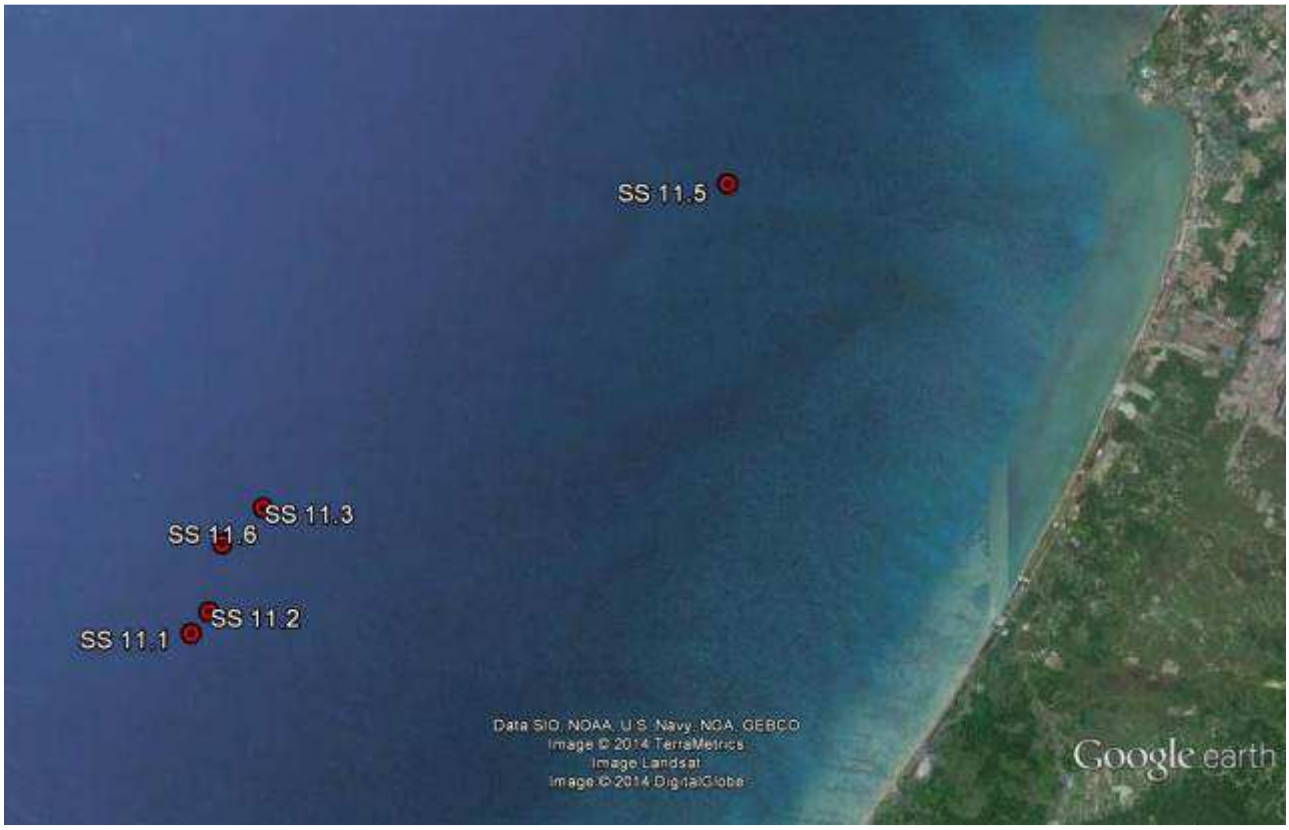
Diadema urchins were the only indicator invertebrate species recorded during the survey. Their high abundance of 31 ind/100m^2 may indicate that due to the low number of herbivore fish, urchins have take over as the main herbivores on the reef.

No signs of human impacts were seen during surveys. A green turtles nest was seen on the beach and there are reports of turtles frequently nesting on the island.

3.2.10 Miri

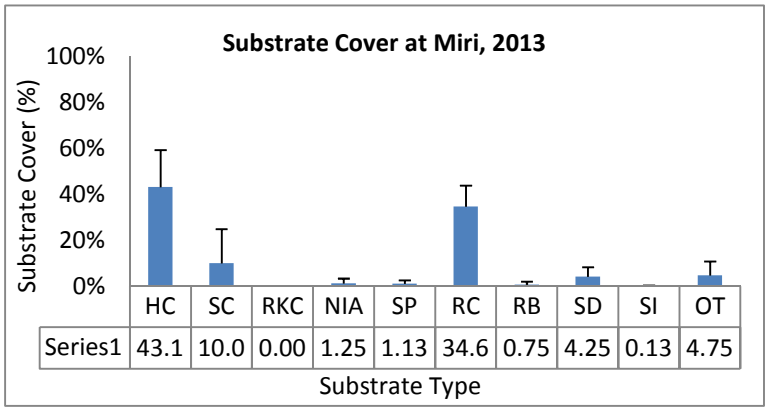
Miri is located at the northern end of Sarawak and is the State's second largest city. Miri is the birthplace of Malaysia's petroleum industry, which remains the major industry in the city, alongside timber and oil palm production and a growing tourism sector.

Miri has extensive submerged off-shore reefs, generally flat in profile, in depths ranging from 7 to 30m. In many areas, the presence of oil production facilities creates effective Marine Protected Areas, as boats are not allowed in the area due to security concerns.



Map 12: Surveyed sites in Miri

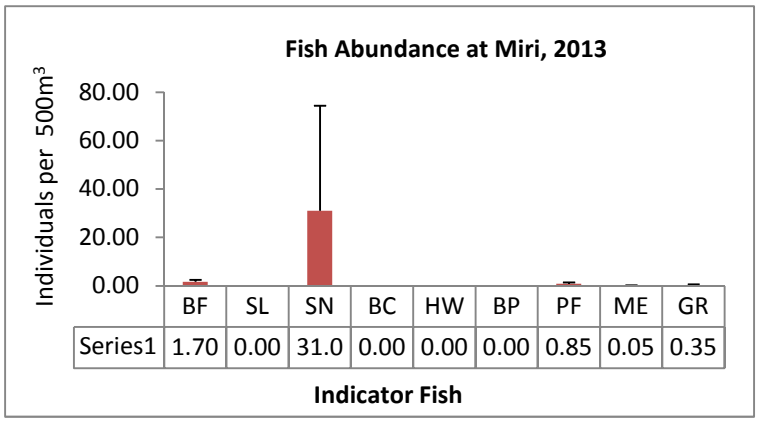
Substrate



Reefs in Miri are in 'Good' condition with 53.1% of LCC. The increase compared to 2012 (41.43%) is mainly due to the increase in SC cover (2012 SC 5.0%).

NIA cover dropped to 1.25% from 3.84% in 2012 and RB cover also dropped to 0.75% from 2.14% in 2012. These are signs that the reefs are recovering from past disturbances and this recovery should be monitored further.

Fish

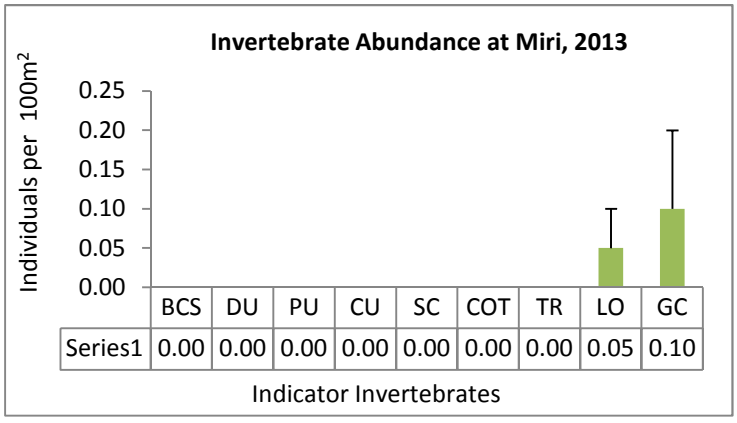


Four indicator species were completely absent from surveys (Sweetlips, Barramundi Cod, Bumphead Parrotfish and Humphead Wrasse).

Snappers were the most abundant (31 individuals/500m^3) indicator fish and Miri had one of the highest abundances of Snappers in the Sunda Shelf region.

Abundance of other indicators is generally low (Butterflyfish 1.70, Parrotfish 0.85, Moray Eel 0.05, and Grouper 0.35).

Invertebrate



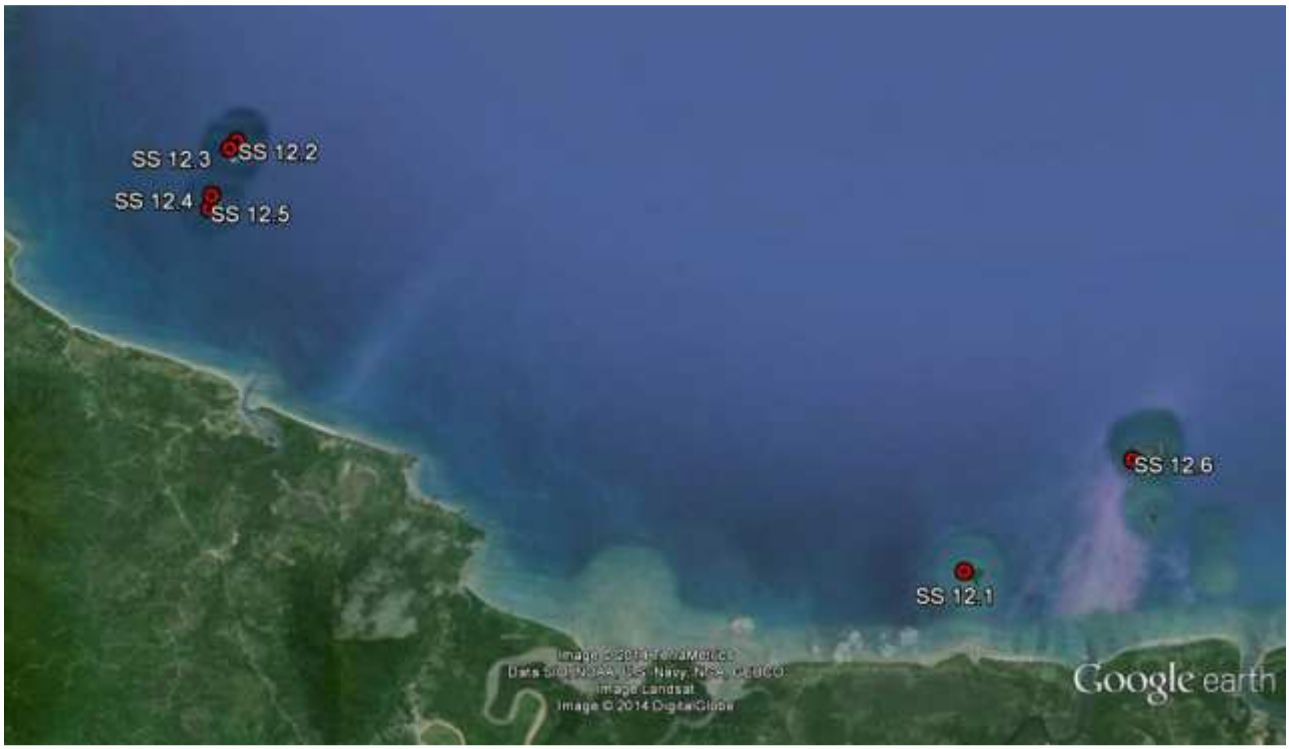
Most of the indicator invertebrates were absent during surveys. Ony one lobster was recorded and only a few Giant Clams were seen (average of 0.10 individuals/100m^2.

Discarded fish nets and anchor damage were the main impacts seen on reefs during surveys. The reefs monitored were not inside protected areas and thus fishing activities were common.

3.2.11 Kuching

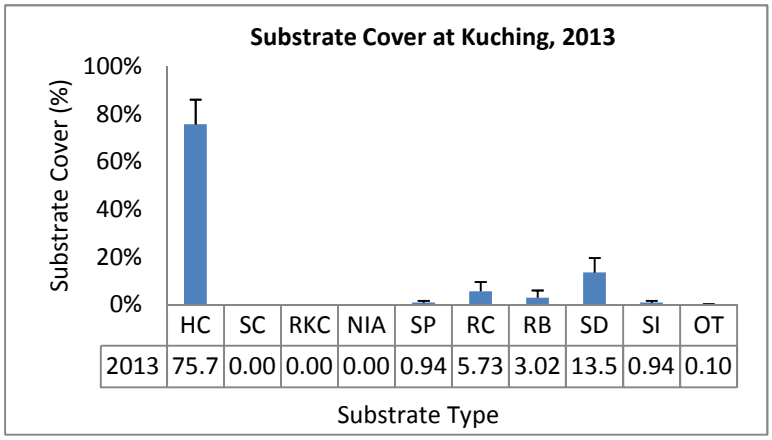
Kuching is located at the southern end of Sarawak and is the capital of the state. This developed city is also the most highly populated area in Sarawak.

Kuching is not well known for diving but there are some fringing and submerged reefs off the shores of this city.



Map 13: Surveyed sites in Kuching

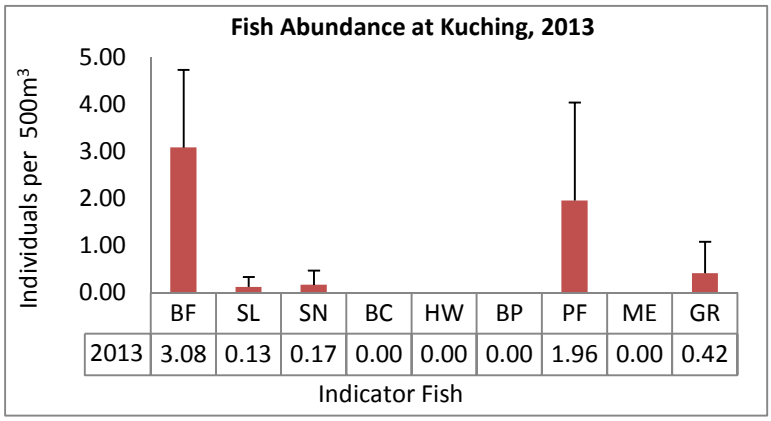
Substrate



Coral reefs around Kuching are considered to be in 'Excellent' condition, with 75.73% live coral cover, much higher than the average for reefs of the Sunda Shelf region.

Levels of other substrate categories are low (e.g. RKC 0%, NIA 0%, RB 3.02% and SI 0.94%), indicating few recent disturbances in the area.

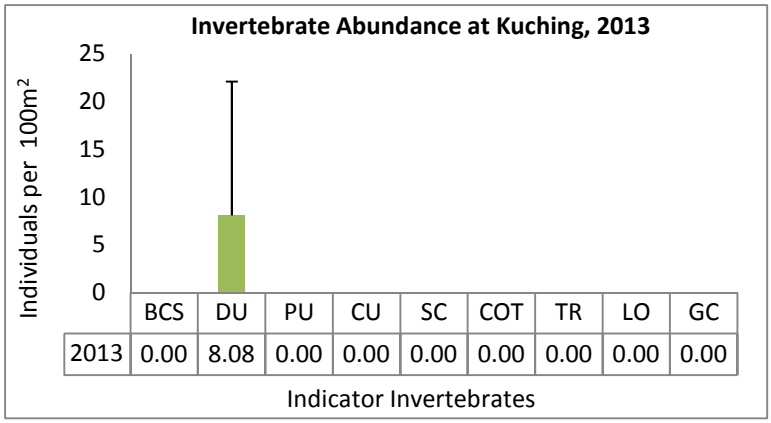
Fish



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

Abundance of Butterflyfish (3.08 individuals/500m^3) was the highest, followed by Parrotfish (1.96). Abundance of other indicators were very low, (Sweetlips 0.13, Snapper 0.17, and Grouper 0.42).

Invertebrates



Similarly to Miri, very few indicator invertebrates were seen during the surveys. But unlike Miri there were no Lobsters or Giant Clams instead only Diadema (8.08 individuals/100m^2) were recorded during the surveys.

Trash and discarded fishing nets were found on the reef and were the main impact damaging reefs in the area. One turtle was seen during surveys in Kuching.

Straits of Malacca

3.2.12 Sembilan Islands and Pangkor Laut Island

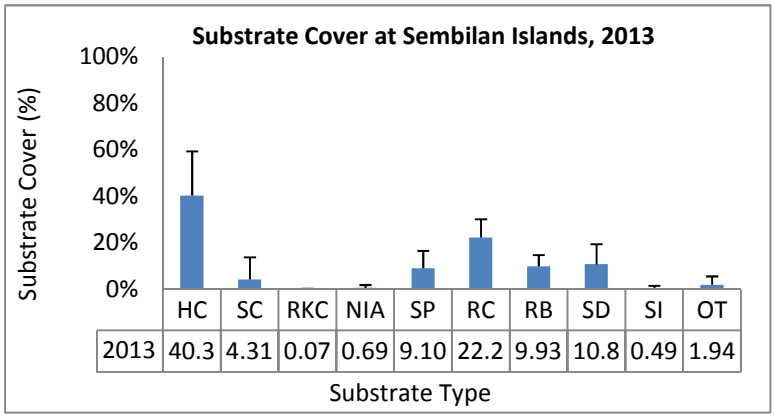
The Sembilan Islands consist of a cluster of nine islands (Pulau Agas, Pulau Payong, Pulau Nipis, Pulau Rumbia, Pulau Lalang, Pulau Saga, Pulau Buluh, Black Rock and White Rock) which are located some 20km from the coast of Perak (Lumut) and 15km south of Pulau Pangkor off the west coast of Peninsular Malaysia, in the Straits of Malacca.

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

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

Map 14: Surveyed sites in Sembilan (left) and Pangkor Laut (right)

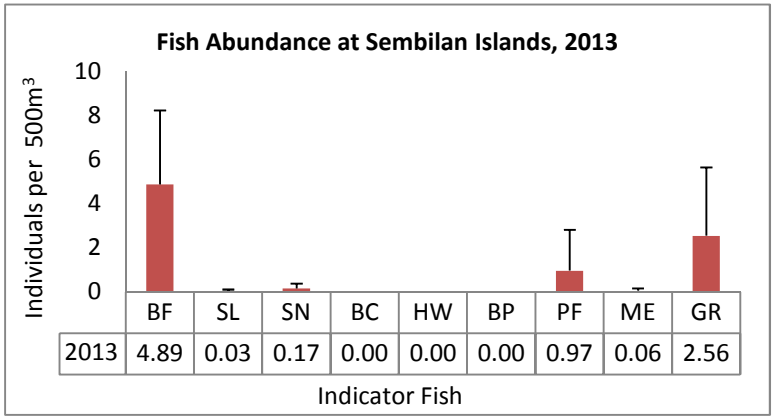
Substrate



Coral reefs around the islands are considered to be in 'Fair' condition, with 44.61% live coral cover.

The islands in general have high levels of SD, with an average of 10.8%. The levels of RB and SP are high, similar to levels in 2012 (RB 10.55% and SP 9.61%). It should be noted that these islands are not gazetted as a Marine Protected Area and are heavily impacted by development (on the mainland), fishing pressure as well as shipping activity in the Malacca Strait.

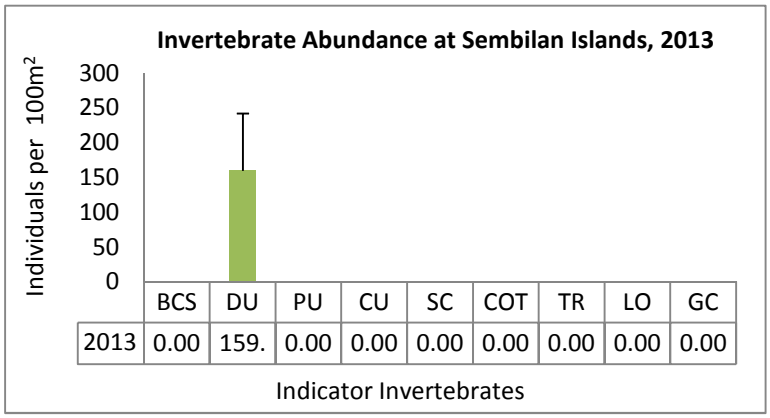
Fish



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

Abundance of most targeted indicators is generally low, including Butterflyfish (4.89 individuals/500m^3), Sweetlips (0.03, Snapper (0.17), Parrotfish (0.97), Moray Eel (0.06) and Grouper (2.56).

Invertebrates



The only indicator species observed was Diadema Urchin and their abundance was high (159.83 individuals/100m^2).

Other non indicator invertebrates were seen such as crabs, snails and seahorses.

Trash, discarded fishing lines and nets were seen on the reefs impacting coral to a certain extent. Two seahorses, a bamboo shark and a green turtle were also recorded during surveys.

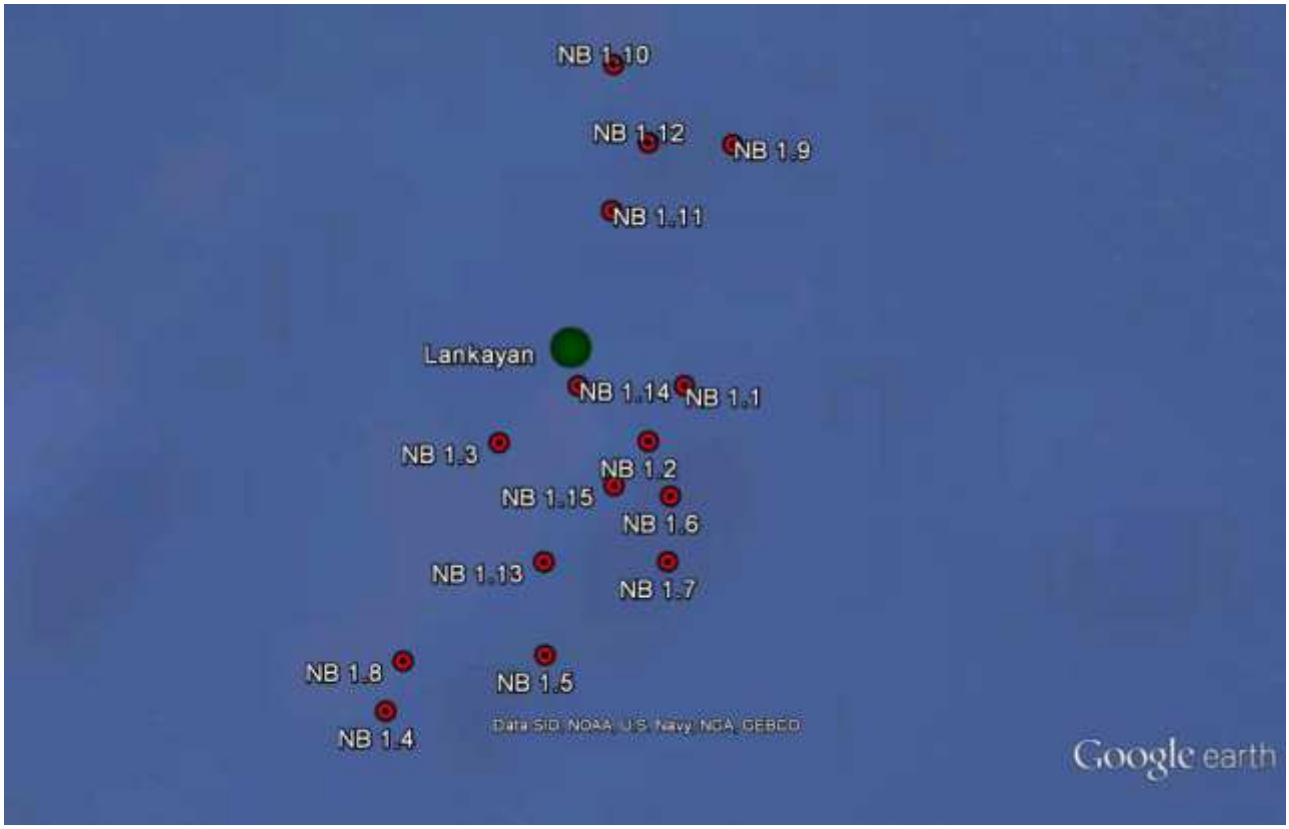
North Borneo

3.2.13 Lankayan

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

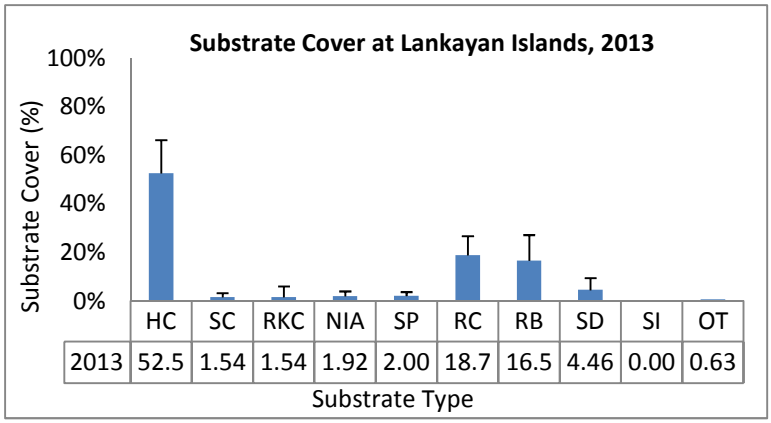
SIMCA is remote and distant from populated areas and no communities exist on the islands within the protected area. However, the SIMCA area is known to be a traditional fishing ground and is fished by both artisanal and commercial fishers from Sandakan, Kudat and the Philippines.

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



Map 15: Surveyed sites in Lankayan

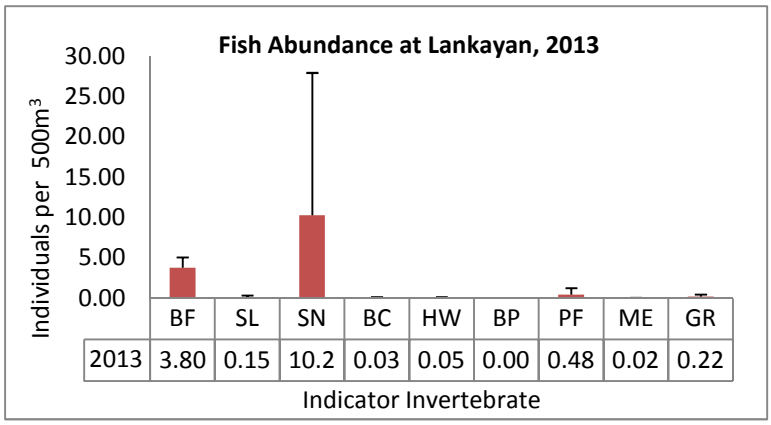
Substrate



The island is considered to be in 'Good' condition, with 52.58% live coral cover, above the average (42.72%) for reefs of the North Borneo region.

The high level of RB (16.5%) probably reflects the history of fish bombing in the area. while the low amount of RKC seems to suggest that fish bombing may be under control in some extent around Lankayan.

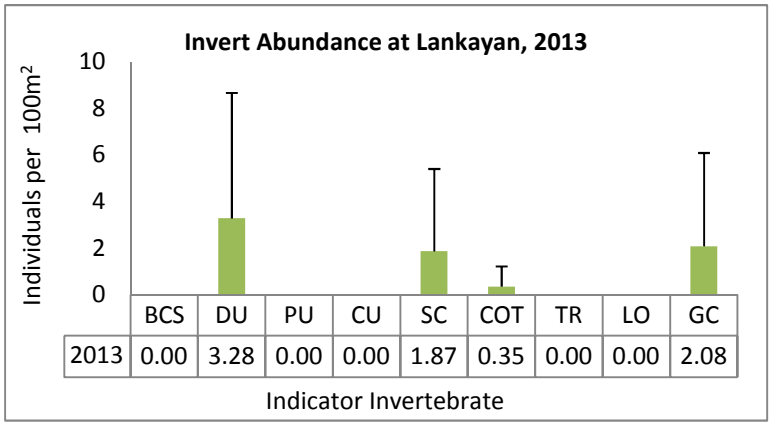
Fish



All indicator fish except for the Bumphead parrotfish were seen during surveys.

However, abundance of most species was generally low, with the exception of Butterfly fish (3.80 individuals/500m^3) and Snappers (10.2). It is suggested that fish population are still recovering from over exploitation in the past.

Invertebrates



Five indicators were absent from all surveys (Banded Coral Shrimp, Pencil and Collector Urchins, Lobster and Triton).

Sea Cucumber (1.87), Crown of Thorns (0.35), and Giant Clam (2.08) had higher than average abundance within the region and COT numbers were actually just above the acceptable numbers for a healthy reef. Their populations must be monitored closely and actions should be taken to avoid a bloom in the area.

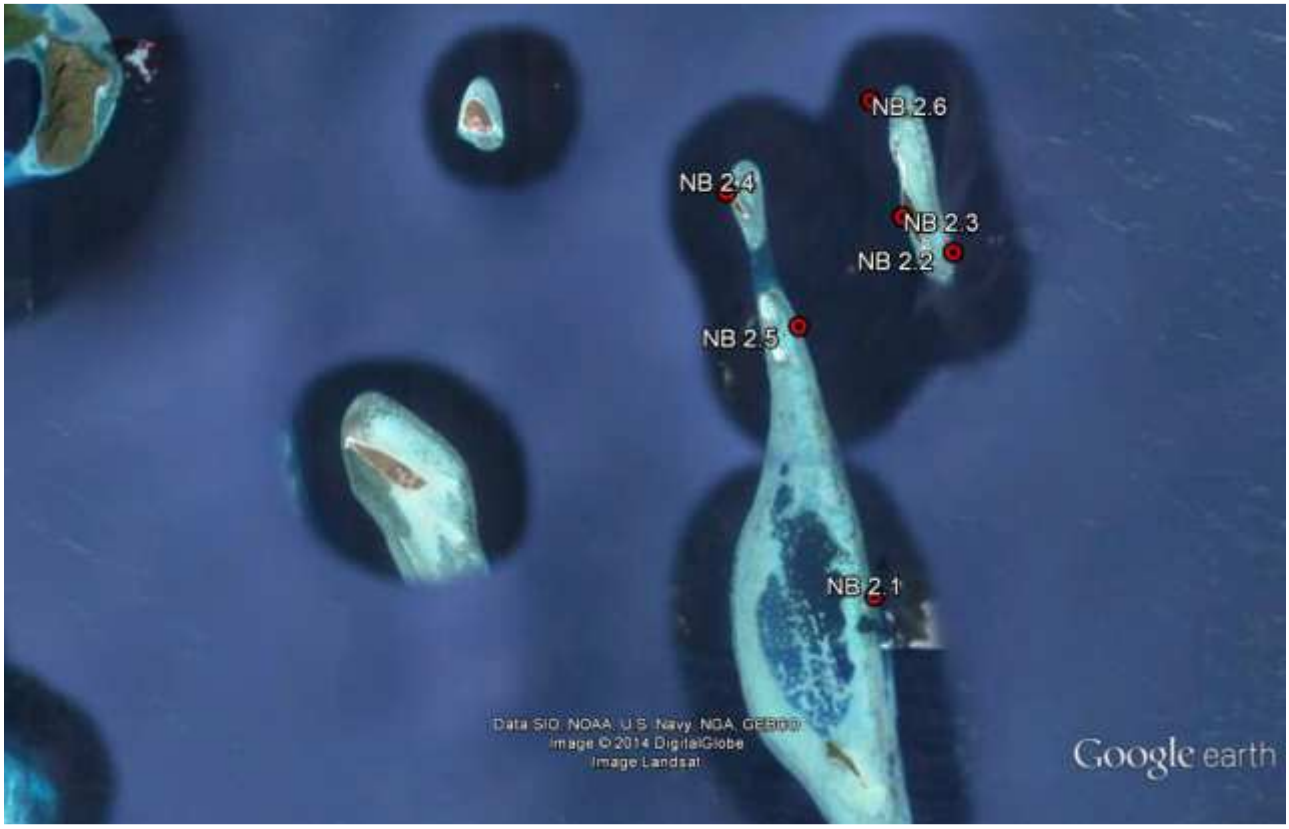
Trash and bleaching were the main impacts seen during surveys and 3 sharks were also recorded during these surveys.

3.2.14 Mataking

This island is approximately 35km East from the major town of Semporna in the South of Sabah. The island is a well known tourist spot and has two resorts. Diving and snorkelling are the main activities.

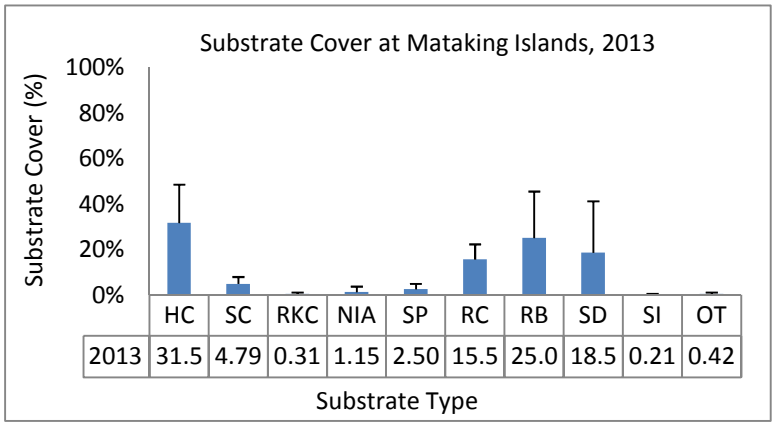
While the island has no legal protected status, the presence of the resorts has effectively created small protected areas, keeping fishermen (including fish bombers) away from parts of the reefs surrounding the island.

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



Map 16: Surveyed sites in Mataking

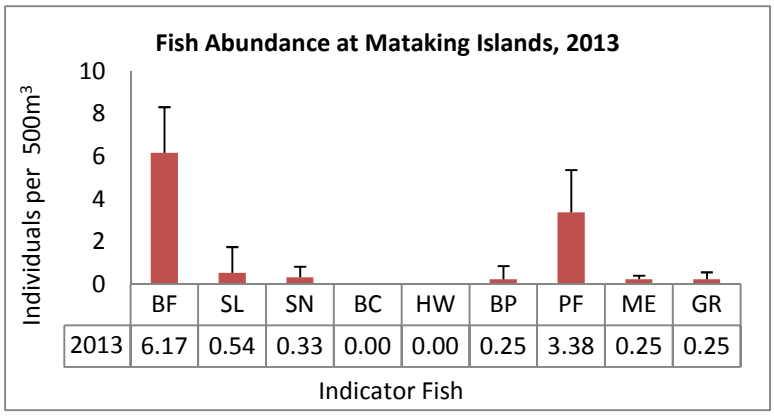
Substrate



The reefs around the island were considered to be in 'Fair' condition, with 36.29% live coral cover, below the average (40.61%) in the North Borneo region.

The area in general had very high RB, with an average of 25%, rising to as high as 63.75% on one site (Coral Garden Mataking). This is likely to be the result of extensive fish bombing over a long period of time.

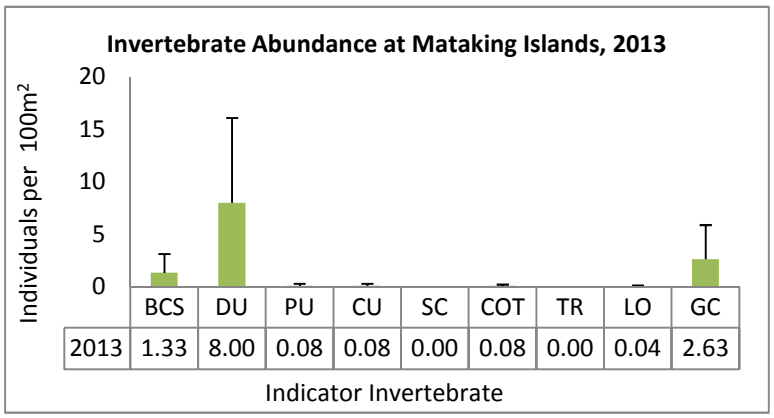
Fish



Abundance of most species is generally low, with the exception of Butterflyfish (6.75 individuals/500m^3) and Parrotfish (3.38).

Two indicator species were completely absent from surveys (Barramundi Cod and Humphead Wrasse).

Invertebrates



Only two indicators were absent from all surveys (Sea Cucumber and Triton).

The abundance of Diadema (8 individuals/100m^2) is the highest, followed by Giant Clam (2.63). Populations of other indicator invertebrates were low (Banded Coral Shrimp 1.33, Pencil Urchin 0.08, Collector Urchin 0.08, Crown-of-thorns 0.08, and Lobster 0.04).

Recent damage to the reefs was mainly due to natural factors as well as boat anchors. A total of 12 turtles were seen during the surveys.

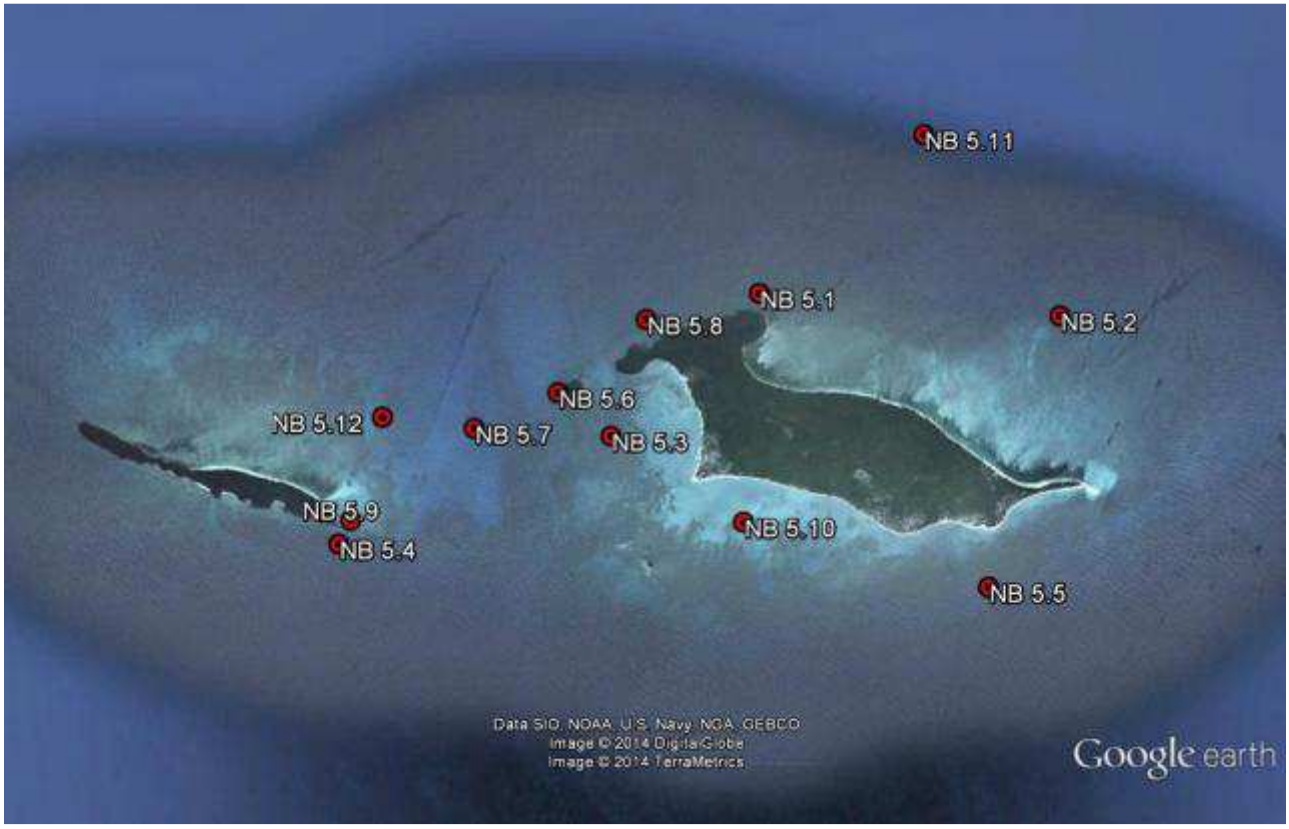
3.2.15 Mantanani

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

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

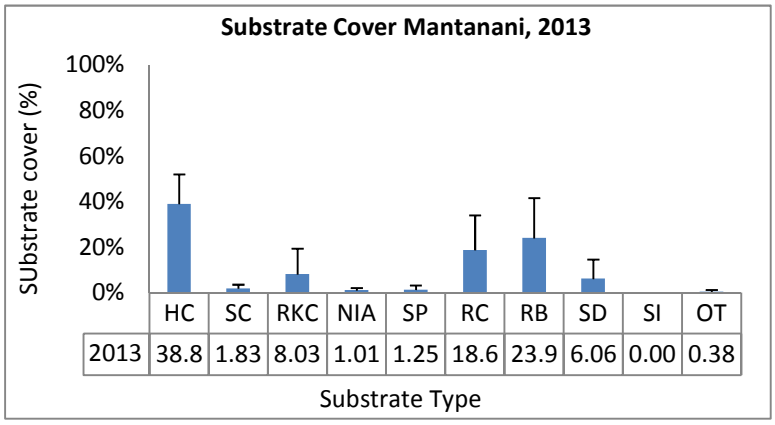
Mantanani is an increasingly popular snorkelling and diving destination, and tourist numbers have grown four-fold in the last three years, mainly day trippers from Kota Kinabalu. The number of resorts is increasing and there are plans for further development.

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



Map 17: Surveyed sites in Mantanani

Substrate

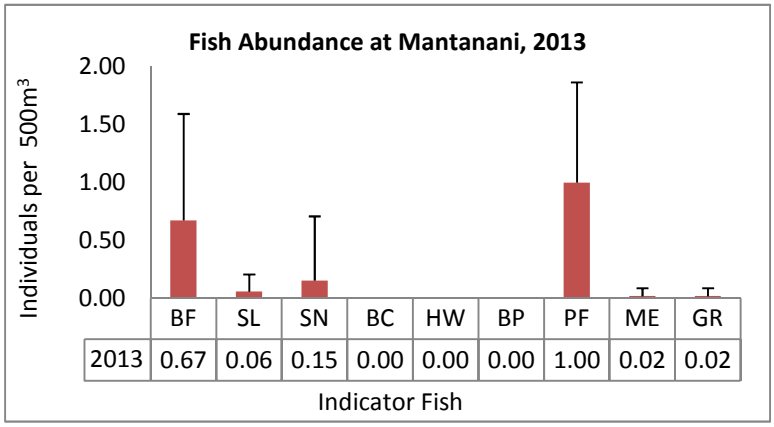


Coral reefs around the islands are considered to be in 'Fair' condition, with 40.63% live coral cover, similar to the average for reefs in the North Borneo region.

This site had very high levels of RB (23.94% compared to the regional average of 17.89%), rising to as high as 50% on some sites. This is due to extensive ongoing fish bombing over long periods of time.

The level of NIA (7.55%) is moderately high, indicating high levels of nutrient in the waters and perhaps reflecting the low abundance of herbivorous Parrotfish

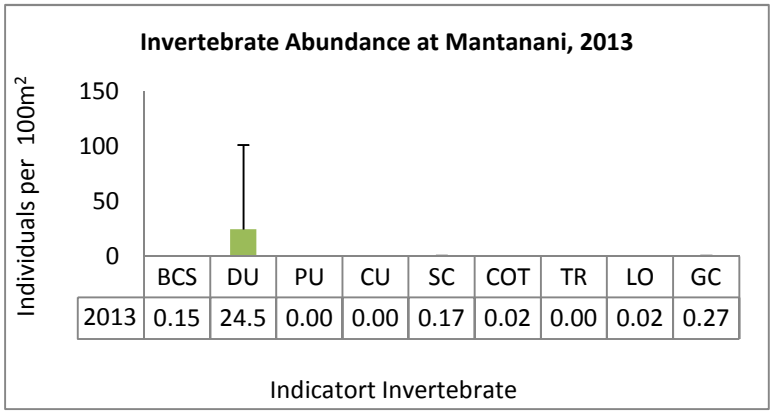
Fish



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

Abundance of most other indicators were the lowest of all islands in the North Borneo region, including Butterflyfish (0.67 individuals/500m^3), Sweetlips (0.06), Snappers (0.15), Parrotfish (1.0), Moray Eels (0.02) and Grouper (0.02).

Invertebrates



Several targeted species were absent, including Pencil & Collector Urchin, and Triton.

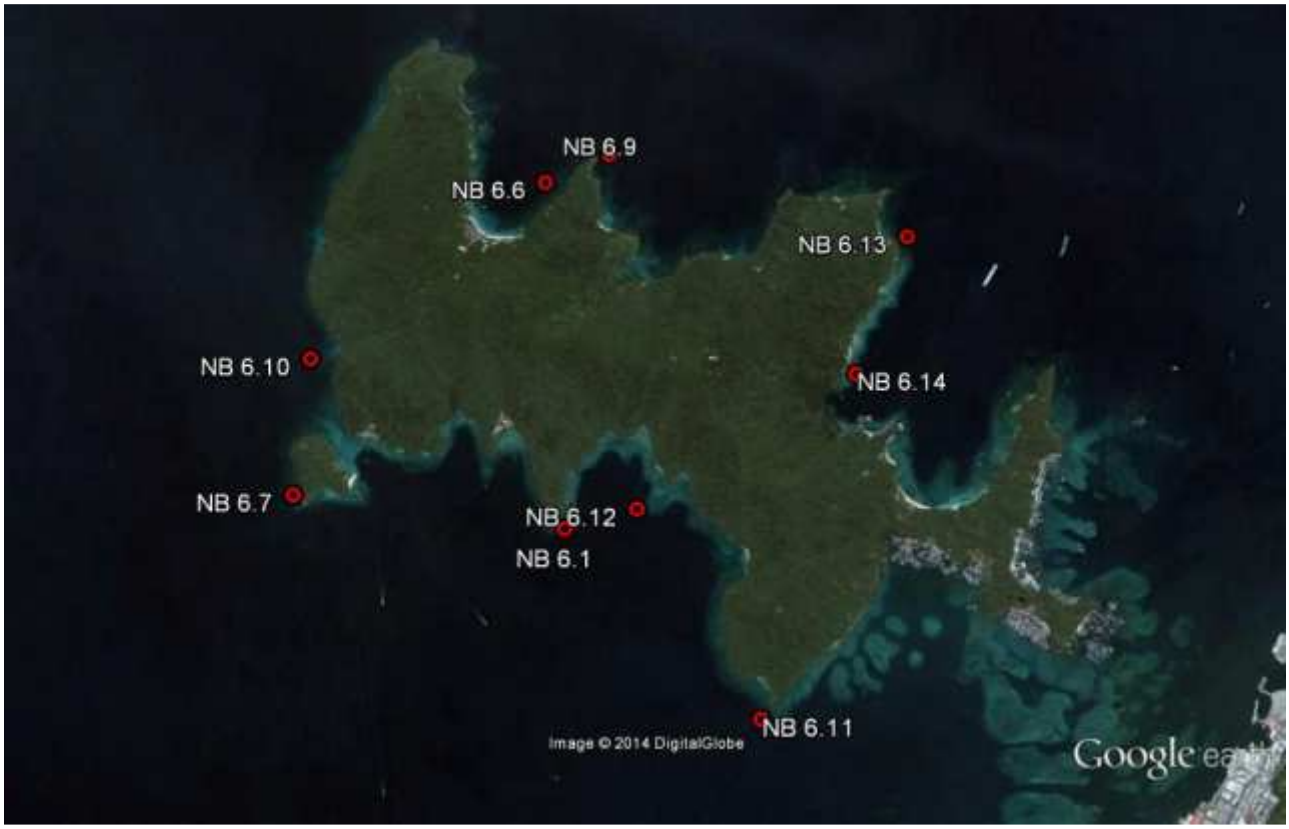
Abundance of Diadema Urchin was high, with an average of 24.5 individuals/100m^2. Abundance of the remaining indicator species is low (Banded coral shrimp, 0.15, Sea Cucumber 0.17, COT 0.02 Lobster 0.02 and Giant Clam 0.27).

Damage due to boat anchors, dynamite fishing and trash were some of the visible impacts seen during surveys. One turtle was also recorded during surveys.

3.2.16 Tunku Abdul Rahman Park, Kota Kinabalu

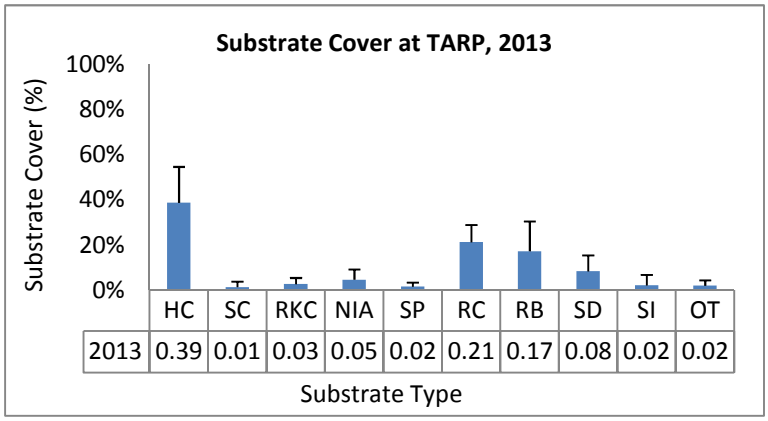
Tunku Abdul Rahman Park is located between 3 to 8 km off Kota Kinabalu, the capital of Sabah, and covers and area over 4,929 hectares, two thirds of which covers the sea. There is a cluster of islands in the Park comprising Pulau Gaya, Pulau Sapi, Pulau Manukan, Pulau Mamutik and Pulau Sulug. The reefs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

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



Map 18: Surveyed sites in TARP, Kota Kinabalu

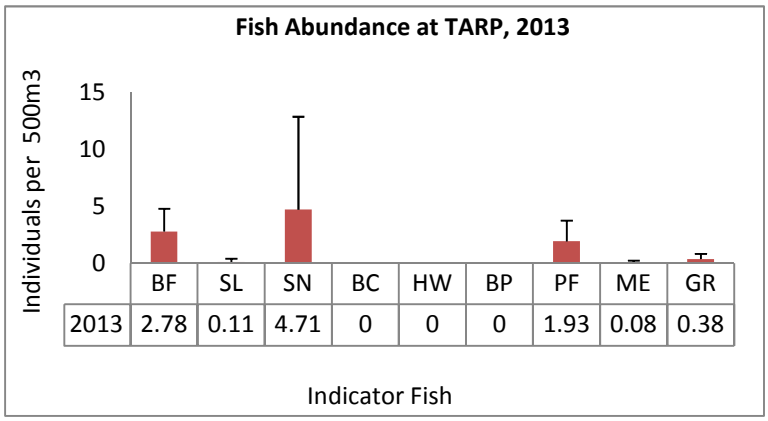
Substrate



Coral reefs around the islands are considered to be in 'Fair' condition, with 40.07% live coral cover

The high levels of RB (17.22%) and NIA (4.58%) indicate recent disturbances to the reefs, as high as 53.75% at one site. This is a cause for concern and needs to be monitored closely.

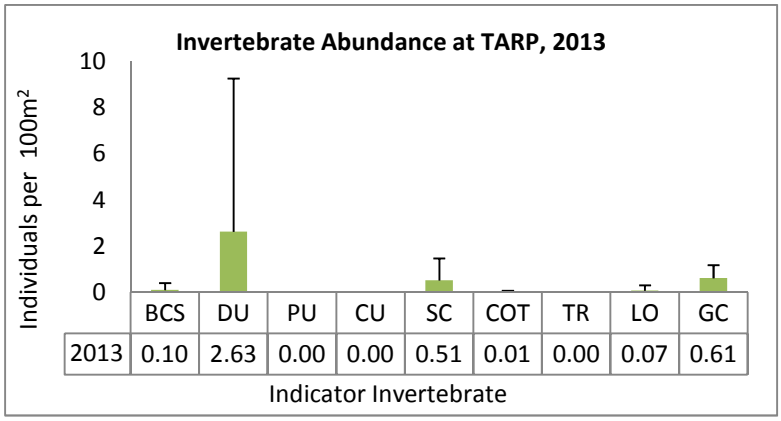
Fish



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

Snapper (4.71 individuals/500m^3) were the most abundant indicator fish, with followed by Butterflyfish (2.78). Abundance of all other indicators were low (Sweetlips 0.11, Parrotfish 1.93, Moray Eel 0.08 and Grouper 0.38).

Invertebrates



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

Abundance of other species were low (Banded Coral Shrimp 0.10, Diadema Urchin 2.63, Sea Cucumber 0.51, Crown-of-thorns 0.01, Lobster 0.07 and Giant Clam 0.61).

Extensive human and natural impacts were seen on the reefs with signs of boat anchor damage and dynamite fishing. Trash, discarded fishing nets and line were observed and coral predators were recorded. One shark was recorded during the surveys.

3.2.17 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 island.

Administratively, it falls within the Tawau Division and is estimated to have a population of over 156,000 (2000 census).

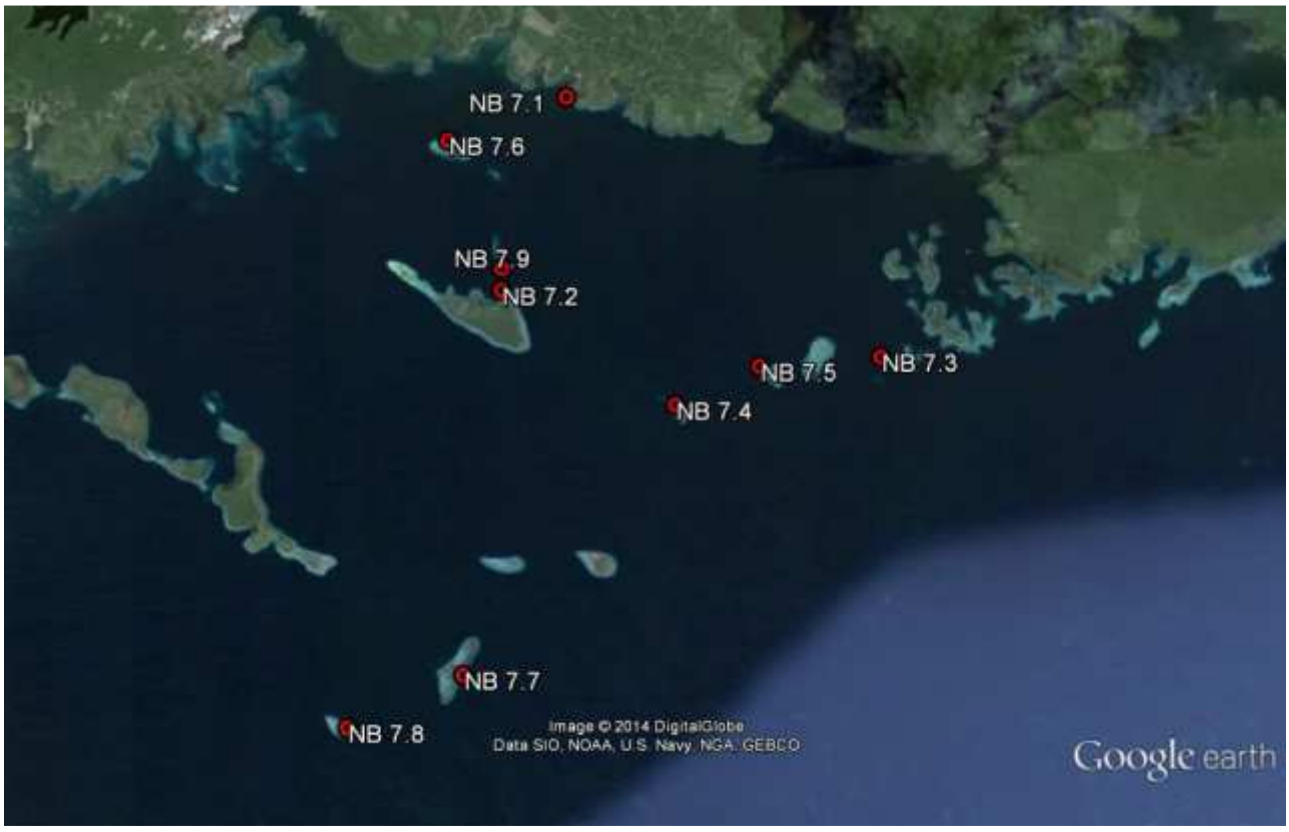
Historically the Lahad Datu area has been home to a number of Sabahan native tribes, including the Segama Dusuns, Idahans and Bagahak Dusuns. However in recent years, Indonesian and Philippines influence have grown, initially with Indonesians receiving citizenship in the early 1980's, and more recently with growing numbers of Philippino migrants.

The economy in the area has traditionally been based on agriculture. Cocoa and oil palm plantations are a common sight in Lahad Datu, along with palm oil refineries. The Lahad Datu Palm Oil Cluster (POIC) was the first dedicated industrial cluster in Malaysia focusing on Palm Oil. It is also an important timber exporting port and has an airport for domestic flights.

Currently, there is little other 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.

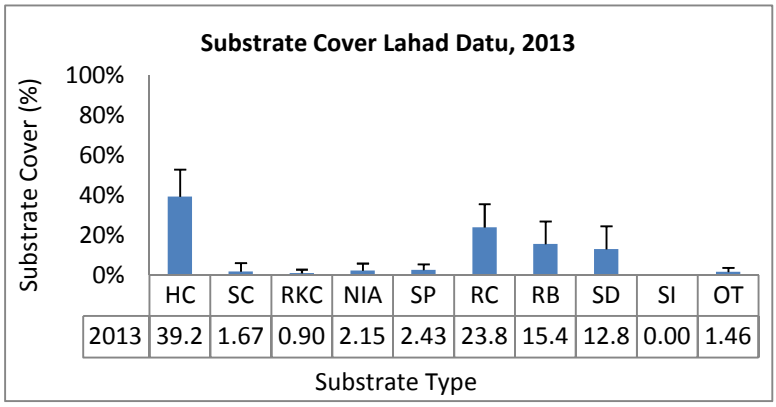
Darvel Bay has yet to not become established as a popular diving destination.

The area includes both fringing and submerged reefs.



Map 19: Surveyed sites in Lahad Datu

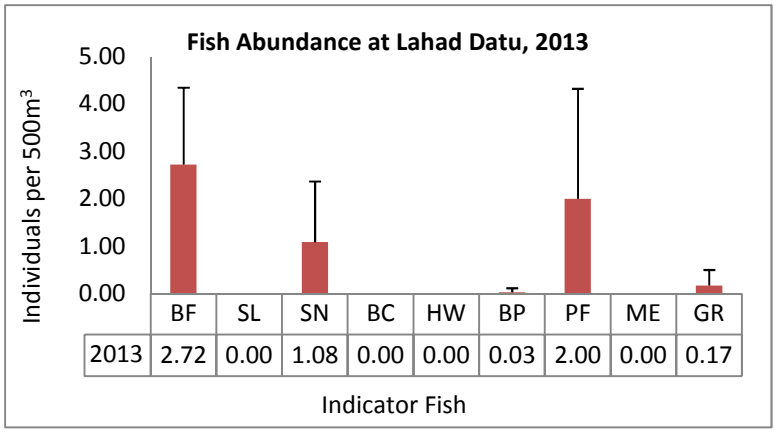
Substrate



Reefs in Lahad Datu are considered to be in 'Fair' condition with live coral cover of 40.87% which was similar to the average for reefs in the region.

High amounts of RB were also recorded and this could be due to the extensive fish bombing activities in the past.

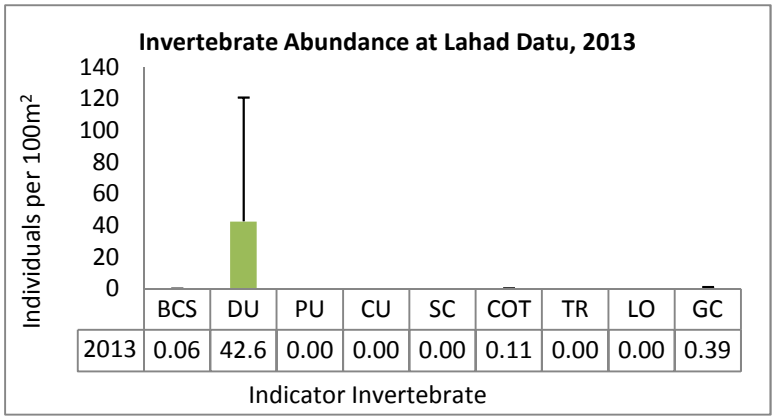
Fish



Four indicator fish were absent during surveys (Sweetlips, Barramundi Cod, Humphead Wrasse and Moray Eels).

Butterfly fish were the most common (2.72 ind/500m^3) followed by Snappers (1.08) and Groupers (0.17). Fishing is common in this area and none of the reefs are protected by law.

Invertebrates



Pencil urchins, Collector urchins, Seacucumber, Tritons and Lobsters were absent during all surveys. Diadema urchins were the most abundant invertebrate with an average of 42.6 ind/100m^2 while the second was Giant clams (0.39) and the least was COTs (0.11).

Signs of coral damage due to dynamite fishing were seen on the reef. Discarded fish nets and trash were also found on the reef.

3.2.18 Labuan

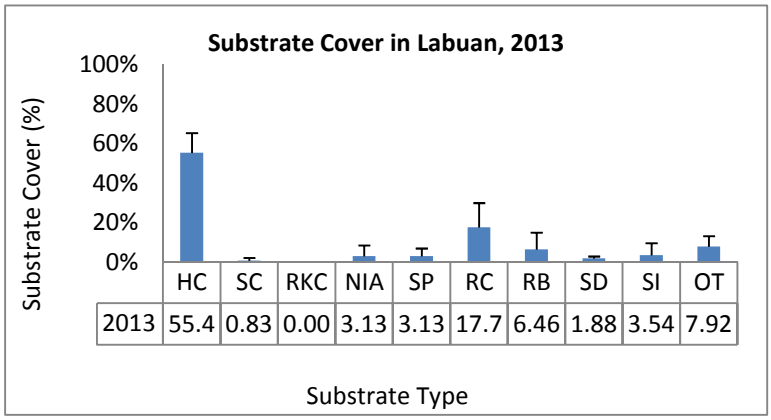
Labuan is located 8 km off the coast of Sabah and the Labuan Marine Park consist of 3 small islands (Kuraman, Rusukan Besar & Rusukan Kecil) located 4km off the coast of Labuan.

These three islands have very shallow fringing reefs along with a few submerged shallow reefs. Unlike most Marine Parks, the Labuan Marine Park is only protected to an extent of 1 nautical mile from the low tide mark (most Marine Parks in Malaysia extend 2 nautical miles from low tide mark).

The status of these island have also been of political debate as some parties want the protected status removed and the island opened to fishing.

Map 20: Surveyed sites in Labuan

Substrate

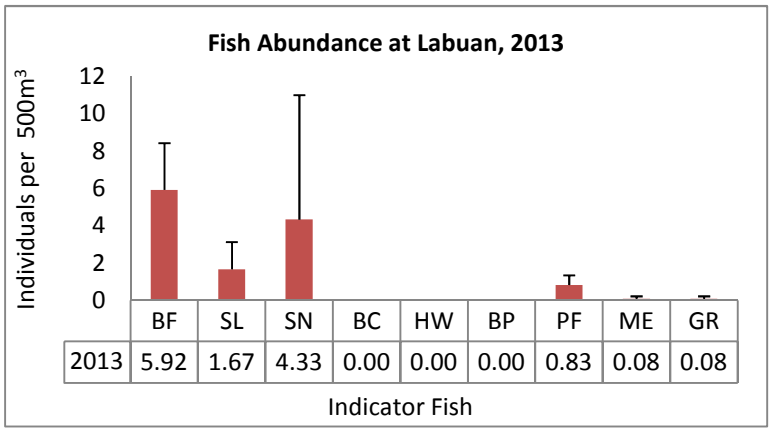


The reefs within Labuan MP were considered in 'Good' condition with the highest live coral cover (56.2%) for North Borneo region.

NIA, SP and SI levels were high but this is mainly due to the runoff from rivers on Labuan which carry nutrient and sediment rich waters into the sea.

Ascidians and tunicates were also exceptionally common in Labuan and this is reflectd in the high level of OT

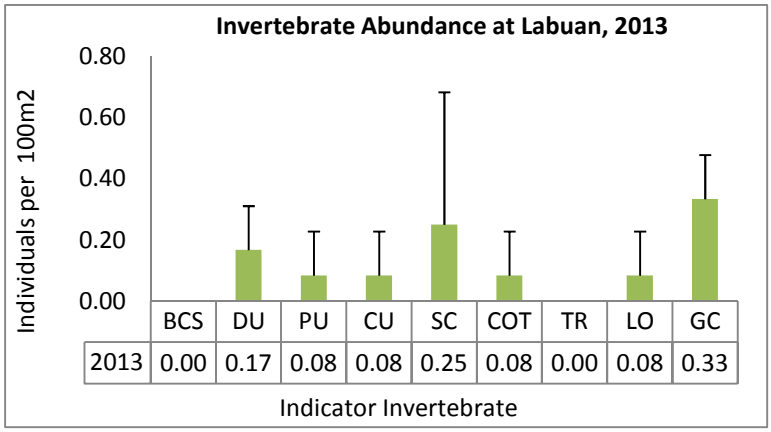
Fish



Three indicator fish were absent (Barramundi cod, Humphead Wrasse and Bumphead parrotfish) while Moray Eels, Groupers and Parrotfish were present but in small numbers.

Butterfly fish (5.92 ind/500m^3) were the most abundant followed by Snappers (4.33) and Sweet lips (1.67).

Invertebrate



Only the Banded coral shrimp and Triton were absent during surveys. While all other indicators were recorded, their numbers were low.

Some signs of dynamite fishing were seen on the reefs along with damage caused by natural events such as storms.

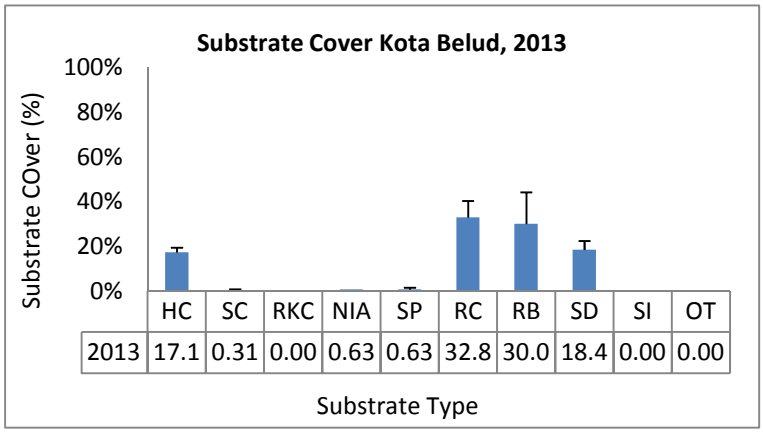
3.2.19 Kota Belud

Kota Belud is located on the North West coast of Sabah approximately half way between Kota Kinabalu and Kudat.

Though mostly famous for its mountains, Kota Belud does have some fringing reefs along its shores.

Map 21: Surveyed sites in Kota Belud

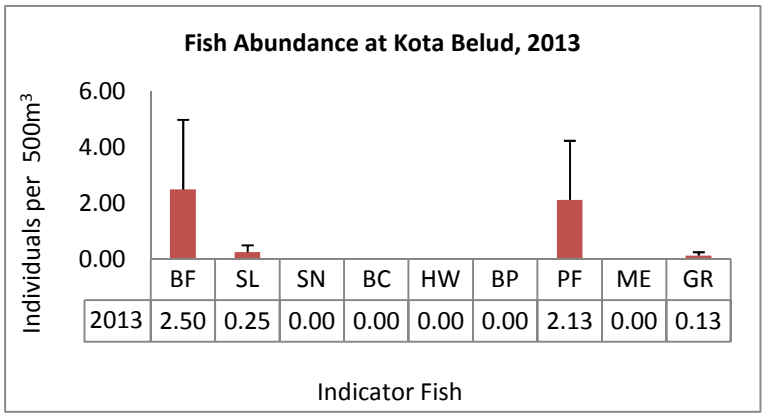
Substrate



Reefs in Kota Belud are considered to be in 'Poor' condition with LCC of only 17.41%. Large areas of the reefs consist mainly of dead coral (RC and RB). Fish bombing was common in this area and this is likely to have caused the damage in the past. No new signs of fish bombing were recorded.

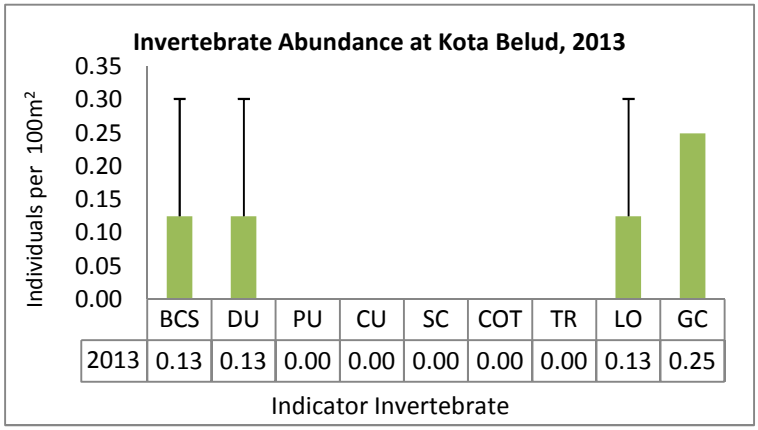
Low levels of silt, sponge and algae indicate that water conditions are suitable for coral to grow and large areas of rock provide suitable substrate for coral recruitment. If the threat of dynamite fishing is removed coral may be able to recolonise this area.

Fish



Snappers, Barramundi Cod, Humphead Wrasse, Bumphead Parrotfish and Moray Eels were not seen during surveys while Groupers and Sweetlips were present in very low abundance. The most abundant indicator recorded was Butterfly fish followed by Parrotfish.

Invertebrates



Five indicators (Pencil urchin, Collector Urchin, Sea Cucumber, COT and Triton) were not seen during surveys at Kota Belud. Two Giant clams were seen along with one Lobster, one Banded coral Shrimp and one Diadema urchin.

Coral damage due to anchors was the only damage seen during surveys.

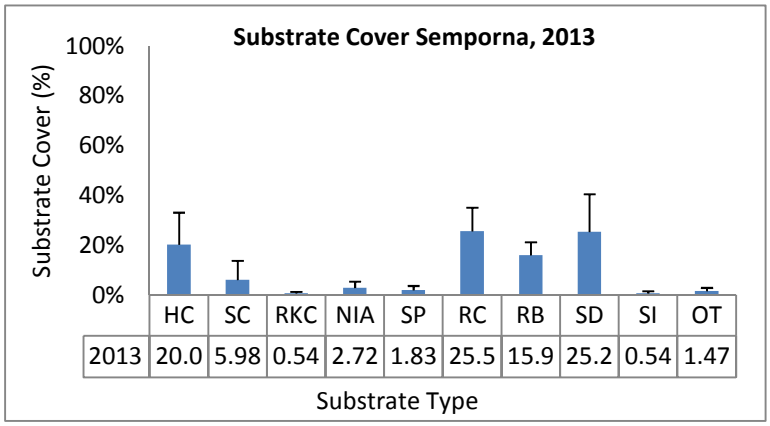
3.2.20 Semporna

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

Tourism is also an important element of the economy. Semporna is a popular base for tourists visiting Sipadan, Mabul and other islands nearby.

Map 22: Surveyed sites in Semporna

Substrate

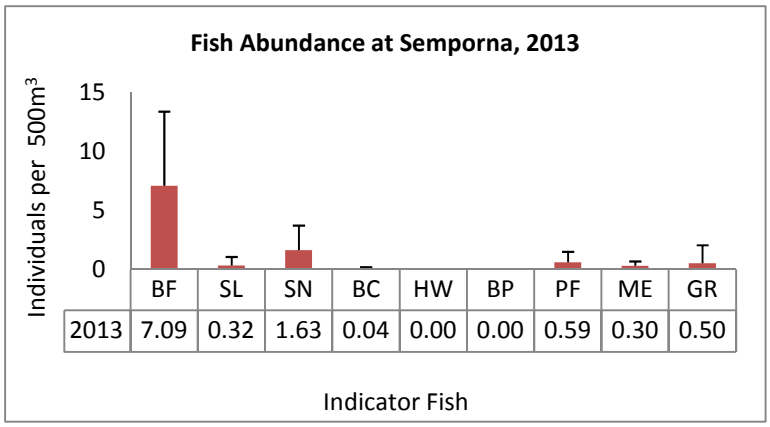


Reefs in Semporna were considered to be in 'Fair' condition with LCC of 25.98% and were below the average for North Borneo Region.

The high level of RB may be due to the ongoing practice of fish bombing within the region.

The high levels of SP and NIA indicate that the waters around Semporna are rich in nutrients.

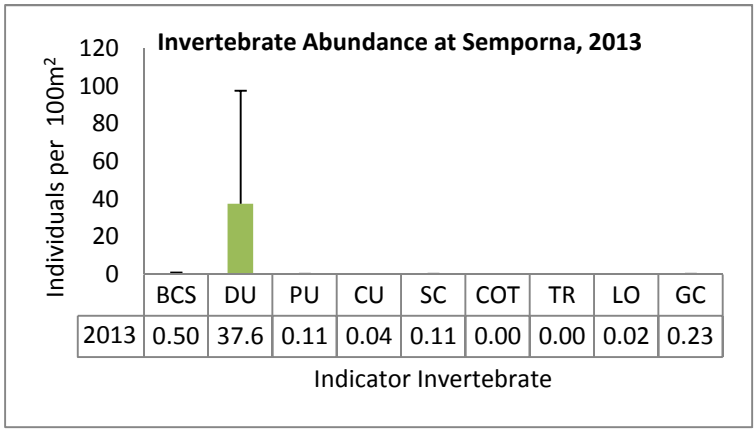
Fish



Butterfly fish were very abundant, recording an average of 7.09 ind/500m^2, higher than the average for North Borneo of only 3.82.ind/500m^2.

All other indicators were recorded in very low numbers and two indicators (Humphead Wrasse and Bumphead Parrotfish) were entirely absent from all surveys. This reflects the fishing pressure around Semporna, with edible fish rarely seen.

Invertebrate



Diadema urchins were very common at some sites (as high as 229.5 ind/100m2) but were totally absent at other sites. There was a positive correlation between Diadema abundance and Nutrient Indicating Algae abundance as these invertebrates have taken on the role as primary herbivores due to the lack of fish.

All other indicators were rare with an average of less than 1 ind/100m^2.

Signs of coral damage due to boat anchors and dynamite fishing as well as trash and discarded fishing gear were seen on the reefs during surveys. Two turtles were also recorded during surveys.

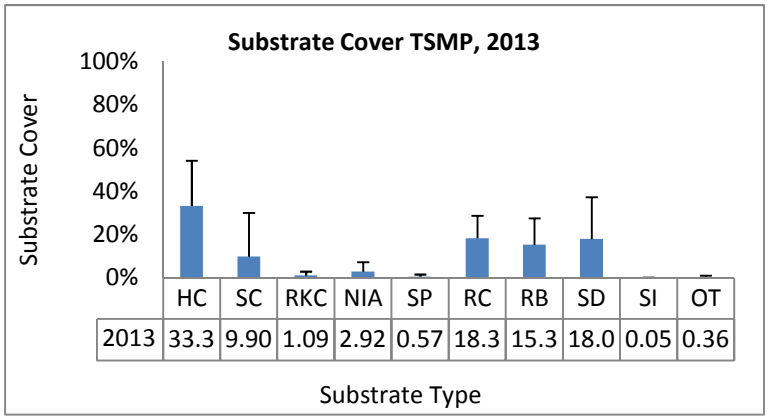
3.2.21 Tun Sakaran Marine Park, Semporna

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

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

Map 23: Surveyed sites in Tun Sakaran Marine Park, Semporna

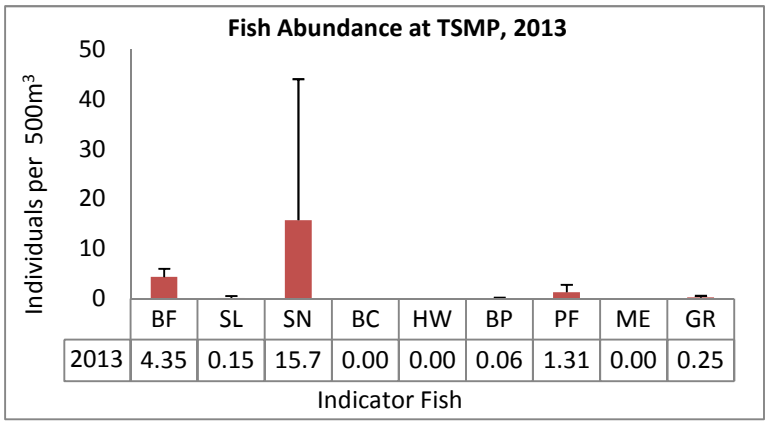
Substrate



Coral reefs within the TSMP were considered to be in 'Fair' condition with 43.2% LCC.

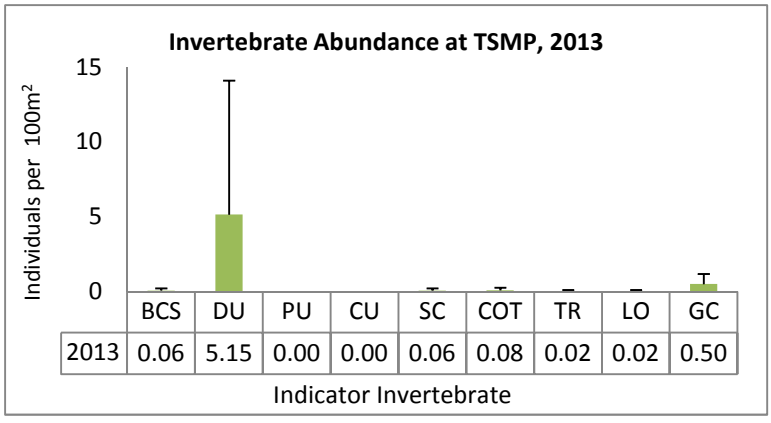
High amounts of rock were recorded and this indicates that there is suitable substrate for coral recruits to settle and grow. High amounts of rubble were also recorded and this may be due to illegal fish bombing activities that are known to occur.

Fish



Snappers were the most abundant indicator recorded during surveys, with an average abundance of 15.7 and a maximum abundance of 87.5 ind/500m^3 at one site. Butterfly fish were the second most abundant indicator with an average of 4.35 ind/500m^3. Barramundi Cod, Humphead Wrasse and Moray Eels were absent during all surveys while other indicators were present in low numbers.

Invertebrates



Diadema urchins were the most common indicator with an average of 5.15 ind/100m^2 while all other indicators were rare with average abundance of less than 1 ind/100m^2.

Some sign of natural damage as well as trash were seen on the reefs during surveys. There was also a small amount of localised bleaching recorded (0.96% of the population and 0.63% of the colony) along with 1 stingray and 1 turtle.

3.3 Six Year Comparison – Perhentian, Tioman and Redang

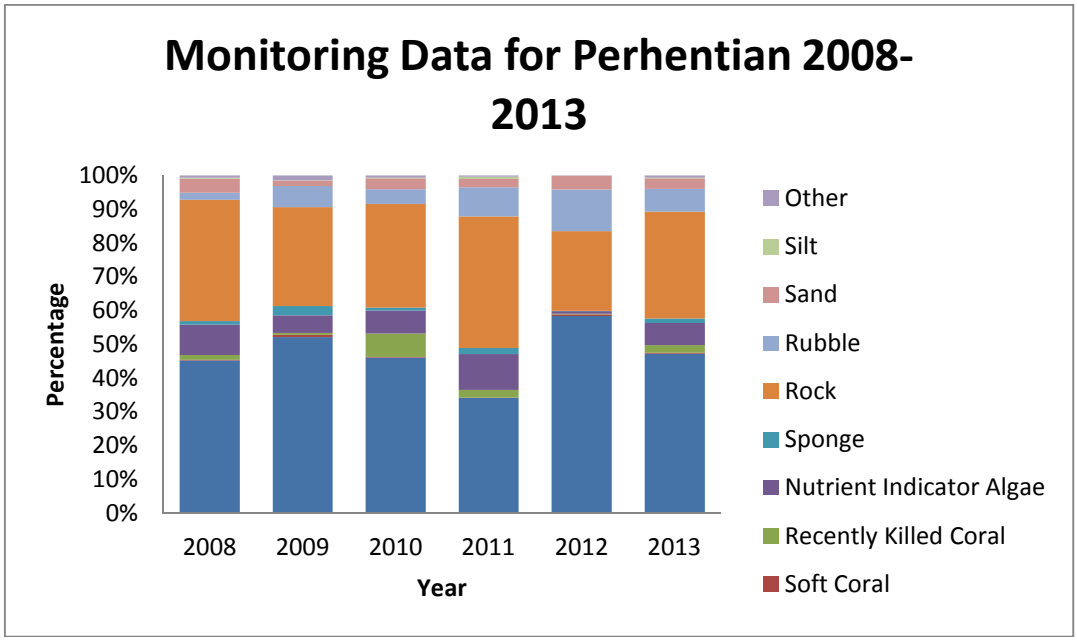
Reef Check data are primarily used for monitoring coral reef health and comparisons of data over time can highlight significant changes and indicate potential problems. The sections below provide details of the health of selected coral reefs in Perhentian, Tioman and Redang over six years, from 2008 to 2013. Only sites that were surveyed every year over the six year period are included in this section: six in Perhentian, seven in Tioman and six in Redang:

Perhentian D' Lagoon, Sea Bell, Tanjung Besi, Batu Nisan, Batu Layar and Sharkpoint

Tioman Batu Malang, Renggis North, Soyak North, Teluk Kador, Pirate Reefs, Chebeh, Tomok

Redang Chagar Hutang East, Pulau Lima Southern Tip, P. Paku Kecil, P. Paku Besar, Redang Kalong House Reef, P. Kerengga Besar

3.3.1 Perhentian



The data from the surveys conducted on Perhentian over the last six years show that there have been substantial variations over that period of time.

Hard Coral cover increased from 2008 to 2009, continuing a recovery (noted in 2007) from a very strong and damaging monsoon season in 2006.

A subsequent decrease in Hard Coral cover over the next three years from 51.19% (2009) to 33.96% (2011) is probably reflecting the impact of the major bleaching event experienced in 2010.

This is mirrored by concomitant changes in RKC and RC over the period. The data are consistent with HC killed by the 2010 bleaching event being reclassified first as RKC (large increase from 2009 to 2010 and declining in 2011) and then RC (highest level in 2011).

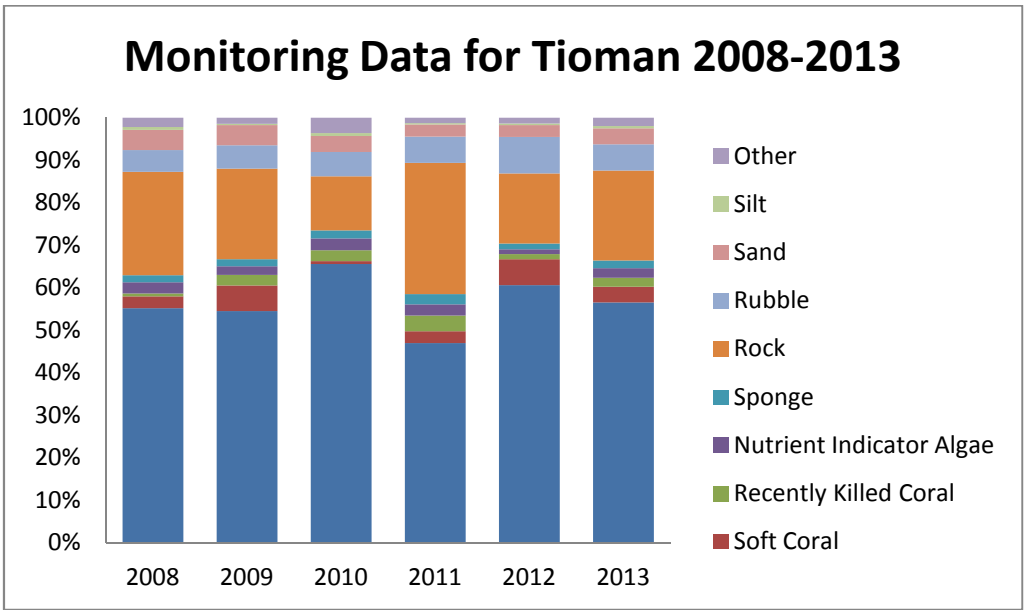
The 2012 surveys then show a substantial recovery, with level of HC increasing to the highest recorded in the Perhentian islands since regular surveys started in 2007 (just under 60%). The HC level however declines again in 2013 to 47.18%.

The inconsistent factor is the level of NIA detected during surveys. From 2008 to 2013 (except in 2012) the level of NIA remained in the range 5-10%, reaching its highest level in 2011. 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. In 2012 the level of NIA recorded was at its lowest over the five year period.

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

3.3.2 Tioman



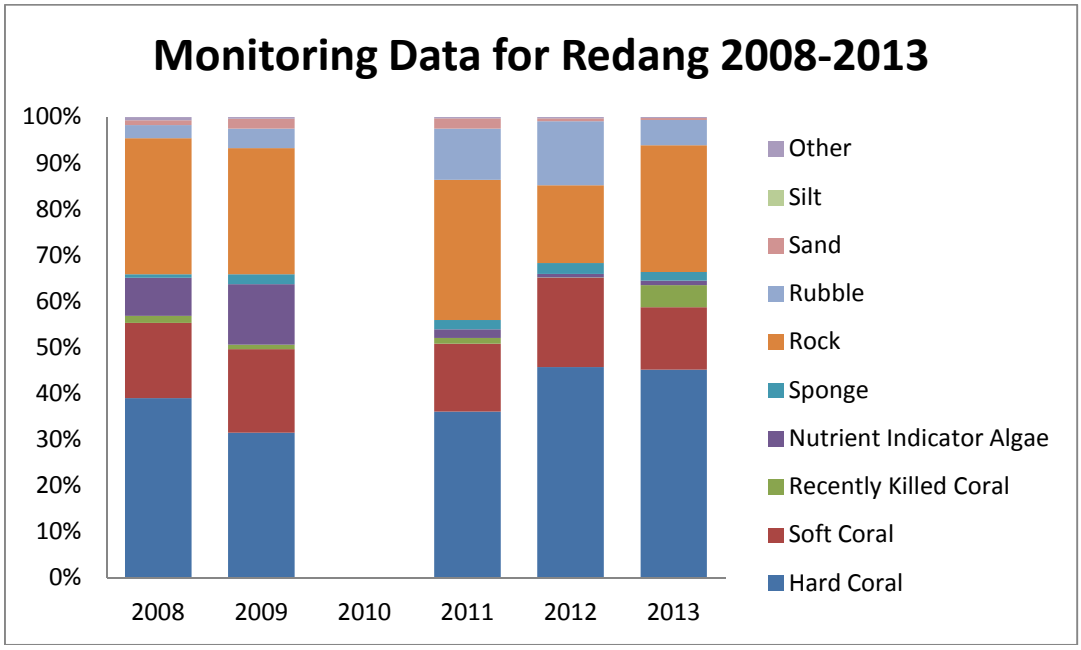
The data from the surveys conducted on Tioman over the last six years show that there have been some changes during that period of time, but less compared to Perhentian. The overall condition of the coral reefs surveyed around Tioman Island has been consistently good over the years, with LCC above 50%, a rating of "good" according to the Coral Reef Health Criteria, with the exception of 49.50% of LCC in 2011.

There was a considerable decrease in Hard Coral cover from 66.21% in 2010, to 49.70% in 2011. The decrease of HC is likely due to the 2010 mass bleaching event. In 2012, LCC increased to 66.66%, probably showing the reefs are resilient, being able to recover from the destructive effect of bleaching. However, in 2013 the level of LCC decreases by around 6% to 60.21%.

Changes at one particular site during the period demonstrate the benefits of long term monitoring. At Chebeh, there was a significant reduction in HC cover from 25.63% in 2011 to 13.75% in 2012. At the same time, NIA increased from zero to 4.38%. In 2013 the situation was again reversed, with HC increasing to 28.13% and NIA returning to zero. Monitoring allows these changes to be tracked and, if continued, provides an opportunity to intervene before problems become too acute.

3.3.3 Redang

The data from surveys conducted on Redang since 2008 show that there have been no significant changes over that period of time. Despite the lack of data for 2010, we can still see that there has been a slight increase in Hard Coral cover over the years, with the exception of a slight decline between 2008 and 2009. The overall condition of coral reefs around Redang Island has been good over the years, with average LCC above 50%, with the exception in 2009 which recorded 49.64% LCC.



There is a need to look into the increase of RKC in 2013 as it was a significant increase from 0.10% in 2012 to 4.79% in 2013. The sites of most concern are Pulau Paku Besar and Pulau Kerengga Besar where over 7% RKC was recorded during the survey. Other sites affected are Chagar Hutang, Pulau Lima Southern Tip, and Pulau Paku Kecil. This situation needs to be monitored to ensure no continuing recent damage as it could have a negative impact on the corals over a long term period.

4. Summary and Recommendations

4.1 Summary

4.1.1 On average, reefs in Malaysia are in fair to good condition, as measured by widely used coral reef health criteria (Chou *et al*, 1994). Average Live Coral Cover (LCC) for Malaysia is 48.33%.

4.1.2 The average masks a wide range of variation in reef health, from reefs with over 75% live coral cover (LCC) to reefs with below 5% LCC.

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

4.1.4 Overall, fish populations and abundance in Peninsular and East Malaysia are similar. However, indicator invertebrate populations and abundance are higher in East Malaysia than in Peninsular.

4.1.5 Average populations of both fish and invertebrate indicators are universally low, with average abundance far below what can be considered healthy populations on "good" reefs, as indicated in the table below.

Table 3: Average and Maximum abundance of Indicator Species

Fish			Invertebrates		
Indicator	Abundance		Indicator	Abundance	
	Average	Maximum		Average	Maximum
Butterflyfish	4.30	24.50	Banded Coral Shrimp	0.13	4.50
Sweetlips	0.16	3.00	Pencil Urchin	0.01	1.00
Snapper	5.50	100.25	Collector Urchin	0.01	0.50
Barramundi Cod	0.01	0.50	Sea Cucumber	2.10	117.50
Hump Head Wrasse	0.01	0.75	Triton	0.00	0.50
Bump Head Parrotfish	0.03	1.50	Lobster	0.02	1.00
Parrotfish	2.30	20.50	Giant Clam	1.49	32.50
Moray Eel	0.07	1.00			
Grouper	0.62	10.50			

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

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

4.1.8 Coral reef management strategies need to consider management on a site by site basis, as the averages mask wide variations in coral reef health, as well as at island level.

4.1.9 Observations suggest that threats facing reefs in Malaysia can be divided into local and global impacts:

- Local threats are those that arise locally due to human intervention and activity such as pollution and sedimentation, over-fishing and direct impacts by reef users
- Global threats are global warming and the associated risks from climate change and ocean acidification.

4.2 Recommendations

4.2.1 Increase the scale and scope of the existing reef monitoring programme by:

- Increasing the number of sites covered by the programme in both Peninsular and East Malaysia, and include sites outside existing Marine Protected Areas
- Encouraging more dive operators to participate in monitoring programmes and train staff as EcoDivers
- Establish permanent transects for surveys and disseminate details widely among dive operators and government agencies.

4.2.2 Improve the availability of timely and relevant information to all reef users, including:

- Install better signage (where relevant) to ensure that visitors realize that ALL waters surrounding the islands form part of the Marine Park, rather than only the area immediately adjacent to the marine park centre; include signs of “do’s and don’ts” in coral reef areas
- Make available handouts to be given to each visitor to coral reef areas (e.g. “do’s and don’ts” and how and where to report any offense observed).

4.2.3 Implement more education and awareness campaigns and talks for visitors and operators alike in coral reef areas:

- Encourage resorts and dive operators to apply Responsible Tourism guidelines to their operations and improve management practices
- Establish a rating system for resorts operating in coral reef areas, to provide information to customers on the degree to which operators care for the environment
- Encourage dive operators to join reef management programmes such as Green Fins and improve education to customers
- Encourage wise usage of fresh water (storing rainwater from roofs, recycling water for watering plants etc.)
- Install recycling bins and improve collection of rubbish in all areas.

4.2.4 Large areas of coral reefs around the coast of East Malaysia remain unprotected, though there are plans to establish new MPAs in several areas. Protecting reefs in gazetted areas can contribute to increasing their resilience to both natural (e.g. storms, disease) and man-made (e.g. dynamite fishing, over fishing) impacts, both of which are clearly significant problems in East Malaysia. There is an urgent need to increase the amount of coral reef within gazetted marine protected areas, and to put in place the necessary resources to ensure effective enforcement. In particular, resorts and communities should be given authority to establish MPAs which they can manage on a local level.

4.2.5 Coral reef managers are not in a position to address the root causes of global threats. The focus of management should therefore be on controlling and reducing local threats to ensure that reefs are as healthy as possible to survive the emergence of global threats such as coral beaching. Managers should take steps to reduce local threats by:

- Communicating the need to conserve coral reefs at the local level to all stakeholders, particularly those in coral reef areas
- Improve waste management in coral reef areas to eliminate solid waste pollution to coral reefs
- Improve sewage treatment in coral reef areas (resorts, communities) to eliminate sewage pollution to coral reefs
- Combat over-fishing by implementing effective no-take zones
- Eliminate destructive-fishing activities through local campaigns, conducted in association with relevant government agencies (maritime, police)
- Reduce impacts from land clearing for resort or other developments in coral reef areas by implementing effective construction site management policies (use of silt curtains, etc)
- Eliminating impacts from reef users (particularly divers and snorkelers) through education programmes and management programmes such as Green Fins.

Acknowledgements

We are grateful to the following sponsors for their support during 2013:

KHAZANAH NASIONAL	**The Khazanah Grants Programme** aims to guide all its Civil Society Partner Organisations towards achieving sustainable funding, operational excellence and organisational development
MURPHY	**Murphy Oil Corporation:** supporting reef rehabilitation efforts in Mantanani island, Sabah
ALSTOM	**Alstom Power:** through Alstom Foundation, is funding our Rainforest to Reef Programme, targeted at school children from the Marine Park Island schools.
YTL SINCE 1955	**YTL:** Supporting efforts by RCM to improve coral reefs around Malaysia, including through its Pangkor Laut Resort which supports surveys at the Sembilan islands.
SGP The GEF Small Grants Programme	**SGP:** funding a programme of work in Sabah to raise awareness of the negative impacts of fish bombing, including education and public awareness campaigns.
KOSÉ	**Kose:** supporting reef rehabilitation programmes
F&N	**F & N:** funding recycling and awareness campaign in Redang.
KPMG	**KPMG in Malaysia:** donates funds to support a Corporate Reef Check team and education programmes in two schools in KL.
PAM PERTUBUHAN AKITEK MALAYSIA MALAYSIAN INSTITUTE OF ARCHITECTS	**PAM:** Pertubuhan Akitek Malaysia is funding reef rehabilitation programmes in Tioman and Pangkor
	Shell Malaysia: supporting community programme in Sabah
LA MER	**La Mer:** donates funds to support a Reef Check survey programme in Lahad Datu, Sabah
Russell Bedford	**Russell Bedford LC & Company:** provides *pro bono* company secretarial services for RCM.
JABATAN TAMAN LAUT MALAYSIA	**Department of Marine Park Malaysia:** donates funds and assists Reef Check surveys on Marine Park islands, as well as supports Reef Check reef rehabilitations and island-based school programmes

We have also received donations from a number of individuals, to whom we extend our thanks.

Reef Check Malaysia cannot work in isolation. We continue to maintain a close working relationship with the Department of Marine Park Malaysia, Ministry of Natural Resources and Environment, and Sabah Parks. In addition, we work with scientists at several universities, particularly Kee Alfian at UKM and Affendi Yang Amri at UM. We are grateful to them for their guidance and expertise.

We work through a small network of dive centres, who continue to support our work. These include:

Reef Check Certified Facilities:

- Bubbles Dive Centre, Perhentian
- Redang Kalong, Redang
- Tioman Dive Centre, Tioman
- Scuba Explorers, Tenggol
- Borneo Divers, KK
- Reef Guardian, Lankayan, Sandakan
- Mataking Reef & Dive Resort.
- Usukan Cove Lodge Dive Centre, KK
- Scuba Junkie, Semporna.

Other dive operators:

- Eco Divers Dive Centre, Tioman
- Seamonkey Dive Centre, Merang
- Aqua Sport Divers, Kapas
- Kapalai Resort
- Pom Pom Island Resort
- Scooba Tank and Mari Mari Dive Lodge, Mantanani.
- Flora Bay Divers, Perhentian
- Pelangi Resort, Redang
- Ecodivers, Tioman
- B&J Diving Centre, Tioman
- Darvel Bay Diving, Lahad Datu
- Red Monkey Divers, Miri

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

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Appendix 1: Survey Sites (2013)

Sunda Shelf

No.	Site Name	Island	Coordinate
SS 1.1	Batu Layar	Perhentian	5 54 43.69 N 102 45 00.28 E
SS 1.2	Batu Nisan	Perhentian	5 55.265 N 102 43.508 E
SS 1.3	Batu Tabir	Perhentian	5 56 24.33 N 102 43 20.11 E
SS 1.4	Tiga Ruang	Perhentian	5 55.019 N 102 45.233 E
SS 1.5	Tukas Laut	Perhentian	5 53 06.45 N 102 46 01.13 E
SS 1.6	D' Lagoon	Perhentian	5 55.929 N 102 43.396 E
SS 1.7	P. Rawa	Perhentian	5 57.777 N 102 40.833 E
SS 1.8	Sea Bell	Perhentian	5 54.532 N 102 42.574 E
SS 1.9	Shark Point	Perhentian	5 53.075 N 102 44.812 E
SS 1.10	Tanjung Besi	Perhentian	5 55.414 N 102 45.498 E
SS 2.1	Chagar Hutang	Redang	5 48 53.5 N 103 00 25.8 E
SS 2.2	Chagar Hutang East	Redang	5 49 3.58 N 103 00 37.30 E
SS 2.3	P. Kerengga Besar	Redang	5 45 14.03 N 103 01 44.07 E
SS 2.4	P. Kerengga Kecil	Redang	5 45 10.14 N 103 01 46.55 E
SS 2.5	P. Lima Southern Tip	Redang	5 46 18.1 N 103 03 32.8 E
SS 2.6	P. Paku Besar	Redang	5 46 37.43 N 103 02 30.33 E
SS 2.7	P. Paku Kecil	Redang	5 46 18.1 N 103 02' 20.5 E
SS 2.8	P. Pinang Marine Park Centre	Redang	5 44 48.92 N 102 59 59.35 E
SS 2.9	Pasir Akar	Redang	5 44 24.71 N 102 59 58.37 E
SS 2.10	Redang Kalong HR	Redang	5 45 44.14 N 103 01 42.43 E
SS 2.11	Terumbu Kili	Redang	5 43 57.76 N 102 59 51.88 E
SS 2.12	Mak Simpan	Redang	5 47.302 N 102 59.556 E
SS 3.1	Pirates Reef	Tioman	2 49.428 N 104 09.445 E
SS 3.2	Renggis North	Tioman	2 48.594 N 104 08.183 E
SS 3.4	Soyak South	Tioman	2 52.480 N 104 08.810 E
SS 3.5	Soyak North	Tioman	2 52 33.59 N 104 08 53.03 E
SS 3.6	Batu Malang	Tioman	2 54.139 N 104 06.148 E
SS 3.8	Chebeh	Tioman	2 55 56.76 N 104 05 48.87 E
SS 3.11	Juara South	Tioman	2 46 51.13 N 104 12 37.11 E
SS 3.12	Labas	Tioman	2 53 19.09 N 104 3 55.19 E
SS 3.14	Sepoi	Tioman	2 53 53 N 104 3 6 E
SS 3.15	Fan Canyon	Tioman	2 54 38.97 N 104 6 45.20 E
SS 3.16	Tekek HR	Tioman	2 48 57.6 N 104 09 03.74 E
SS 3.17	Teluk Kador	Tioman	2 54.891 N 104 06.507 E
SS 3.18	Tumuk	Tioman	2 47 32.61 N 104 7 22.89 E
SS 3.19	Abect HR	Tioman	2 49.087 N 104 09.237 E
SS 3.20	Batu Nipah	Tioman	2 43.928 N 104 08.125 E
SS 3.21	Bugis Bay 2	Tioman	2 43.899 N 104 13.301 E
SS 3.22	Jahat East	Tioman	2 40.127 N 104 10.518 E
SS 3.23	Jahat West	Tioman	2 39.687 N 104 09.987 E

SS 3.24	Mungor South	Tioman	2 49 27.9 N 104 13 5 E
SS 3.25	Nyak	Tioman	2 46 45.5 N 104 12 45.6 E
SS 3.26	Pasir Munjor	Tioman	2 45.053 N 104 13.215 E
SS 3.27	Pasir Penut	Tioman	2 45.618 N 104 13.227 E
SS 3.28	Teluk Dalam	Tioman	2 52.456 N 104 11.254 E
SS 3.29	Teluk Tambong	Tioman	2 48.239 N 104 12.589 E
SS 3.30	Siang	Tioman	n/a
SS 4.1	Coral Garden 1	Kapas	5 13 59 N 103 15 38 E
SS 4.2	Coral Garden 3	Kapas	5 13 56 N 103 15 37 E
SS 4.3	Silent Reef	Kapas	5 13 37 N 103 16 9 E
SS 4.4	Teluk Jawa	Kapas	5 12 32 N 103 16 6 E
SS 4.5	Jellyfish City	Kapas	5 13.468 N 103 15.658 E
SS 5.1	Heritage Row	Bidong/Yu	5 36.900 N 103 03.400 E
SS 5.2	Pasir Tenggara	Bidong/Yu	5 36.614 N 103 03.813 E
SS 5.3	P. Karah	Bidong/Yu	5 35.934 N 103 03.851 E
SS 5.4	P. Tengkorak	Bidong/Yu	5 39.500 N 103 04.200 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 48.456 N 103 40.706 E
SS 6.2	Gua Rajawali	Tenggol	4 49 13.19 N 103 40 58.63 E
SS 6.3	Pasir Tenggara	Tenggol	4 48.03 N 103 40.56 E
SS 6.4	Rajawali Reef	Tenggol	4 49 17.61 N 103 41 25.35 E
SS 6.5	Turtle Point	Tenggol	4 48 21.31 N 103 40 29.25 E
SS 6.6	Teluk Rajawali	Tenggol	4 49.2 N 103 41.05 E
SS 7.1	Bumphead Bay	Pemanggil	2 34 53.4 N 104 20 7.15 E
SS 7.2	Lobster Bay	Pemanggil	2 34 45.74 N 104 18 56.32 E
SS 7.3	Old Man of the Sea	Pemanggil	2 34 53.06 N 104 20 15.0 E
SS 7.4	Pemanggil Village North	Pemanggil	2 34.905 N 104 18.750 E
SS 7.5	Pemanggil Village South	Pemanggil	2 34.761 N 104 18.945 E
SS 7.6	Tridacna Bay	Pemanggil	2 35.800 N 104 19.635 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	Rimba	Sibu	2 14.071 N 104 03.661 E
SS 9.4	Sibu Hujung	Sibu	2 10.374 N 104 06.721 E
SS 9.5	Beach 3	Sibu	2 11.268 N 104 05.888 E
SS 9.6	Sibu Tengah HR	Sibu	2 11.014 N 104 05.743 E
SS 10.1	P. Mentinggi	Tinggi	2 16.405 N 104 6.940 E
SS 10.2	P. Nanga	Tinggi	2 16.274 N 104 7.640 E
SS 10.3	P. Ibol	Tinggi	2 18.183 N 104 8.935 E
SS 10.4	P. Tanjung Gua Subang	Tinggi	2 18.792 N 104 7.552 E
SS 11.1	Siwa 4A	Miri	4 16 23 N 113 48 53 E
SS 11.2	Siwa Penyu	Miri	4 16 35 N 113 49 3 E
SS 11.3	Anemone Centre	Miri	4 17 33 N 113 49 33 E

SS 11.5	Eve's Garden	Miri	4 20 35 N 113 53 54 E
SS 11.6	Sunday Reef	Miri	4 17 13 N 113 49 10 E
SS 12.1	Sampadi	Kuching	01 44 11 N 110 5 6 E
SS 12.2	Satang Besar West	Kuching	n/a
SS 12.3	Talang Besar East	Kuching	01 55.212 N 109 46.651 E
SS 12.4	Talang Besar West	Kuching	01 55.033 N 109 46.465 E
SS 12.5	Talang Kecil East	Kuching	n/a
SS 12.6	Talang Kecil West	Kuching	n/a
SS 13.1	North Reef	Babi Tengah	2 28.912 N 103 57.385 E

Malacca Strait

No.	Site Name	Island	Coordinate
MS 1.1	Site 1 P.Lalang	Sembilan	4.0027 N 100.5467 E
MS 1.2	Site 1 P.Saga	Sembilan	4.0122 N 100.5449 E
MS 1.3	Site 2 P. Lalang	Sembilan	4.0008 N 100.5491 E
MS 1.4	Site 2 P. Rumbia	Sembilan	4.0224 N 100.5479 E
MS 1.5	Zoanthid Garden P. Rumbia	Sembilan	4.0321 N 100.5500 E
MS 1.6	P. Buluh	Sembilan	3.9945 N 100.5357 E
MS 1.7	Anemone Garden P. Saji	Sembilan	4.0065 N 100.5348 E
MS 1.8	Frogfish P. Nipis	Sembilan	4.0575 N 100.5397 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 29.14 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 30.47 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 HR	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 35.96 N 118 56.454 E

NB 5.1	Sahara	Mantanani	6 43.295 N 116 20.905 E
NB 5.2	Abalone	Mantanani	6 43.207 N 116 22.105 E
NB 5.3	Police Gate	Mantanani	6 42.73 N 116 20.313 E
NB 5.4	Italian Place	Mantanani	6 42.308 N 116 19.232 E
NB 5.5	Rizal	Mantanani	6 42.136 N 116 21.812 E
NB 5.6	Linggisan	Mantanani	6 42.832 N 116 20.84 E
NB 5.7	Stingray Point	Mantanani	6 42.764 N 116 19.771 E
NB 5.8	Indian Brothers	Mantanani	6 43.191 N 116 20.454 E
NB 5.9	Mari Mari House Reef	Mantanani	6 42.396 N 116 19.275 E
NB 5.10	Kolam	Mantanani	6 43.93 N 116 21.567 E
NB 5.11	Coral Reef	Mantanani	6 42.389 N 116 20.84 E
NB 5.12	Gilly Rock	Mantanani	6 42.804 N 116 19.402 E
NB 6.1	Base Camp	TARP, Kota Kinabalu	6 00 16.94 N 116 01 31.48 E
NB 6.6	Police Beach	TARP, Kota Kinabalu	6 1 55.49 N 116 01 24.93 E
NB 6.7	Sapi	TARP, Kota Kinabalu	6 0 29 N 116 0 13 E
NB 6.9	Meranggis Reef	TARP, Kota Kinabalu	6 2 4 N 116 1 43 E
NB 6.10	Ribbon Reef	TARP, Kota Kinabalu	6 1 5 N 116 0 19 E
NB 6.11	Tanjung Wokong	TARP, Kota Kinabalu	5 59 26 N 116 2 25 E
NB 6.12	Teluk Kuari	TARP, Kota Kinabalu	6 0 23 N 116 1 51 E
NB 6.13	Teluk Tavajun	TARP, Kota Kinabalu	6 1 40 N 116 3 8 E
NB 6.14	Teluk Melohom	TARP, Kota Kinabalu	n/a
NB 7.1	House Reef	Lahad Datu	4 58.027 N 118 15.841 E
NB 7.2	Cabbage Reef	Lahad Datu	4 56.927 N 118 15.47 E
NB 7.3	Paradise	Lahad Datu	4 56.548 N 118 17.637 E
NB 7.4	Lam's Point	Lahad Datu	4 56.275 N 118 16.464 E
NB 7.5	Nemo Garden	Lahad Datu	4 56.494 N 118 16.945 E
NB 7.6	Fish Eyes	Lahad Datu	4 57.782 N 118 15.165 E
NB 7.7	Mid Reef	Lahad Datu	4 54.74 N 118 15.256 E
NB 7.8	Small Reef	Lahad Datu	4 54.444N 118 14.595 E
NB 7.9	Adam's Point	Lahad Datu	4 57.052 N 118 15.473 E
NB 8.1	Kuraman	Labuan	5 13.360 N 115 8.508 E
NB 8.2	Rusukan Besar	Labuan	5 11.343 N 115 8.105 E
NB 8.3	Rusukan Kecil	Labuan	5 12.097 N 115 8.511 E
NB 9.1	Station 3	Kota Belud	6 23 21.96 N 116 19 52.26 E
NB 9.2	Station 11	Kota Belud	6 20 59.1 N 116 18 35.04 E
NB 10.1	Alert Patches 2	Semporna	4 9.139 N 118 15.451 E
NB 10.2	Alert Patches 3	Semporna	4 9.808 N 118 16.511 E
NB 10.3	Alert Patches 1	Semporna	4 8.364 N 118 14.039 E
NB 10.4	Cust Reef	Semporna	4 17.226 N 118 43.520 E
NB 10.5	Darby Bank	Semporna	4 6.751 N 118 13.504 E
NB 10.6	Erzherzog Reef	Semporna	4 14.728 N 118 23.219 E
NB 10.7	Friedrich Heaven	Semporna	4 14.363 N 118 26.011 E
NB 10.8	Hand Rock	Semporna	4 8.455 N 118 10.792 E

NB 10.9	Kapalai Rock	Semporna	4 12.615 N 118 40.797 E
NB 10.10	Ligitan 1	Semporna	4 9.728 N 118 52.335 E
NB 10.11	Ligitan 2	Semporna	4 9.298 N 118 53.923 E
NB 10.12	Ligitan 3	Semporna	4 11.513 N 118 54.040 E
NB 10.13	Paradise 2	Semporna	4 14.956 N 118 37.889 E
NB 10.14	Yoshi Point 2	Semporna	4 14.193 N 118 33.190 E
NB 11.1	Dead End Hannel	TSMP, Semporna	4 34 24.5 N 118 45 30.4 E
NB 11.2	Kapikan Reef	TSMP, Semporna	4 37 41.9 N 118 50 06.7 E
NB 11.3	Mantabuan	TSMP, Semporna	4 37 56 N 118 47 47.9 E
NB 11.4	Ribbon Reef	TSMP, Semporna	4 36 08.1 N 118 46 05.4 E
NB 11.5	South Rim	TSMP, Semporna	4 34 04.7 N 118 45 29.9 E
NB 11.6	Sibuan	TSMP, Semporna	n/a