Status of Coral Reefs in Malaysia, 2012

Reef Check Malaysia

Contents

Executive Summary

1. A total of 141 sites were surveyed in 2012 (2011: 100), 83 in Peninsular Malaysia (2011: 52) and 58 in East Malaysia (2011: 48). The surveys are a continuation of a successful National Reef Check Survey Programme that has now run for six years.

2. The surveys were carried out by volunteers trained and certified in the global standard Reef Check method. Nearly 80 people were trained in 2012 (2011: 50), adding to the base of volunteers who are participating in Reef Check Malaysia's programmes. 8% of trainees were officers of the Department of Marine Parks Malay sia and 25% were of Sabah Parks Malaysia, 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 few 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 46.37% (2011: 42.57%). 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 small scale investments, 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 biodiver sity. One estimate puts the economic value of well-managed coral reefs in Malaysia at RM 50 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 82 countries worldwide, and in Malaysia since 2001. The non-profit Reef Check Malaysia Bhd (RCM) is available to oversee training and surveys in Malaysia.

This report is available for download at: www.reefcheck.org.my/downloads.php

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

1. Introduction

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

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

- The 2008 "Status of Coral Reefs of the World" report stated that the world has effectively lost 19% of the original area of coral reefs and that 15% are seriously threatened with loss within the next 10-20 years, with a further 20% under threat of loss in the next 20-40 years.

- In 2011, "Reefs at Risk Revisited" stated that more than 60% of the world's reefs are under immediate and direct threat from one or more local sources.

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

- Over-fishing, which can result in detrimental changes to reef ecology

- Destructive fishing (such as dynamite and cyanide fishing), which destroy the reef structure

- Coastal development, releasing silt and sediment that can smother reefs and altering hydrological flows

- Pollution, from industrial and agricultural activities as well as sewage pollution

- Physical impacts from tourism, including divers, snorkelers and boats.

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

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

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

- Respond effectively to mass coral reef bleaching events with management interventions to protect reefs during bleaching events

- Build the "survivability" of coral reefs to better withstand future bleaching events.

Reef Check Malaysia 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 2012, the sixth 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 contribute 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 sixth annual report, and details the results of Reef Check surveys carried out during 2012. 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.

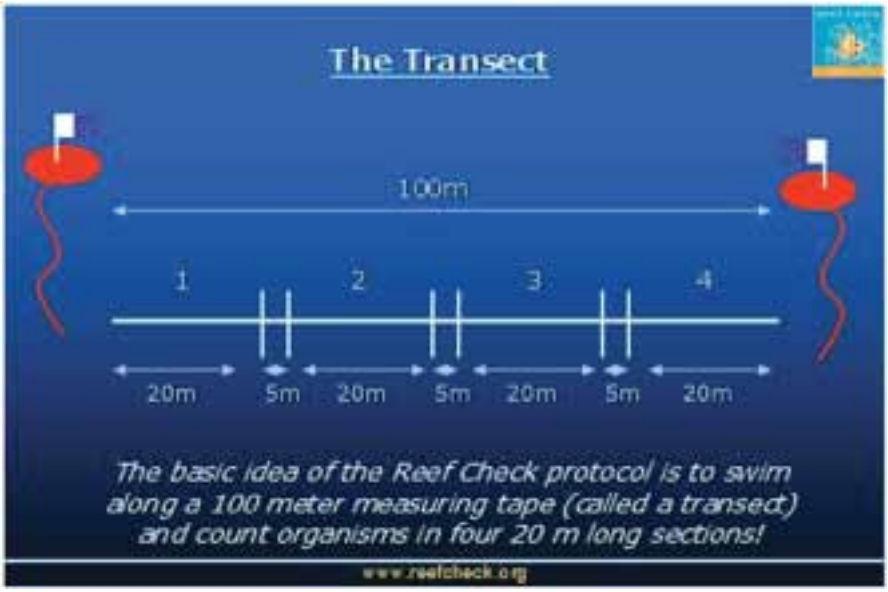


Figure 1: The Transect

2.3 Survey Sites

During 2012, a total of 141 sites were surveyed, 83 in Peninsular Malaysia and 58 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 two islands off the West coast (Sembilan and Payar) and four islands off the East coast (Pemanggil, Aur, Sibu and Tinggi). 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 Miri, 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. 2012 Survey Results and Analysis

This section details the results of surveys conducted during 2012, providing an overview of the situation for Malaysia, and more detailed analysis by island/survey area.

3.1 Status of Coral Reefs in Malaysia 2012

The results from all 165 surveys have been compiled to provide an overview of the status of coral reefs for the whole of Malaysia. Many of these sites are popular dive sites which are frequently visited by divers and snorkelers. However, there are still many areas, especially off the coasts of Sabah and Sarawak, which are less explored, but are facing threats (e.g. destructive fishing methods such as fish bombing).

Map 1: Survey Locations in Peninsular Malysia

Map 2: Surveyed islands in East Malaysia

3.1.1 Substrate

The table below shows the Coral Reef Health Criteria developed by Chou et

Table 1: Coral Reef Health Criteria

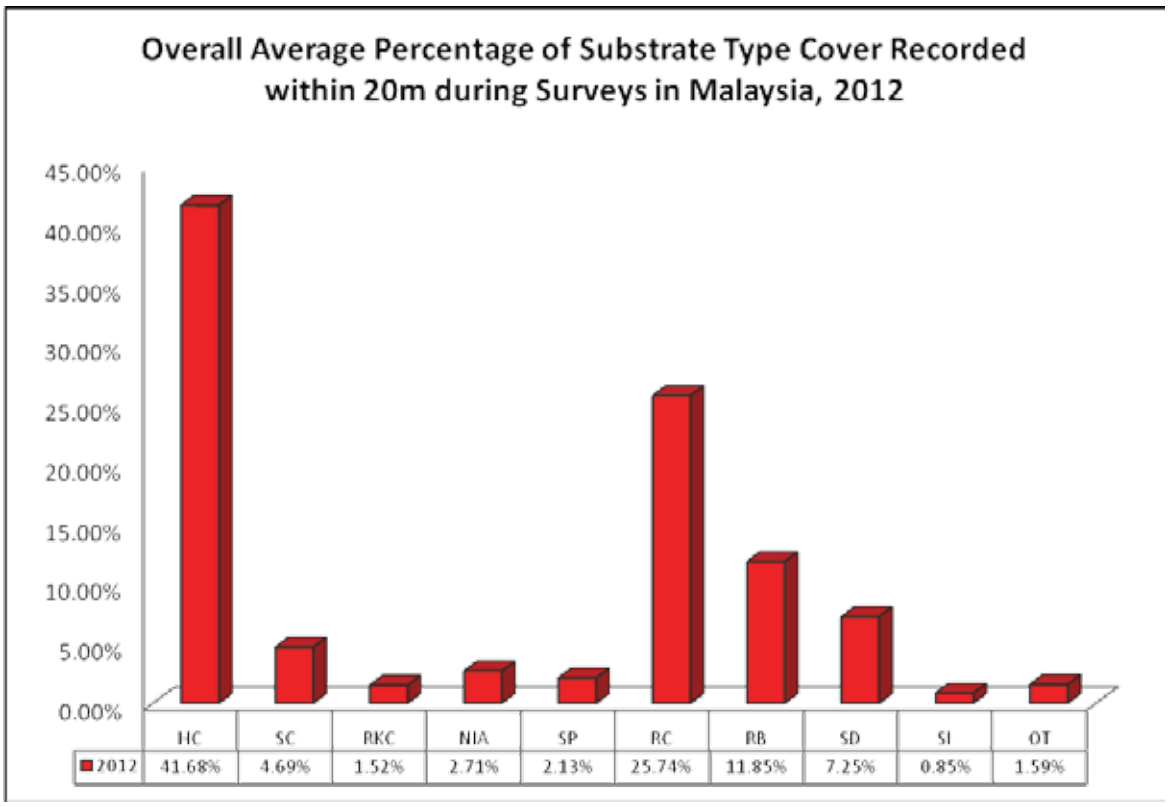
Percentage of live coral cover	Rating
0-25	Poor
26-50	Fair
51-75	Good
76-100	Excellent

According to these criteria, the general condition of Malaysia's coral reefs is categorised as "fair", based on the average live coral cover (Hard Coral + Soft Coral – see Chart 1) from all the surveys of 46.37% (42.57% in 2011).

Recently Killed Coral (RKC) results from a variety of impacts, including bleaching, predation (e.g. by Crown of Thorns starfish and Drupella snails) and other local stressors (e.g. sedimentation). The low level of RKC (1.52%) in 2012 mirrored that of 2011 (1.77%) and it indicates few recent impacts to reefs.

Nutrient Indicator Algae (NIA) is a measure of the amount of algae growing on reefs, and can provide an indication both 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 a coral reef, but if allowed to grow un-checked, algae can smother corals, cutting off the sunlight they need for photosynthesis and eventually killing them. This leads 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. RC is critical for reef recovery, regeneration and extension as it forms the base for new corals to recruit onto. Therefore, some amount of RC is important, and the 2012 level of 25.74% (28.28% in 2011) is considered normal. It should be noted that new coral recruits cannot settle onto RC that has significant algae coverage; 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. These are created by a number of factors, some natural such as wave action (normal and storm surge) and others from human activities, including fish bombing and physical impacts (from boats, anchors and reef users). Changing levels of RB can be an indicator of recent disturbance, and on damaged reefs with high levels of RB, coral regeneration is slow due to the difficulty of coral recruiting onto a mobile substrate: new coral recruits are easily damaged or displaced on a mobile substrate moving around in local currents. The average level of RB for Malaysia in 2012 (11.85%) was similar to 2011 (12.04%) and is considered within acceptable limits, though as described below in the sections on specific reef areas, the level of RB varies widely and in some areas it is a cause for concern.

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 current level of SD (7.25%) is considered acceptable

Silt (SI) arises from a variety of natural sources (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. 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 (the average level of SI for Malaysia is low at 0.85% (1.06% in 2011). However, changing levels of SI in a specific area can indicate a local impact, and SI should be monitored on a local level (see sections below for further comments).

The category Other (OT) contains all other substrate types that are not indicating any impacts, but which are natural parts of coral reefs. The average level of OT in Malaysia in 2012 was 1.59%.

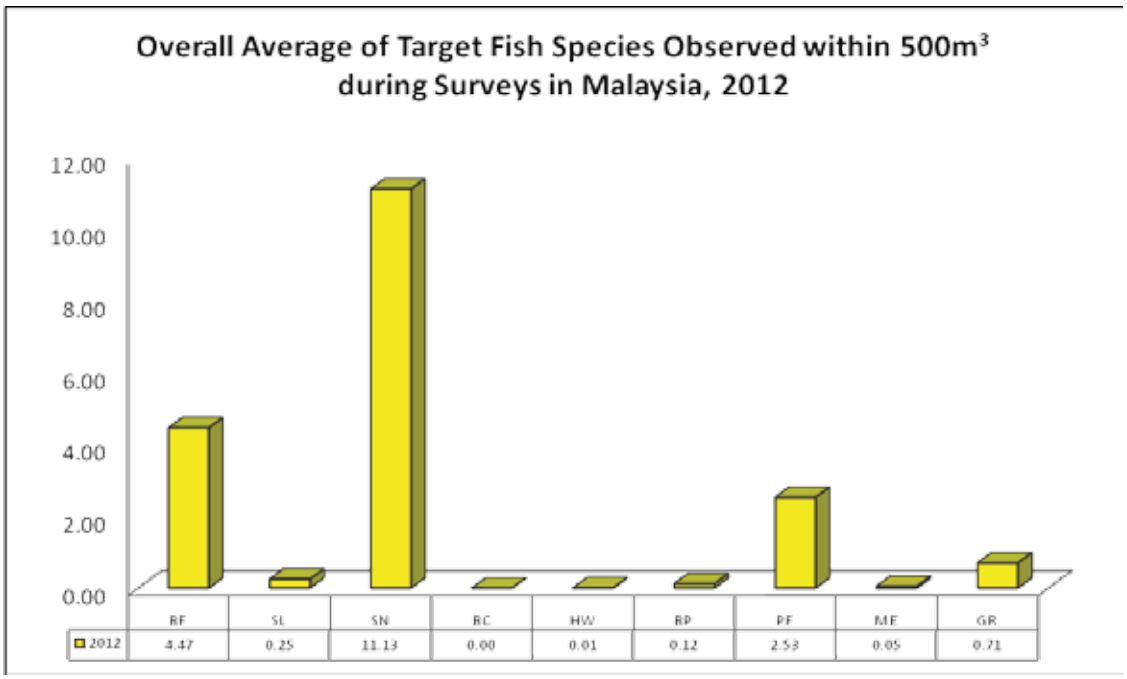
3.1.2 Fish

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 abundance of indicator fish counted during the 2012 surveys is shown in Chart 2 below.

Chart 2



Abundance of several varieties that are targeted for food is low in most of the areas where surveys have been conducted, with abundance of many being less than 1 individual per 500m3 survey transect (including Sweetlips, Barramundi Cod, Moray Eel and Grouper).

The high value of large, single Humphead wrasse and Bumphead Parrotfish (which can be worth up to US$ 10,000 on live fish markets) results in targeted fishing effort for these particular species. Abundance of these important species is very low, less than 0.15 individuals per 500m3 survey transect. Greater protection

(including enforcement of Marine Park regulations) will be necessary to aid recovery of populations of these iconic species, and on-going monitoring will help to track recovery in populations.

On a more positive note, the presence of Butterfly fish in all survey sites is a good indication that there is low collection pressure for these fish, a popular item in the aquarium trades. Furthermore, the high numbers of Butterfly fish at some survey sites reflects the fairly healthy status of reefs around Malaysia, as they thrive on reefs with healthy corals, feeding mainly on coral polyps.

Equally important are healthy Parrotfish populations (average abundance 2.53 individuals per 500m3 survey transect). Parrotfish are herbivores and are an important control on the amount of algae growing on coral reefs, helping to protect corals from proliferation of algae.

Notwithstanding the variations noted above for individual indicator populations, it should be noted that the abundance of five out of nine of the indicator species (Butterfly fish, Barramundi Cod, Parrotfish, Moray Eel and Grouper) has declined slightly from 2011. Since most of the sites surveyed are in MPAs, this highlights a cause for concern for managers.

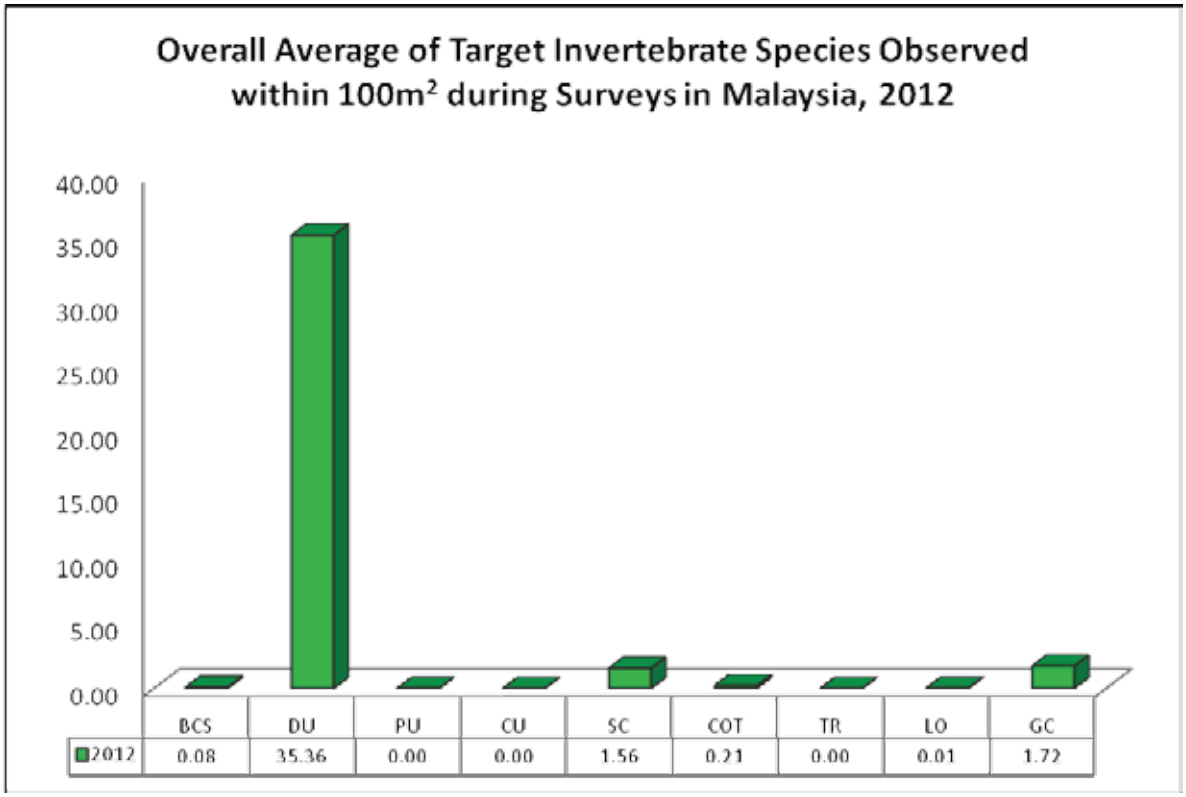
3.1.3 Invertebrates

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 2012 surveys is shown in Chart 3 below.

Chart 3



Abundance of those invertebrates targeted for the curio trade is at or near zero (Banded Coral Shrimp 0.08 individuals per 100m2 survey transect; Pencil Urchin – only observed at two sites; Triton – not observed during surveys). While this may be partly explained by low natural abundance and cryptic behaviour (e.g., night feeders), clearly there has been significant historical fishing pressure for these species, and significant conservation measures will be required to assist populations to recover.

Similarly, several species targeted for the food trade are at or near zero (Lobster 0.01 individuals per 100m2 survey transect; Collector Urchin – only observed at one site). However, some populations are larger, including Sea Cucumbers (1.56) and Giant Clams (1.72).

The abundance of long-spined sea urchins (Diadema sp.) varies widely between survey sites, and in some sites they are present in sufficient numbers to cause a concern (particularly Sembilan Islands and Tioman Island). 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 or increasing numbers of Diadema could indicate above normal levels of nutrient, causing algae to grow.

However, 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 can contribute to reducing this problem, as can healthy populations of herbivores.

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 (10,000m2), or 0.2-0.3 per 100m2 (Harriott et al., 2003) The abundance of COTs found during surveys (0.21 per 100m2) 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 regular COT removal activities to reduce the threat posed by these creatures. Continued monitoring is essential to track and help to manage significant outbreaks of this dangerous coral predator.

Notwithstanding the variations noted above for individual indicator populations, it should be noted that the abundance of all indicator species except Banded Coral Shrimp has declined slightly from 2011. Since most of the sites surveyed are in MPAs, this highlights a cause for concern for managers.

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

The sections below provide details of the health of coral reefs surveyed in three Eco-regions in Malaysia. An Eco-region is defined as an area of relatively identical species composition, clearly distinct from adjacent regions (Spalding et al, 2007). Since conditions at different sites within an Eco-region will be relatively uniform, consideration should be given to managing coral reefs at an Eco-region level. Data on surveys are therefore presented in three sections, corresponding to these Eco-regions.

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

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

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

The results of surveys highlight the different problems each island/area is facing. Islands/regions covered in each Eco-region are shown in table below.

Table 2: Site Coverage by Eco-region

Islands/Areas	No. of sites	Protection Status
Sunda Shelf		
Perhentian	12	Marine Park
Redang	11	Marine Park
Tioman	18	Marine Park
Kapas	4	Marine Park
Bidong	3	No protection
Yu	3	Marine Park
Tenggol	6	Marine Park
Pemanggil/Aur	8	Marine Park
Sibu/Tinggi	6	Marine Park
Miri/Kuching	7	No protection
Malacca Strait		
Sembilan	9	No protection
Payar	3	Marine Park
North Borneo		
Lankayan	15	SIMCA
Mataking/Pom Pom	7	No protection
Mabul	9	No protection
Mantanani	12	No protection
Kota Kinabalu	8	Tunku Abdul Rahman Park

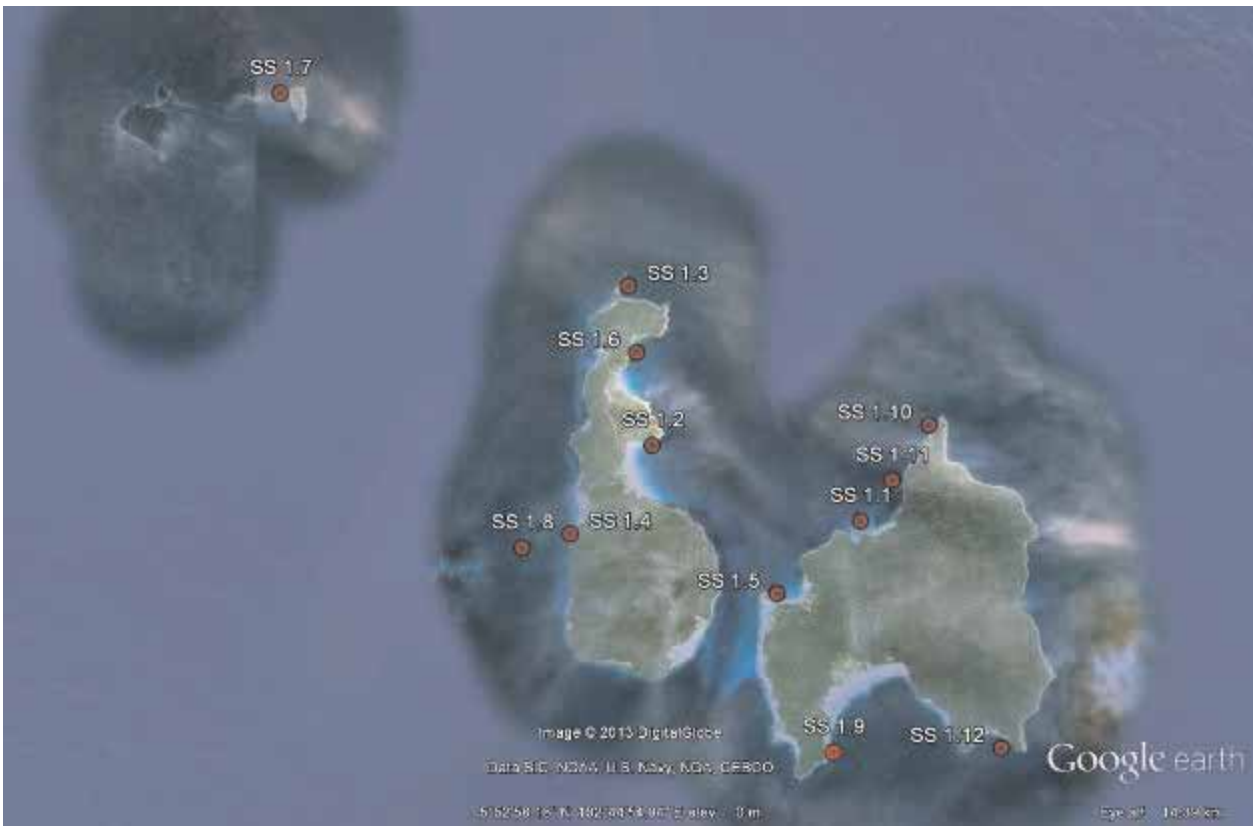
Sunda Shelf Region

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).

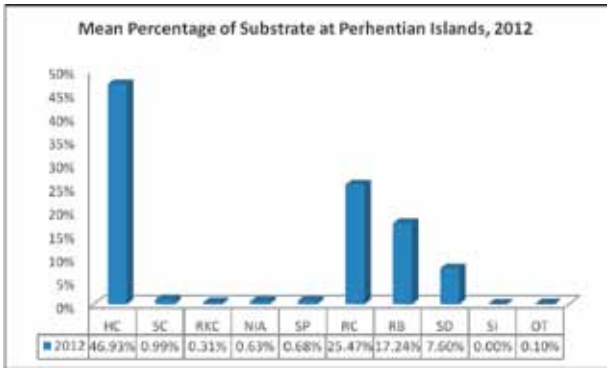
A popular tourist destination, particularly among backpackers, there are some 40 resorts, mainly small, family run chalets with a couple of large resorts, and 15 dive operators, spread around the two main islands. Diving and snorkelling are the main tourist activities. Growth in tourism has been rapid 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 fair condition, with 47.92% live coral cover, below the average (50.39%) for reefs in the Sunda Shelf region.

Level of RB (17.24%) is moderately high, possibly a result of damage to shallow reefs from the large numbers of snorkelers visiting the island. The proportion of RC is also moderately high (25.47%), a significant proportion of which is dead coral.

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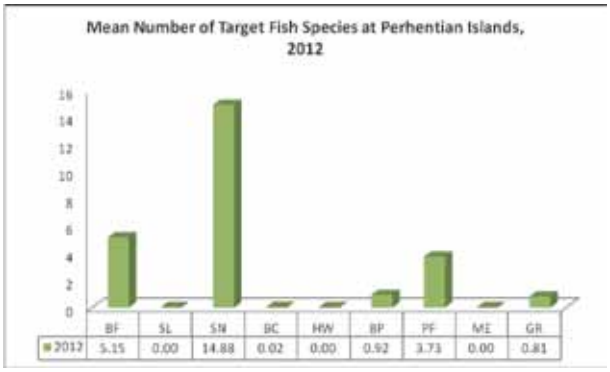
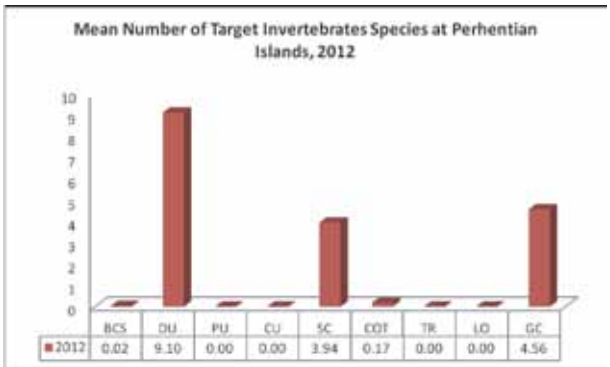


Abundance of most fish species targeted for food is low, with some important species (Sweetlips and Humphead Wrasse) absent entirely.

Most abundant are Snapper (14.88 individuals/500m3) and Butterflyfish (5.15). Numbers of Grouper are low (0.81).

Abundance of Bumphead Parrotfish (0.92) is the highest of all islands surveyed in the Sunda Shelf region.

Inverte-



Numerous targeted species are absent, including Pencil Urchin, Collector Urchin, Triton and Lobster.

Other targeted species are more abundant, including Sea Cucumber (3.94 individuals/100m2) and Giant Clam (4.56). Diadema Urchin abundance (9.10) is high.

3.2.2 Redang

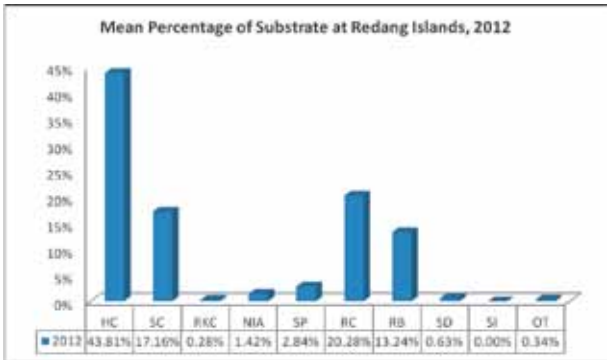
Redang Island is located some 25km from Merang, off the East coast of Terengganu, Malaysia. The island has a population of approximately 1,500, only a small proportion of who work in tourism, the main industry on the islands. The islands are gazetted as a Marine Park (since 1994).

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.

Reefs are both fringing off-shore reefs and submerged reefs.

Map 4: Surveyed sites in Redang

Substrate

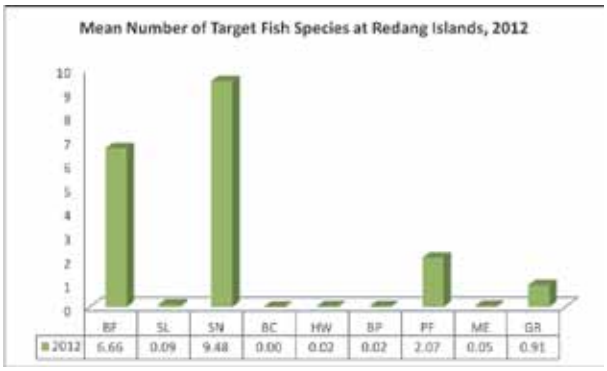


Coral reefs around the islands are considered to be in good condition, with 60.97% live coral cover, above the average (50.39%) and the highest of all islands surveyed in the Sunda Shelf region. However this high live coral cover is mainly due to the extremely high amount of soft coral cover in three survey sites.

Redang has a higher level of SC (17.16%) than other islands, perhaps reflecting the fact that it is closer to deeper waters compared to the other islands in this Eco-region.

Level of RB (13.24%) is high, possibly a result of damage to shallow reefs from the large numbers of snorkelers visiting the island.

Fish

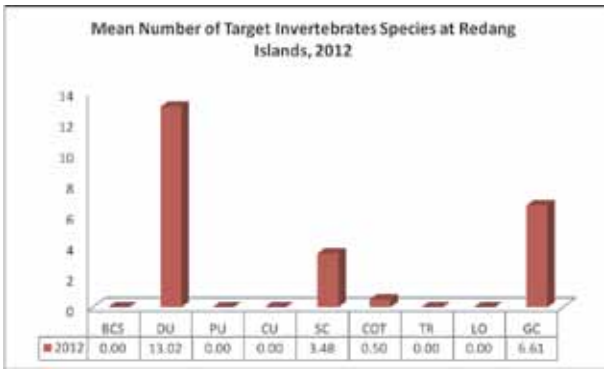


Only one indicator species was completely absent from surveys (Barramundi Cod), though abundance of several other indicators is very low (Sweetlips 0.09 individuals/500m3, Humphead Wrasse 0.02, Bumphead Parrot 0.02, and Moray Eel 0.05).

Snapper (9.48) are the most abundant food fish, with lower populations of Parrotfish (2.07). Numbers of Grouper are low (0.01).

Abundance of Butterflyfish (6.66) is the highest of all islands surveyed in the Sunda Shelf region.

Invertebrates



Numerous targeted species are absent, including Banded Coral Shrimp, Pencil and Collector Urchins, Triton and Lobster.

Other targteted species are present in low numbers, including Sea Cucumber (3.58 individuals/100m2) and Giant Clam (6.61). Abundance of Giant Clam at Redang is the highest of all islands surveyed in the Sunda Shelf region.

Diadema Urchin abundance (13.02) is high.

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

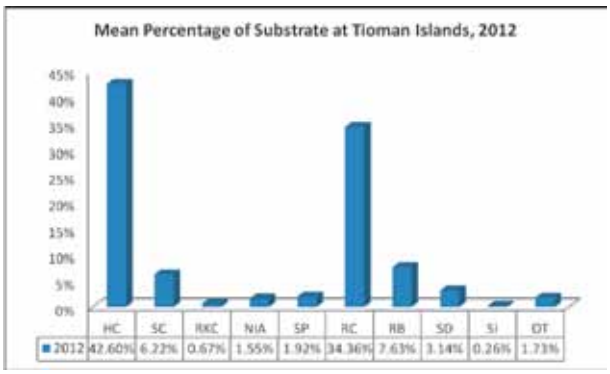
Diving and snorkelling are the main tourist activities. The island has long been a popular tourist destination, though in recent years it has been eclipsed by other destinations (particularly Redang and Perhentian). As a result, resort development has been at a slower pace, with no significant new resorts in the last 12 years. There are some 40 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 time 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

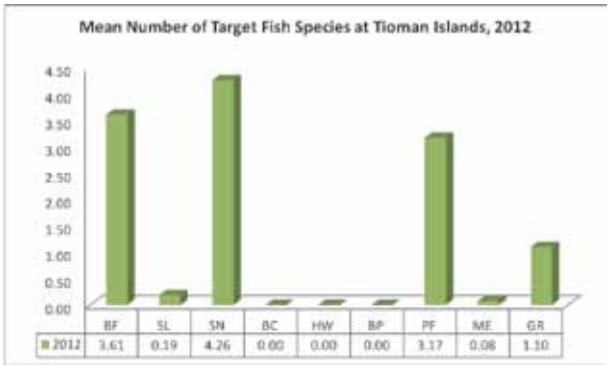


The site is considered to be in fair condition, with 48.82% live coral cover (48.93% in 2011), below the average (50.39%) for reefs of the Sunda Shelf region.

Levels of other substrate categories are low (e.g. RKC 0.67%, NIA 1.55%, SI 0.26%), indicating few recent disturbances at Tioman and improvements from 2011 (RKC 3.27% & NIA 2.73%).

The rather high level of RC (34.36%) can provide good surface for recruitment of new corals, provided that NIA is kept in check and herbivore populations are protected.

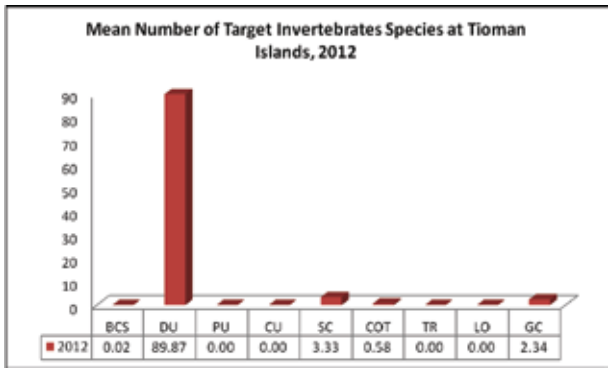
Fish



Three indicator species were completely absent from surveys (Barramundi Cod, Humphead Wrasse and Bumphead Parrot), though abundance of several other indicators is very low (Sweetlips 0.19 individuals/500m3 and Moray Eel 0.08).

Snapper (4.26) are the most abundant food fish, with lower populations of Parrotfish (3.17). Numbers of Grouper are low (1.10), however it is the highest of all islands surveyed in the Sunda Shelf region.

Invertebrates



Several targeted species are absent, including Pencil and Collector Urchins, Triton and Lobster.

Numbers of Diadema (89.87 individual/100m2) are high, which as noted previously could create problems with bioerosion. However, they are likely to play a role in controlling NIA (see above).

Abundance of Sea Cucumber (3.33) and Giant Clam (2.34) is low. Crown-of-thorns (0.58) is the highest of all islands surveyed in the Sunda Shelf region.

3.2.4 Kapas

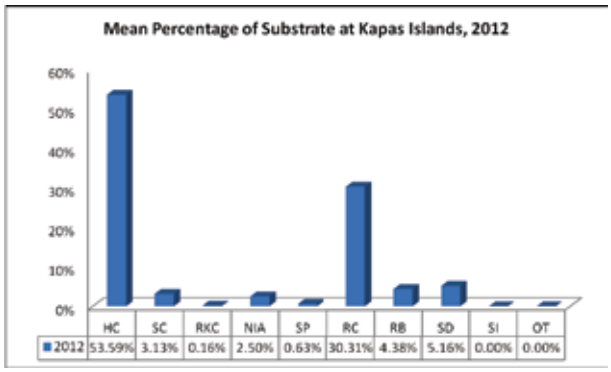
Kapas Island is located just 6km from Marang, off the East coast of Terengganu, Malaysia. This small island has no local population. The islands are gazetted as a Marine Park (since 1994).

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

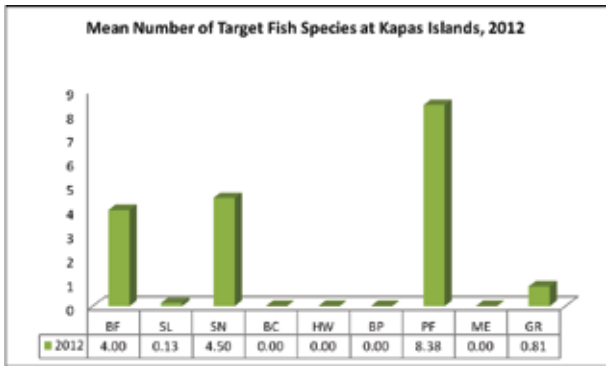


Coral reefs around the island are considered to be in good condition, with 56.72% (50.50% in 2011) live coral cover, above the average (50.39%) and the second highest of all islands surveyed in the Sunda Shelf region.

Levels of other substrate categories are low (e.g. RKC 0.16%, RB 4.38%, SI 0%), indicating few recent disturbances at Kapas.

Level of NIA is relatively low at 2.50% (4.75% in 2011), perhaps reflecting the high abundance of Parrotfish (see below).

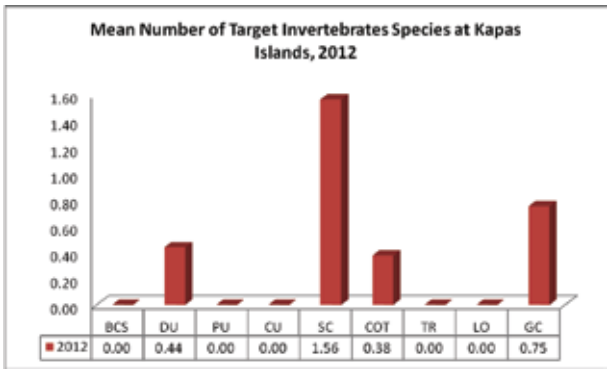
Fish



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

Parrotfish (8.38 individuals/500m3) are the most abundant food fish (highest of all islands surveyed in the Sunda Shelf region), with lower populations of Snapper (4.50). Abundance of several other food fish is low (Sweetlips 0.13 and Grouper 0.81).

Invertebrates



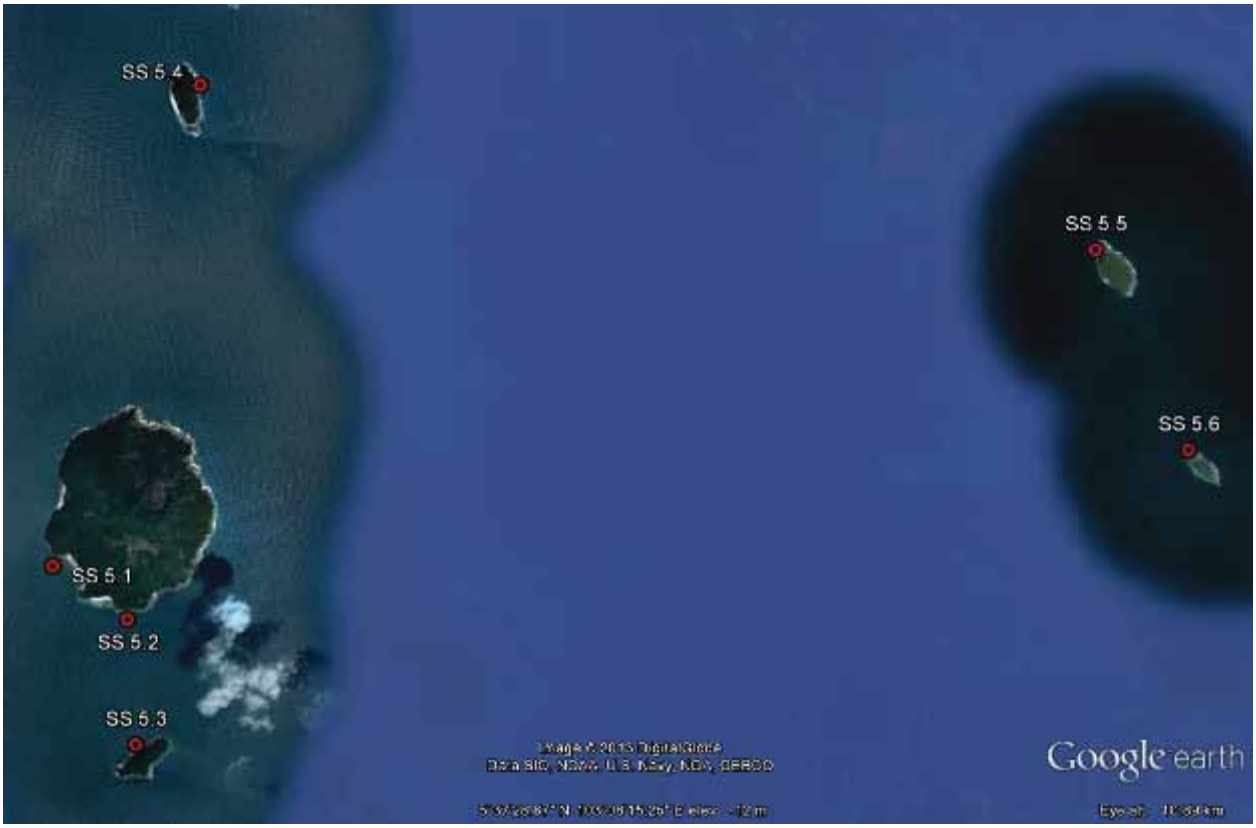
Several targeted species are absent, including Banded Coral Shrimp, Pencil and Collector Urchins, Triton and Lobster.

Abundance of all other indicators is very low, including Diadema Urchin (0.44 individuals/100m2), Sea Cucumber (1.56), Crown-of-thorns (0.38) and Giant Clam (0.75).

3.2.5 Bidong/Yu

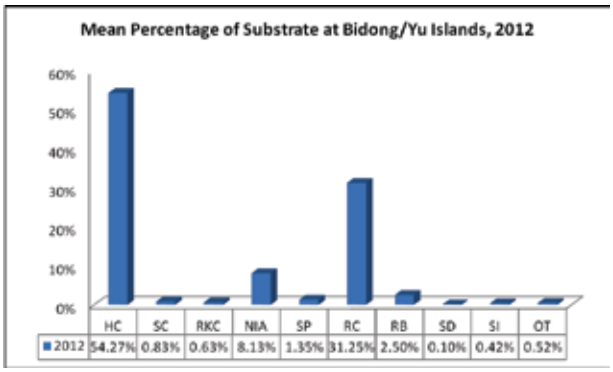
The island grouping of Bidong/Yu comprises several small islands, located 15-25km from Marang, off the East coast of Terengganu, Malaysia. The islands are unpopulated, though from 1978 to 1991 Bidong was a centre for Vietnamese refugees. None of the islands is gazetted as a Marine Park.

The islands are growing in population as a diving destination. Bidong has some sandy beaches and fringing reefs. Pulau Yu Besar and Kecil are mainly rocky, with boulder slopes dropping to 25-30m, with some coral reef areas.



Map 7: Surveyed sites in Bidong & Yu

Substrate

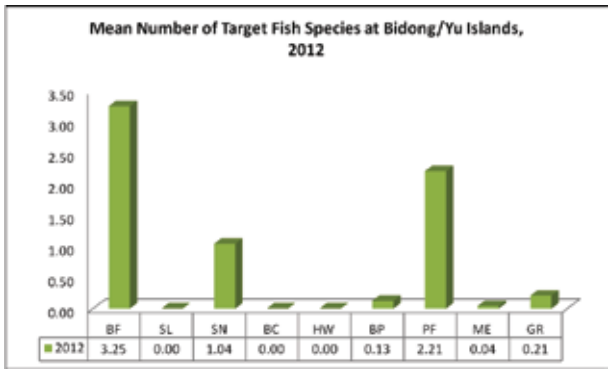


Coral reefs around the islands are considered to be in good condition, with 55.10% (42.83% in 2011) live coral cover, above the average (50.39%) for reefs of the Sunda Shelf region. The increase in coral cover compared to 2011 is probably due to the change in two survey sites in 2012.

The level of NIA is rather high (8.13%), indicating high levels of nutrient in the waters around the islands. Since there are no resorts on the islands, this may be an impact from rivers on the mainland, given the relative proximity of the island to the East coast. It could also be related to the relatively low abundance of parrot fish, an important grazer (see below).

The moderately high level of RC (31.25%) reflects the rocky nature of much of the coastline of the islands, particularly the Yu islands

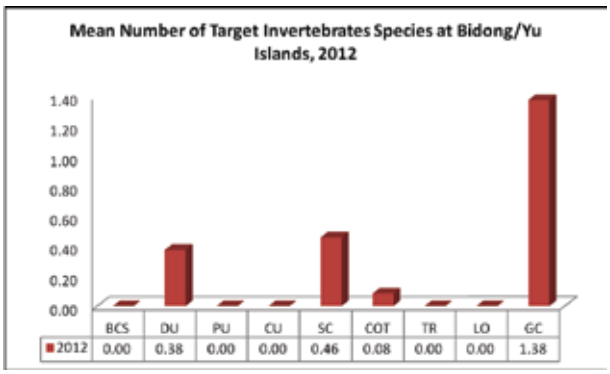
Fish



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

Abundance of several other indicators is low (Butterflyfish 3.25 individuals/500m3, Moray Eel 0.04). Similarly, food fish were all present in low numbers (Snapper 1.04, Parrotfish 2.21 and Grouper 0.21). The lack of protected status may be one cause of low fish abundance.

Invertebrates



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

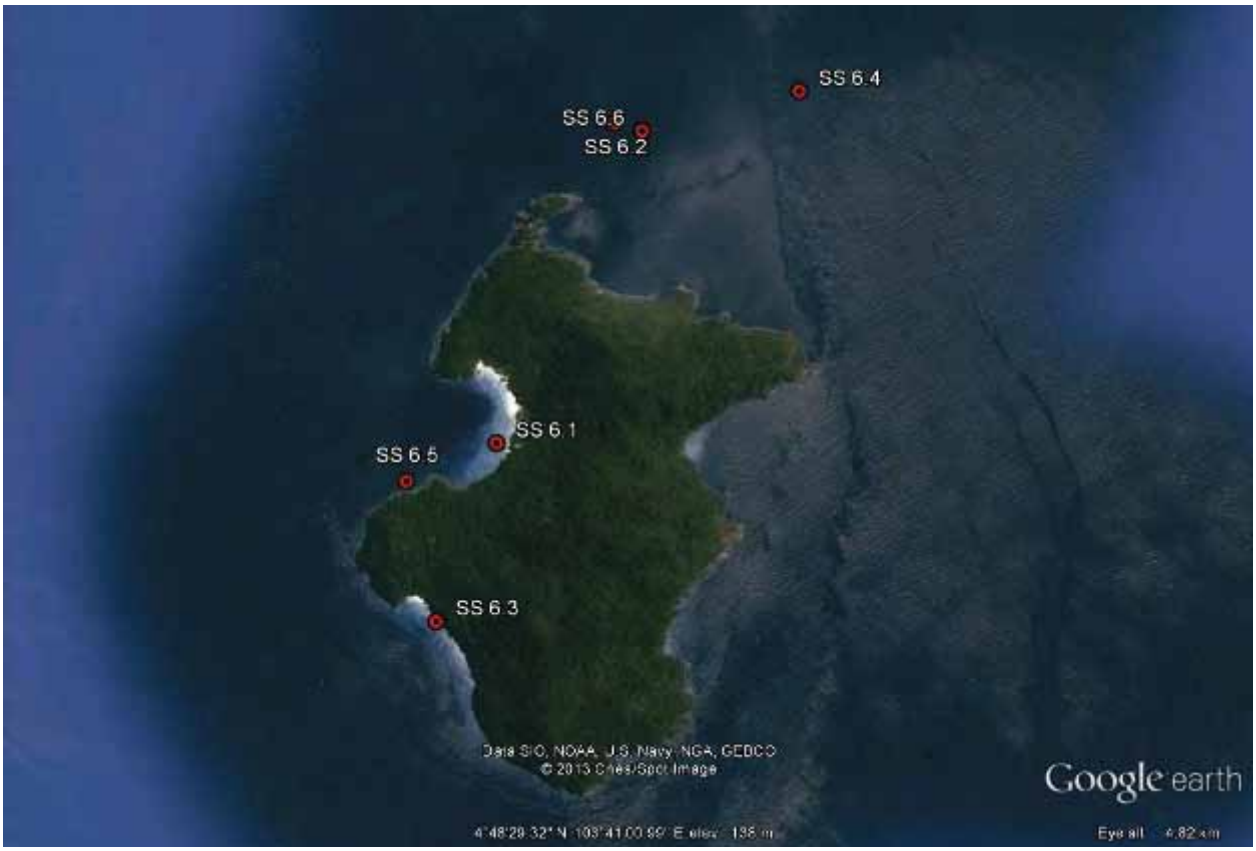
Abundance of most other indicators is low, including Diadema (0.38 individuals/100m2), Sea Cucumber (0.46), Crown of Thorns (0.08) and Giant Clam (1.38).

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).

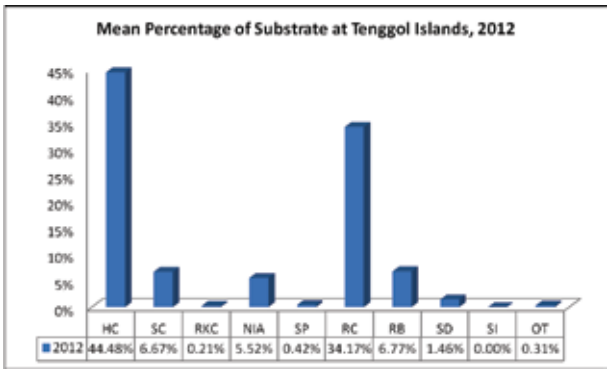
The island is a popular diving destination, due to the surrounding deep water which attracts more mega fauna than other islands (whale sharks are common around the island). There are three resorts on the island, each with its own dive operator. There is no mains electricity, groundwater supplies are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

Much of the islands' coastline is rocky, but there are fringing reefs and submerged reefs.



Map 8: Surveyed sites in Tenggol

Substrate

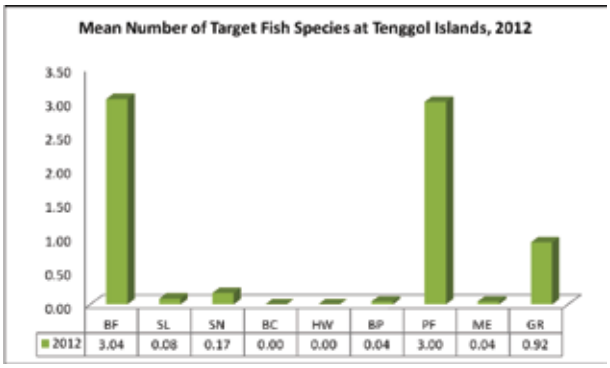


The site is considered to be in good condition, with 51.15% live coral cover, above the average (50.39%) for reefs of the Sunda Shelf region.

The level of NIA is moderately high (5.52%). A large proportion of this is recorded at Fresh Water Bay (NIA 21.25%), where the three resorts are located.

Levels of other substrate categories are low (e.g. RKC 0.21%, RB 6.77%, SI 0%), indicating few recent disturbances at Tenggol.

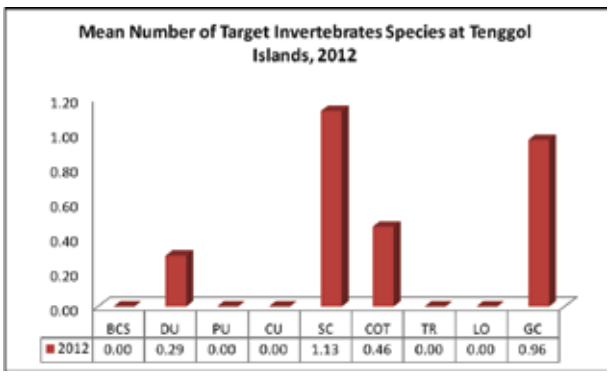
Fish



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

Abundance of Butterflyfish (3.04 individuals/500m3) is the highest. Other indicators are present in low numbers (Sweetlips 0.08, Snapper 0.17 and Grouper 0.92).

Invertebrates



Several targeted species are absent, including Banded Coral Shrimp, Pencil and Collector Urchins, Triton and Lobster.

Abundance of most other indicators is low, including Diadema (0.29 individuals/100m2), Sea Cucumber (1.13), Crown of Thorns (0.46) and Giant Clam (0.96).

3.2.7 Pemanggil/Aur

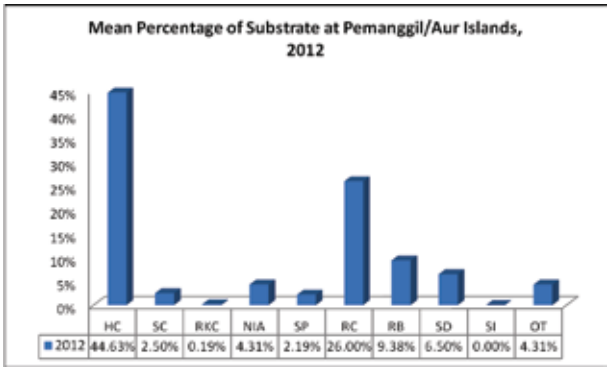
The two islands of Pemanggil and Aur, which are about 15km apart, are approximately 45-65km east of Mersing off the East coast of Peninsular Malaysia. Both islands and their surrounding waters were gazetted as Marine Parks in 1994 under the Fisheries Act 1985 (Amended 1993).

The islands are sparsely populated with few villages and have for many years been a frequent stopover point for fishermen. Aur is a popular diving destination among tourists from Singapore.

In this report the data for these two islands are presented together due to their proximity and the limited amount of sites surveyed on both islands

Map 9: Surveyed sites in Pemanggil/Aur

Substrate

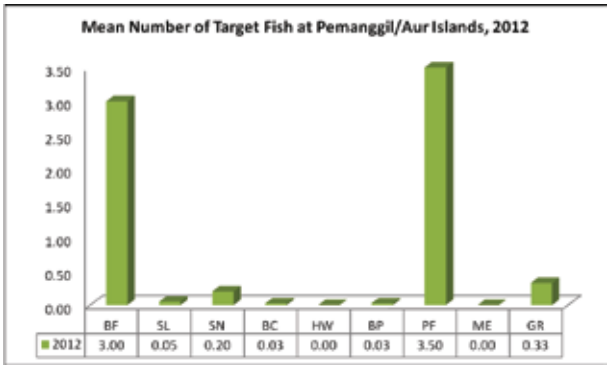


The site is considered to be in fair condition, with 47.13% live coral cover, below the average (50.39%) for reefs of the Sunda Shelf region.

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

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

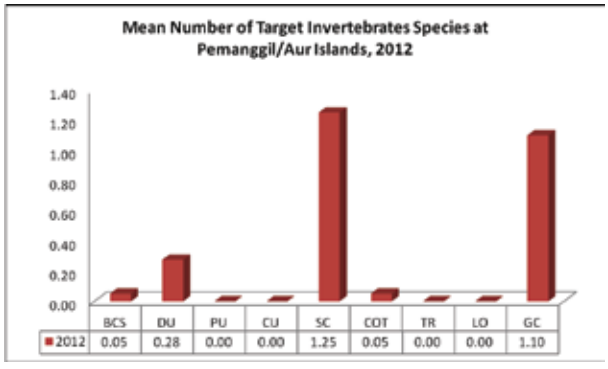
Fish



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

Abundance of most other indicators is low, including Butterflyfish (3 individuals/500m3), Snapper (0.20), Barramundi Cod (0.03), Bumphead Parrot (0.03), Parrotfish (3.50), and Grouper (0.33).

Inverte-



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

Other indicators are present in low, including Banded Coral Shrimp (0.05 individuals/100m2), Diadema Urchin (0.28), Sea Cucumber (1.25), Crown-of-thorns (0.05), and Giant Clam (1.10).

3.2.8 Sibu/Tinggi

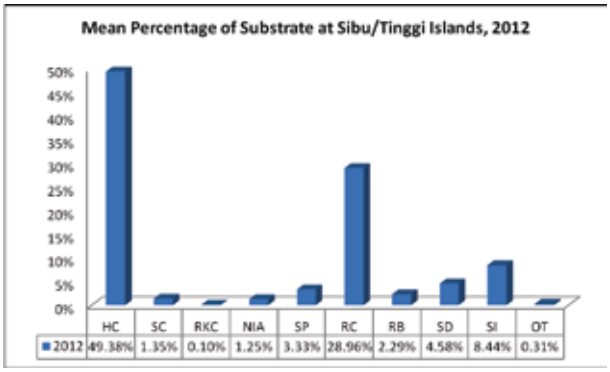
Sibu Island is located less than 10km off the East coast of mainland Peninsular Malaysia and Tinggi Island less than 15km. Both islands and their surrounding waters were gazetted as Marine Parks in 1994 under the Fisheries Act 1985 (Amended 1993).

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 non 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/Tinggi

Substrate

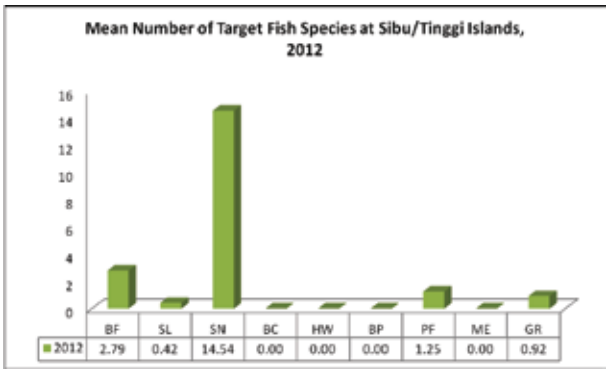


Results of the surveys in Sibu/Tinggi suggest that coral reefs around the islands are in good condition, with 50.73% live coral cover, slightly above the average (50.39%) for reefs in the Sunda Shelf region. However this high number is probably not a very good representation of reef cover around these islands, as time limits allowed for only 6 sites to be surveyed in this area and thus the best sites were selected.

Sibu/Tinggi has the second highest level of SI (8.44%). 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.

The levels of other substrate categories are low, indicating few recent disturbances. The exception is RC (28.96%), which forms a good base for new coral recruits.

Fish

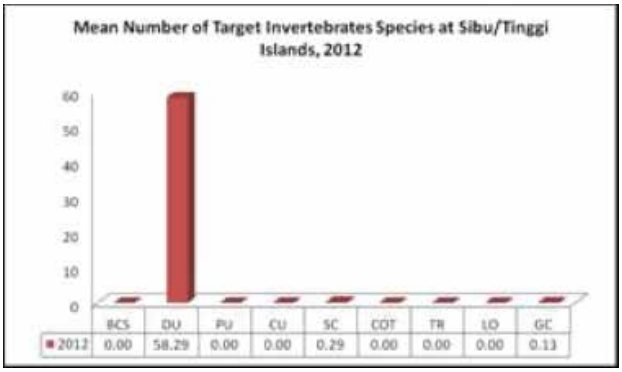


Four indicator species were completely absent from surveys (Barramundi Cod, Humphead Wrasse, Bumphead Parrot and Moray Eel).

Snapper (14.54 individuals/500m3) are the most abundant food fish, with lower populations of Parrotfish (1.25) and is the lowest of all islands surveyed in the Sunda Shelf region.

Abundance of other indicators is low, including Butterflyfish (2.79), Sweetlips (0.42), and Grouper (0.92).

Invertebrates



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

Abundance of Diadema Urchin (58.29 individuals/100m2) is high. For the remaining indicators, abundance is generally very low (Sea Cucumber 0.29 and Giant Clam 0.13).

3.2.9 Miri/Kuching

Miri, located in northern Sarawak, is the State's second largest city. Kuching, situated at the banks of the Sarawak River in the south western part of Sarawak, is the capital city of Sarawak.

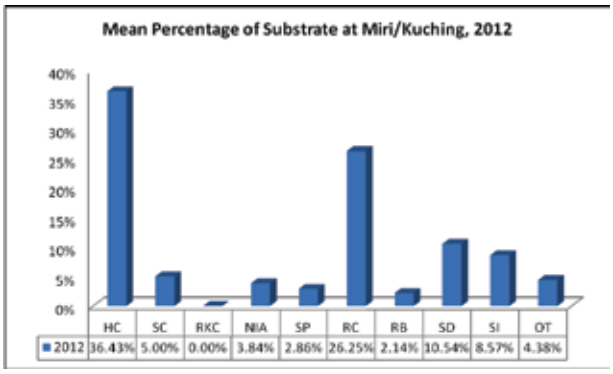
Miri is the birthplace of Malaysia's petroleum industry, which remains the major industry in the city, alongside timber and oil palm production and a growing tourism sector. The data for these two areas in Sarawak are being presented together because both areas come under the same Eco-region and the limited number of surveys conducted in Kuching.

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, due to security concerns

Map 11: Surveyed sites in Miri

Map 12: Surveyed sites in Kuching

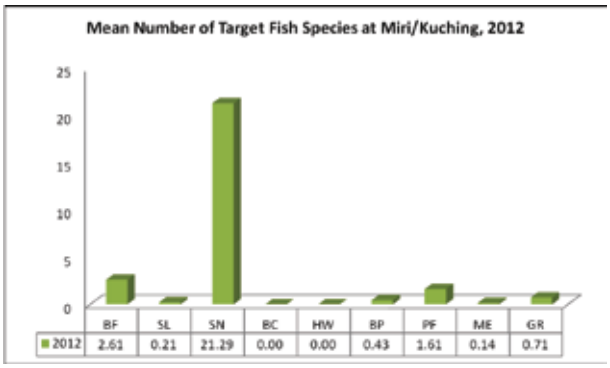
Substrate



The site is considered to be in fair condition, with 41.43% live coral cover, below the average for reefs of the Sunda Shelf region (50.39%)

The reefs in general have high levels of SI (8.57%), which is not unexpected given the nature of the coastline of much of Sarawak (extensive mud flats and mangroves). Levels of other substrate categories are low (e.g. RKC 0%, NIA 3.84% and RB 2.14%), indicating few recent disturbances at Miri/Kuching.

Fish

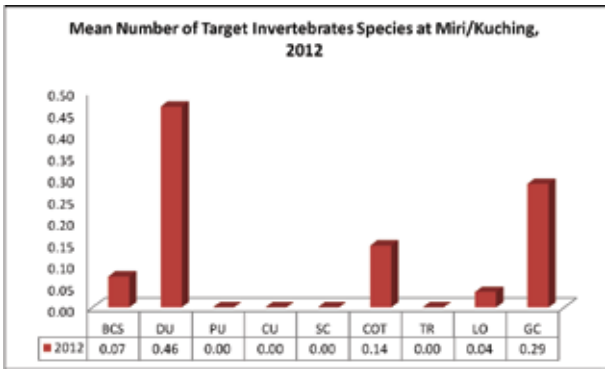


Only two indicator species were completely absent from surveys (Barramundi Cod and Humphead Wrasse).

Abundance of Snapper (21.29 individuals/500m3) is the higest of all islands surveyed in the Sunda Shelf region.

Abundance of other indicators is generally low (Butterflyfish 2.62, Sweetlips 0.21, Bumphead Parrot 0.43, Parrotfish 1.61, Moray Eel 0.14, and Grouper 0.71).

Invertebrates



Diadema, Pencil and Collector Urchins, Sea Cucumber and Triton are not recorded in any surveys.

For the remaining indiators, the populations are very low (Banded Coral Shrimp 0.07 individuals/100m2, Diadema Urchin 0.46, Crown-of-thorns 0.14, Lobster 0.04 and Giant Clam 0.29)

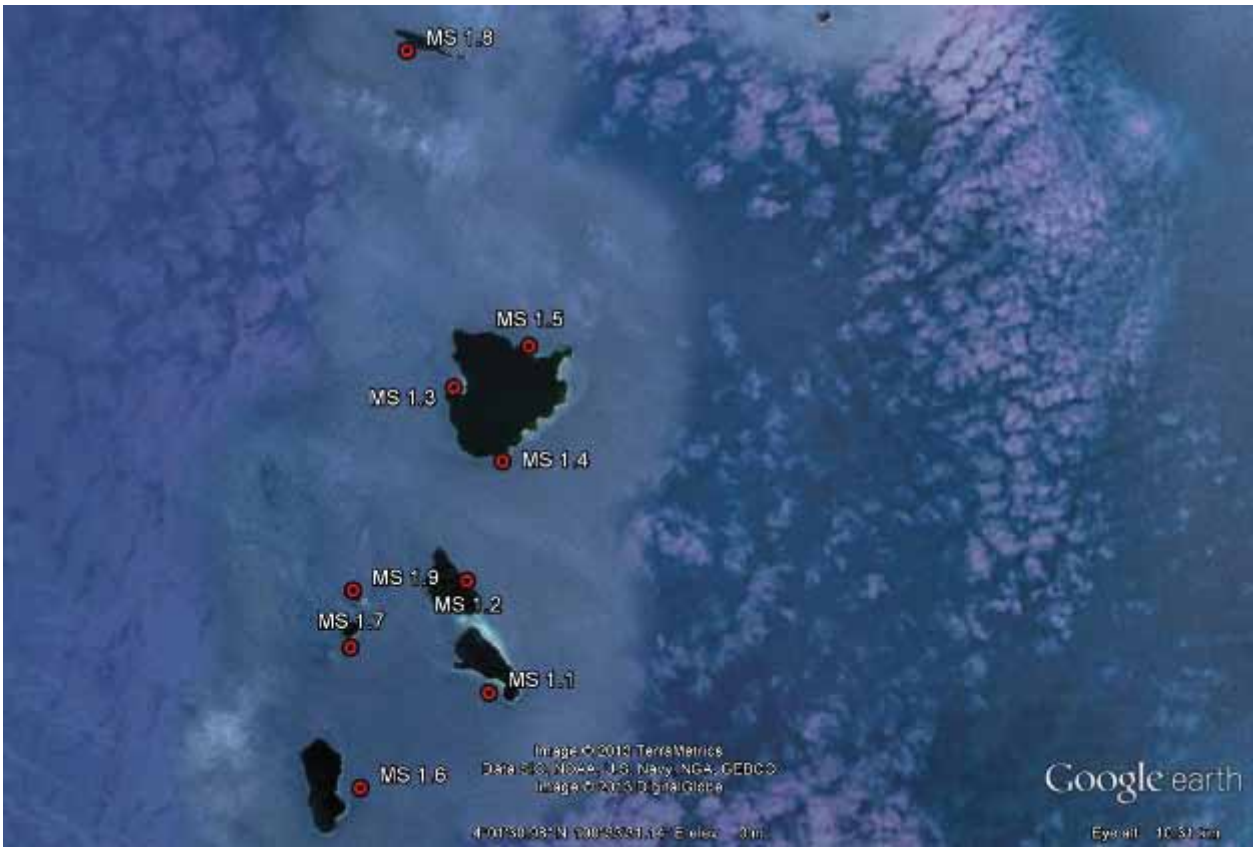
Straits of Malacca

3.2.10 Sembilan Islands

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

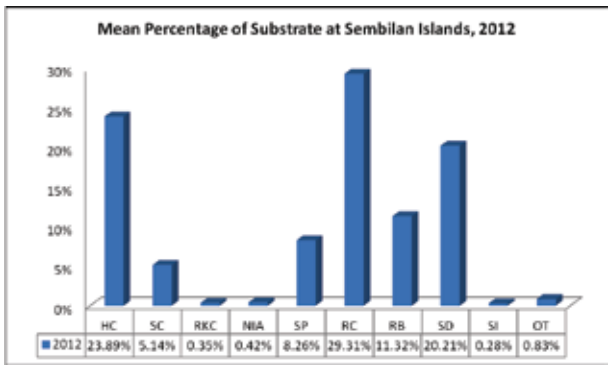
The islands are uninhabited and the only structures on the islands are small rest areas on Pulau Saga, constructed for the use of tourists and fishermen.

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.



Map 13: Surveyed sites in Sembilan

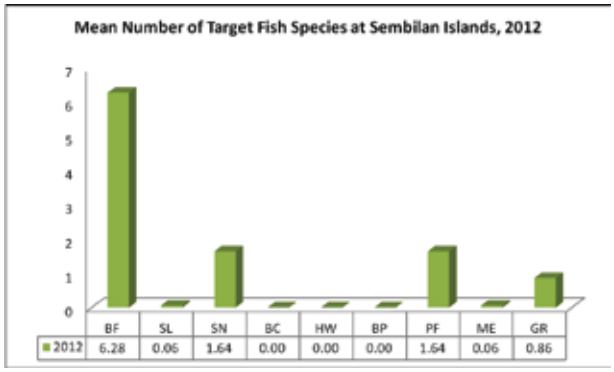
Substrate



Coral reefs around the islands are considered to be in fair condition, with 29.03% live coral cover, below the average for reefs in the Malacca Strait (32.24%).

The islands in general have very high SD, with an average of 20.21%, rising to as high as 38.13% on one site. The level of SP (8.26%) is high. However, 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 in the Malacca Strait.

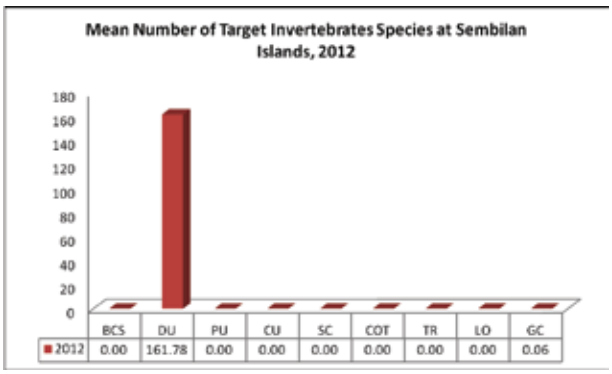
Fish



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

Abundance of most targeted indicators is generally low, with the exception of Butterflyfish (6.28 individuals/500m3).

Invertebrates



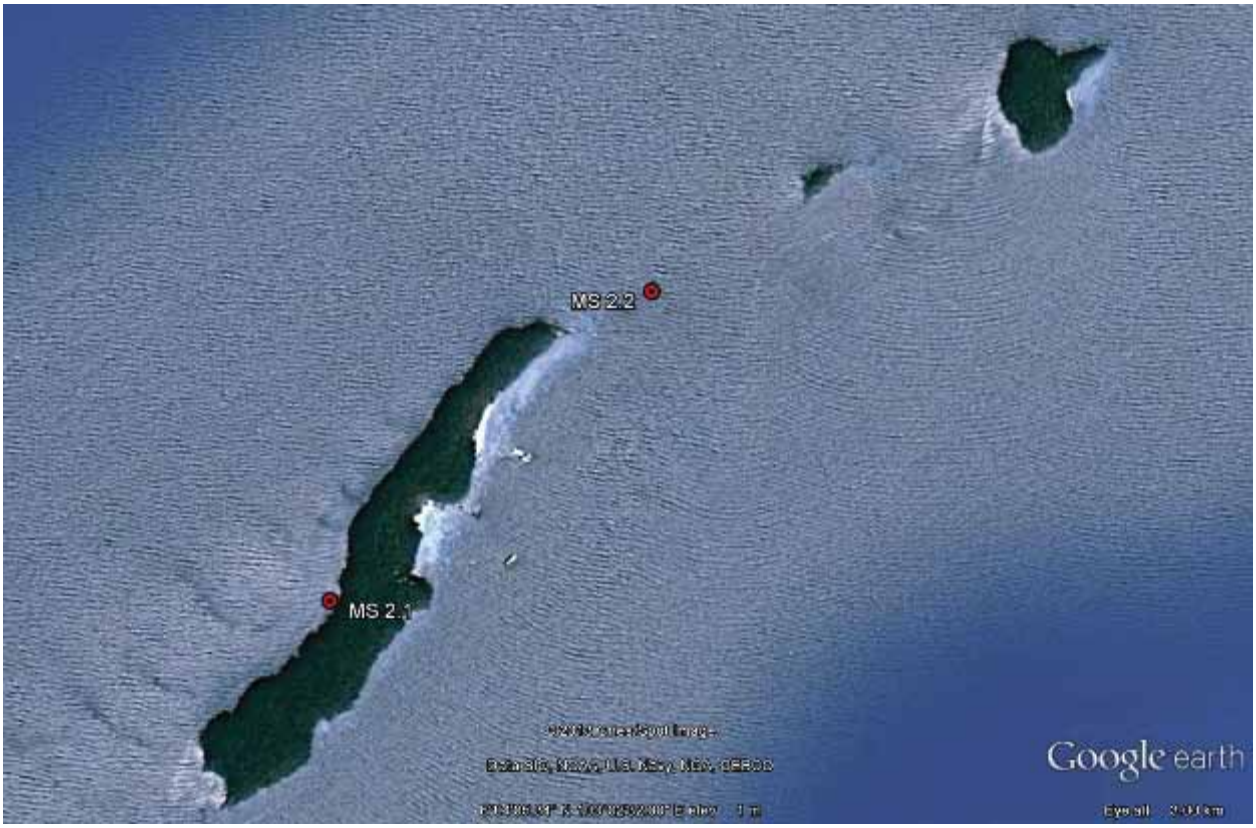
The only indicator species observed was Diadema Urchin. Other indicator species were completely absent from surveys (Banded Coral Shrimp, Pencil and Collector Urchin, Sea Cucumber, Crown-of-thorns, Triton and Lobster).

3.2.11 Payar

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

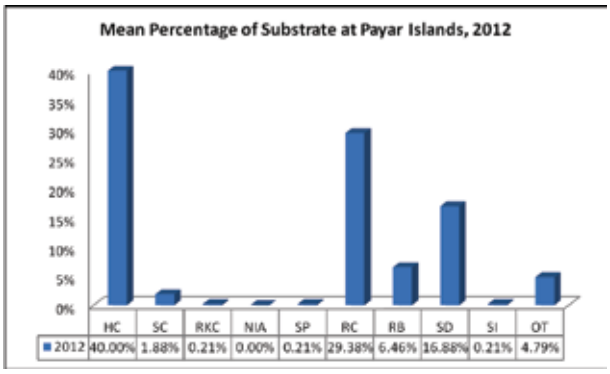
The island is a popular destination for tourists (mainly from Langkawi) famous for its corals and reef fishes. Measuring 2km long and 0.25km wide, its sheltered waters are ideal for snorkelling, diving and swimming.

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



Map 14: Surveyed sites in Payar

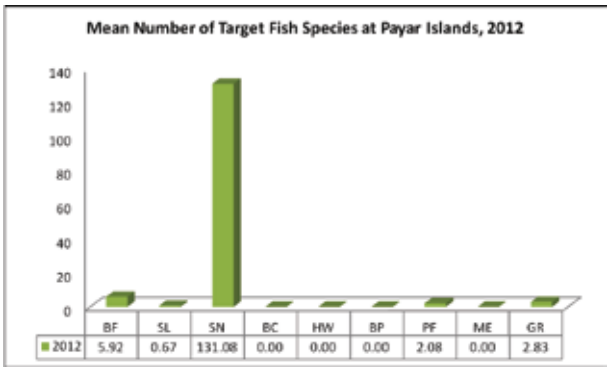
Substrate



The site is considered to be in fair condition, with 41.88% live coral cover, above the average (32.24%) for reefs of the Malacca Strait.

The island in general has very high SD, with an average of 16.88%, rising to as high as 28.13% on one site. Levels of other substrate categories are low (e.g. RKC 0.21%, NIA 0% and SI 0.21%), indicating few recent disturbances at Payar.

Fish

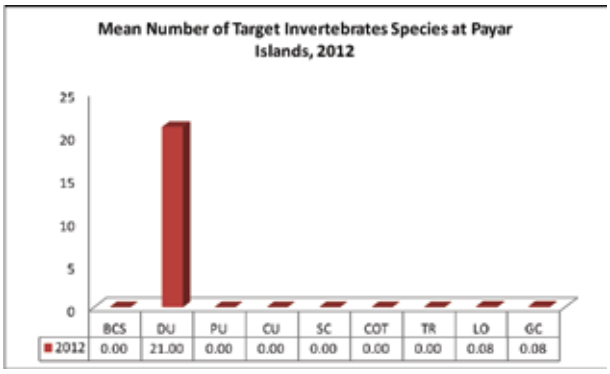


Four indicator species were completely absent from surveys (Barramundi Cod, Humphead Wrasse, Bumphead Parrot and Moray Eel).

Snapper (131.08 individuals/500m3) are the most abundant food fish, with lower populations of Grouper (2.83) and Parrotfish (2.08). Both Snapper and Grouper are the highest of all islands surveyed in Malaysia.

Abundance of Sweetlips (0.67) is low.

Invertebrates



Many of the indicator species were completely absent from surveys (Banded Coral Shrimp, Pencil and Collector Urchin, Sea Cucumber, Crown-of-thorns, and Triton).

Abundance of all other indicators is very low, with the exception of Diadema Urchin (21 individuals/100m2).

3.2.12 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.

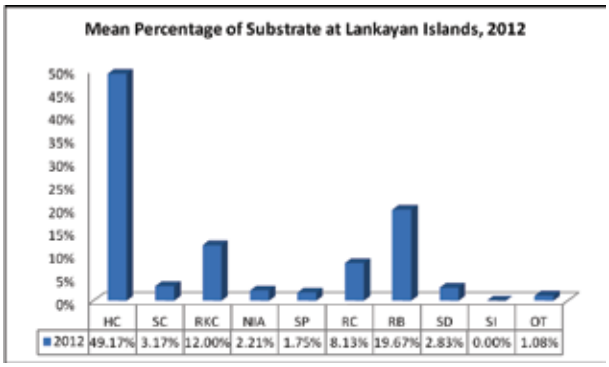
SIMCA is remote and distant from populated areas and no communities exist on the islands within the protected area. However, the SIMCA area is known to be a traditional fishing ground and is fished by both artisanal and commercial fishers from Sandakan, Kudat and the Philippines.

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 km2 island is the site of the Lankayan Island Dive Resort (LIDR), which is the only structure on the otherwise uninhabited island.

Survey sites are clustered around Lankayan Island; most within 5 km of the island (individual sites are not shown on the map).

Map 15: Lankayan Location Map (North Sabah)

Substrate

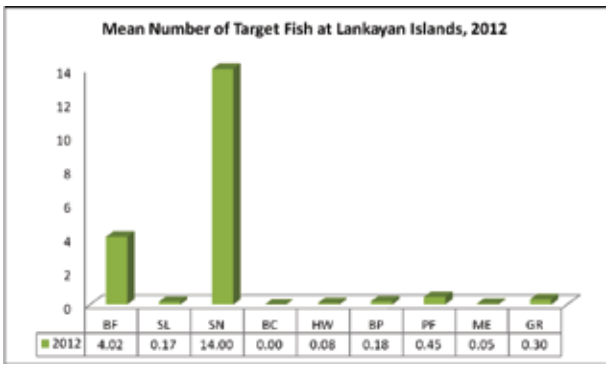


Coral reefs around the island are considered to be in good condition, with 52.33% live coral cover, above the average (42.72%) and the highest for reefs of the North Borneo region.

The high levels of RKC (12%) and RB (19.67%) indicate considerable disturbance around the island, probably reflecting the history of fish bombing in the area.

The level of other substrate categories is low (NIA 2.21% and SI 0%).

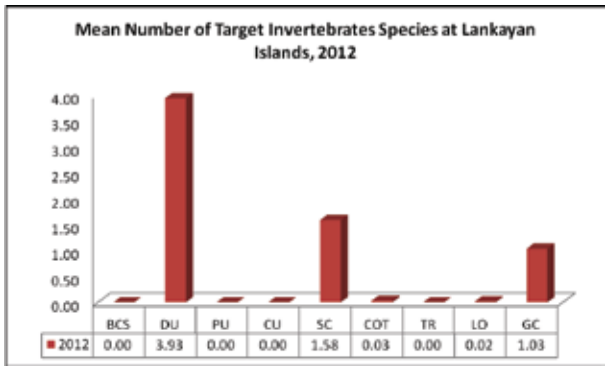
Fish



Fish populations are among the most diverse of any area surveyed in 2012, with only one indicator species completely absent from surveys (Barramundi Cod).

However, abundance of most species is generally low, with the exception of Butterfly fish (4.02 individuals/500m3) and Snapper (14). This is perhaps indicative of previous over-fishing.

Invertebrates



Four indicators are absent from all surveys (Banded Coral Shrimp, Pencil and Collector Urchins, and Triton).

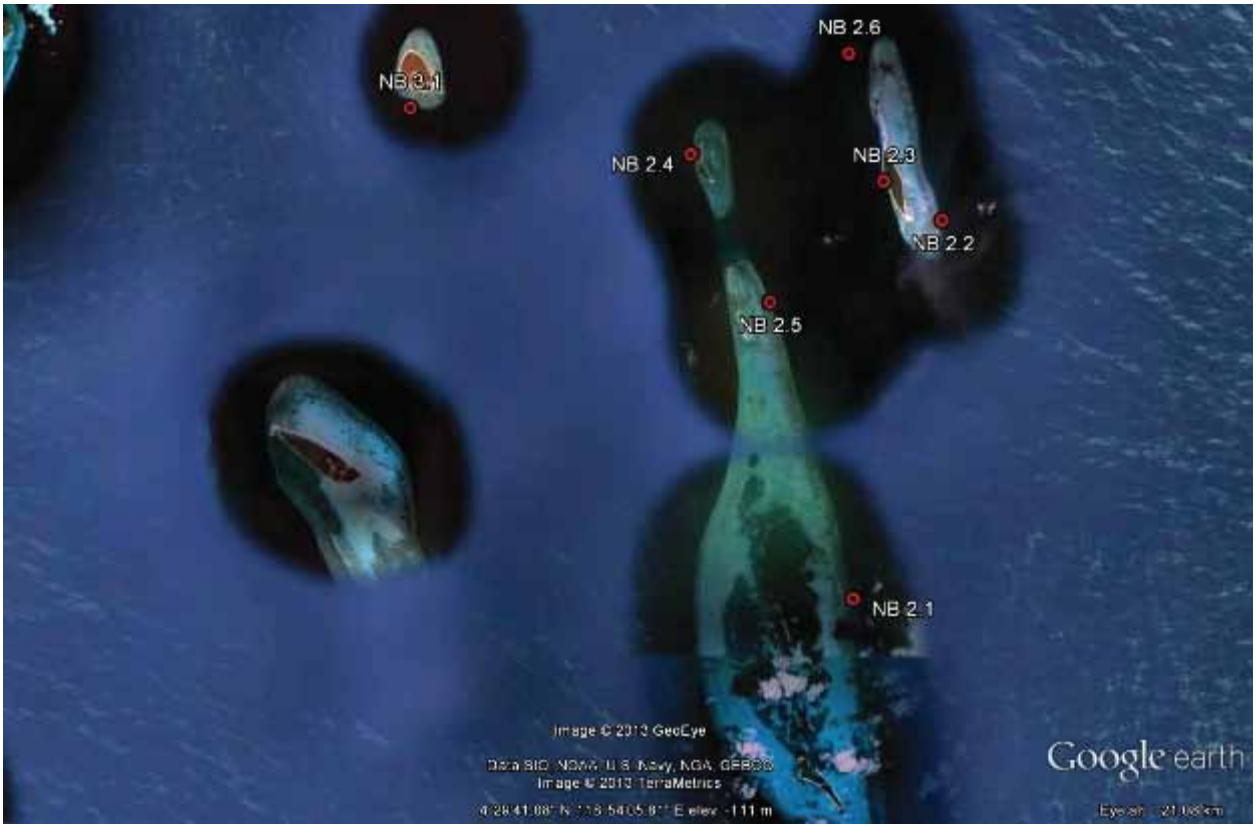
Abundance of most other indicators is low, including Diadema Urchin (3.93 individuals/100m2), Sea Cucumber (1.58), Crown of Thorns (0.03), Lobster (0.02) and Giant Clam (1.03).

3.2.13 Mataking/Pom Pom

The two islands of Mataking and Pom Pom, which are 8km apart, are approximately 35km east from the major town of Semporna in South Sabah. Both are resort islands, with two resorts on each island. Diving is the main activity on both islands, and they access the same coral reef dive sites.

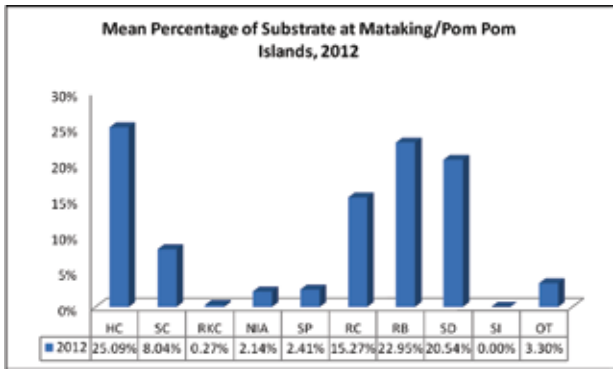
While the islands have no legal protected status, the presence of the resorts has effectively created small protected areas, keeping fishermen (including fish bombers) away from parts of the reefs surrounding the islands.

Both islands have fringing reefs, and coral extends down to almost 30m. Coral reefs around these, and surrounding, islands have been extensively damaged by fish bombing in the past.



Map 16: Surveyed sites in Mataking/Pom Pom

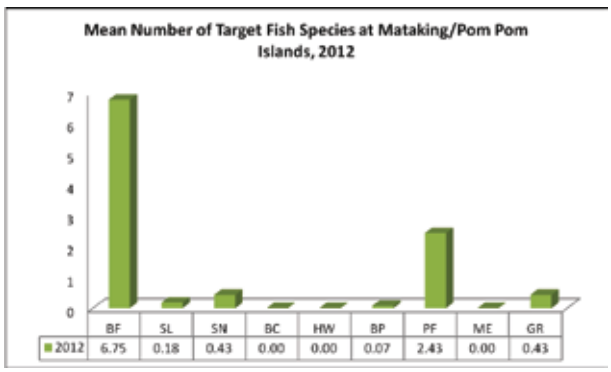
Substrate



The site is considered to be in fair condition, with only 33.13% live coral cover, below the average (42.72%) and the lowest of all sites surveyed in the North Borneo region.

The area in general has very high RB, with an average of 22.95%, rising to as high as 48.75% on one site. This is likely to be the result of extensive fish bombing over a long period of time.

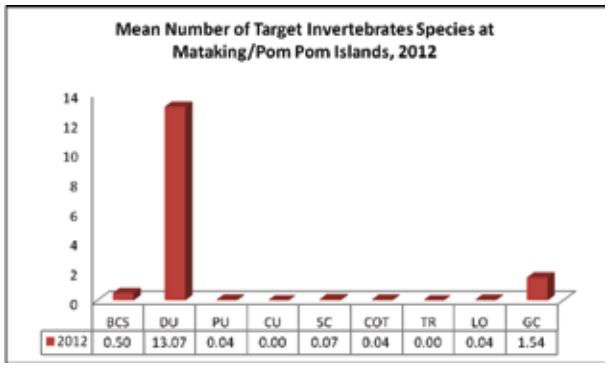
Fish



Abundance of most species is generally low, with the exception of Butterflyfish (6.75 individuals/500m3) and Parrotfish (2.43).

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

Invertebrates



Only two indicators are absent from all surveys (Collector Urchin and Triton).

With the exception of Diadema (13.07 individuals/100m2) and Giant Clam (1.54), populations of other indicator inverterbrates are low (Banded Coral Shrimp 0.50, Pencil Urchin 0.04, Sea Cucumber 0.07, Crown-of-thorns 0.04, and Lobster 0.04).

3.2.14 Mabul

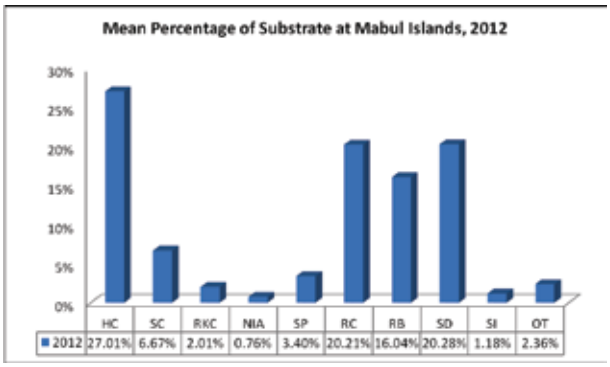
Mabul is located some 30km South of Semporna in South East Sabah, but only 13 km from the nearest river mouth and the same distance from Sipadan. It is a base for diving Sipadan and surrounding sites.

The island has two villages and a population of over 2,000, many immigrants from the Southern Philippines. These latter have no legal status and thus have no access to government education or health care services.

A popular diving destination in its own right, the island is home to a growing number of resorts and home stays, now numbering over 15 in total. It has no centralised electricity supply, severely limited fresh water supplies and the villages have no sewage treatment facilities

Map 17: Surveyed sites in Mabul

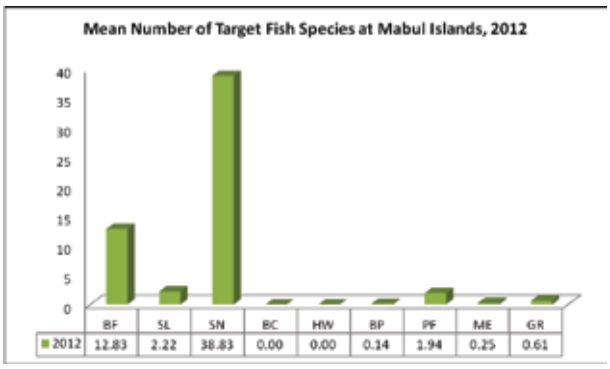
Substrate



The site is considered to be in fair condition, with 33.68% live coral cover, below the average for reefs of the North Borneo region (42.72%).

Mabul has a higher level of SD (20.28%) than other islands in the North Borneo region. Levels of other substrate categories is generally high (RB 16.04% and SI 1.18%), except for NIA (0.76%)

Fish

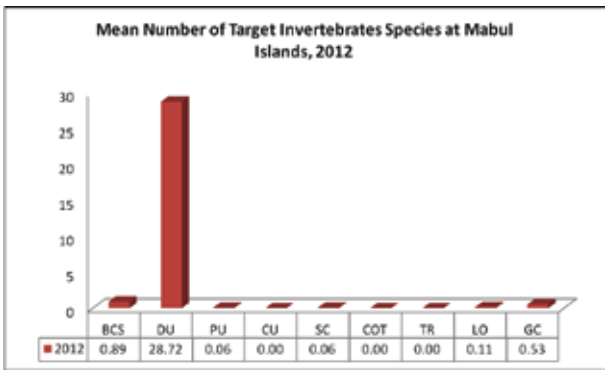


Only two indicator species were completely absent from surveys (Barramundi Cod and Humphead Wrasse).

Abundance of Butterflyfish (12.83 individuals/500m3) and Sweetlips (2.22) is the highest compared to other islands in East Malaysia.

Apart from Snapper (38.83), other indicator species are present in relatively low numbers.

Invertebrates



Four indicators are absent from all surveys (Collector Urchin, Sea Cucumber, Crown of Thorns and Triton).

With the exception of Diadema (28.72 individuals/100m2) and Banded Coral Shrimp (0.89), populations of other indicator inverterbrates are low, (less than 1).

3.2.15 Mantanani

The Mantanani islands form a small group of three islands 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.

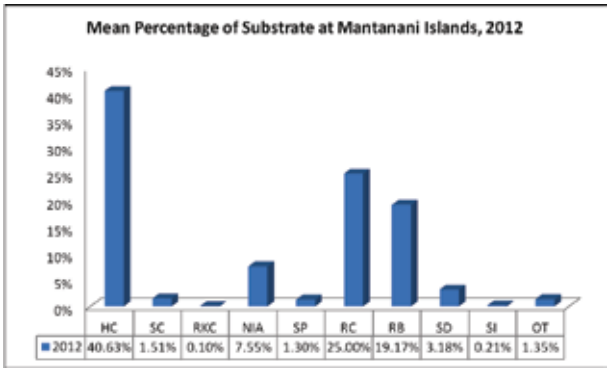
Mantanani is mainly populated by Bajau Ubian, with a small population of about 1,000 in two villages. The three main economic activities are fishing, drying salted fish and collecting shellfish.

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 18: Surveyed sites in Mantanani

Substrate

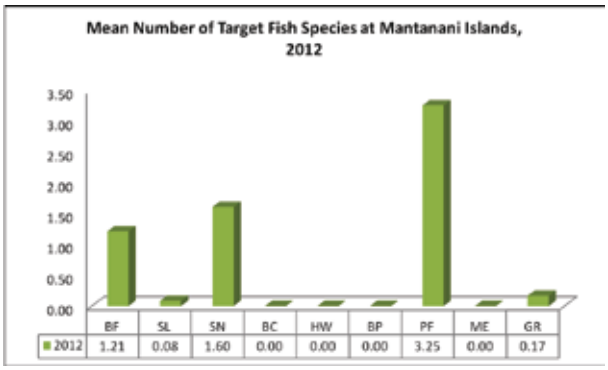


Coral reefs around the islands are considered to be in fair condition, with 42.14% live coral cover, slightly below the average (42.72%) for reefs in the North Borneo region.

This site has very high levels of RB (19.17%), rising to as high as over 30% on several sites. This is likely due to extensive fish bombing over a long period 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

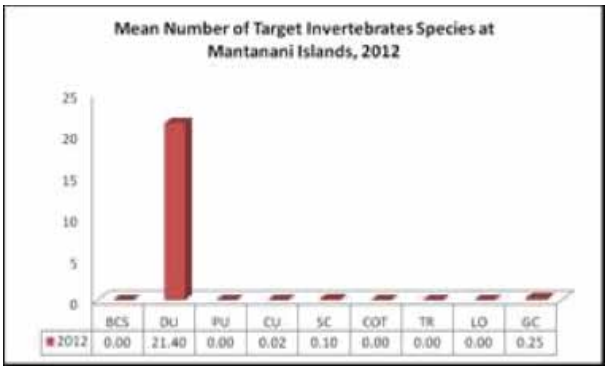
Fish



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

Abundance of most other indicators is the lowest of all islands in the North Borneo region, including Butterflyfish (0.21 individuals/500m3), Sweetlips (0.08), and Grouper (0.17).

Invertebrates



Several targeted species are absent, including Banded Coral Shrimp, Pencil Urchin, Crown-of-thorns, Titon and Lobster.

Abundance of Diadema Urchin is high, with an average of 21.40 individuals/100m2. Abundance of the remaining indicator species are low (Collector Urchin 0.02, Sea Cucumber 0.10, and Giant Clam 0.25).

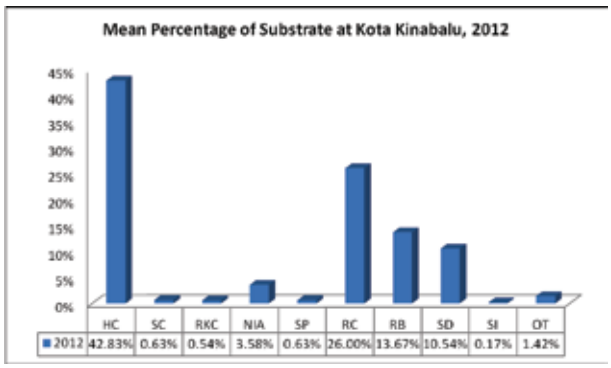
3.2.16 Kota Kinabalu – Tunku Abdul Rahman Park

Tunku Abdul Rahman Park is a cluster of islands comprising Pulau Gaya, Pulau Sapi, Pulau Manukan, Pulau Mamutik and Pulau Sulug. The park is located between 3 to 8 km off Kota Kinabalu the capital of Sabah, and spread over 4,929 hectares, two thirds of which cover the sea. 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 19: Surveyed sites in TARP, Kota Kinabalu

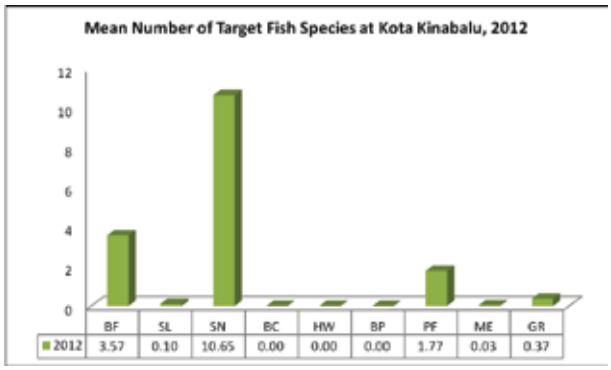
Substrate



Coral reefs around the islands are considered to be in fair condition, with 43.46% live coral cover, above the average (42.72%) for reefs of the North Borneo region.

The low levels of RKC (0.54%), NIA (3.58%) and SI (0.17%) indicate few recent disturbances.

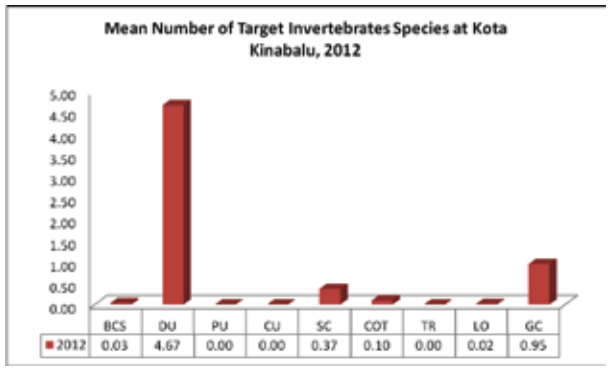
Fish



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

Snapper (10.65 individuals/500m3) are the most abundant food fish, with lower numbers of Parrotfish (1.77). Abundance of all other indicators is low, with the exception of Butterflyfish (3.57).

Invertebrates



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

Abundance of most species is generally low (Banded Coral Shrimp 0.03, Sea Cucumber 0.37, Crown-of-thorns 0.10, Lobster 0.02 and Giant Clam 0.95), with the exception of Diadema Urchin (4.67 individuals/100m2).

3.3 Five Year Comparison – Perhentian, Tioman and Redang

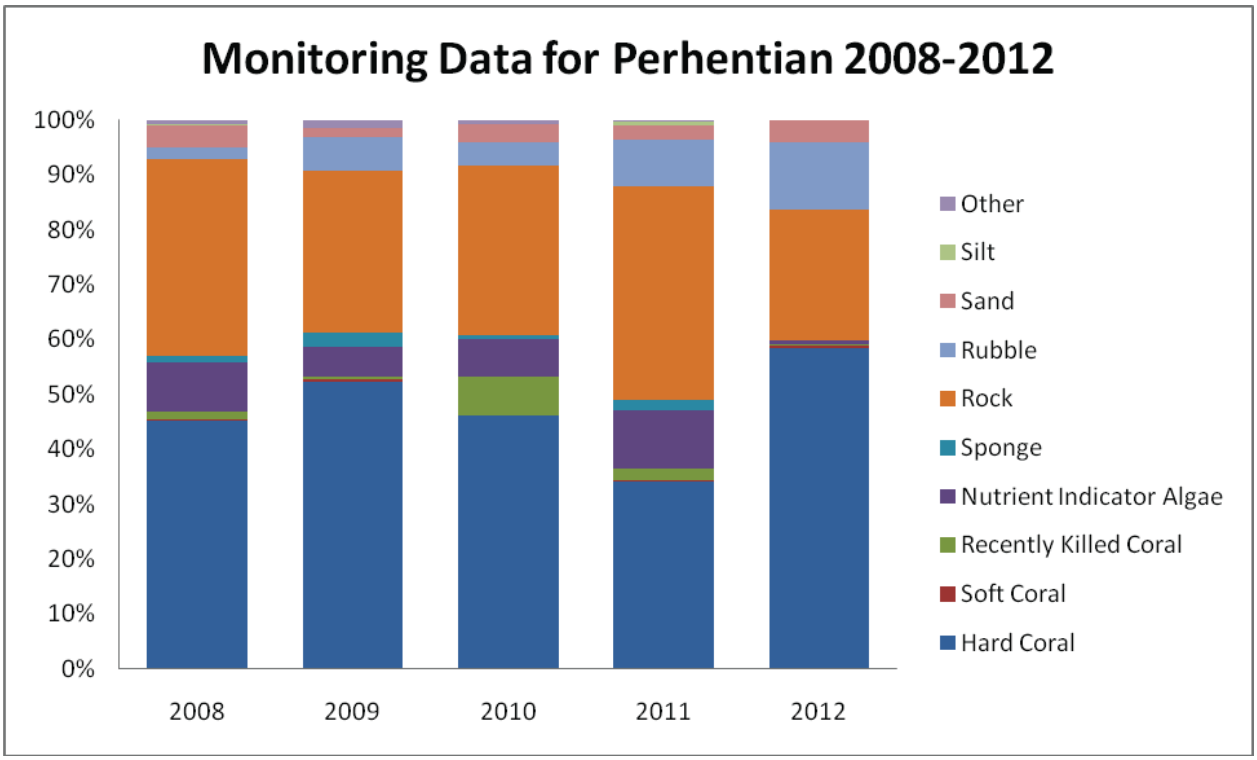
Reef Check data are primarily used for monitoring coral reef health and comparisons of data over time can highlight significant changes and indicate potential problems. The sections below provide details of the health of selected coral reefs in Perhentian, Tioman and Redang over five years, from 2008 to 2012. Only sites that were surveyed every year over the five 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 five 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.

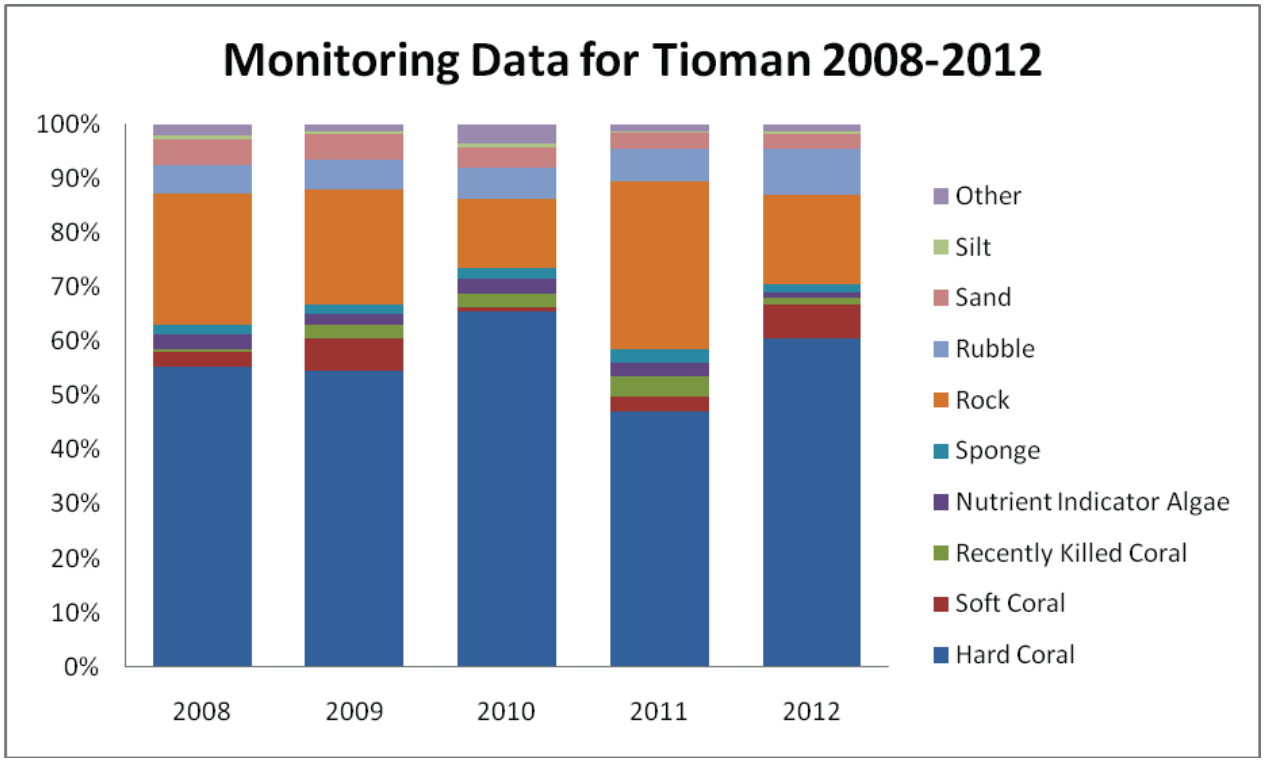
This is mirrored by concomitant changes in RKC and RC over the period. The data are consistent with HC killed by the 2010 bleaching event being reclassified first as RKC (large increase from 2009 to 2010 and declining in 2011) and then RC (highest level in 2011).

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 inconsistent factor is the level of NIA detected during surveys. From 2008 to 2011 the level of NIA remained in the range 5-10%, rising to 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. However, in 2012 the level of NIA recorded was at its lowest over the five year period, despite the fact that no changes were made to sewage treatment systems on the islands.

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

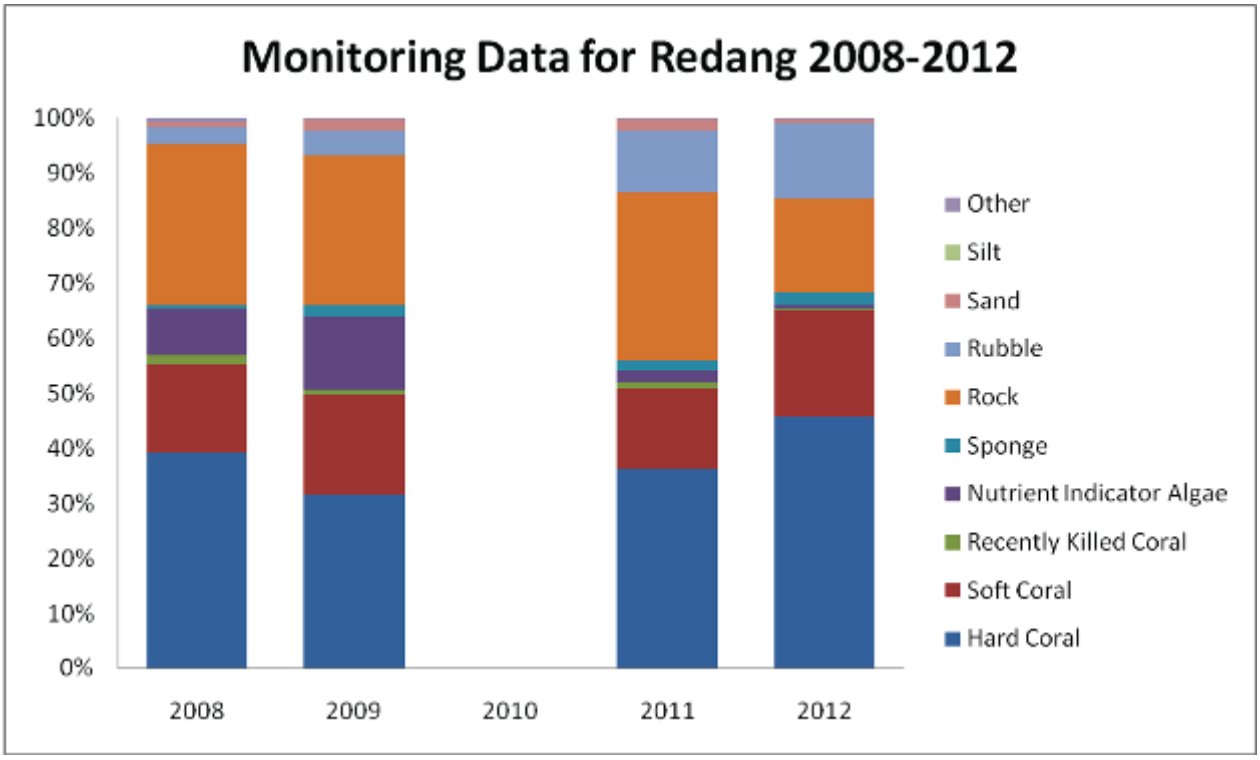


The data from the surveys conducted on Tioman over the last five years show that there have been no significant changes over that period of time. The overall condition of the coral reefs surveyed around Tioman Island has been consistently good over the years, with LCC above 50%, a rating of "good" according 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.

There is a need to look into the decrease of HC cover and increase of NIA in 2012 in Chebeh, as it was a considerably decrease from 25.63% in 2011 to 13.75% in 2012 for HC and increase from 0% in 2011 to 4.38% in 2012 for NIA. This situation needs to be monitored to ensure no continuing proliferation of algae as it could have a negative impact on the corals over a long term period.

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 an increase of Hard Coral cover over the years, with the exception of a slight decline between 2008 and 2009. However, 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 RB in 2011 and 2012 as it was a significant increase from 4.27% in 2009 to 13.85% in 2012. The sites of most concern are Chagar Hutang and Pulau Lima Southern Tip where over 37% RB was recorded during the survey. 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. Recommendations and Challenges

The following general recommendations apply to all coral reef areas:

- Increase number of sites covered by survey programmes in both Peninsular and East Malaysia, and including sites outside existing Marine Parks
- Encourage 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.
- 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 immedi ately 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)
- 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 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.

A number of broader challenges facing Malaysia's coral reefs are described below. These have changed little since Reef Check Malaysia began intensive and structured monitoring in 2007.

4.1 Protected Areas

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.

Educational programmes for local populations are also urgently required to reduce instances of destructive fishing, and to create awareness of the economic importance of reefs for future generations.

RCM is working with various stakeholders to promote the establishment of additional MPAs in two areas: Sembilan Islands (off Lumut, Perak) and Mantanani (off Kota Belud, Sabah). These programmes include surveys, education and institution building.

4.2 Pollution

Numerous sources of pollution can have impacts on coral reefs, including run off from agriculture and oil palm, municipal waste and industrial activities.

In East Malaysia, algal growth has accelerated on reefs formerly free of NIA in previous years. Dissolved inorganic nitrogen from fertilisers used on oil palm plantations is a threat to reef quality and with bleaching of corals already a problem, a transition to algae-dominated reefs becomes a possibility, with consequent loss of ecosystem services.

Sewage pollution is a particular concern. Levels of NIA recorded in some survey areas indicate the presence of nutrient, and it is likely that one source of this nutrient is sewage effluent. This observation is supported by water quality testing conducted in 2009 (Perhentian and Tioman) and 2011 (Perhentian).

Most resorts (and households) in coral reef areas rely on a septic tank system for sewage treatment which, if not correctly designed and maintained, can overflow, releasing sewage effluent into the sea. It is recommended that State Governments establish a system for regular de-sludging of septic tanks, to ensure they operate effectively. This will be a lower cost and less disruptive solution than the construction of large scale, centralised sewage treatment facilities.

In some areas, COT predation is a problem (particularly East coast of Sabah around Lankayan). The cause of COT outbreaks is still not well understood, but recent research links population explosions to a combination of fresh water inflow and nutrient pollution. Large scale COT removal programmes have shown some success, but continued efforts are required to reduce numbers of this coral predator. Control of sewage discharges will help to mitigate this.

RCM is working with resort and dive operators in the Perhentian islands to improve sewage treatment by implementing septic tank maintenance and de-sludging programmes. This programme can be replicated for all the islands off the East coast of Peninsular Malaysia. RCM is also working with dive operators on the East coast islands to promote regular COT clean-up programmes

4.3 Waste Recycling and Composting

The high number of tourists visiting Malaysia's coral reefs puts significant strain on waste collection and disposal systems. Many resorts areas rely on transportation of waste to municipal facilities, often some distance from the resort itself.

There is a need to promote waste segregation and recycling, composting of organic wastes and separation of hazardous and toxic wastes (such as used engine oil and batteries). This will reduce the load on waste collection and transportation systems. A well designed system should also generate revenue from the sale of recyclables and compost.

Finally, education and awareness campaigns should be implemented to promote better waste management and reduce littering, particularly among local communities as well as tourists.

Working with resort operators and the local authority, RCM has facilitated the implementation of an improved solid waste management system for the Perhentian islands. A composting machine has been installed in the village. On Tioman, a recycling programme will be launched for plastics and cooking oil.

4.4 Construction & Development

Tourism is a major industry in Malaysia, and an important source of revenue and jobs. However, as tourist numbers continue to rise, increased construction of resorts and tourism infrastructure can have negative impacts on reefs, if not properly controlled.

Construction projects, some of which are poorly planned, often lack the implementation of appropriate mitigation measures to protect the environment. Construction on the islands, especially works that involve land clearing or construction in the sea, can cause sedimentation of nearby reefs if control measures, such as silt curtains, are not adequately used and maintained. The location of jetties needs to be carefully planned so that they are not built directly on reefs and have the least impact on water movement. Resort development should be managed to ensure minimum land clearing. If poorly managed, such developments can have a significant impact on coral reefs.

More broadly, sediments also come from the river outflows around the coasts of both Peninsular and East Malaysia. Although silt levels on Reef Check surveys do not show up as a major substrate effect, observations during surveys detected significant amounts of silt on dead coral, as well as and in patches on live coral. Comments from dive operators on the East coast islands indicate that water quality is deteriorating from year to year, perhaps an indication of increasing amounts of silt from mainland waters spreading to the islands. This issue needs further investigation.

RCM will continue to monitor reefs and assess the impacts of coastal development. RCM will engage with relevant departments at State government level.

4.5 Tourist Impacts

Physical damage caused by divers and snorkelers can be a significant source of impacts on coral reefs. Some research suggests maximum numbers of visitors that a given reef can tolerate before the inevitable physical damage begins to degrade the reef.

Awareness campaigns should be implemented to educate all reef users on correct "reef etiquette", to encourage them to minimise their impacts. This should be targeted both directly at tourists (public displays of information) and at tourist operators (dive and snorkel operators), to ensure adequate supervision of tourists in the water. Such campaigns for tourists should be holistic, incorporating guidance on minimising their impacts in general, including waste recycling and water and electricity conservation.

One further controversial issue relating to tourist impacts concerns fish feeding. Many tourists feed fish while visiting the islands, and there is growing evidence that this is not healthy for fish populations. It is recommended that awareness materials be developed for tourists and snorkelling guides on this issue, to encourage visitors not to feed fish.

Fish feeding may also be an unintended source of nutrient that encourages algae growth. At the Redang Marine Park Centre, for example, large numbers of snorkelers visit daily and feed fish. A type of calcareous algae, Halimeda, was observed to be overgrowing the branching corals in the area, possibly reacting to the excess nutrient from fish feeding. A more detailed study should be carried out to establish the reason for the growth of the Halimeda so that action can be taken to prevent it from outcompeting the corals.

Through its regular Newsletter, Facebook page and printed materials, RCM actively promotes coral reef conservation issues to divers and snorkelers. Programmes are designed to raise awareness of coral reef conservation issues, and encourage tourists to minimise their impacts. RCM has trained snorkelling guides in Perhentian and Tioman to be "eco-friendly" guides and reduce impacts from their activities. RCM is working with stakeholders in Semporna to introduce regulations to better supervise divers.

4.6 Fisheries

There are regular reports of illegal fishing around some Peninsular islands, particularly Perhentian and Tenggol. These often occur during the monsoon season when visitor numbers are much lower and enforcement patrols more difficult due to sea conditions.

In some areas of East Malaysia, particularly southern Sabah, high population levels are resulting in significant fishing pressure on reefs. This is exacerbated by the high mobility of local populations, which are a mix of local, bajau and Philippine citizens.

While further resources will be required to stop such activities, other simple steps can be taken to reduce the impact of fishing boats visiting the islands. In Tenggol, for example, the only sheltered bay on the island is used as a mooring point for fishing boats throughout the year, and they discard huge amounts of trash (a cleanup in November 2011 yielded, among others, discarded oil filters, batteries, food cans, tyres and an air conditioner compressor). Closer monitoring of the activities of fishermen is required, as well as education to reduce the amount of trash they discard.

In Sabah, Fish bombing is still commonplace in some areas, and urgent efforts are required to combat this before large areas of reef are destroyed beyond recovery

There is concern amongst divers and local fishermen about commercial trawler fishing occasionally sweeping up fish from the reefs in some areas. Targeted fishing for high value species is still a problem in East Malaysia. Bumphead parrotfish, the last large fish species in Miri, have been found in the local fish market. If these fish are lost, Miri will lose an iconic fish and an important herbivore.

RCM participates in underwater clean ups to highlight the problems of trash and illegal fishing activities. In Sabah, RCM is implementing an education programme for schools and the general public to raise awareness of the economic and ecological damage caused by fish bombing.

4.7 Improving Management through Monitoring

As stated in "Reefs at Risk", additional monitoring of coral reefs across Southeast Asia is essential to provide details of where and how coral reefs are threatened.

This conclusion is supported by the paucity of historical information available in Malaysia. Although coral reef surveys are being conducted by various institutions (government, academia, NGOs), lack of coordination means that:

- No standardised method is applied, as a result of which data from different surveys are often not easily compared
- The data are distributed between various institutions, preventing a clear picture from emerging.

Establishing a comprehensive, coordinated monitoring programme which also includes monitoring reefs outside of the Marine Parks would have the following benefits:

- Improved management of marine protected areas: better information on the current status of reefs, particularly within Marine Parks, would allow managers to design improved management interventions
- Fisheries: monitoring reef health provides an indication of the health of fish stocks on the reef, allowing better management decisions on fishing policies
- Economic development: tourism is an important industry in Malaysia, and the country's marine resources are a key part of the attraction to visitors. Conserving coral reefs will protect this sector and allow further growth
- Stakeholder engagement: the involvement of local communities, tourism operators and tourists in the monitoring enhances the sense of ownership and responsibility while creating awareness about the reefs. It also allows for large amounts of data to be collected at a lower cost.

It is clear that there is a need for many more sites to be surveyed regularly before a detailed understanding of the status of coral reefs in the East coast islands, and Malaysia more generally, can be established. More permanent transects need to be placed at selected sites on each island to ensure regular monitoring of the same reef areas.

By supporting additional EcoDiver training in Malaysia, not only will the numbers of educated snorkelers and divers increase, but more will be available to participate in surveys of Malaysia's most valuable marine resource – coral reefs.

RCM trains EcoDivers and conducts Reef Check surveys around Malaysia. Every year, the number of sites covered by surveys increases.

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The Khazanah Grants Programme aims to guide all its Civil Society Partner Organisations towards achieving sustainable funding, operational excellence and organisational development

YTL: Supporting efforts by RCM to improve coral reefs around Malaysia.

Alstom Power: through Alstom Foundation, is funding our Rainforest to Reef Programme, targeted at school children from the Marine Park Island schools.

Malakoff: community based programme to rehabilitate coral reefs and raise awareness in Tioman island

Murphy Oil Corporation: supporting reef rehabilitation efforts in Mantanani island, Sabah

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

Kose: supporting reef rehabilitation programmes

F & N: funding recycling and awareness campaign in Redang.

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

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

United Nation Development Programme Malaysia: donates fund to support Reef Check resilience surveys

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 are grateful to Director General Dr Sukarno bin Wagiman, Deputy Director General En. Kamarruddin bin Ibrahim and Director En. Abdul Rahim bin Gor Yaman for their support, assistance and encouragement.

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
- Scuba Explorers, Tenggol
- Tioman Dive Centre, Tioman
- Borneo Divers, KK
- Reef Guardian, Lankayan, Sandakan
- Mataking Reef & Dive Resort
- Scuba Junkie, Mabul.

Other dive operators:

- Eco Divers Dive Centre, Tioman
- Seamonkey Dive Centre, KL
- Aqua Sport Divers, Kapas
- Kapalai Resort
- Pom Pom Island Resort
- Scooba Tank and Mari Mari Dive Lodge, Mantanani.

We also rely on volunteers to help conduct surveys, and the following provided outstanding assistance during 2012:

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- Colin Wong
- Lee Hwok Lok
- Lincoln Liew
- Ng Liang Giap
- Lee Choon Siong
- Sharon Phia

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References

Burke, L., Selig, E. and Spalding, M. 2002. Reefs at Risk in Southeast Asia. World Resource Institute.

Carpenter KE M Abrar, G Aeby, RB. Aronson, S Banks, A Bruckner, AChiriboga, J Cortés, JCDelbeek, L DeVantier, GJ Edgar, A J Edwards, D Fenner, HM Guzmán, BW Hoeksema, G Hodgson, O Johan, WY Licuanan, SR Livingstone, ER Lovell, JA Moore, DO Obura, D Ochavillo, BA Polidoro, WF Precht, MC Quibilan, C Reboton, ZT Richards, AD Rogers, J Sanciangco, A Sheppard, C Sheppard, J Smith, S Stuart, E Turak, JEN Veron, C Wallace, E Weil, E Wood. 2008. One-Third of Reef-Building Corals Face Elevated Extinction Risk from Climate Change and Local Impacts. Science 25 July 2008: Vol. 321. no. 5888, pp. 560 – 563 DOI: 10.1126/science.1159196

Chou, L.M., C.R. Wilkinson, W.R.Y. Licuanan, P.M. Aliño, A.C. Cheshire, M.G.K. Loo, S. Tangjaitrong, A.R.Ridzwan and Soekarno, 1994. Status of coral reefs in the ASEAN region. p. 1-10. In : Wilkinson, C.R., S. Sudara and L.M. Chou (eds.) Proceedings Third ASEAN-Australia Symposium on Living Coastal Resources. Vol. 1: Status Review. Chulalongkorn University, Bangkok, Thailand.

Harriott, V., Goggin, L. and Sweatman, H. 2003. Crown of horns starfish on the Great Barrier Reef. Current state of knowledge November 2003 revised edition. CRC Reef Research centre Ltd. Queensland, Australia.

Hodgson, G. 1999. A global assessment of human effects on coral reefs. Marine Pollution Bulletin. 38 (5) 345-355.

Hodgson, G. 2001. Reef Check: The first step in community-based management. Bull. Mar. Sci. 69(2): 861-868.

Hodgson, G. and J. Liebeler. 2002. The global coral reef crisis – trends and solutions. Reef Check, Institute of the Environment, University of California at Los Angeles.77 pp ISBN 0-9723051-0-6.

Hodgson, G. J Hill W Kiene, L Maun, J Mihaly, J Liebeler C Shuman, R Torres 2006. Instruction Manual. A guide to coral reef monitoring. Reef Check Foundation. Pacific Palisades, CA 86 pp.

Malaysian Coral Reef Conservation Project, 2004. Pulau Redang Coral Reef Ecosystem Resources Assessment Studies Report. Marine Park Section, NRE, Kuala Lumpur, Malaysia.

Malaysian Coral Reef Conservation Project, 2005. Pulau Perhentian Coral Reef Ecosystem Resources Assessment Studies Report. Marine Park Section, NRE, Putrajaya, Malaysia.

Maritime Institute Malaysia. 2006. Malaysia National Coral Reef Report. UNEP-GEF South China Sea Project and Marine Park Section, Ministry of Natural Resources and Environment, Malaysia.

Status Report on the Coral Reefs of the East Coast of Peninsular Malaysia, 2000. A consultancy report prepared for the UNDP-GEF Project Development Facility Block B document for the Conservation of Marine Biodiversity in the Marine Park Islands in Peninsular Malaysia. Department of Fisheries, Kuala Lumpur, Malaysia.

Spalding M. D., Fox, H., Allen G. R., Davidson N., Ferdana Z. A., Finlayson M., Halpern B. S., Jorge M. A., Lombana AL, Lourie S. A., Martin K. D., McManus E., Molnar J., Recchia C., and Robertson J. Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. 2007. BioScience. Vol. 57 (7)

Wilkinson, C. and G. Hodgson 1999. Coral reefs and the 1997-1998 mass bleaching and mortality. Nature and Resources. 35(2):17-25.

Appendix 1: Survey Sites (2012)

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	Coral Bay	Perhentian	5 54.633 N 102 42.921 E
SS 1.5	Coral View Reef	Perhentian	5 54.208 N 102 44.407 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 1.11	Tiga Ruang	Perhentian	5 55.019 N 102 45.233 E
SS 1.12	Tukas Laut	Perhentian	5 53 06.45 N 102 46 01.13 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 3.1	Pirates Reef	Tioman	2 49.428 N 104 09.445 E
SS 3.2	Renggis North	Tioman	2 48.594 N 104 08.183 E
SS 3.3	Renggis West	Tioman	2 48.633 N 104 8.123 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 3.7	Bugis Bay	Tioman	2 44 11 N 104 13 34 E
SS 3.8	Chebeh	Tioman	2 55 56.76 N 104 05 48.87 E
SS 3.9	Jahat North	Tioman	2 39 50.79 N 104 10 2.24 E
SS 3.10	Juara Rocks	Tioman	2 47 44.62 N 104 12 51.68 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 3.13	Rock & Roll Bay	Tioman	2 52 28.6 N 104 11 11.18 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 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 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 8.1	P. Lang	Aur	2 27.594 N 104 29.358 E
SS 8.2	P. Dayang	Aur	2 28.651 N 104 30.271 E
SS 8.3	Tk. Air Nenek	Aur	2 25.722 N 104 32.305 E
SS 8.4	Tk. Rekai	Aur	2 27.671 N 104 31.600 E
SS 8.5	Tk. Miyang	Aur	2 27.131 N 104 30.094 E
SS 9.1	Buntut Meriam	Sibu/Tinggi	2 13.860 N 104 3.130 E
SS 9.2	Malang Acha	Sibu/Tinggi	2 11.040 N 104 6.409 E
SS 9.3	P. Mentinggi	Sibu/Tinggi	2 16.405 N 104 6.940 E
SS 9.4	P. Nanga	Sibu/Tinggi	2 16.274 N 104 7.640 E
SS 9.5	P. Ibol	Sibu/Tinggi	2 18.183 N 104 8.935 E
SS 9.6	P. Tanjung Gua Subang	Sibu/Tinggi	2 18.792 N 104 7.552 E
SS 10.1	Siwa 4A	Miri	4 16 23 N 113 48 53 E
SS 10.2	Siwa Penyu	Miri	4 16 35 N 113 49 3 E
SS 10.3	Anemone Centre	Miri	4 17 33 N 113 49 33 E
SS 10.4	Anemone North	Miri	4 17 37 N 113 49 34 E
SS 10.5	Eve's Garden	Miri	4 20 35 N 113 53 54 E
SS 10.6	Sunday Reef	Miri	4 17 13 N 113 49 10 E
SS 11.1	Sampadi	Kuching	1 44 11 N 110 5 6 E

Malacca Strait

No.	Site Name	Island	Coordinate
MS 1.1	Site 1 P.Lalang/Pasir Tengkorak	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 1 P. Rumbia	Sembilan	4.0286 N 100.5437 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
MS 1.9	Rock Garden P. Saji North	Sembilan	4.0114 N 100.5351 E
MS 2.1	Coral Garden	Payar	6 3.701 N 100 2.328 E
MS 2.2	Japanese Garden	Payar	6 4.161 N 100 2.807 E
MS 2.3	Payar South	Payar	6 3.961 N 100 2.436 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 3.1	Pom Pom Jetty	Pom Pom	4 35.411 N 118 51.867 E
NB 4.1	D Wall	Mabul	4 14 51.17 N 118 37 30.92 E
NB 4.2	Eel Garden	Mabul	N/A
NB 4.3	Scuba Junkie HR	Mabul	4 14 56.3 N 118 37 55.48 E
NB 4.4	Mandarin Valley	Mabul	N/A
NB 4.5	Panglima	Mabul	4 14.922 N 118 37.529 E
NB 4.6	Stingray City	Mabul	N/A
NB 4.7	Froggie Lair	Mabul	N/A
NB 4.8	Old Jetty	Mabul	N/A
NB 4.9	Paradise 2	Mabul	4 14 59.37 N 118 37 49.78 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	Great Wall	Mantanani	6 42.987 N 116 12.945 E
NB 6.1	Base Camp	TARP, Kota Kinabalu	6 00 16.94 N 116 01 31.48 E
NB 6.2	Mamutik	TARP, Kota Kinabalu	5 58 03.48 N 116 00 45.60 E
NB 6.3	Manukan West	TARP, Kota Kinabalu	5 58 14 N 115 59 48 E
NB 6.4	Mid Reef	TARP, Kota Kinabalu	5 58 26.6 N 116 0 59.49 E
NB 6.5	Paut Paut	TARP, Kota Kinabalu	6 02 22.84N 116 00 34.86 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 26.76 N 116 0 15.47 E
NB 6.8	Sulug	TARP, Kota Kinabalu	5 57 43 N 115 59 41 E

REEF CHECK
MALAYSIA

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