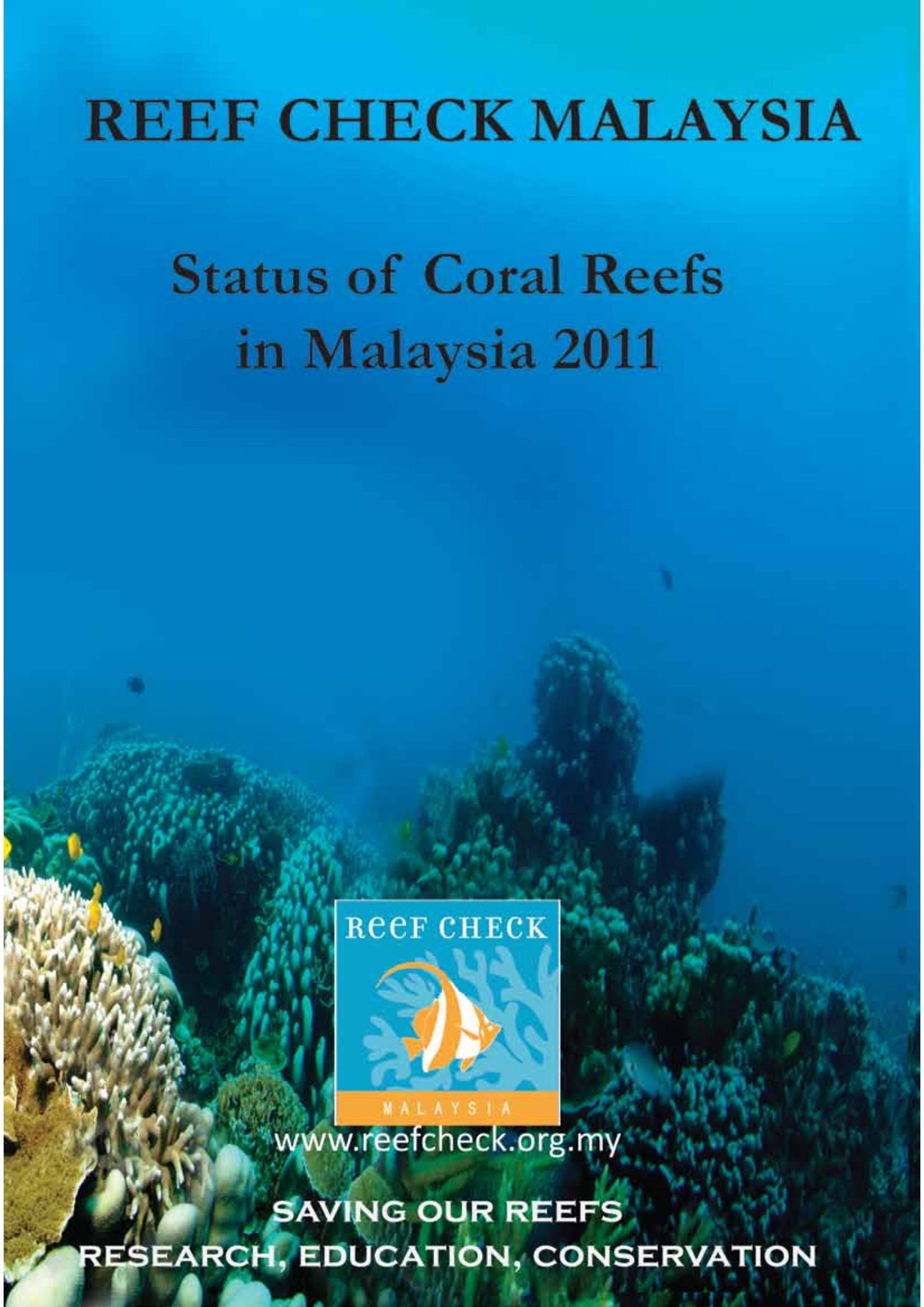
REEF CHECK MALAYSIA

Status of Coral Reefs in Malaysia 2011



Status of Coral Reefs in Malaysia, 2011

Reef Check Malaysia

Contents

Executive Summary

1. A total of 100 Reef Check surveys were completed in 2011, 52 in Peninsular Malaysia and 48 in East Malaysia, a slight increase on 2010. The surveys are a continuation of a successful National Reef Check Survey Programme that has now run for five years.

2. The surveys were carried out by volunteers trained and certified in the global standard Reef Check method. Nearly 50 people were trained in 2011, adding to the base of volunteers who are participating in Reef Check Malaysia's programmes. 10% of trainees were officers of the Department of Marine 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 coast, covering both established Marine Protected Areas and non-protected areas, and in various parts of East Malaysia, both Sabah and Sarawak.

3. The results indicate that the reefs surveyed have a relatively high level of living coral (42.57%). The level of recently killed corals indicates continuing recovery from the 2010 bleaching event that killed coral reefs around South East Asia. Early estimates suggest that mortality in Malaysia was 5-6%.

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, 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 wherever possible, including careful attention to sewage treatment and discharge, and education of clients so as to avoid damage to reefs.

10. Coral reefs are a valuable economic and biological resource in Malaysia, where they are a major attraction for the tourism industry, serve as a protein source for millions of people and are a major source of biodiversity. One estimate puts the economic value of well-managed coral reefs in Malaysia at RM 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 90 countries worldwide, and has been used in Malaysia since 2001. The non-profit Reef Check Malaysia Bhd (RCM) was registered in 2007 and runs several programmes dedicated to coral reef conservation.

1. Introduction

Coral reefs are the most diverse marine ecosystems on earth. They 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.

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
- Destructive fishing
- Coastal development
- Pollution
- Siltation/sedimentation
- Physical impacts from tourism, including divers, snorkelers and boats.

In Malaysia, the Department of Marine Parks (National), 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 2011, the fifth year of surveys. A review of the five years of data is available separately.

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 90 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 five years RCM has trained over 350 divers to conduct reef surveys at 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, the programme was replicated, on a larger scale, in Tioman. 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 fifth annual survey report, and details the results of Reef Check surveys carried out during 2011. 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.

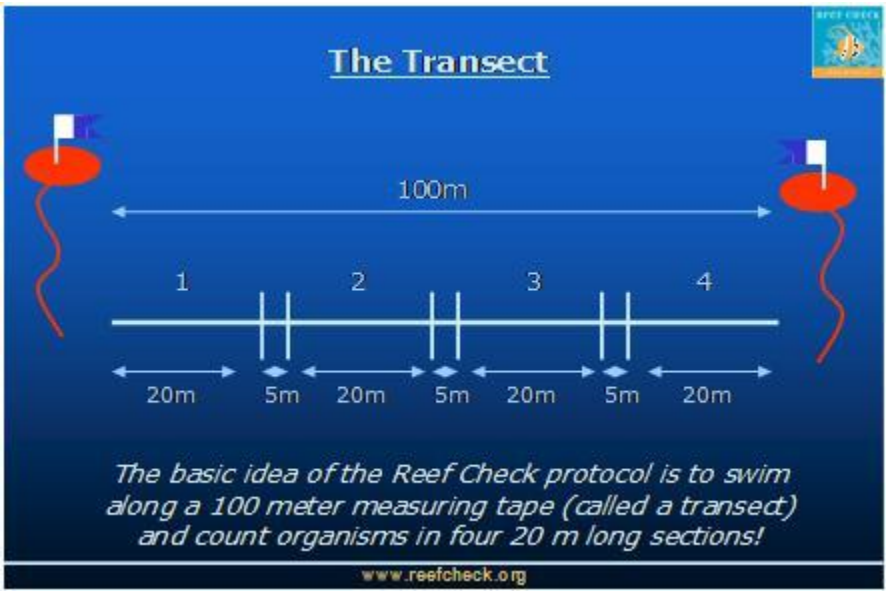
Reef Check surveys are conducted along two depth contours (3 m to 6 m and 6 m to 12 m depth). A 100 m transect line is deployed and along it four 20 m transects are surveyed, each separated by 5m, which provides four replicates per transect (8 per complete survey) for statistical analysis (see Figure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

Four types of data are collected:

- the first is the fish survey which 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
- second is the invertebrate survey during which divers count the indicator invertebrates along the same four 20 m x 5 m belts

- an 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.
- data on the substrate is collected by the Point Intercept method whereby the substrate category such as live coral is noted every 0.5 m.

Figure 1: The Transect



2.3 Survey Sites

During 2011, a total of 100 surveys were completed, 52 in Peninsular Malaysia (2010: 46) and 48 in East Malaysia (2010: 47). 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, Kapas, Perhentian, Redang, Tenggol, Tioman and Yu). 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. 2011 Survey Results and Analysis

This section details the results of surveys conducted during 2011, providing an overview of the situation for Malaysia, and more detailed analysis by island/survey area.

3.1 Status of Coral Reefs in Malaysia 2011

The results from all 100 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, which are unexplored, but are facing threats from destructive fishing methods such as fish bombing.

3.1.1 Substrate

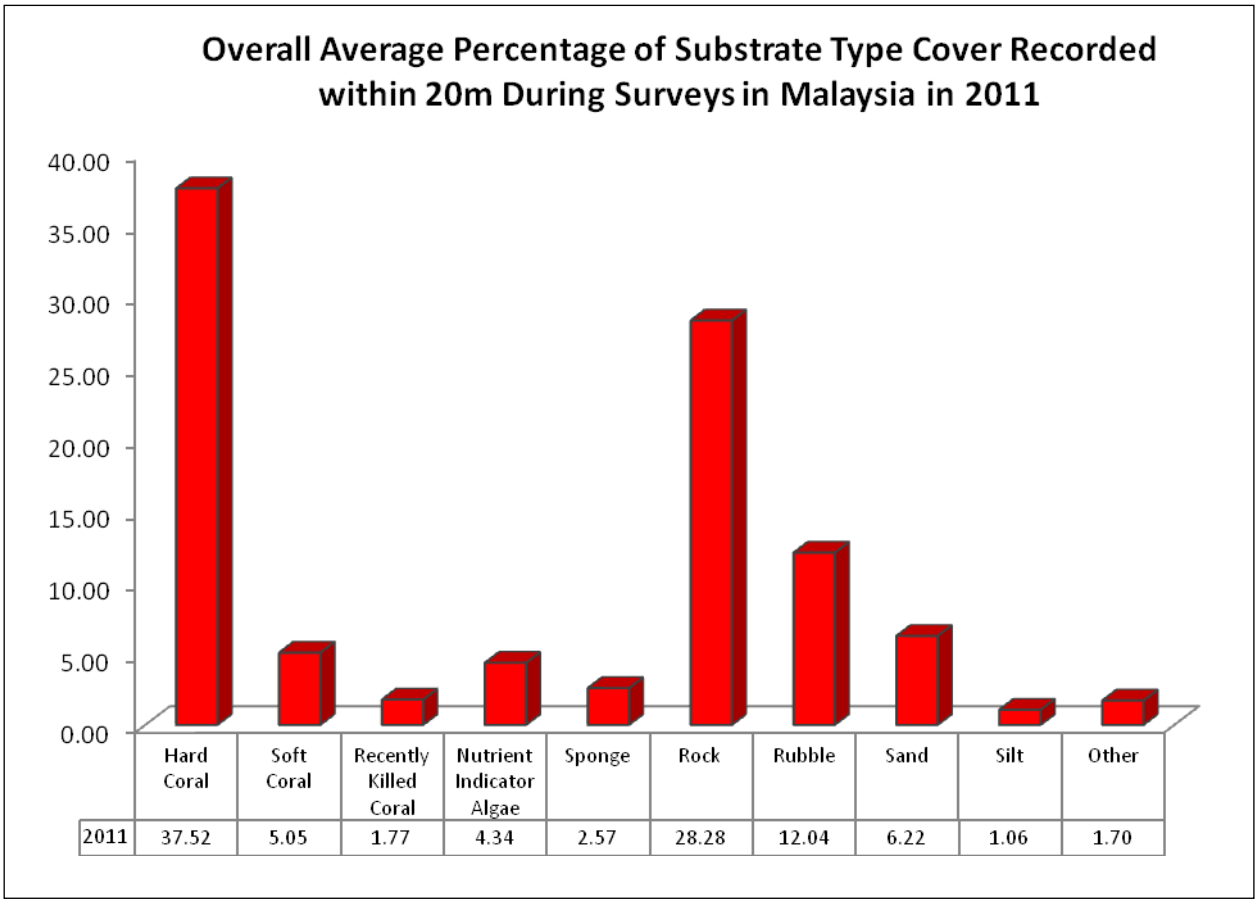
The table below shows the Coral Reef Health Criteria developed by Chou *et al*, 1994.

Table 1: Coral Reef Health Criteria

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

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

Chart 1: Substrate Cover – Malaysia



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 (1.77%) 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 nearly 5%, NIA is rather high, suggesting either that herbivorous fish populations are low, or that there is excess nutrient flowing onto reefs – or both. Fish populations need to be managed and nutrient sources need to be identified and actions taken to reduce nutrient inputs to reefs.

Sponges (SP) are another normal component of coral reefs that, under the right conditions, can proliferate in the presence of high levels of nutrients, smothering and killing corals. At 2.57%, 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 2011 level (28.28%) 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 recruit are easily damaged or displaced on a mobile substrate moving around in local currents. The average level of RB for Malaysia (12.04%) 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 (6.22%) 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) appear to 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 1.05%). 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 2011 was 1.70%.

Three Year Comparison, 2009-2011

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. A detailed analysis of Reef Check data for Malaysia over the last five years is currently being prepared and will be published later in 2012. A preliminary comparison for the last three years is shown in the table below.

Table 2: Comparison of Substrate Categories, 2010/2011

	HC	SC	RKC	NIA	SP	RC	RB	SD	SI	OT
2009	43.82	6.14	2.43	3.68	1.81	23.05	10.30	6.56	0.66	1.52
2010	38.56	5.75	3.30	4.35	1.83	21.25	13.60	7.65	1.67	2.04
2011	37.52	5.05	1.77	4.34	2.57	28.28	12.04	6.22	1.06	1.70

The data seem to indicate a reduction in Live Coral Cover (HC + SC) over the last three years, which has declined from 49.94% to 42.57%. One possible explanation for this is the major bleaching event of 2010, which saw up to 90% of corals bleaching during May-September that year. The 2010 survey programme included surveys carried out before, during and after the bleaching event.

Although many corals recovered towards the end of 2010, there was some mortality, and the three year data above seem to indicate that some 5-6% of corals died, with a decline in LCC of 7.37% and an increase in RC of 5.23%. More accurate monitoring is required to track changes in LCC.

On a more positive note, other indicators, particularly NIA and SP, appear little changed over the same period, perhaps suggesting that local threats to coral reefs in Malaysia (sewage, development, tourism development, etc.) have not yet had significant impacts.

However, scientists are predicting that bleaching events will recur with increasing frequency, and other global threats (e.g. ocean acidification) are growing. Given the damage apparently caused by the 2010 bleaching event, it is evident that local threats need to be managed more aggressively to ensure optimum reef health is maintained to resist future bleaching, and related, events.

Even though the average live coral cover of the reefs from the surveys indicates that the reefs in Malaysia are in “fair” condition, there is still room for improvement. A range of issues such as development, sedimentation, pollution and tourist activities need to be managed so that impacts on coral reefs are minimised, creating the conditions for improvements in the future.

Furthermore, as most of the survey sites are easily accessible dive sites, many other unexplored sites around Malaysia need to be surveyed to provide a better overall picture of the condition of reefs in Malaysia.

3.1.2 Fish

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

- Butterfly fish: targeted for the aquarium trade
- Sweetlips, Snapper, Barramundi Cod, Parrotfish, Moray Eel, Grouper: targeted as food fish
- Humphead Wrasse, Bumphead Parrotfish: targeted for live-food fish trade.

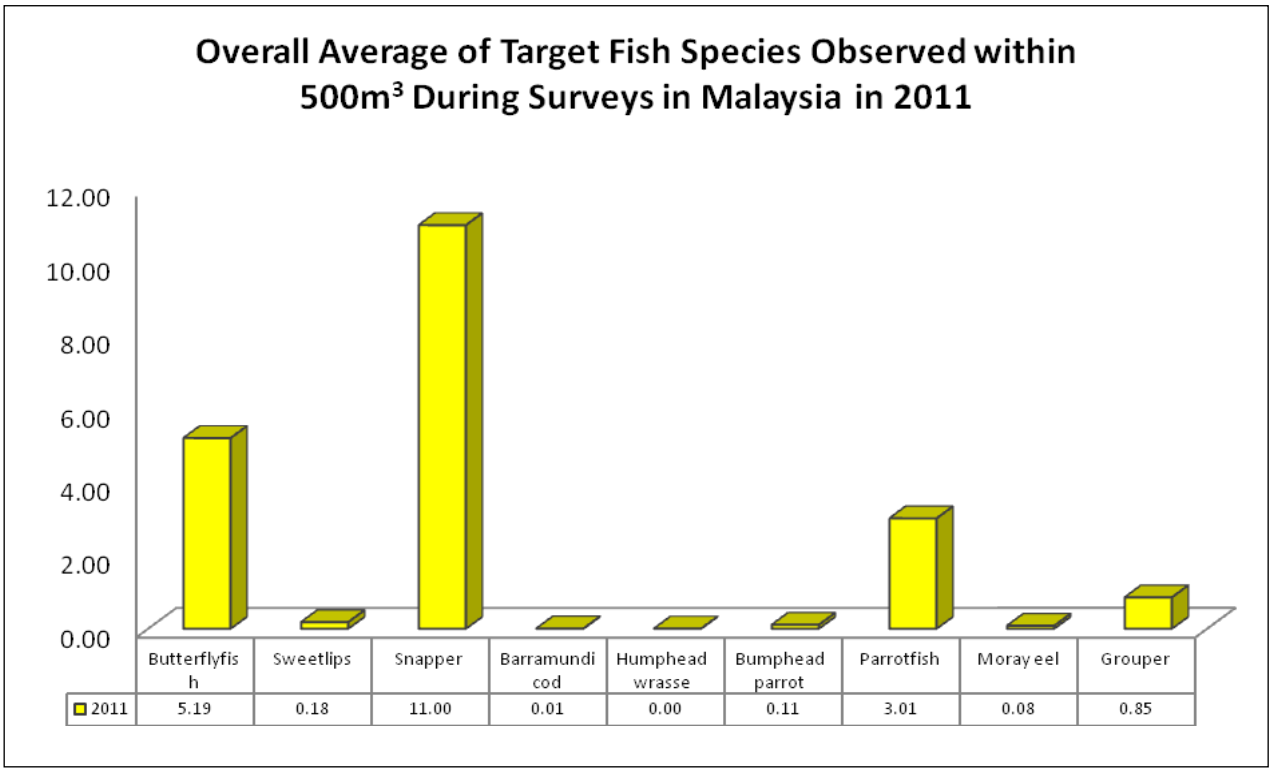
Abundance of several varieties that are targeted for food is low in most of the areas where surveys have been conducted, with abundance of many being less than 1 individual per 500m^3 survey transect (including Sweetlips, Barramundi Cod, Moray Eel and Grouper).

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 0.1 individuals per 500m^3 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.

The abundance of indicator fish counted during the 2011 surveys is shown in Chart 2 below.

Chart 2: Fish Abundance - Malaysia



Equally important are healthy Parrotfish populations (average abundance 3.01 individuals per 500m^3 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.

Three Year Comparison, 2009-2011

A detailed analysis of five years of Reef Check data will be published later in 2012. The table below shows a preliminary comparison of fish populations in Malaysia over the last three years.

Table 3: Comparison of Fish Abundance, 2010/2011

	Butterfly Fish	Sweet Lips	Snapper	Barram-undi	Hump-head	Bump-head	Parrot Fish	Moray Eel	Grouper
2009	4.62	0.16	11.48	0.01	0.02	0.12	1.06	0.05	0.53
2010	5.64	0.28	10.70	0.00	0.01	0.10	5.39	0.10	0.78
2011	5.19	0.18	11.00	0.01	0.00	0.11	3.01	0.08	0.85

There are few significant changes in abundance of fish indicator species over the past three years. It should be noted that in some cases this is due to very low abundance, and it is difficult to monitor the populations of scarce fish using the Reef Check methodology. However, it is clear also that these populations have not grown over the last three years, and as stated above greater protection will be necessary to aid recovery of populations of these important species.

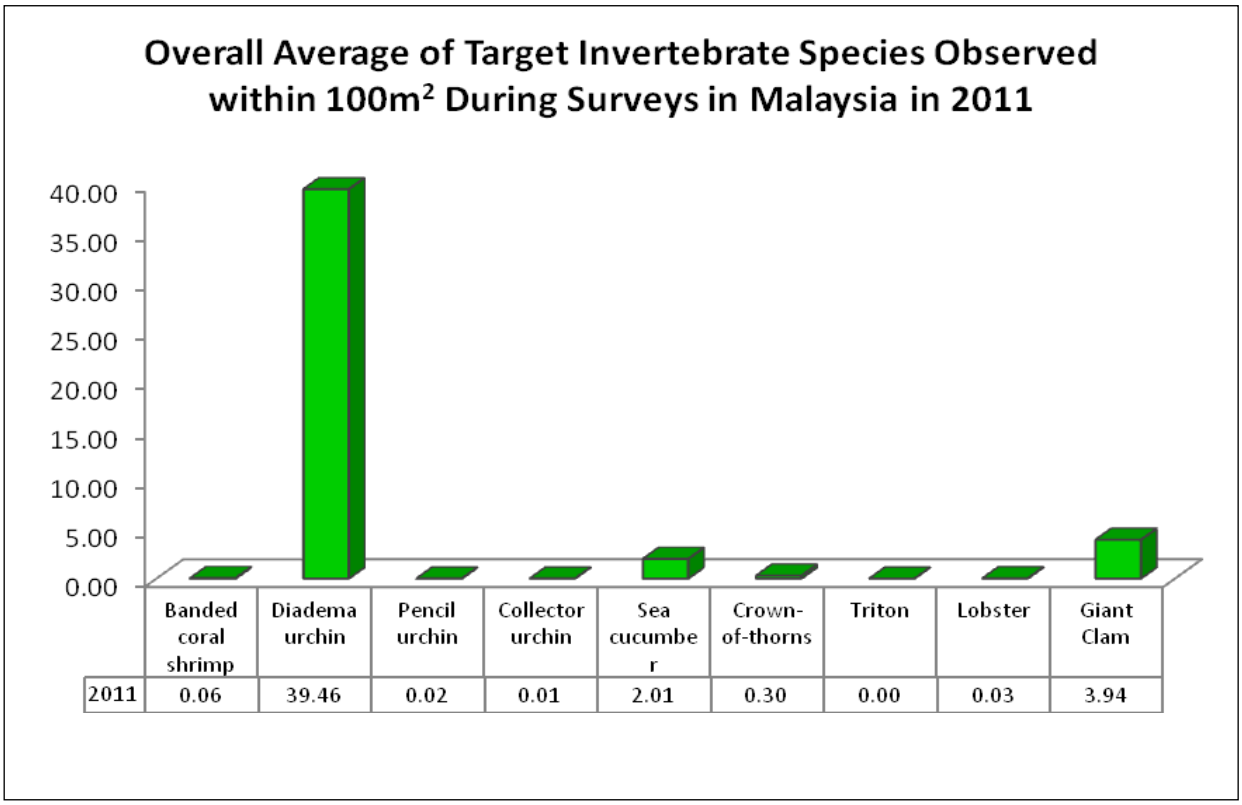
3.1.3 Invertebrates

The invertebrate indicators are targeted for differing reasons:

- Curio trade: Pencil Urchin, Triton Shell
- Food: Banded Coral Shrimp, Collector Urchin, Sea Cucumber, Lobster, Giant Clam (also food)
- Imbalance/predator: Diadema Urchin, Crown of Thorns

The abundance of indicator invertebrates counted during the 2011 surveys is shown in Chart 3 below.

Chart 3: Invertebrate Abundance - Malaysia



Abundance of those invertebrates targeted for the curio trade is at or near zero (Pencil Urchin 0.02 individuals per 100m^2 survey transect; Triton Shell – not observed during surveys). While this may be partly explained by low natural abundance, clearly there has been significant historical fishing pressure for these species, and appropriate conservation measures will be required to assist populations to recover.

Similarly, several species targeted for the food trade have very low abundances (Banded Coral Shrimp 0.06 individuals per 100m^2 survey transect, Collector Urchin 0.01, Lobster 0.03). However, some populations are larger, including Sea Cucumbers (2.01) and Giant Clams (3.94).

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 Tioman Island and a few sites in Sabah). 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.

In very high numbers, Diadema can have two negative impacts. First, if algae is 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 (10,000m^2), or 0.2-0.3 per 100m^2. The abundance of COTs found during surveys (0.30 per 100m^2) is at the high end of this range, suggesting that COT numbers are just 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 COT removal activities to reduce the threat posed by these creatures. Continued monitoring is essential to track significant outbreaks of this dangerous coral predator and more studies are required into the factors that cause COT numbers to increase, providing for better management.

Three Year Comparison, 2009-2011

The table below shows a preliminary comparison of fish populations in Malaysia over the last three years.

Table 4: Comparison of Invertebrate Abundance, 2010/2011

	BCS	Diad	Pencil	Collect	Cucumb	COT	Triton	Lobster	Clam
2009	0.01	32.98	0.00	0.02	2.06	0.68	0.11	0.01	2.97
2010	0.32	36.59	0.01	0.06	1.78	0.28	0.00	0.03	4.22
2011	0.06	39.46	0.02	0.01	2.01	0.30	0.00	0.03	3.94

There have been few significant changes in abundance of invertebrate indicator species over the past three years. It should be noted that in some cases this is due to very low abundance, and it is difficult to monitor the populations of scarce invertebrates using the Reef Check methodology. However, it is clear also that these populations have not grown over the last three years, and as stated above greater protection will be necessary to aid recovery of populations of these important species.

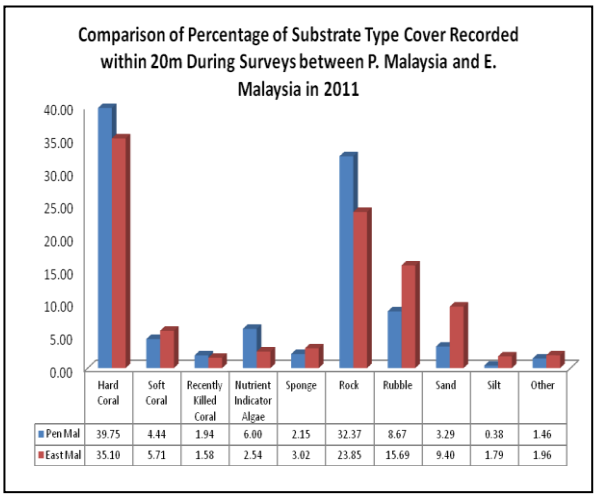
3.2 Comparison between Peninsular Malaysia and East Malaysia

This section briefly compares the results of surveys conducted in Peninsular Malaysia and East Malaysia and identifies some key differences between the two areas.

3.2.1 Substrate

Coral reefs in both Peninsular and East Malaysia are in “fair” condition (see Chart 4 below).

Chart 4: Comparison of Substrate Cover between Peninsular and East Malaysia



Many of the differences can in part be explained by the different impacts on coral reefs in the two regions. In Peninsular Malaysia, the key threat is from development, both of tourism facilities on the East coast islands, and on the mainland. In East Malaysia, the key threats are population-related, leading to over-fishing and destructive fishing. As a result:

- HC is 4% higher in Peninsular Malaysia due to less fish bombing that has, over many years, reduced some reefs in East Malaysia to rubble; this also explains the higher level of RB in East Malaysia, almost twice as high as in Peninsular

- NIA in Peninsular is more than twice the level in East Malaysia, partly due to the high concentration of tourist resorts on the East coast islands off Peninsular Malaysia. Sewage pollution is a significant problem on those islands, and contributes to the nutrient causing algal growth
- RC is nearly 10% higher in Peninsular, resulting from higher HC levels, which when corals die are re-classified as RC.

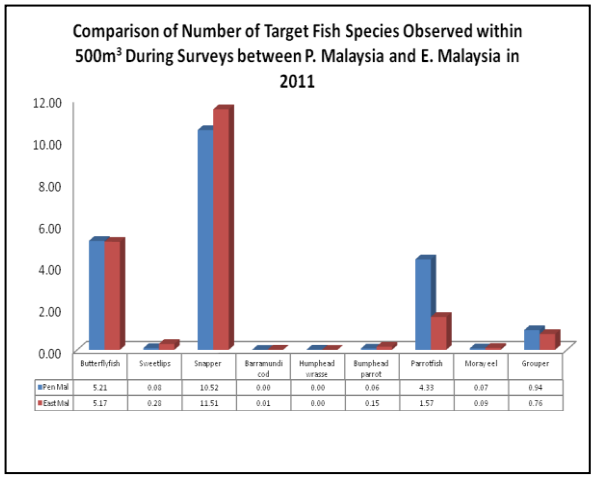
The key issues for managers are:

- In Peninsular Malaysia: high abundance of NIA, partly due to nutrient pollution, could, in time, cause a phase shift from coral to algae dominated reefs, negatively impacting tourism on the islands. Action is needed to improve sewage treatment systems, and to protect fish stocks, particularly herbivores
- In East Malaysia: fish bombing is still having a significant impact on coral reefs, as indicated by the high RB level. This physical destruction of reefs has long-lasting impacts, with many years required for reef regeneration. Action is needed to reduce fish bombing and rehabilitate damaged areas.

3.2.2 Fish

The diversity of fish observed during the surveys is similar in both Peninsular Malaysia and East Malaysia (see chart 5).

Chart 5: Comparison of Fish Abundance between Peninsular and East Malaysia



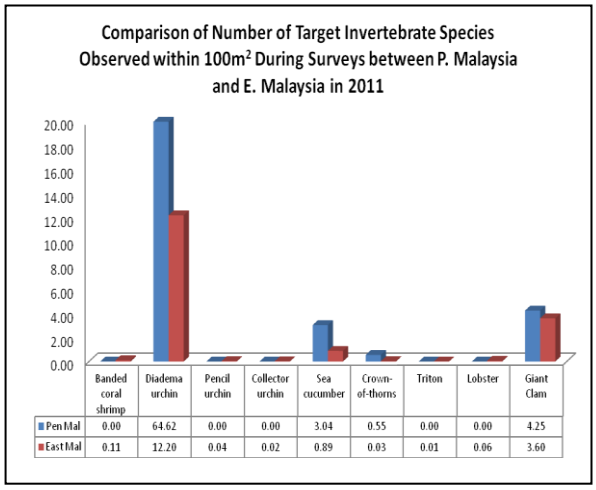
In both Peninsular and East Malaysia, one indicator species was not recorded at all during the surveys – Humphead wrasse. Food fish such as Sweetlips, Barramundi Cod and Grouper are all present in low numbers, an indication of current or historical fishing pressure. Parrotfish are also low in abundance in East Malaysia.

Butterfly Fish and Snapper both show fairly healthy populations in both areas. The key issue for managers is to manage fish stocks to allow for populations to re-establish.

3.2.3 Invertebrates

Diversity of invertebrates observed is higher in East Malaysia than Peninsular Malaysia (see chart 6).

Chart 5: Comparison of Invertebrate Abundance between Peninsular and East Malaysia



Several invertebrates (e.g. Pencil Urchins, Collector Urchin, Triton and Lobster) which are highly sought after for the aquarium and curio trade as well as for food, were absent from all the surveys conducted in Peninsular Malaysia. Although known to be uncommon in some of these areas, the rarity of these invertebrates suggests that small populations may have been affected by previous over-harvesting activities and are recovering very slowly.

The number of *Diadema* sea urchins in both the Peninsula and East Malaysia is relatively high compared to the other invertebrates. While their presence (together with herbivorous fish) is important to control algal growth, their number should be monitored as an increase could indicate nutrient pollution.

3.3 Status of Coral Reefs on Islands/Regions in Malaysia

The sections below provide details of the health of coral reefs on the islands and regions surveyed in Peninsular and East Malaysia. The results highlight the different problems each island/region is facing. Islands/regions covered are shown in table 5.

Peninsular Malaysia	No. of sites	East Malaysia	No. of sites
Perhentian island	11	Talang-Satang	3
Redang island	10	Miri	7
Kapas island	4	Lankayan	22
Bidong/Yu islands	6	Mataking/Pom Pom	9
Tenggol island	6	Mabul	7
Tioman island	15		

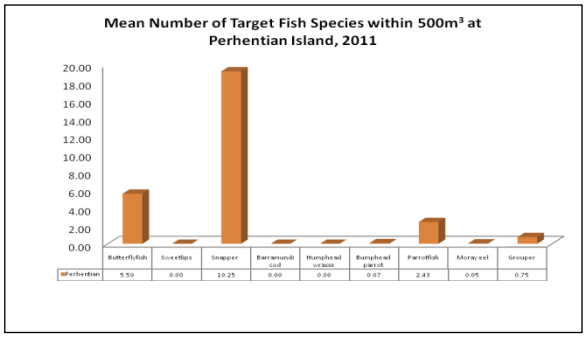
3.3.1 Perhentian

The Perhentian islands are located some 20km from Kuala Besut off the East coast of Terengganu, Malaysia. The island has 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 35 resorts, mainly small, family run operations, 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.

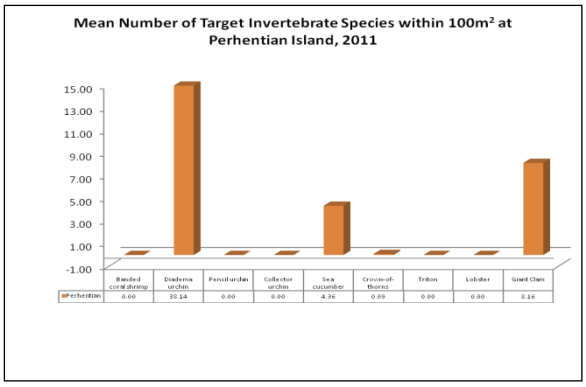
Fish



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

Most abundant are Snapper (19.25 individuals/500m^3) and Butterfly Fish (5.59). Numbers of Grouper are low (0.75).

Invertebrates

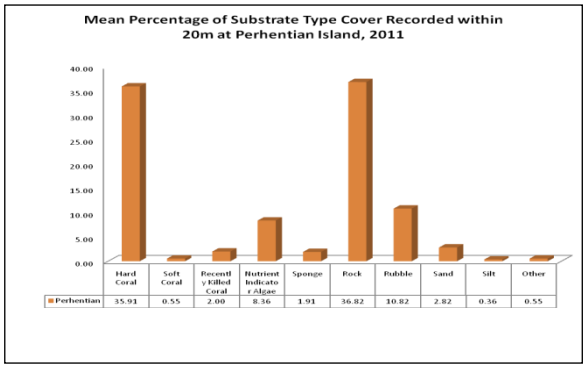


Numerous targeted species are absent, including Pencil and Collector Urchins, Triton and Lobster.

Other targteted species are more abundant, including Sea Cucumber (4.36 individuals/100m^2) and Giant Clam (8.16)

Diadema Urchin abundance (38.14) is high, perhaps reflecting the high level of NIA.

Substrate



Coral reefs around the islands are considered to be in fair condition, with 36.46% live coral cover, the lowest of all islands surveyed in Peninsular Malaysia.

The level of NIA is high (8.36%), indicating high levels of nutrient in the waters around the islands. The most likely source of this is the islands' resorts, most of which have limited sewage treatment facilities.

The proportion of RC is high (36.82%), a significant proportion of which is dead coral.

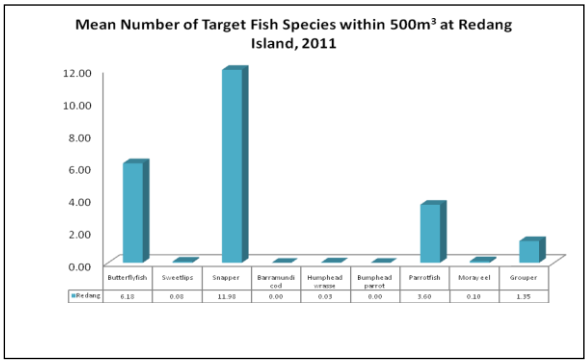
3.3.2 Redang

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.

Fish

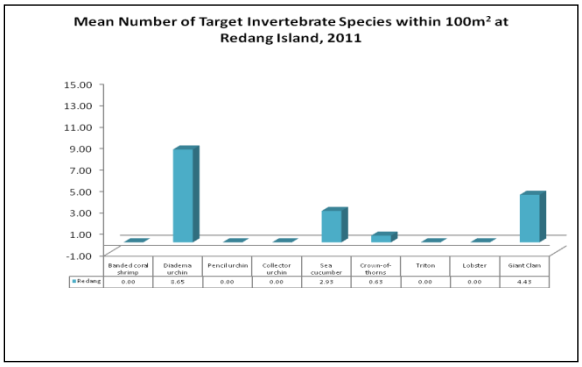


Only two indicator species were completely absent from surveys (Barramundi Cod and Bumphead Parrotfish), though abundance of several other indicators is very low (Sweetlips 0.08 individuals/500m^3, Humphead Wrasse 0.03, Moray Eel 0.10).

Snapper (11.98) are the most abundant food fish, with lower populations of Parrotfish (3.60).

Abundance of Grouper (1.35) and Butterflyfish (6.18) is the highest of all the islands off the East coast of Peninsular Malaysia.

Invertebrates

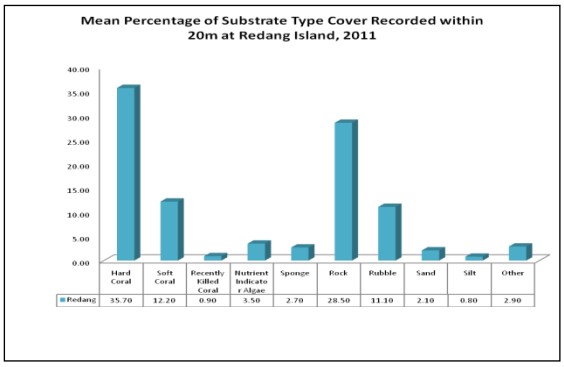


Numerous targeted species are absent, including Pencil and Collector Urchins, Triton and Lobster.

Other targteted species are present in low numbers, including Sea Cucumber (2,93 individuals/100m^2) and Giant Clam (4.43).

Diadema Urchin abundance (8.65) is low.

Substrate



Coral reefs around the islands are considered to be in fair condition, with 47.9% live coral cover, above the average (44.19%) for reefs of Peninsular Malaysia.

Redang has a higher level of SC (12.2) than other islands, reflecting the fact that it has deeper water nearby.

Level of RB (11.10) is moderately high, possibly a result of damage to shallow reefs from the large numbers of snorkelers visiting the island.

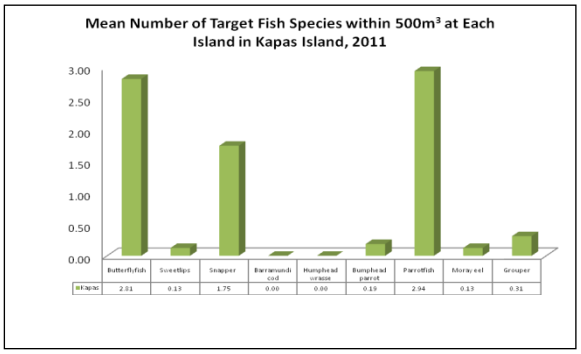
3.3.3 Kapas

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.

Fish

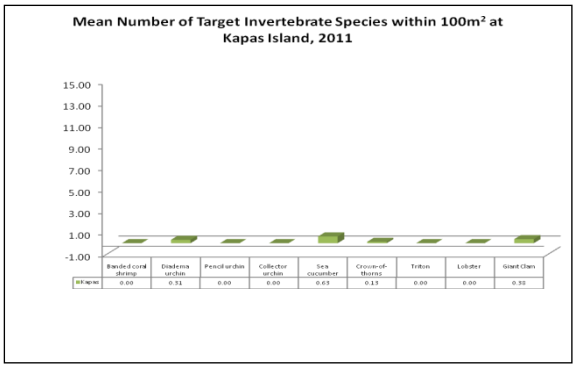


Only two indicator species were completely absent from surveys (Barramundi Cod and Humphead Wrasse).

Abundance of several other indicators is low (Bumphead Parrotfish 0.19 individuals/500m^3, Moray Eel 0.13).

Abundance of food fish is lower than some other islands, with Sweeetlips (0.13), Snapper (1.75), Parrotfish (2.94) and Grouper (0.31) all present in low numbers. The number of Butterflyfish (2.81) is lower than other islands.

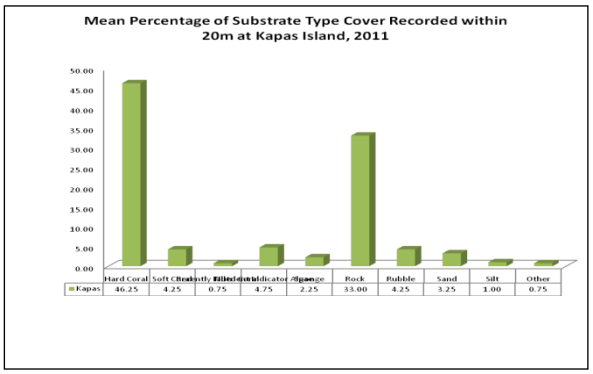
Invertebrates



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 Sea Cucumber (0.63 individuals/100m^2) and Giant Clam (0.38). Diadema Urchin abundance (0.31) is the lowest of all the islands surveyed off the East coast of Peninsular Malaysia.

Substrate



Coral reefs around the island are considered to be in good condition, with 50.50% live coral cover, the highest of all islands surveyed in Peninsular Malaysia.

Levels of other substrate categories are low (e.g. RKC 0.75%, RB 4.25%, SI 1.0%), indicating few recent disturbances at Kapas.

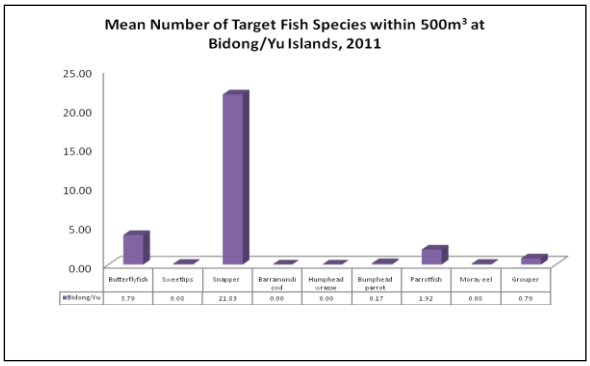
Level of NIA is relatively low at 4.75, perhaps reflecting the high abundance of Parrotfish.

3.3.4 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.

Fish

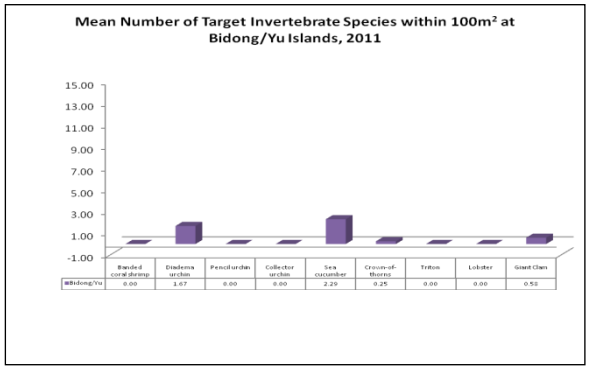


Only two indicator species were completely absent from surveys (Barramundi Cod and Humphead Wrasse).

Abundance of several other indicators is low (Bumphead Parrotfish 0.17 individuals/500m^3, Moray Eel 0.08).

Abundance of food fish is lower than some other islands, with Sweeetlips (0.08), Parrotfish (1.92) and Grouper (0.79) all present in low numbers. The number of Butterflyfish (3.79) is lower than most other islands. The lack of protected status may be one cause of low fish abundance.

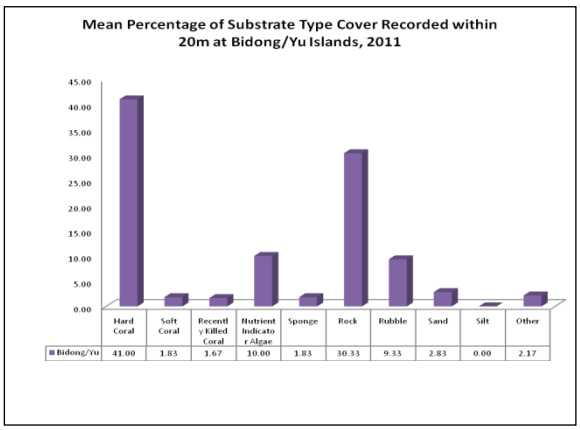
Invertebrates



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 (1.67 individuals/100m^2), Crown of Thorns (0.25) and Giant Clam (0.58). Sea Cucumber abundance (2.29) is above average for the islands surveyed off the East coast of Peninsular Malaysia.

Substrate



Coral reefs around the islands are considered to be in fair condition, with 42.83% live coral cover, just below the average (44.19%) for reefs of Peninsular Malaysia

The level of NIA is moderately high (8.36%), 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 nearby mainland. The low abundance of fish, particularly herbivorous Parrotfish, may be contributing to the relatively high level of NIA.

The moderately high level of RC (30.33) reflects the rocky nature of much of the coastline of the islands, particularly the Yu islands.

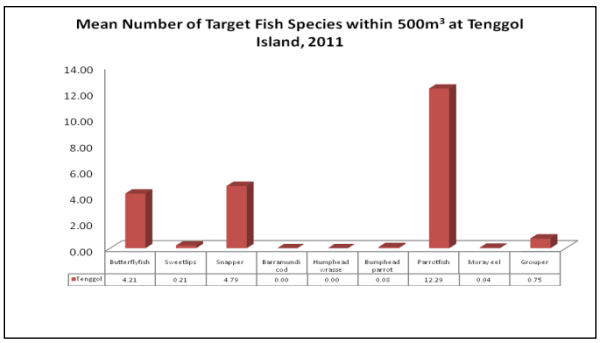
3.3.5 Tenggol

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.

Fish

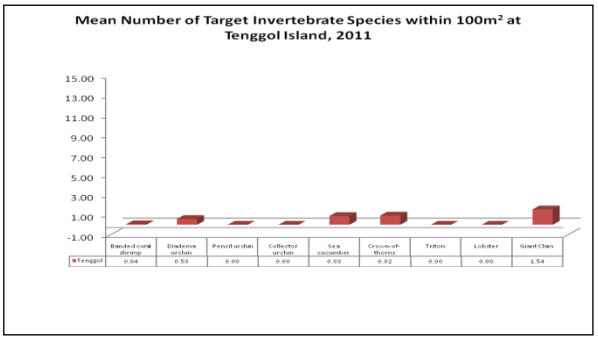


Only two indicator species were completely absent from surveys (Barramundi Cod and Humphead Wrasse)

Abundance of Parrotfish (12.29 individuals/500m^3) is the highest of all the islands off the East coast of Peninsular Malaysia.

Other indicators are present in varying numbers. Butterflyfish abundance (4.21) is moderately high, while Sweetlips (0.21), Snapper (4.79) and Grouper (0.75) show similar numbers to other islands.

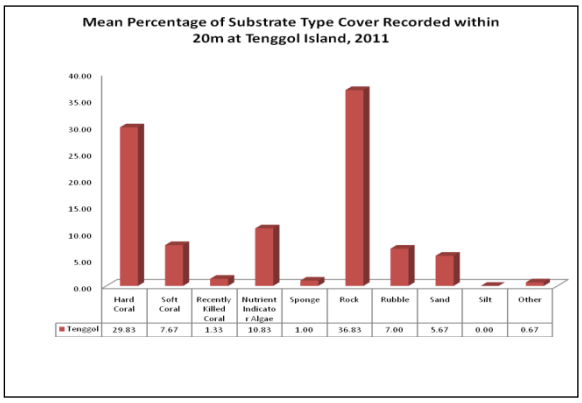
Invertebrates



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

Abundance of most other indicators is low, including Banded Coral Shrimp (0.04 individuals/100m^2), Diadema (0.58), Sea Cucumber (0.88), Crown of Thorns (0.25) and Giant Clam (1.54).

Substrate



The site is considered to be in fair condition, with 37.5% live coral cover, below the average (44.19%) for reefs of Peninsular Malaysia. SC level is higher than most areas, probably due to the surrounding deeper water and strong currents.

The level of NIA is high (10.83%), is the highest of all islands surveyed. A large proportion of this is recorded at Fresh Water Bay (NIA 38%), where the three resorts are located. It is possible that inadequate sewage treatment at these resorts is resulting in high nutrient levels in the bay, promoting algal growth. This issue needs to be addressed.

3.3.6 Tioman

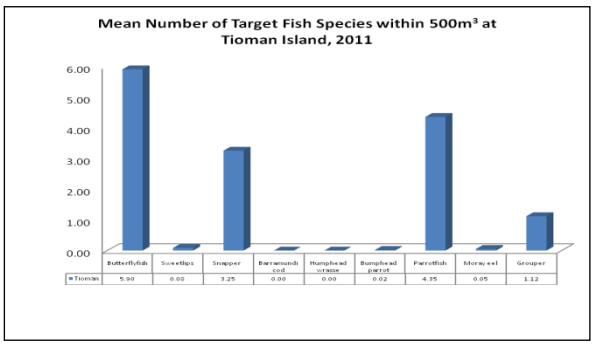
Tioman island is located some 50km from Mersing, off the East coast of Pahang, Malaysia. It is the largest island off the East coast of Peninsular Malaysia. The island has five villages, with a total population of approximately 3,000, most of whom work in tourism, the main industry on the islands. The 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 years ago. The island is served by an airport as well as boat services.

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

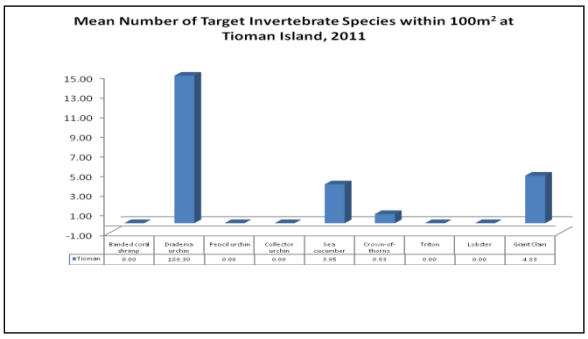
Fish



Only two indicator species were completely absent from surveys (Barramundi Cod and Humphead Wrasse), though abundance of several other indicators is very low (Sweetlips 0.08 individuals/500m^3, Bumphead Parrotfish 0.02, Moray Eel 0.05).

Abundance of three indicators, Butterfly fish (5.90), Parrotfish (4.35) and Grouper (1.12), is the second highest of all islands surveyed.

Invertebrates

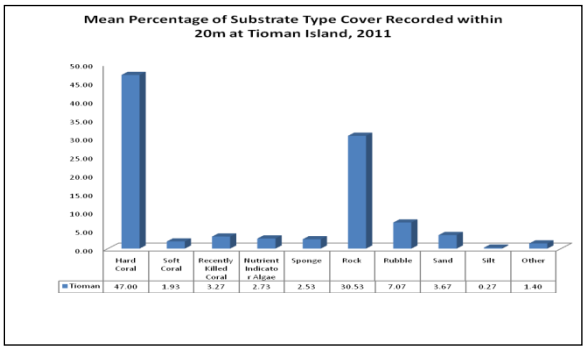


Several targeted species are absent, including Banded Coral Shrimp, Pencil and Collector Urchins, Triton and Lobster.

Numbers of Diadema are the highest of all sites in Malaysia, which as noted previously could create problems with bioerosion. However, they are likely to play a role in controlling NIA (see below).

Abundance of Sea Cucumber (3.95) and Giant Clam (4.83) is the second highest of all islands surveyed.

Substrate



The site is considered to be in fair condition, with 48.93% live coral cover, above the average (44.19%) and the second highest of all islands surveyed in Peninsular Malaysia

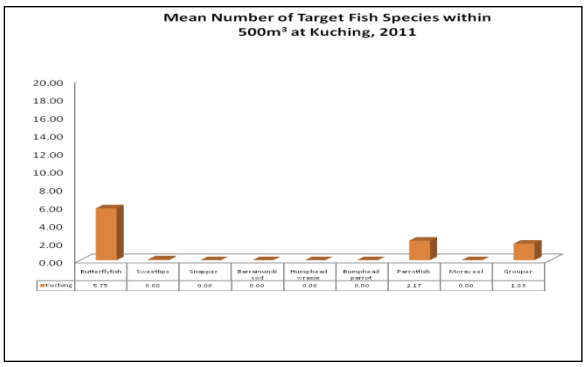
The relatively high level of RKC (3.27%) is probably a result of the 2010 mass bleaching event. However, NIA (2.73%) is the lowest of all peninsular sites, and this will aid recovery.

3.3.7 Talang-Satang

Talang-Satang is Sarawak's first Marine National Park, established with the primary aim of conserving Sarawak's marine turtle population. The park comprises the coastline and sea surrounding four islands of the southwest coast of Sarawak; Pulau Talang Besar and Pulau Talang Kecil off Sematan, and Pulau Satang Besar and Pulau Satang Kecil off Santubong, near Kuching. These four "Turtle Islands" are responsible for 95% of all the turtle landings in Sarawak.

Talang-Satang National Park covers a total area of approximately 19,400 hectares. Shallow reef areas surround all four islands, generally consisting of several species of hard coral and colonies of soft coral. They provide shelter and resting grounds for sea turtles, and are also important fish breeding areas.

Fish

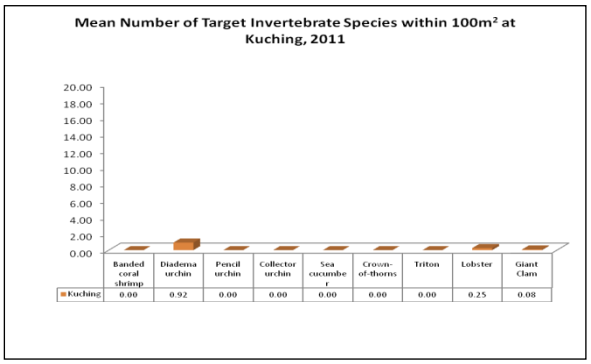


Five indicator species were completely absent from surveys (Snapper, Barramundi Cod, Humphead Wrasse, Bumphead Parrotfish and Moray Eel).

Abundance of Grouper (1.83 individuals/ 500m^3) is higher than other areas in East Malaysia.

Butterflyfish (5.75) and Parrotfish (2.17) show similar abundance to other regions in East Malaysia.

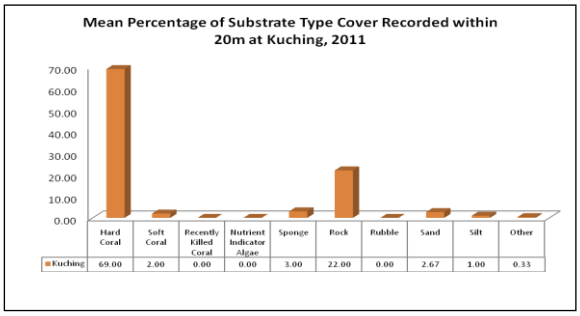
Invertebrates



Populations of indicator inverterbrates are very low. Six indicators (Banded Coral Shrimp, Pencil and Collector Urchins, Sea Cucumber, Crown of Thorns and Triton) are absent from all surveys.

Abundance of the remaining indicator species are very low (Diadema 0.92, Lobster 0.25 and Giant Clam 0.08).

Substrate



The site is considered to be in good condition, with 71% live coral cover, the highest of any area surveyed in Malaysia.

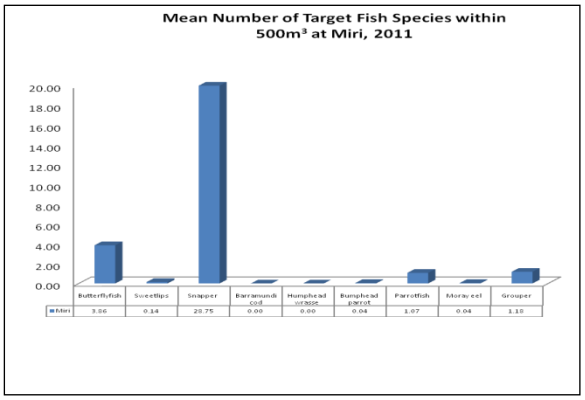
The levels of other substrate categories are all very low, indicating few recent disturbances. The exception is RC (22%), which forms a good base for new coral recruits.

3.3.8 Miri

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

Miri's 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.

Fish

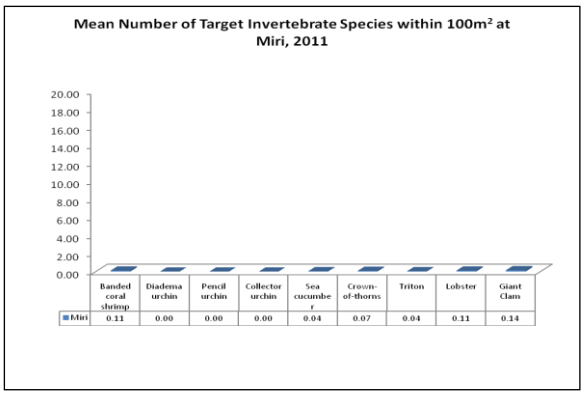


Only two indicator species were completely absent from surveys (Barramundi Cod and Humphead Wrasse).

Abundance of Snapper (28.75 individuals/500m^3) is higher than other areas in East Malaysia.

Abundance of Grouper (1.18) is the second highest in East Malaysia, while for several other indicators it is similar to other areas (Sweetlips 0.14, Bumphead Parrotfish 0.04, Parrotfish 1.06, Moray Eel 0.04).

Invertebrates

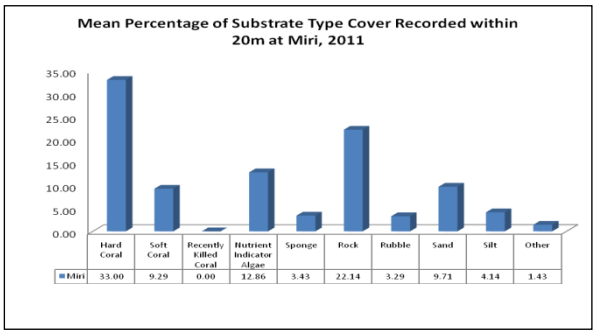


While only three indicators are absent from all surveys, populations of indicator inverterbrates are very low.

Diadema, Pencil and Collector Urchins are not recorded in any surves.

For the remaining indiators, with the exception of Banded Coral Shrimp and Triton, abundance of the remaining indicator species is generally much lower than sites in Peninsular Malaysia (Sea Cucumber 0.04, Crown of Thorns 0.07, Giant Clam 0.14).

Substrate



The site is considered to be in fair condition, with 42.20% live coral cover, above the average for reefs of East Malaysia (40.81%)

The level of NIA (12.86%) is the highest of all areas surveyed in East Malaysia. However, it should be noted that the majority of this is in one near-shore reef area that is exposed to nutrient inflow from nearby oil palm plantations. Other reef areas are further off-shore and show little or no NIA.

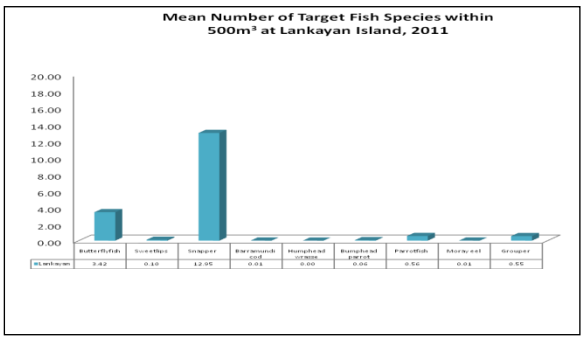
3.3.9 Lankayan

Lankayan is a small island in the Sulu Sea, 1.5 hour boat ride north of Sandakan; Lankayan has been declared 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. No island communities exist in the vicinity of SIMCA, and the surrounding waters are not known to be traditional fishing grounds. However, the SIMCA area is frequented by fishers from Sandakan, Kudat and the Philippines and the area is fished by artisanal and commercial fishers. Before the creation of SIMCA, blast fishing was a constant problem, and turtle eggs were poached on a regular basis.

Lankayan Island is the only developed island within SIMCA. The 0.05 km^2 island is the site of the Lankayan Island Dive Resort (LIDR), which is the only structure on the otherwise uninhabited island.

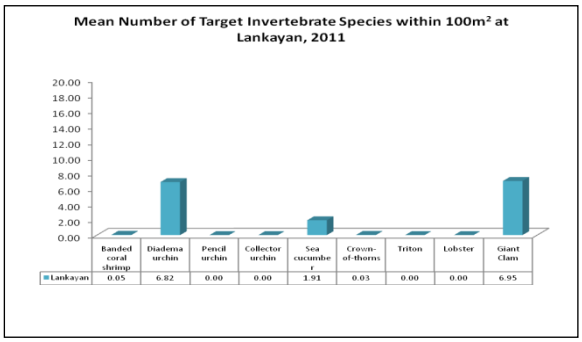
Fish



Fish populations are among the most diverse of any survey area (equal with Mataking/Pom Pom), with only one indicator species completely absent from surveys (Humphead Wrasse).

Abundance of most species is generally low, with the exception of Butterfly fish (3.42 individuals/500m^3) and Snapper (12.95).

Invertebrates

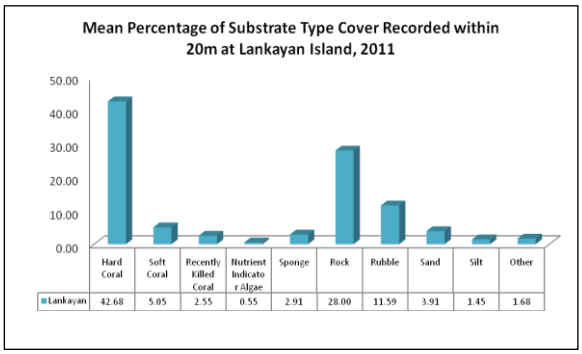


Four indicators are absent from all surveys (Pencil and Collector Urchins, Triton and Lobster).

Abundance of Giant Clam (6.95) is the highest of any site in Malaysia.

Populations of two other indicator inverterbrates are very low: Banded Coral Shrimp (0.05 individuals/100m^2) and Crown of Thorns (0.03).

Substrate



The site is considered to be in fair condition, with 47.74% live coral cover, above the average for reefs of East Malaysia (40.81%).

The low level of RKC (2.55), NIA (0.55), RC (11.59) and SI (1.45) are consistent with few recent disturbances.

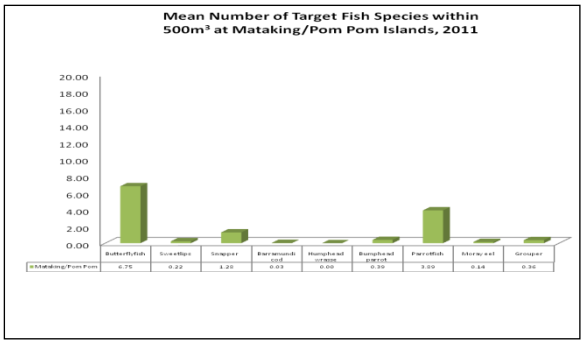
3.3.10 Mataking/Pom Pom

The two islands of Mataking and Pom Pom, which are 8km apart, are approximately 35km 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.

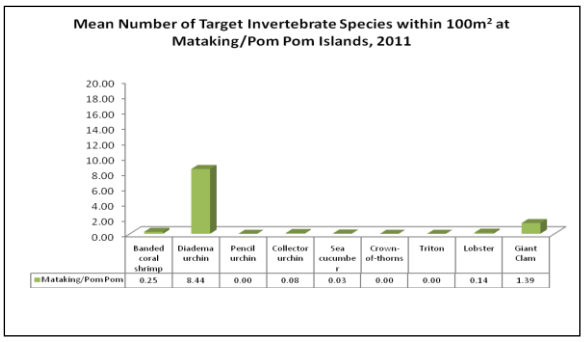
Fish



Fish populations are among the most diverse of any survey area (equal with Lankayan), with only one indicator species completely absent from surveys (Humphead Wrasse).

Abundance of most species is generally low, with the exception of Butterfly fish (6.75 individuals/500m^3) and Parrotfish (3.89).

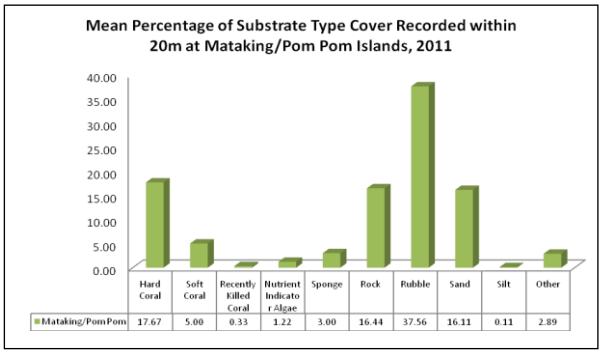
Invertebrates



Three indicators are absent from all surveys (Pencil Urchin, Crown of Thorns and Triton).

With the exception of Diadema (8.44) and Giant Clam (1.39), populations of other indicator inverterbrates are low, (less than 0.25).

Substrate



The site is considered to be in poor condition, with only 22.67% live coral cover, below the average for reefs of East Malaysia (40.81%).

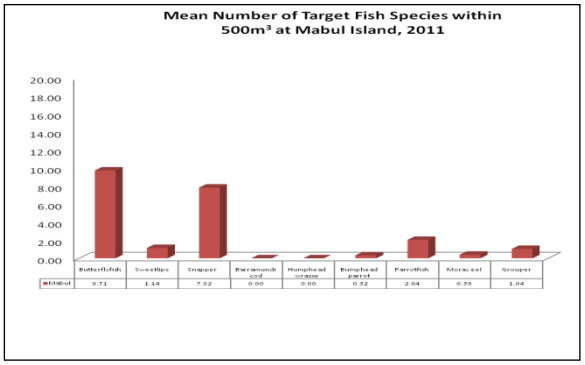
The area in general has very high RB, with an average of 37.56%, rising to as high as 78% on one site. This is likely to be the result of extensive fish bombing over a long period of time.

3.3.11 Mabul

Mabul is located some 30km from 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. 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.

Fish

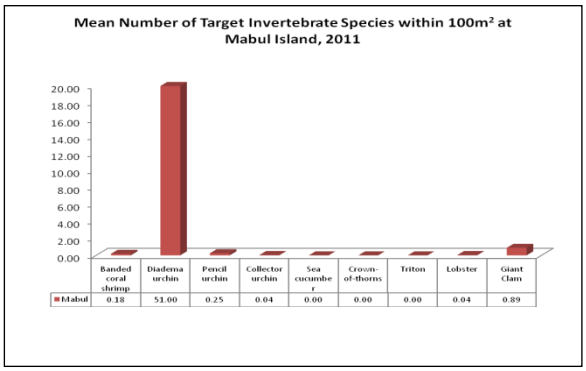


Only two indicator species were completely absent from surveys (Barramundi Cod and Humphead Wrasse).

Abundance of Butterfly Fish (9.71 individuals/500m^3) and Sweetlips (1.14) are higher than other areas in East Malaysia.

Apart from Snapper (7.82), other indicator species are present in relatively low numbers.

Invertebrates

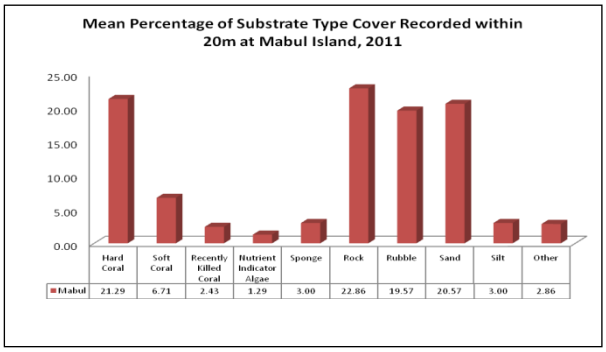


Three indicators are absent from all surveys (Sea Cucumber, Crown of Thorns and Triton).

Mabul is one of few areas in which both Pencil and Collector Urchins are recorded.

With the exception of Diadema (51.00) and Giant Clam (0.89), populations of other indicator inverterbrates are low, (less than 0.25).

Substrate



The site is considered to be in fair condition, with 28.00% live coral cover, below the average for reefs of East Malaysia (40.81%).

The high level of RB (19.57%) indicates considerable disturbance around the island, probably due in part to the rapid date of resort development on the island. The relatively high level of SI (3.00) supports this.

4. Challenges & Recommendations

This section outlines some of the challenges facing coral reefs in Malaysia, and suggests a number of recommendations for coral reef conservation, based both on the objective data collected through the Reef Check surveys as well as based on the subjective, but informed, observations of survey participants. These recommendations are more detailed for the islands off the East coast of Peninsular Malaysia, where more work has been carried out. For East Malaysia, recommendations are less detailed.

4.1 General Recommendations

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 immediately adjacent to the marine park centre; include signs of “do’s and don’ts” in coral reef areas
- Make available handouts to be given to each visitor to coral reef areas (e.g. “do’s and don’ts” and how and where to report any offense observed)
- 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.

4.2 Peninsular Malaysia

Most of the islands where reefs were monitored in Peninsular Malaysia are gazetted Marine Parks, where many human impacts on reefs, such as fishing, trawling, anchoring and collection of any marine life, are prohibited. However, despite the legal protection afforded (for most islands) by their Marine Park status, coral reefs still face a number of threats. These are outlined below, with some recommendations on actions designed to eliminate or reduce impacts, allowing coral reef ecosystems to recover and thrive.

4.2.1 Sewage treatment

Levels of NIA recorded on several islands 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) on the islands rely on a septic tank system which, if not correctly designed and maintained, can overflow, releasing sewage effluent into the sea. It is recommended that the 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.

4.2.2 Solid waste disposal

The high number of tourists visiting the islands puts significant strain on waste collection and disposal systems. Tioman has an incinerator, but the other islands rely on transporting waste back to the mainland.

There is a need to promote waste segregation to resorts and households, to allow easier recycling of valuable wastes, 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.

In addition, there is a need to improve waste collection infrastructure on the islands. Many busy tourist areas lack sufficient waste bins, and some waste inevitably remains behind after tourists have gone. This appears to be a particular problem in Perhentian. Resort operators should be involved in implementing and managing these systems, to ensure their cooperation and participation.

Finally, education and awareness campaigns should be implemented to promote better waste management and reduce littering, particularly among the village communities.

4.2.3 Construction of tourist resorts & facilities

Tourism is the main industry on most islands, and tourist numbers continue to rise, leading to the construction of more resorts and tourism infrastructure (e.g. jetties).

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.

4.2.4 Tourist impacts

Divers and snorkelers visiting the islands can have a variety of physical impacts on coral reefs, including touching and standing on corals, boat anchor use and littering.

There is an increasing body of research on the impact of tourists, particularly divers, on coral reefs. In some cases, the research suggests maximum numbers of visitors that a given reef can tolerate before the inevitable physical damage begins to degrade the reef.

It is recommended that awareness campaigns are 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.

4.2.5 Illegal fishing

There are regular reports of illegal fishing around some 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.

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.

4.3 East Malaysia

For East Malaysia, only some of the areas monitored have formal protection as gazetted Marine park areas (Gaya, Lankayan), though informal protection exists in others as a result of land/resort ownership or on-going work by NGOs (Mataking, Pom Pom). These areas therefore present a different set of challenges for conservation.

The main threats to reefs in East Malaysia can be summarised as follows:

- Fish bombing is still commonplace in some parts of the coastline of East Malaysia, particularly Sabah, and urgent efforts are required to combat this before large areas of reef are destroyed beyond recovery
- Sedimentation is a threat to the reefs. Sediments come from the river outflows around the coasts of both Sabah and Sarawak. 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.
- 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 is a concern.
- 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.
- There is concern amongst divers and local fishermen about commercial trawler fishing occasionally sweeping up fish from the reefs in some areas.
- 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.
- In some areas, COT predation is a problem (particularly East coast of Sabah around Lankayan). Large scale COT removal programmes have shown some success, but continued efforts are required to reduce numbers of this coral predator.

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.

4.4 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 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 Malaysia's coral reefs can be established. More permanent transects need to be placed at selected sites on each island/reef area 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.

5. The Broader Picture: Building Coral Reef Resilience

Most of the impacts to Malaysia's coral reefs described in this report result from local threats (e.g. fish bombing, over-fishing, tourism development). These are well understood and can be managed at the local level. However, there is a growing body of evidence that it is the global threats that will determine the long term health of coral reefs, and there is little that managers can do about combating these global threats.

The 2010 mass coral bleaching event resulted in widespread mortality of corals around South East Asia. Early estimates suggest that mortality in Malaysia was approximately 5-6%. With scientists predicting that the frequency of bleaching events will increase, this serves as a timely warning that action is required to better manage local threats to build the "survivability" of coral reefs so they are in better condition to withstand future bleaching events.

Such efforts will need to consider the following issues:

- Resistance: some coral reef communities remain relatively unchanged in the face of a major disturbance or event such as bleaching. These resistant areas are essential to long term reef health as sources of seed to damaged areas. Such natural resistance needs to be studied, to understand how it arises. Naturally resistant communities need to be identified and rigorously protected against local threats.
- Resilience: similarly, some coral reefs are able to bounce back or recover quickly after experiencing a stressful event such as bleaching caused by elevated temperatures. Resilience criteria need to be defined, resilient areas identified and included into protected areas to manage local threats.
- Connectivity: increasingly, managers are designing and developing networks of MPAs that recognise that reef areas are connected, particularly with regard to larval flow. Managers need to better understand how reef areas in Malaysia are connected in order to protect the transport corridors between them. This will provide for continuing flow of larva from resistant and resilient areas (sources) to areas damaged by both local and global threats (sinks).

In summary, the goal is to manage and reduce local threats to ensure that reefs are better able to survive predicted future events caused by global scale threats, including mass coral bleaching. Success in this goal will require collaboration between managers, government, non-governmental agencies and stakeholders, to implement the urgent immediate actions necessary to improve reef ecosystem resilience.

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YTL SINCE 1955	• YTL: Supporting efforts by RCM to improve coral reefs around Pangkor island on Malaysia's West coast.
ALSTOM	• Alstom Power: through Alstom Foundation, is funding our Rainforest to Reef Programme, targeted at school children from the Marine Park Island schools.
KHAZANAH NASIONAL	• The Khazanah Grants Programme aims to guide all its Civil Society Partner Organisations towards achieving sustainable funding, operational excellence and organisational development
SGP The GEF Small Grants Programme	• SGP: funding an on-going programme of work on the Perhentian Islands to involve the local community in managing the marine resources around the islands
KPMG	• KPMG: donates funds to support a Corporate Reef Check team and education programmes in two schools in KL.
Russell Bedford	• Russell Bedford LC & Company: provides *pro bono* company secretarial services for RCM.

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

- Bubbles Dive Centre, Perhentian
- Redang Kalong, Redang
- Scuba Explorers, Tenggol
- Tioman Dive Centre and Fishermen Dive Centre, Tioman
- Borneo Divers, KK
- Reef Guardian, Lankayan, Sandakan
- Mataking Reef & Dive Resort
- Kapalai Resort
- Pom Pom Island Resort.

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Appendix 1: Survey Sites (2007-2011)

Peninsular Malaysia

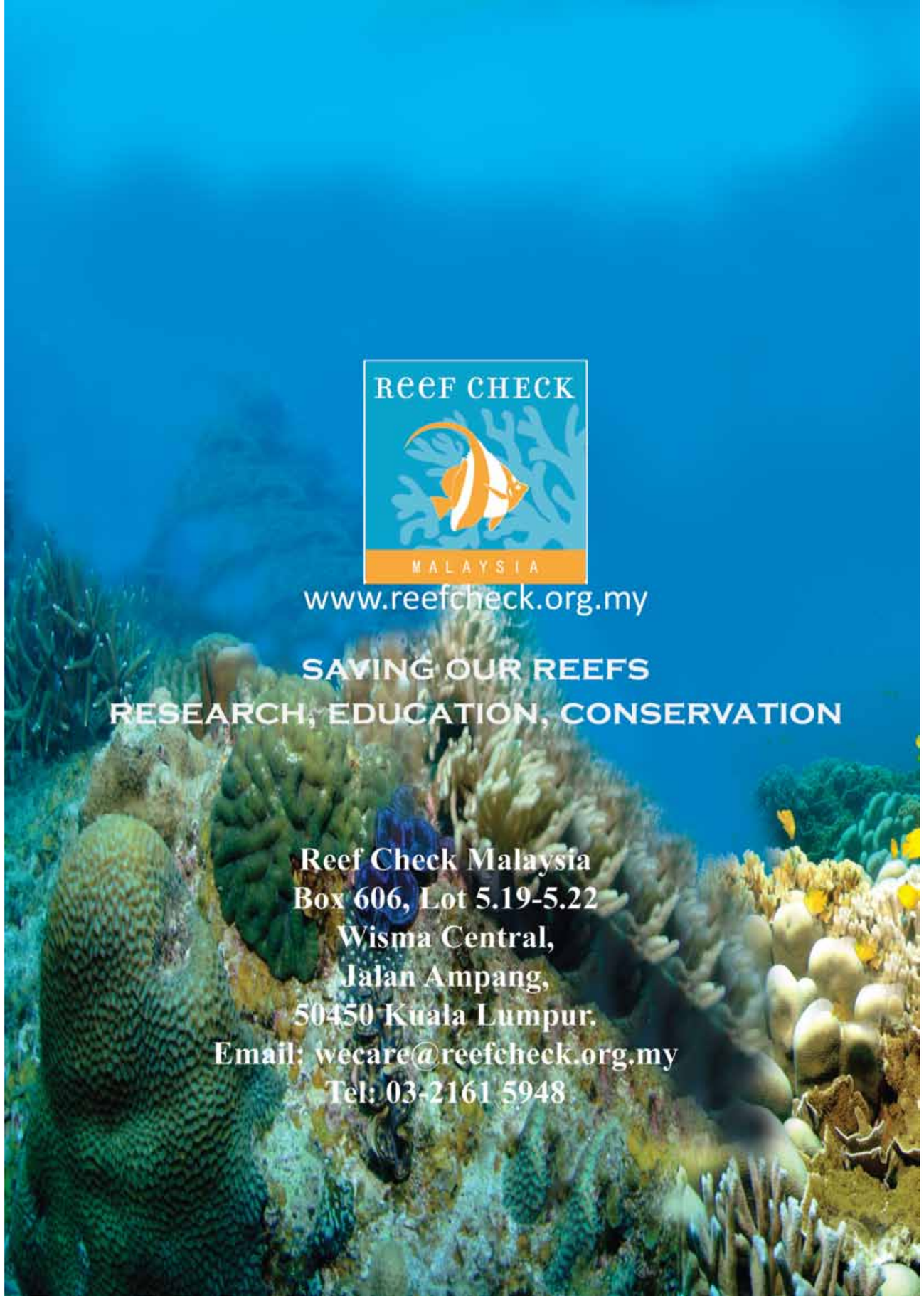
Site Name	Island/Region
Batu Layar	Perhentian
Batu Nisan	Perhentian
Batu Tabir	Perhentian
D'Lagoon	Perhentian
Lighthouse	Perhentian
Pulau Rawa	Perhentian
Sea Bell	Perhentian
Sharkpoint	Perentian
Tanjung Besi	Perhentian
Tiga Ruang	Perhentian
Tukas Laut	Perhentian
Pulau Lima Southern Tip	Redang
Chagar Hutang	Redang
Pasir Akar	Redang
Kerengga Kecil West	Redang
Pulau Kerengga Besar	Redang
Paku Besar	Redang
Paku Kecil	Redang
Pulau Pinang Marine Park	Redang
Redang Kalong House Reef	Redang
Terumbu Kili	Redang
Coral Garden 1	Kapas
Coral Garden 3	Kapas
Silent Reef	Kapas
Teluk Jawa	Kapas
Heritage Row	Bidong/Yu
Pasir Tenggara	Bidong/Yu
Pulau Karah	Bidong/Yu
Pulau Tengkorak	Bidong/Yu
Pulau Yu Besar	Bidong/Yu
Pulau Yu Kecil	Bidong/Yu
Fresh Water Bay	Tenggol
Gua Rajawali	Tenggol
Pasir Tenggara	Tenggol
Rajawali Reef	Tenggol
Teluk Rajawali	Tenggol
Turtle Point	Tenggol
Chebeh	Tioman
Sepoi	Tioman

Tumuk	Tioman
Renggis Island North	Tioman
Renggis Island North	Tioman
Malang Rock	Tioman
Malang Rock	Tioman
Soyak South	Tioman
Teluk Kador	Tioman
Tekek House Reef	Tioman
Pirate Reef	Tioman
Soyak	Tioman
Soyak	Tioman
Fan Canyon	Tioman
Labas	Tioman

East Malaysia

Site Name	Island/Region
Batu Penyu	Talang-Satang
Talang Besar East	Talang-Satang
Talang Besar West	Talang-Satang
Anemone North	Miri
Sunday Reef	Miri
Batu Batik	Miri
Beting Niah North	Miri
Beting Niah South	Miri
Eve's Garden	Miri
Siwa 4	Miri
Froggie Fort	Lankayan
G. Kolam	Lankayan
Katching Star (new)	Lankayan
Bimbo Rock (new)	Lankayan
SSR	Lankayan
Reef 38	Lankayan
Mels Rock (new)	Lankayan
Jawfish	Lankayan
Sand Bar South	Lankayan
Zorro	Lankayan
Sand Bar North	Lankayan
Goby Rock	Lankayan
Lycia Garden	Lankayan
Pegaso (new)	Lankayan
Edwin Rock	Lankayan
Moray	Lankayan

Veron Shallow	Lankayan
Ken's Rock	Lankayan
Reef 77	Lankayan
Ikok Rock	Lankayan
Malu Malu	Lankayan
Twin Rock	Lankayan
Cahaya Way, Bohayan Island	Mataking/Pom Pom
Timba Timba, Sting Ray City	Mataking/Pom Pom
Pandanan Bay, Pandanan Island	Mataking/Pom Pom
Coral Garden Mataking	Mataking/Pom Pom
Mataking House Reef	Mataking/Pom Pom
Sweetlips Rock Mataking	Mataking/Pom Pom
Northern Valley	Mataking/Pom Pom
Pom Pom Jetty	Mataking/Pom Pom
Cliff Hanger	Mataking/Pom Pom
Scuba Junkie House Reef M	Mabul
Scuba Junkie House Reef S	Mabul
Paradise 2 M	Mabul
Paradise 2 S	Mabul
Eel Garden	Mabul
Mandarin Valley	Mabul
Panglima Reef	Mabul



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