REEF CHECK MALAYSIA

Status of Coral Reefs in Malaysia 2009

REEF CHECK MALAYSIA

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SAVING OUR REEFS

RESEARCH, EDUCATION, CONSERVATION

CONTENTS

Executive Summary

1. A total of 115 Reef Check surveys have been completed in 2009, 50 in peninsular Malaysia and 65 in East Malaysia. This represents a significant increase over 2008, particularly in East Malaysia.

2. The surveys were carried out by volunteers trained and certified in the global standard Reef Check method. A total of 61 people were trained as EcoDivers during 2009. The surveys took place on five islands off Peninsular Malaysia's East coast inside established Marine 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 hard coral, at least 10% above the regional average.

4. A low level of recently killed corals indicates that coral recovery continued in 2009, a pattern since the 1997-8 global bleaching event that killed 10% of the world's reefs, including many in Malaysia.

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

6. A high incidence of algae at some reefs indicates that the reefs 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.

7. A series of recommendations is provided with a focus on better education and enforcement of existing laws. In particular, the government is asked to support more education for schools and training for volunteers, to increase participation in Reef Check Malaysia's coral reef survey programmes and to build support for government conservation efforts. Reef Check Malaysia offers its EcoDiver certification program for students and members of the public to learn about coral reefs and monitoring.

8. 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.

9. 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 South East Asia at around US $ 12.7 billion per annum. Coral reefs are threatened due to global warming, overfishing, pollution and sedimentation.

10. 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.

1. Introduction

1.1 Why Are Coral Reefs Important?

Coral reefs provide a number of valuable services to mankind, among which are:

- **Food:** coral reefs are a key source of protein for coastal communities in Malaysia and around the world
- **Fisheries:** reefs are nurseries and breeding grounds for an estimated 25% of all marine animals, and home to one third of all fish species found worldwide
- **Tourism:** reefs attract millions of tourists annually, creating jobs and bringing revenue to local economies
- **Coastal protection:** reefs form a natural barrier for coastal protection, reducing erosion of land.
- **Medicine:** drugs from the sea are currently on the market to combat illnesses including cancer and many more are undergoing trials.
- **Aesthetic, spiritual and religious**: the beauty of reefs is well known, and many religions including Christianity, Buddhism and Islam recognize the value of living organisms other than humans.

The complexity of the economic, social and biological systems surrounding the use of coral reefs makes it difficult to put a value on these services. However, three estimates serve to demonstrate just how important coral reefs are:

- The Global Coral Reef Monitoring Network report, “Status of the Coral Reefs of the World: 2004” suggests that the potential economic value of well managed coral reefs in South East Asia is some US $ 12.7 billion per annum.
- Coral reefs provide economic goods and ecosystem services worth about $375 billion each year to hundreds of millions of people (Costanza, Robert *et al.*, 1997, *The Value of the World's Ecosystem Services*).
- The World Resources Institute report “Reefs at Risk in South East Asia (2002) indicates that sustainable coral reefs fisheries alone are worth some US $ 2.4 billion per year in the region. The coral reefs of Indonesia and Philippines provide annual economic benefits estimated at US $ 1.6 billion and US $ 1.1 billion per year, respectively.

Protecting these resources to ensure that they continue to provide these benefits in the future is important to the well being of hundreds of millions of people around the world who rely on coral reefs for their livelihoods.

1.2 Background to Reef Check

Founded in 1996, Reef Check is the world's largest international coral reef monitoring programme involving volunteer recreational divers and marine scientists (Hodgson 2001, Hodgson *et al,* 2006). The Reef Check Foundation supports the use of a suite of monitoring methods to survey coral reefs and rocky temperate reef ecosystems. First carried out in 1997, Reef Check monitoring of coral reefs provided the first solid evidence that coral reefs have been damaged on a global scale. The survey raised the awareness of scientists, governments, politicians and the general public about the value of coral reefs, threats to their health and solutions to coral reef problems (Hodgson, 1999).

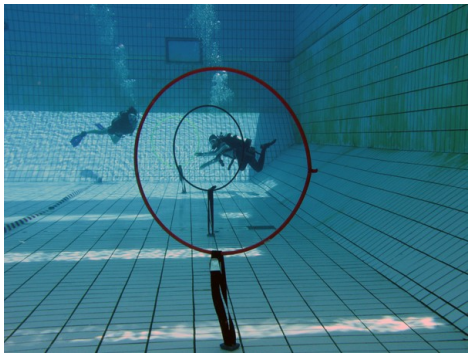
In August 2002, Reef Check released its five-year report, *The Global Coral Reef Crisis – Trends and Solutions* (Hodgson and Liebeler, 2002). Based on data collected in over 80 countries, the report was the first scientific documentation of the dramatic worldwide decline in coral reef health over the previous five years. The rate of decline and the global extent of the damage are alarming. There is virtually no reef in the world that remains untouched by human impacts, such as over fishing, pollution and climate change. Yet the success stories discussed in the report show that, with proper monitoring, management and protection, our coral reefs can recover. It is up to us.

Today, Reef Checks are conducted annually at hundreds of sites around the world, in order to continually monitor the state of the world's reefs. Reef Check teams have been sponsored by a number of large corporations and have worked with many businesses in tourism, diving, surfing and the marine aquarium trade, to develop mutually beneficial solutions - including the creation of self-funding Marine Protected Areas.

A non-profit organization, Reef Check's mission is to:

- **Educate** the public and governments about the value of coral reefs and the crisis facing them;
- **Create** a global network of volunteer teams, trained and led by scientists, that regularly monitor and report on reef health using a standard method;
- **Facilitate** collaborative use of reef health information by community groups, governments, universities and businesses to design and implement ecologically sound and economically sustainable solutions;
- **Stimulate** local action to protect remaining pristine reefs and rehabilitate damaged reefs worldwide.

Reef Check is now active in over 90 countries and territories throughout the world. Reef Check promotes reef education and "citizen science" for students and adults through the EcoDiver certification program that is also a self-funding mechanism for dive shops and resorts.



1.3 Reef Check in Malaysia

Malaysia is part of the "Coral Triangle", the area of the world's oceans recognized by scientists as having the highest marine biodiversity. Coral reefs represent an economically important ecosystem and are the foundation of a significant percentage of the country's tourist industry. There are some 4,000 km^2 of reef around the country, including fringing reefs and offshore islands. It is estimated that there are over 550 species of coral in Malaysian waters (source: "Reefs at Risk in South East Asia").

However, a lack of comprehensive management programmes is leading to degradation of this important economic resource. This situation is exacerbated by inadequate information on the status and location of the reefs, further hindering management efforts.

In 2001, the Reef Check Foundation appointed a National Coordinator for Malaysia, to promote Reef Check and carry out training and surveys. While surveys were carried out in several parts of the country, a lack of funding and support limited the growth and positive impacts of the programme.

In 2006, the British Government provided funding for a one year project to establish a more sustainable Reef Check programme in Malaysia. That project culminated with the registration of Reef Check Malaysia Bhd as a non-profit company in August 2007.

At the end of 2007, Reef Check Malaysia published its first annual survey report, covering 33 surveys at 21 sites on the East coast of Peninsular Malaysia. During 2007, Reef Check Malaysia trained 15 EcoDiver Trainers and 58 EcoDivers. In 2008, almost 100 divers completed the EcoDiver programme, and 58 surveys were completed. A further 61 people were trained in 2009 and 115 surveys completed.

1.4 Goals of Reef Check Malaysia

The goals of Reef Check Malaysia are consistent with the global program and are to educate Malaysians about the value of coral reefs and to build up a constituency of citizens who are knowledgeable and supportive of marine conservation. RCM seeks to do this by training "citizen scientists" – from students to business people, to help monitor these critically important natural resources and to obtain reliable scientific data that will help the general public and the government to understand the health of Malaysia's coral reefs. RCM seeks in particular to bring together academic scientists, businesses, government staff and non-profit organizations in a united effort to sustainably manage coral reefs.

This report is the third annual report, and details the results of Reef Check surveys carried out during 2009. 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. Threats to Coral Reefs

According to “Reefs at Risk in Southeast Asia” (Burke *et al*, 2008), the coral reefs of Southeast Asia are the most threatened in the world. The damage caused by occasional natural phenomena are far outweighed by growing human impacts in the region.

The “Reefs at Risk” report identifies the following key threats to coral reefs.

2.1 Coastal Development

Growing populations and expanding industrial economies, combined with developing tourism markets, drive demand for new infrastructure in coastal zones. This results in both direct and indirect pressures on reefs:

- direct pressure: physical damage to the reef as a result of construction (eg. damage to substrate, sedimentation, dredging), land reclamation activities, and use of corals as a source of lime for cement production
- indirect: development in coastal areas usually results in increased sedimentation and nutrient runoff; destruction of mangroves, an important part of the marine ecosystem, adds to the problem. High levels of sediment mean that corals are unable to photosynthesize, causing coral bleaching; poor waste water treatment leads to high nutrient loads, resulting in algal blooms which also smother coral.

These pressures combined can have significant negative impacts on coral reefs. Irresponsible development of tourist facilities in particular can destroy the very ecosystems tourists come to see.

2.2 Marine-based Pollution

The sea lanes around South East Asia are among the busiest in the world. The volume of sea traffic threatens coral reefs in a number of ways:

- pollution from ports: pollutants can accumulate in these semi-enclosed areas
- oil spills: both large spills and frequent minor spills release oil which can cause significant damage to coral reefs
- ballast and bilge discharge, which can result in release both of pollutants and exotic species
- garbage and solid waste dumping.

2.3 Sedimentation and Pollution from Inland Sources

Corals depend on photosynthetic zooxanthellae for nutrients and therefore thrive in clear tropical waters. High levels of sedimentation can significantly affect coral growth and can even result in coral dying. Logging, river modifications, road construction and other upland activities are causing high rates of soil erosion in South East Asia, which then enters rivers to eventually find its way to the sea.

In addition to sediment, nutrients and fertilizers that are not absorbed by soil also flow into the sea, contributing to algal blooms that smother and kill reefs.

2.4 Overfishing

Coastal populations are growing throughout South East Asia, and over 80% of the populations of Malaysia, Indonesia, the Philippines and other countries live within 50km of the coast. Many rely on marine resources for their food and livelihoods. As a result, coastal resources are increasingly being exploited beyond sustainable limits.

The resulting overfishing causes a variety of impacts:

- many fish species are overexploited, either as a food source or for the marine aquarium trade, resulting in reduced breeding populations
- the mix of fish species can change, reducing the resilience of coral reefs to natural and anthropogenic disturbances
- algal-grazing fish are removed from the coral reef resulting in algal blooms which smother reefs.

2.5 Destructive Fishing

Destructive fishing techniques, particularly poison fishing and blast fishing, contribute to over-exploitation of economically important species and cause damage to other species and the coral reef itself.

Poison fishing is used to stun fish that are subsequently caught for the live fish food trade. Other fish and corals are affected, and repeated applications of cyanide may cause coral death. Blast fishing uses explosives to kill fish, which are subsequently harvested. However, the process causes severe damage to reefs, and can kill up to 80% of coral in the area.

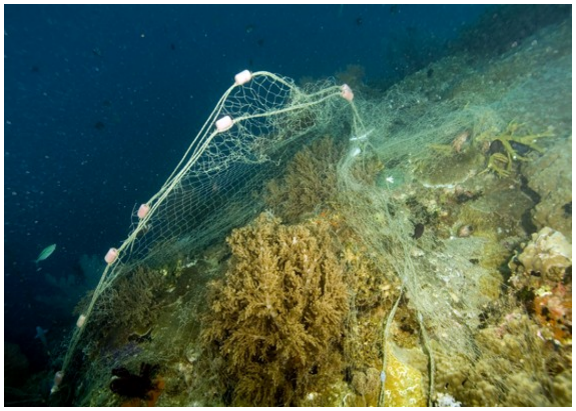
2.6 Physical Impact from SCUBA diving and Snorkelling Activity

The tourism industry has grown significantly over the past decade, resulting in development of new resorts to cater for the increasing numbers of tourists visiting the islands each year. With the increase of numbers of tourists on these islands, recreational activities such as SCUBA diving and snorkelling have also been gaining popularity.

The increasing number of new and inexperienced divers and snorkelers has been identified as one of the threats causing physical damage to the coral reefs around these areas.

2.7 Status of Threats to Reef Corals

In 2008, the International Union for the Conservation of Nature (IUCN), with the assistance of Reef Check, organized a review of the threats to reef building corals. As a result all hard corals were listed on the IUCN Red List with a high percentage considered threatened (Carpenter *et al*. 2008).



3. Survey Methodology and Sites

Coral reefs are complex ecosystems. Changes to one part of the ecosystem (eg. over fishing of a particular species for food) can have a significant impact on other parts (eg. growth of reef-smothering algae), resulting in damage to the entire ecosystem.

3.1 Reef Check Survey Methodology

Reef Check surveys are based on the philosophy of "Indicator Species". These are marine organisms that:

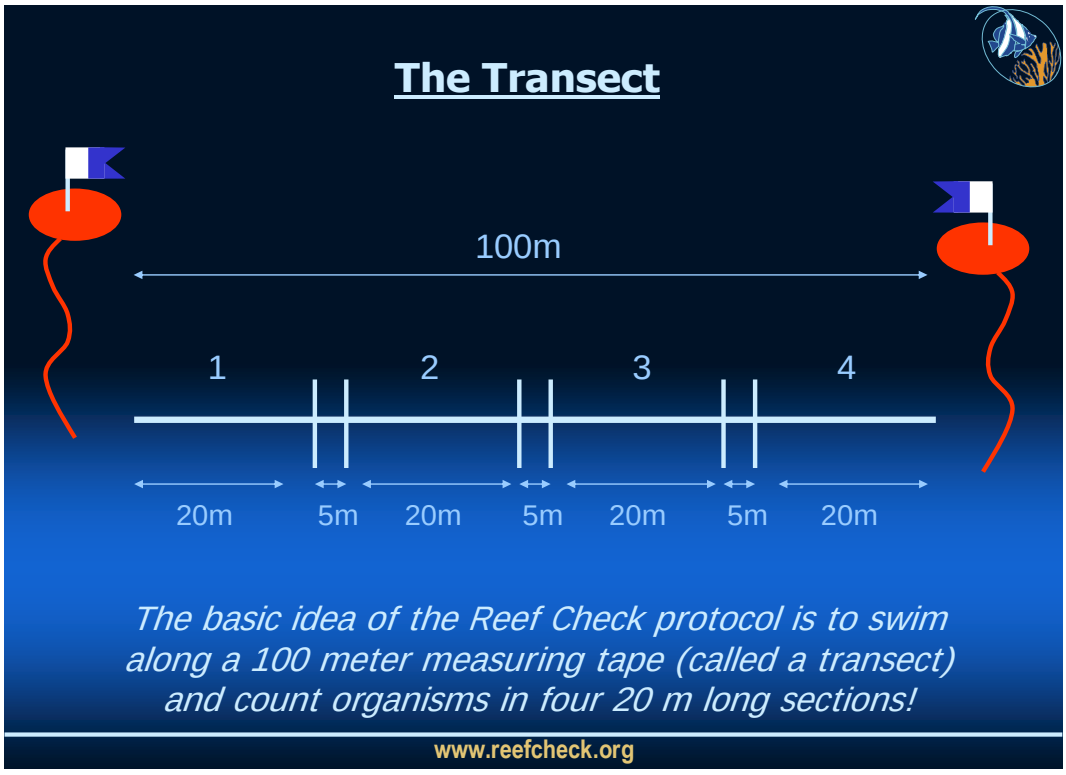
- are widely distributed on coral reefs
- are easy for non-scientists to identify
- provide information about the health of a coral reef.

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, where possible (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).

Figure 1: The Transect



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

3.2 Survey Sites

During 2009, a total of 115 surveys were conducted: 50 in Peninsular Malaysia and 65 in East Malaysia. This latter represents a significant increase over 2008, when only 10 surveys were conducted, a result of Reef Check Malaysia's effort to extend its work to East Malaysia, where 75% of Malaysia's reefs are located.

For Peninsular Malaysia, all the surveys conducted at sites around the five main islands on the East coast (Aur, Perhentian, Redang, Tenggol and Tioman) were carried out as part of the Sustainable Island Programme, which was funded by Sime Plantations Sdn Bhd. Reef Check Malaysia collaborated with Wild Asia in this project to monitor the reefs around these islands and find solutions to solve problems threatening the reefs on these islands through efforts with local resorts and dive operators.

In East Malaysia, a large percentage of the surveys were conducted under the "Ekspedisi Perdana" (coordinated by University of Malaysia Sabah), an expedition to survey the reefs off the coast of Sabah. Other surveys were conducted by dive operators who have undergone Reef Check training this year, particularly in Lankayan and Miri.

The list of sites at which Reef Check surveys have been conducted over the last three years is shown in appendix 1.

4. 2009 Survey Results and Analysis

This section presents the results of Reef Check surveys carried out during 2009. 50 surveys were conducted over 49 sites on 5 islands in Peninsular Malaysia and 65 surveys were conducted in East Malaysia.

Even though this is the third year of an extensive survey programme, new sites are still being added. A total of 19 new sites have been added this year in Peninsular Malaysia. Most of the sites in East Malaysia are new, as this is the first year in which extensive surveys have been carried out there.

4.1 Status of Coral Reefs in Malaysia

In this section, the results from all 115 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.

4.1.1 Substrate

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

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 can only be categorised as "fair", based on the average live coral cover (Hard Coral + Soft Coral) from all the surveys of 49.96%, which is at the borderline between "fair" and "good" condition (see chart 1). However, the low percentage of Recently Killed Coral (2.4 %) indicates that damage to reefs in the last year due to natural or human factors in 2009 was relatively low. The percentage of Rock is relatively high (over 23%), a large proportion of which is old dead corals. This is considered to be an acceptable level, given that most of the reefs surveyed are in areas affected by monsoon and strong waves during certain times of the year.

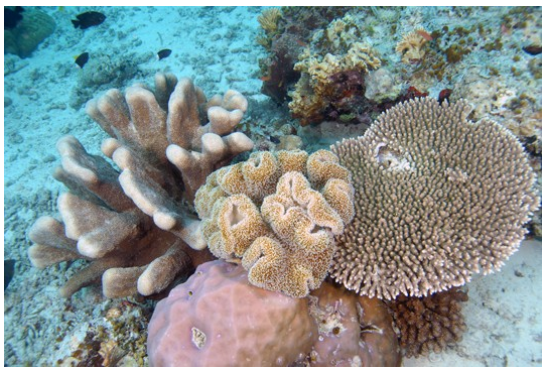
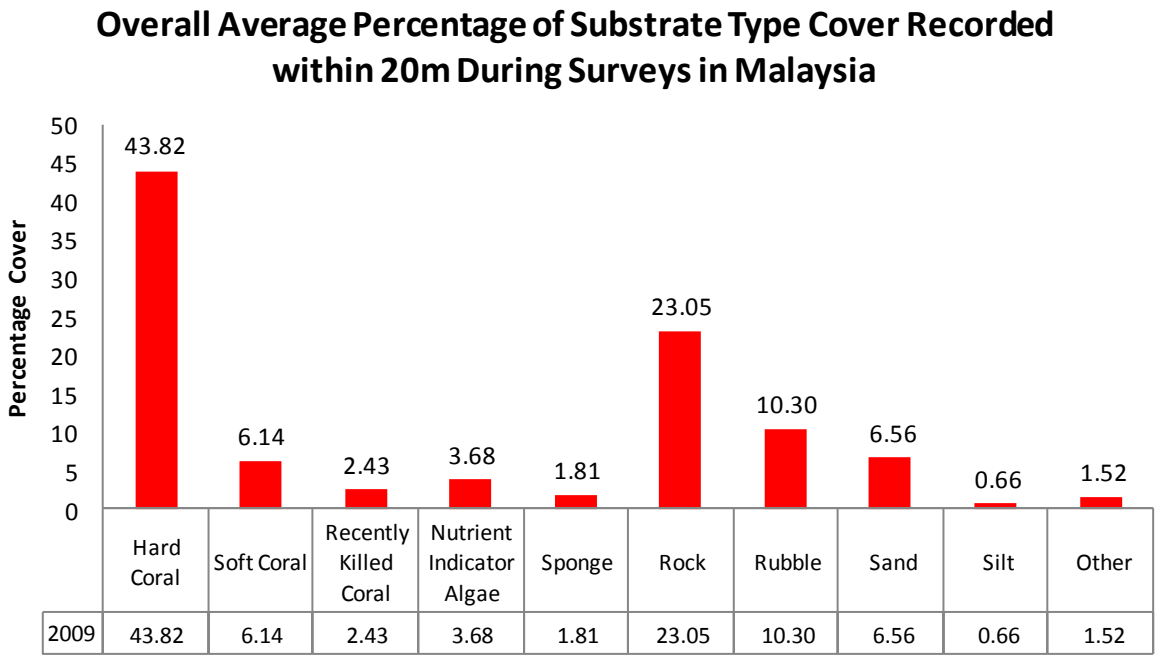


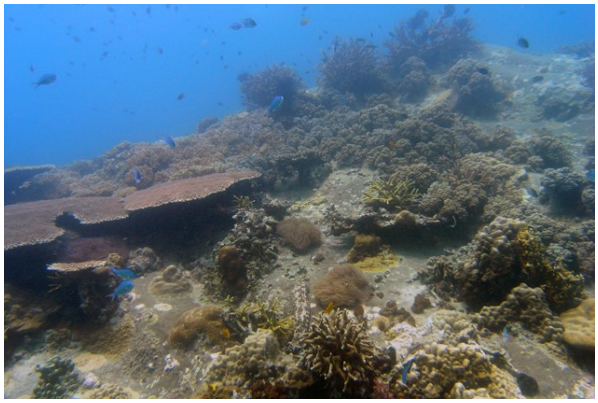
Chart 1: Substrate Cover - Malaysia

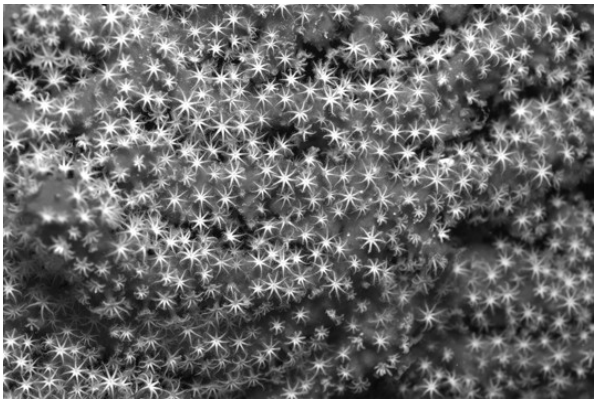


It is also encouraging that the average level of Nutrient Indicator Algae is relatively low at 3.7%. Although algae is a natural component of coral reefs, increasing or high levels of algae can indicate influx of nutrients into the water, which in turn can lead to a proliferation of algae to a level that is above the ability of herbivorous organisms to keep it in check. This results in algae smothering and killing corals, and reduces the surface for potential recruitment of new corals on rock and old dead corals, hindering the recovery of reefs over time.

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.



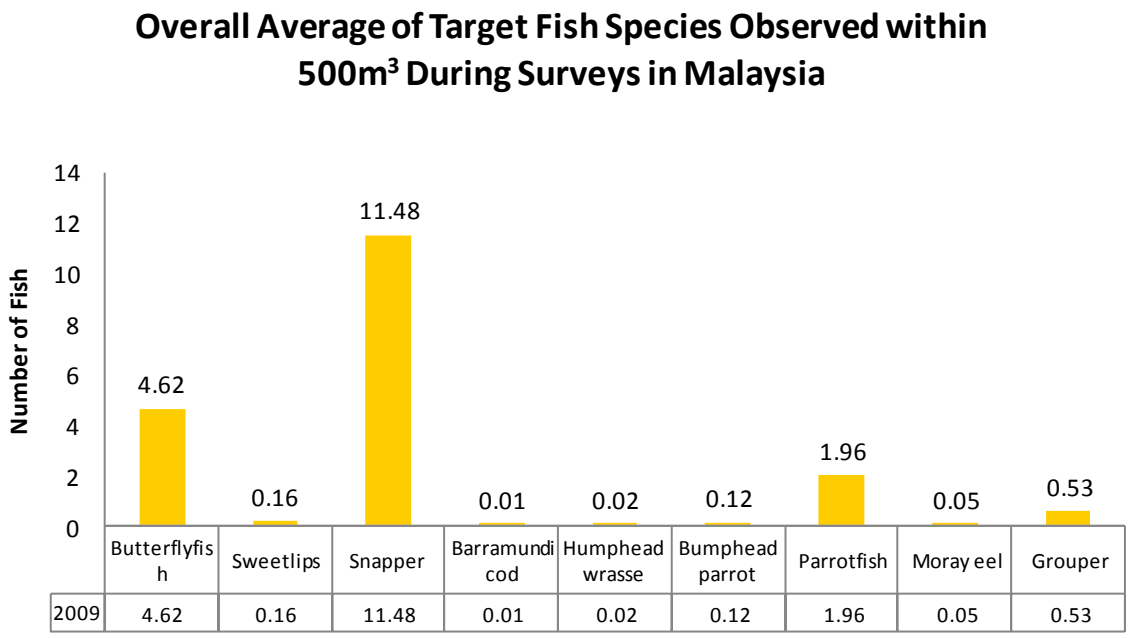


4.1.2 Fish

One criterion used to select Reef Check indicator fish species is their desirability for various types of fishing. Abundance of those varieties that are targeted for the food trade is low in most of the areas where surveys have been conducted (see chart 2). These include groupers and parrotfish, where only adult-sized fish are counted during the survey (over 30cm and 20cm long respectively). The low figure of less than 1 grouper observed per 20 m long replicate transect (500 m^3 of water volume surveyed) indicates heavy fishing pressure for such fish.

Chart 2: Fish Abundance - Malaysia

The numbers of prized fish such as Barramundi cod, Sweetlips and Humphead wrasse were also



very low and rarely sighted during the surveys.

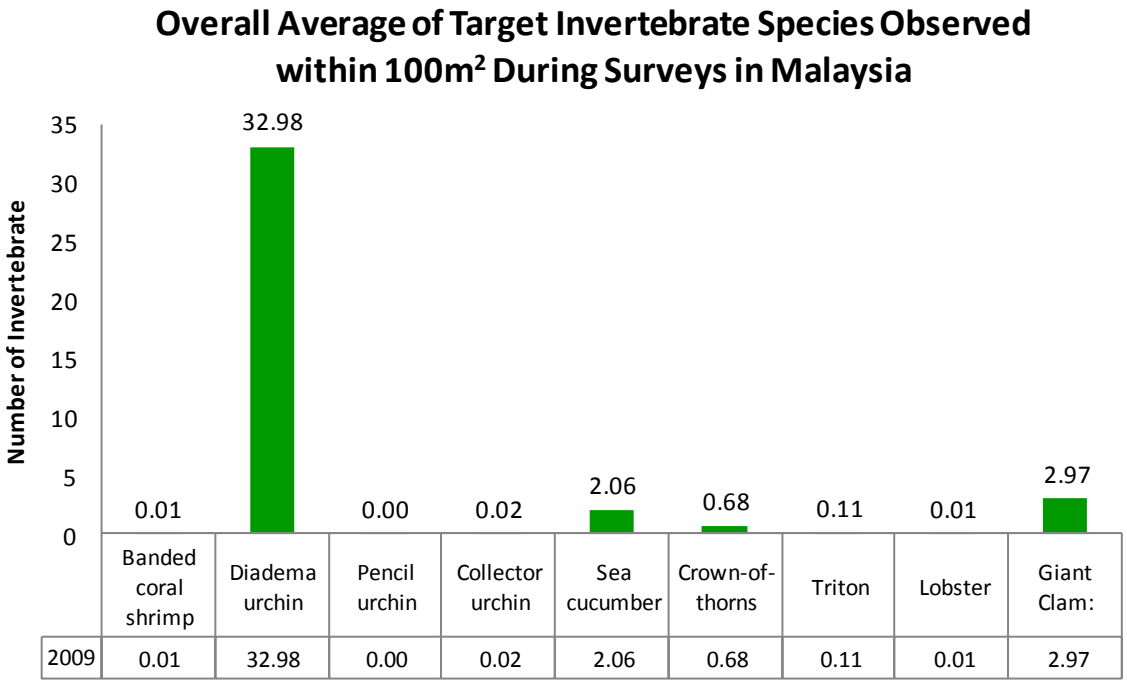
In particular, the high value of a single large Humphead wrasse (which can be worth up to US$ 10,000 on live fish markets), results in targeted fishing effort for this particular species. Greater enforcement of Marine Park regulations will be necessary to aid recovery of populations of this iconic species, and on-going monitoring will help to track recovery in populations.

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

4.1.3 Invertebrates

The invertebrate indicators have been selected on the basis either that they are high-value target organisms for fishing and/or collection, or indicators of an imbalance of, for example, nutrients in the water. Highly sought after invertebrates such as banded coral shrimp, collector urchin, triton shell, lobster and pencil urchin were largely absent from all the surveys we have conducted (see chart 3). These invertebrates are prized either as food, as decorative "curio" pieces at home or for the aquarium trade. Older fishermen in survey areas tell stories of previously high numbers of lobster on some reefs now being substantially depleted due to over-harvesting.

Chart 3: Invertebrate Abundance - Malaysia



The low numbers of Crown-of-thorns starfish (COT), which feed on corals, is a positive indicator, as COTs can destroy large areas of reef over a short period of time. On the islands off the East coast of Peninsular Malaysia, 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.

The abundance of long-spined sea urchins *(Diadema sp.)* at some sites, particularly Tioman Island (see section 4.2.3) and a few sites in Sabah, is a concern. When the reef ecosystem is in balance, 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.

High numbers of *Diadema* can cause a particular problem. The spines which the urchins use to move scrape living corals as they move over the surface of the reef. Very high numbers of *Diadema* can damage the reef structure, degrading the reef if the bioerosion rate exceeds the rate of coral growth. Having a balance of *Diadema* and herbivorous fish such as parrotfish, surgeonfish and rabbitfish is important as a control for algal growth. Even with this balance, the fertilizing effect of nutrient pollution is something that needs to be addressed to prevent further degradation of reefs from algal proliferation.

4.2 Status of Coral Reefs in Peninsular Malaysia

The results below summarise the health of coral reefs on the five islands surveyed off the East coast of Peninsular Malaysia. The results highlight the different problems each island is facing.

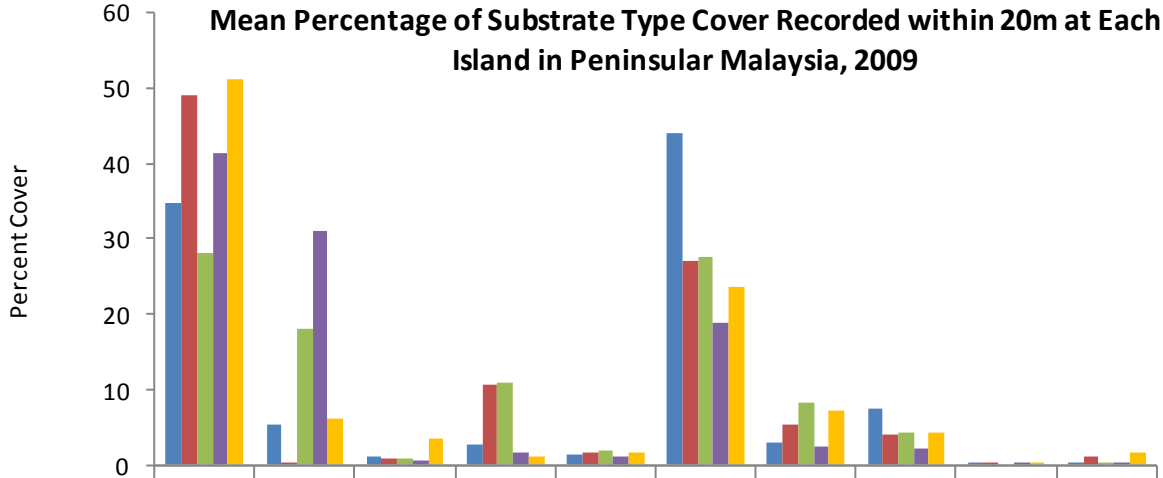
4.2.1 Substrate

The results from the surveys show that Tenggol and Tioman have the highest LCC of 72.6% and 57.2% respectively, which is "good" under the Coral Reef Health Criteria. The reefs around Tenggol consist of a higher percentage of Soft Corals (over 30%), due to the strong currents around most of the survey sites, which support the feeding pattern of these corals. Tioman and Perhentian have the two highest levels of Hard Coral cover of 51.2% and 49.1% respectively. Hard corals provide a healthy reef system as the hard structure with holes and crevices provides habitat for many reef organisms.

Sites in Pulau Aur are generally rocky in nature, and Rock cover, at 44%, is significantly higher than the other islands (see chart 4). However, observations during surveys clearly show that some sites have been damaged by diving activities (the island is a popular location for dive training and leisure diving) and fishing. This is an issue that needs to be addressed by managers.

With high rock cover on all five islands providing a suitable platform for new corals to attach to and grow on, recovery of reefs will be possible with effective management and proper enforcement to protect these islands.

Chart 4: Substrate Cover – Peninsular Malaysia



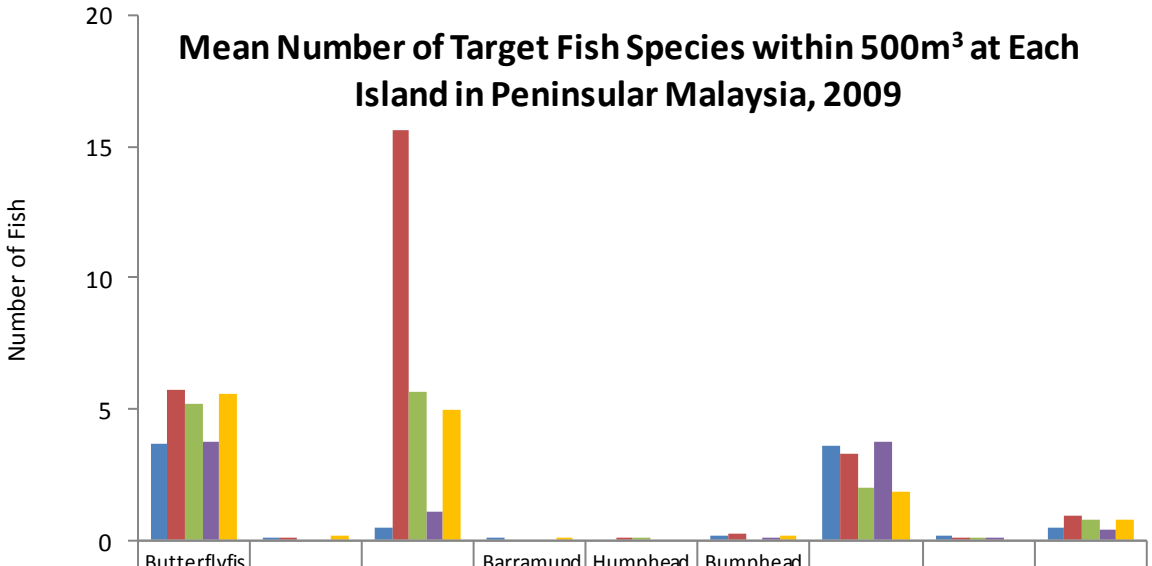
	Hard Coral	Soft Coral	Recently Killed Coral	Nutrient Indicator Algae	Sponge	Rock	Rubble	Sand	Silt	Other
Aur	34.75	5.31	1.06	2.75	1.38	44.00	2.81	7.50	0.31	0.06
Perhentian	49.11	0.36	0.83	10.73	1.51	27.14	5.31	4.01	0.05	0.94
Redang	28.06	17.92	0.69	10.90	1.81	27.57	8.26	4.38	0.00	0.35
Tenggol	41.43	31.16	0.54	1.70	1.16	18.93	2.50	2.14	0.09	0.18
Tioman	51.20	6.04	3.33	1.20	1.56	23.49	7.08	4.17	0.26	1.61

On a more worrying note, the level of Nutrient Indicator Algae (NIA) in Perhentian and Redang is significantly higher than other islands, with over 10% cover on both islands. The algal growth on these two islands needs to be kept in check as further proliferation could result in corals being smothered by algae. This will not only kill the corals due to competition for space and sunlight, but also reduces the amount of suitable surface for new coral recruitment. Anecdotal observations suggest that one source of nutrient is sewage from resorts, as most of the resorts on the islands do not have properly maintained sewage systems. These observations are supported by the results of water quality testing in Perhentian, which indicate the presence of fecal coliforms in water samples from the island. This is an issue that needs to be addressed jointly by Marine Park management, resort operators and state governments.

4.2.2 Fish

Abundance of most fish indicators is low, particularly for prized food fish such as Sweetlips, Barramundi cod and Humphead wrasse (see chart 5). Other food fish such as grouper have also been observed less than once within a 500m^3 area of water in all the 5 islands. This is an indication that these fish may have been overfished, especially before the islands were gazetted as Marine Parks. However, observations during the surveys noted the presence of many juvenile groupers (<30cm) at most sites. This suggests that the fish population is recovering and with proper enforcement, there is a chance for the population to fully recover.

Chart 5: Fish Abundance – Peninsular Malaysia



	Butterflyfish	Sweetlips	Snapper	Barramundi cod	Humphead wrasse	Bumphead parrot	Parrotfish	Moray eel	Grouper
Aur	3.65	0.05	0.45	0.08	0.00	0.13	3.58	0.15	0.48
Perhentian	5.75	0.06	15.60	0.00	0.02	0.27	3.29	0.10	0.90
Redang	5.22	0.00	5.61	0.00	0.03	0.00	1.97	0.06	0.75
Tenggol	3.71	0.00	1.11	0.00	0.00	0.04	3.71	0.04	0.36
Tioman	5.60	0.13	4.96	0.02	0.00	0.17	1.85	0.00	0.75

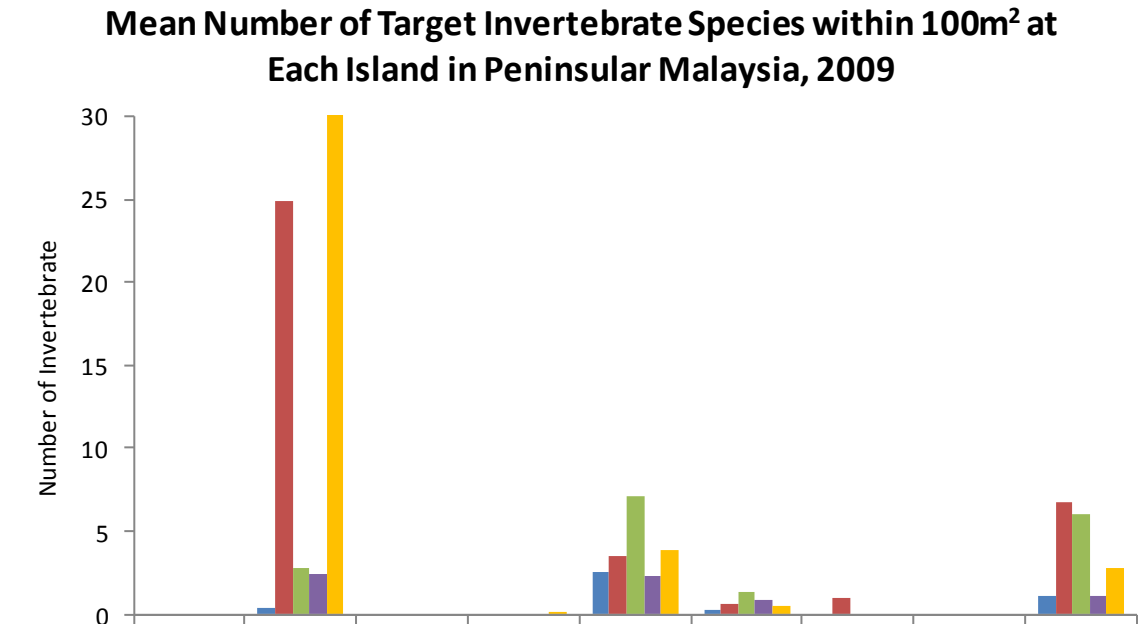
Another type of fish which is sought after for food is parrotfish. The presence of parrotfish is important as these fish are part of the mechanism for controlling the growth of algae on reefs, the main diet of these fish. Observations from the surveys also show that parrotfish populations have the potential to grow further as many juveniles (<20cm) were observed during the surveys.

Snappers, which are sought after as food, are low in numbers in Aur and Tenggol. Reports from locals and operators on these two islands suggest that large-scale fishing activities using nets are the cause for the low numbers of snappers recorded. This is supported by the fact that there is no local presence of the Marine Parks on either of these islands, enabling fishermen to encroach into the area more frequently compared to the other three islands.

4.2.3 Invertebrates

Three invertebrate indicators – banded coral shrimp, pencil urchin and lobster - were totally absent from the 50 surveys conducted over the five islands (see chart 6). Although known to be uncommon around the Peninsula, the small populations previously present could have been over-harvested and it will take a very long time for populations to recover. The presence of edible sea cucumbers and giant clams on a number of the islands is good news, as it suggests that there has been minimal harvesting for food and curio trade of both types of invertebrates. Continuous monitoring and enforcement should be able to help these populations recover in other islands.

Chart 6: Invertebrate Abundance – Peninsular Malaysia



	Banded coral shrimp	Diadema urchin	Pencil urchin	Collector urchin	Sea cucumber	Crown-of-thorns	Triton	Lobster	Giant Clam
Aur	0.00	0.43	0.00	0.00	2.55	0.25	0.00	0.00	1.10
Perhentian	0.00	24.92	0.00	0.00	3.46	0.60	0.98	0.00	6.79
Redang	0.00	2.75	0.00	0.00	7.11	1.36	0.00	0.00	6.06
Tenggol	0.00	2.39	0.00	0.00	2.29	0.89	0.00	0.00	1.11
Tioman	0.00	119.85	0.00	0.15	3.83	0.54	0.00	0.00	2.77

The number of *Diadema* urchins is very high in Tioman compared to the other islands. Although populations could be naturally high, this abundance could also be an indication of nutrient pollution that is in turn causing excessive algal growth, an important food source for these urchins. . While these urchins are important to control the amount of algae on the reefs (as reflected in the low NIA cover in Tioman), it is equally important to find solutions to the problems that are causing the pollution in the first place. As mentioned in section 4.2.1, the issue of proper sewage management in resorts needs to be addressed to prevent further degradation of the reefs around Malaysia caused by proliferation of algae.

4.3 Status of Coral Reefs in East Malaysia

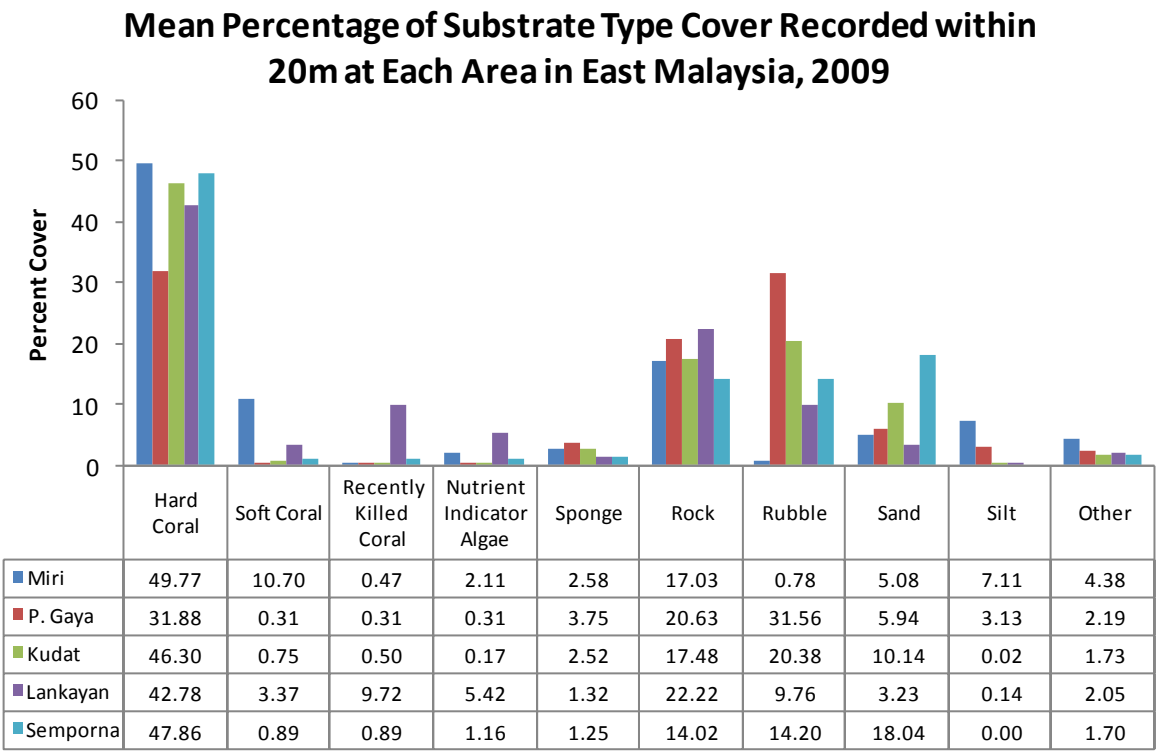
The 65 surveys conducted in East Malaysia are divided into five areas: Miri, Pulau Gaya, Kudat, Lankayan and Semporna. However, most of the surveys were conducted in the areas of Kudat and Lankayan.

4.3.1 Substrate

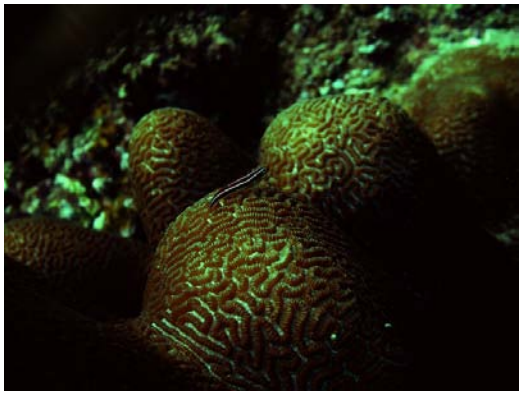
According to the survey results, only the reefs around the Miri area are categorised as "good", under the Coral Reef Health Criteria, with total LCC of 60.5% (see chart 7). Reefs from other areas are in the "fair" category (26-50% LCC).

High percentages of both Recently Killed Coral (RKC) and Nutrient Indicator Algae (NIA) were observed on the reefs around Lankayan, which are indicative both of recent damage to the reefs as well as nutrient pollution in the water. The amount of RKC is a particular concern, and the average level of 9% masks the maximum of 27% RKC in one site. Local reef managers have indicated that COT predation is a problem. Efforts to control these predators are required.

Chart 7: Substrate Cover – East Malaysia



	Hard Coral	Soft Coral	Recently Killed Coral	Nutrient Indicator Algae	Sponge	Rock	Rubble	Sand	Silt	Other
Miri	49.77	10.70	0.47	2.11	2.58	17.03	0.78	5.08	7.11	4.38
P. Gaya	31.88	0.31	0.31	0.31	3.75	20.63	31.56	5.94	3.13	2.19
Kudat	46.30	0.75	0.50	0.17	2.52	17.48	20.38	10.14	0.02	1.73
Lankayan	42.78	3.37	9.72	5.42	1.32	22.22	9.76	3.23	0.14	2.05
Semporna	47.86	0.89	0.89	1.16	1.25	14.02	14.20	18.04	0.00	1.70



The levels of Rock cover on all five areas are similarly high, providing good solid surfaces for new coral recruitment in the future. However, the high Rubble cover recorded in sites around Pulau Gaya and Kudat is something to be concerned about as it can be a result of physical damage, particularly from fish bombing and other human impacts. Observations during the surveys noted that fish bombing activities are likely to be the cause of the damage on those reefs.

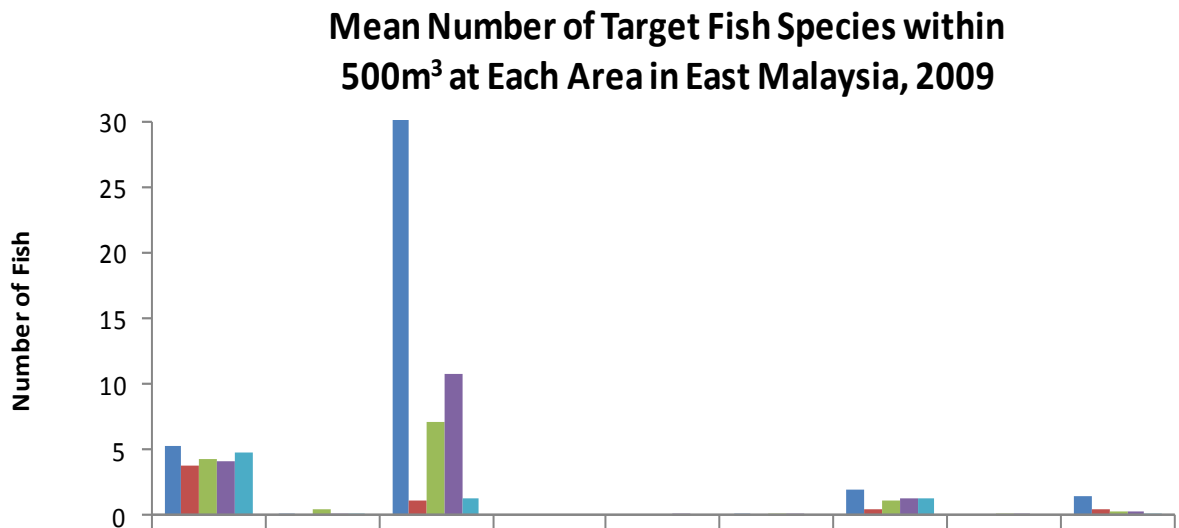
The level of silt recorded in the reefs around Miri and Pulau Gaya also needs to be monitored to track further increase in siltation. Additional silt and sediment load will reduce sunlight penetration to coral, resulting in poor coral health that can lead to mortality. Thick layers of silt on rocks and other hard surfaces will also prevent new coral recruitment. Therefore, it is very important to find the cause of silting and reduce silt load on these reefs before it damages more corals, particularly around Miri where the reefs are still in quite good condition.

4.3.2 Fish

The survey results show that most of the food fish that are highly sought after such as Sweetlips, Barramundi cod, Humphead wrasse, groupers and the large Bumphead parrotfish were rare or absent during most of the surveys in all the islands (see chart 8). Groupers, which are popular on local fish markets, were observed in very low numbers in the areas of Pulau Gaya, Kudat, Lankayan and Semporna, with less than 2 fish sighted in one whole survey. The number of groupers is higher around Miri with average sightings of more than 4 groupers per survey. This is surprising, since both Gaya and Lankayan are within marine protected areas, but Miri isn't, and suggests that enforcement needs to be stepped up in the former areas.

The numbers of butterflyfish recorded during the surveys within all five areas were high compared to other indicator species. This suggests a minimal impact on these fish from fishing activities for the aquarium trade. The presence of snappers, another food fish, especially in the Miri area, is a good indication that fishing pressure is low around the reefs there.

Chart 8: Fish Abundance – East Malaysia



	Butterflyfish	Sweetlips	Snapper	Barramundi cod	Humphead wrasse	Bumphead parrot	Parrotfish	Moray eel	Grouper
Miri	5.34	0.13	72.56	0.00	0.00	0.09	2.03	0.00	1.47
P. Gaya	3.75	0.00	1.13	0.00	0.00	0.00	0.50	0.00	0.38
Kudat	4.34	0.42	7.05	0.00	0.00	0.15	1.13	0.07	0.30
Lankayan	4.05	0.11	10.70	0.00	0.06	0.13	1.27	0.01	0.28
Semporna	4.79	0.14	1.29	0.00	0.00	0.00	1.32	0.00	0.18

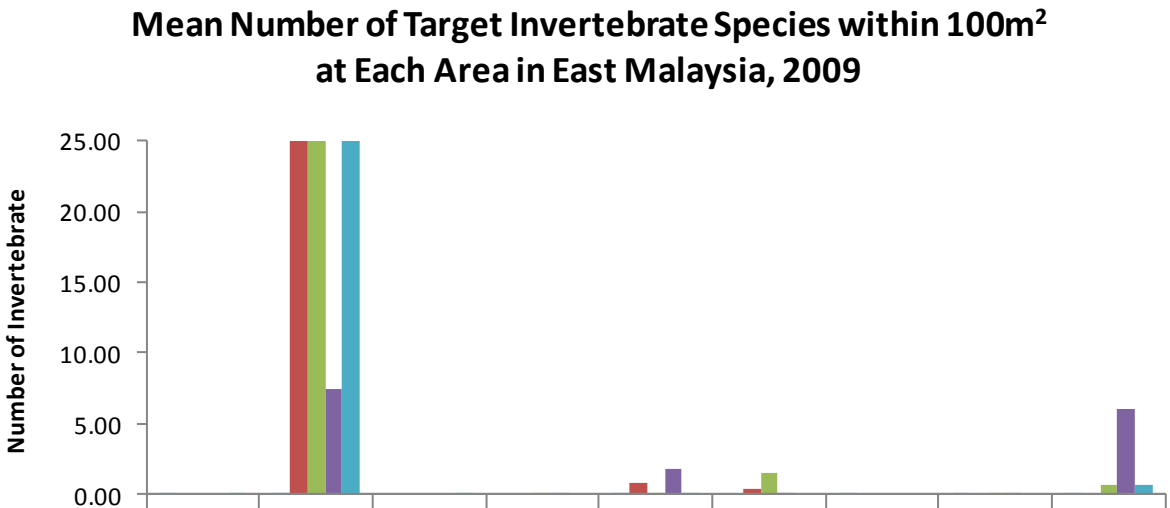
The surveys also show the presence of parrotfish equally distributed in all areas except for Pulau Gaya. It is important to track changes to these numbers to ensure the parrotfish populations are not in decline, as they play a significant role in controlling algal growth through their dietary pattern. There is a need for continuous enforcement to prevent further degradation of fish population around these areas.

4.3.3 Invertebrates

Data from surveys in East Malaysia show that numbers of those invertebrates that are highly sought after for the aquarium trade (such as Banded coral shrimp, pencil urchin, collector urchin and triton shells) are low. While these invertebrates might naturally occur in low numbers, the very low abundance or total absence of some of these species suggests that some harvesting has been practised in the past, with populations now so low as to hinder recovery.

The high numbers of *Diadema* urchins in areas such as Kudat, P. Gaya and Semporna is a cause for concern as their presence in numbers indicates some nutrient pollution in the water. These urchins usually grow in abundance in areas where there is a high cover of algae, which is found in nutrient-rich waters. A continuous monitoring programme is needed to keep check on these urchins and the pollution in the water to avoid damage on these reefs due to bioerosion from these urchins as well as smothering of corals by algal proliferation.

Chart 9: Invertebrate Abundance – East Malaysia



	Banded coral shrimp	Diadema urchin	Pencil urchin	Collector urchin	Sea cucumber	Crown-of-thorns	Triton	Lobster	Giant Clam
Miri	0.09	0.13	0.00	0.00	0.09	0.00	0.06	0.09	0.06
P. Gaya	0.00	51.13	0.00	0.00	0.75	0.38	0.00	0.00	0.00
Kudat	0.00	56.83	0.00	0.02	0.07	1.55	0.00	0.01	0.65
Lankayan	0.00	7.47	0.00	0.01	1.82	0.14	0.00	0.02	5.97
Semporna	0.07	37.75	0.04	0.00	0.04	0.00	0.00	0.00	0.64

4.4 Comparison between Peninsular Malaysia and East Malaysia

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

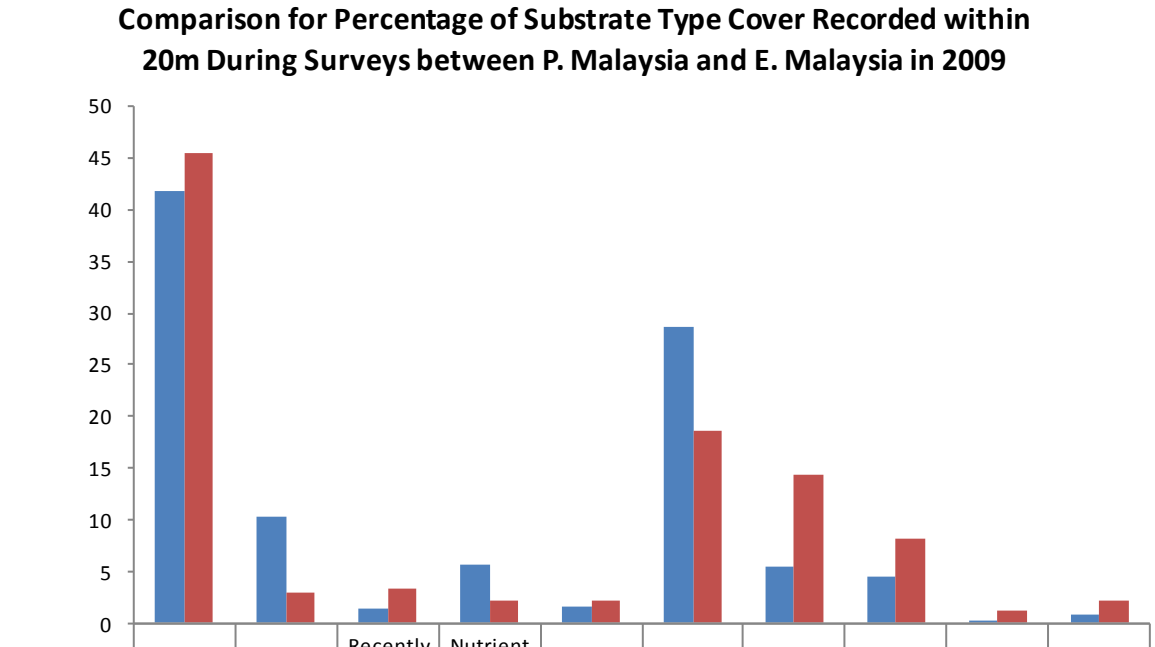
4.4.1 Substrate

According to the Coral Reef Health Criteria, the reefs around the 5 islands off the East coast of Peninsular Malaysia are, on average, in "good" condition, with an average Live Coral Cover (Hard Coral + Soft Coral) of 52.1% (see chart 10). In East Malaysia, the average of Live Coral Cover is only 48.3%, which is in the "fair" category of the Coral Reef Health Criteria. However, reefs in East Malaysia have a higher percentage of Hard Coral with over 45% while Peninsular Malaysia has 41.9%. It should be noted that most of the Soft Coral cover in Peninsular Malaysia is from the survey sites in Tenggol Island (see section 4.2.1), which has stronger currents suitable for soft coral growth.

The high percentage of Rock cover in both areas is a healthy indication as it can facilitate new coral growth by providing a suitable surface for coral recruitment. Reefs around Peninsular Malaysia have a higher percentage of Rock at 28.6% (though much of this is accounted for at Pulau Aur), while the reefs around East Malaysia have 18.5% Rock cover. The high percentage of Rubble on the reefs around East Malaysia is likely to be a result of fish bombing activities in the past.

The average cover of Nutrient Indicator Algae (NIA) in Peninsular Malaysia is relatively high compared to East Malaysia, at 5.6% and 2.2% respectively. This is probably due to the higher density of resorts on the islands off the East coast of Peninsular Malaysia, where the tourism industry is more developed than in many parts of East Malaysia. The high number of resorts and tourists visiting the islands could have led to the influx of nutrients into the sea – through sewage and fertilisers used for landscaping.

Chart 10: Substrate Cover – Peninsular vs. East Malaysia



	Hard Coral	Soft Coral	Recently Killed Coral	Nutrient Indicator Algae	Sponge	Rock	Rubble	Sand	Silt	Other
P. Malaysia	41.88	10.19	1.41	5.61	1.50	28.56	5.38	4.55	0.15	0.71
E. Malaysia	45.42	2.83	3.26	2.09	2.07	18.52	14.33	8.21	1.09	2.18

Recently Killed Coral (RKC) results from a variety of factors, including bleaching, disease and COT predation. The percentage of Recently Killed Corals (RKC), which is higher in East Malaysia, can be a cause for concern as a continuous threat such as COT predation needs to be addressed as soon as possible to reduce the damage caused. Another cause for concern will be the relatively higher percentage of silt recorded in East Malaysia during the survey.

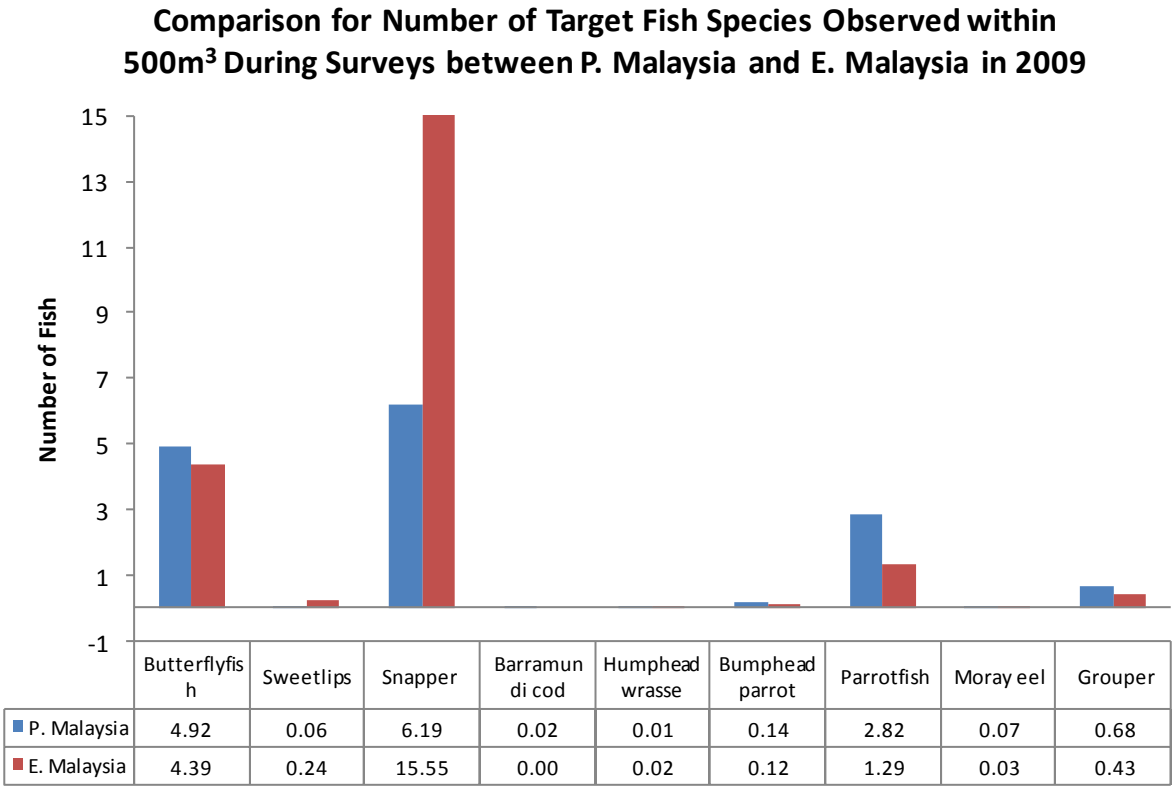
4.4.2 Fish

The diversity of fish observed during the surveys in Peninsular Malaysia is slightly higher than East Malaysia (see chart 11). However, the rarity of prized-food fish such as Sweetlips, Barramundi cod and Humphead wrasse in both East and Peninsular Malaysia suggests that these fish have been over-harvested for the fish trade in both areas. The other food fish low in abundance are groupers and parrotfish, both of which have lower observations in East Malaysia compared to the Peninsula.

Anecdotal observations suggest that the main cause for this is the higher number of people in East Malaysia who live in coastal areas and rely fully on fishing activities for their livelihood. Many of these fishermen are still practicing destructive fishing method such as fish bombing and poison fishing, resulting in damage to large areas of reef (up to 66% reported by managers at Mataking Island Resort) as well as removal of large amounts of fish.

The abundance of snappers on reefs in East Malaysia may be a result of the different fishing pressure applied by fishermen there. As mentioned previously, destructive fishing methods focus more on reef-dwelling fish rather than snappers, which are found above the reef structure.

Chart 11: Fish Abundance – Peninsular vs. East Malaysia



	Butterflyfish	Sweetlips	Snapper	Barramundi cod	Humphead wrasse	Bumphead parrot	Parrotfish	Moray eel	Grouper
P. Malaysia	4.92	0.06	6.19	0.02	0.01	0.14	2.82	0.07	0.68
E. Malaysia	4.39	0.24	15.55	0.00	0.02	0.12	1.29	0.03	0.43

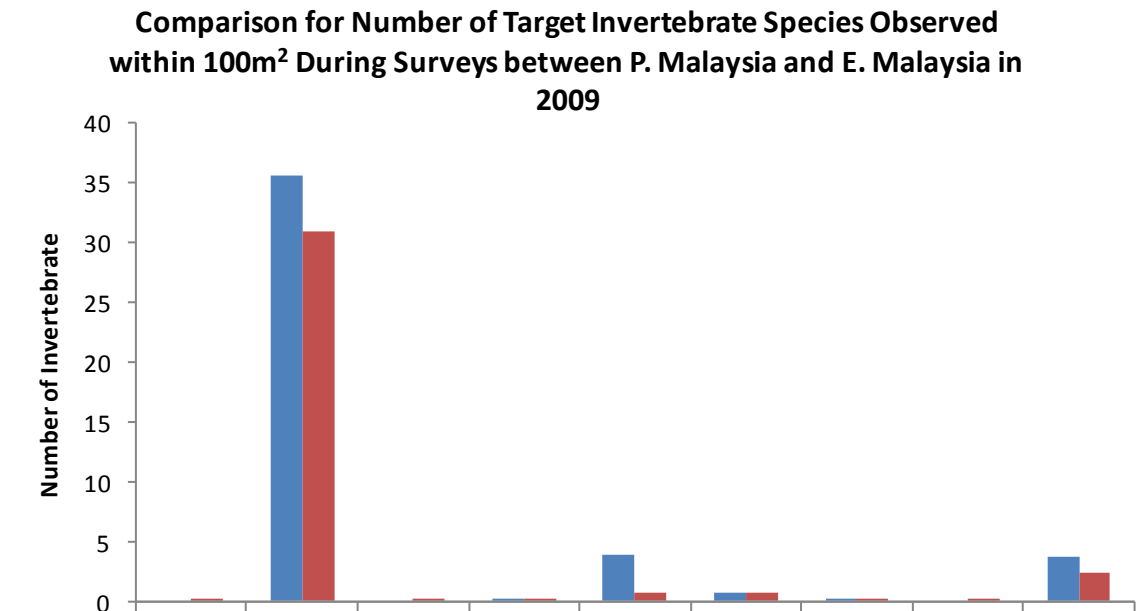
4.4.3 Invertebrates

Diversity of invertebrates observed is higher in East Malaysia than Peninsular Malaysia (see chart 12). Invertebrates such as banded coral shrimp, pencil urchins 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.

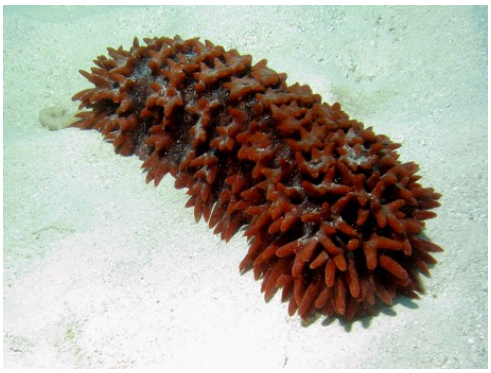
The number of *Diadema* sea urchins in both the Peninsula and East Malaysia is relatively high compared to the other invertebrates. While their presence (together with herbivorous fish) is important to control algal growth, their number should be monitored as an increase could indicate nutrient pollution.

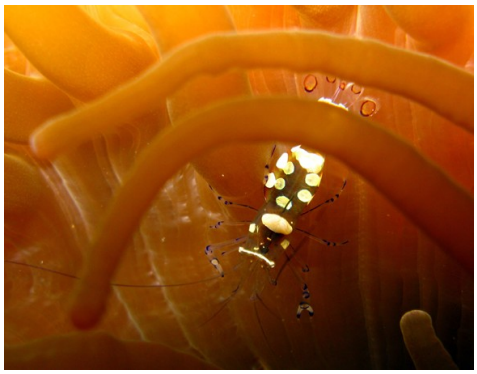
The number of edible sea cucumbers and giant clams, both indicators of harvesting activities, were higher in Peninsular Malaysia compared to East Malaysia. Edible sea cucumbers are usually harvested for food and medicinal purposes while giant clams are harvested for food as well as for their shells which are sold as decorations.

Chart 12: Invertebrate Abundance – Peninsular vs. East Malaysia



	Banded coral shrimp	Diadema urchin	Pencil urchin	Collector urchin	Sea cucumber	Crown-of-thorns	Triton	Lobster	Giant Clam:
P. Malaysia	0.00	35.66	0.00	0.04	3.86	0.70	0.24	0.00	3.76
E. Malaysia	0.02	30.91	0.00	0.01	0.68	0.68	0.01	0.02	2.36





4.5 Monitoring Changes to Reefs on Islands of Peninsular Malaysia

On-going monitoring is an important management tool to track changes to coral reef health. With three years of data for some sites, the results from the 2009 surveys can be compared with data for previous years (for the same sites), to provide an assessment of how coral reefs have changed over the past three years.

For the major islands of Perhentian, Redang and Tioman, data are available for three years (2007-2009) for some sites. Two years of data are available for Aur (2008/09) and Tenggol (2007/09), which still allows some comparisons.

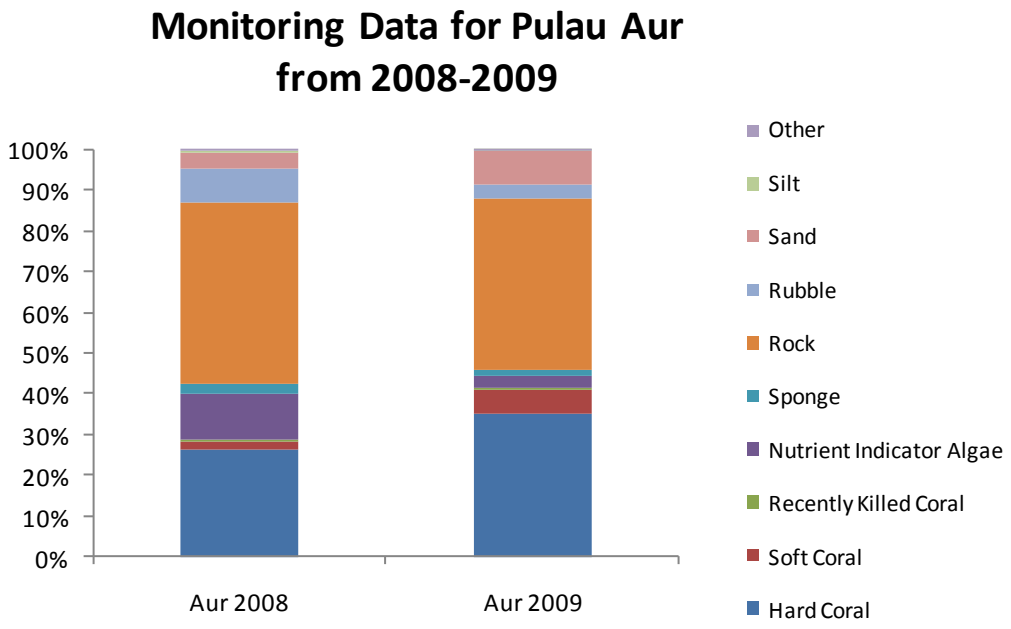
Unfortunately, comparable data do not yet exist for East Malaysia, and there is still a major gap in information on the changing status of reefs around Sabah and Sarawak, making coral reef monitoring in those areas difficult.

4.5.1 Aur Islands

Chart 13 below suggests that there has been a significant increase of LCC at the reefs on Aur Island, from under 30% to over 40% LCC. However, this does not accurately reflect the situation around the island as five new sites were surveyed this year. Some of these sites, such as Pulau Lang, Gadong Bay and Teluran Bay, which have relatively high LCC, probably made a significant contribution to the apparent increase in average LCC for the island.

The results from the three previously-surveyed sites that were repeated in 2009 (see chart 14) showed a slight decline in LCC in two - Pinang and Reyner's Rock. On the plus side, the large area of rocky surface provides a good base for new coral recruits. Even though the LCC at the third site, Pulau Lang, appears to have increased tremendously, the depth at which the survey was conducted varied. Therefore, the results from the two surveys do not provide a reliable picture of changes over the past year.

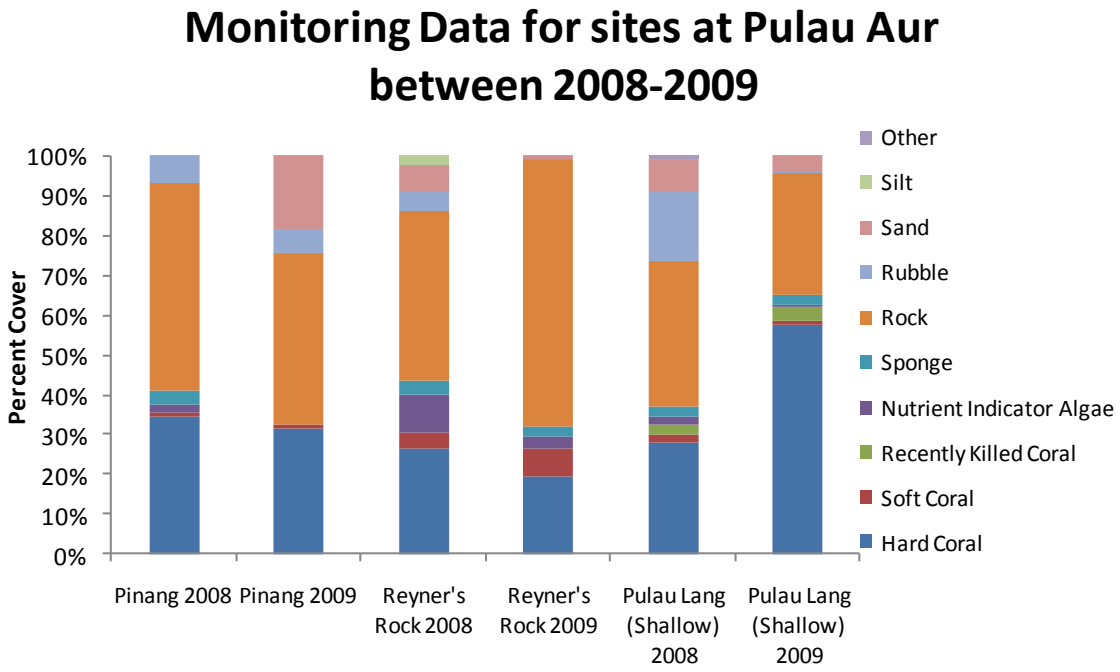
Chart 13: Monitoring Data – Pulau Aur

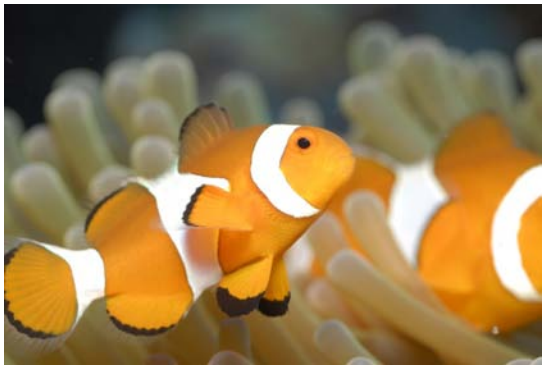


The large increase in RC at Reyners Rock could be indicative of fishing activity at this site, a conclusion supported by observations during the surveys.

Although it is clear that additional data are required before meaningful conclusions can be drawn about changes to coral reefs at Pulau Aur, it appears that there is a need for more effective enforcement of Marine Parks regulations, as well as COT removal activities to minimize further degradation to the reefs around Pulau Aur.

Chart 14: Monitoring Data for Sites at Pulau Aur

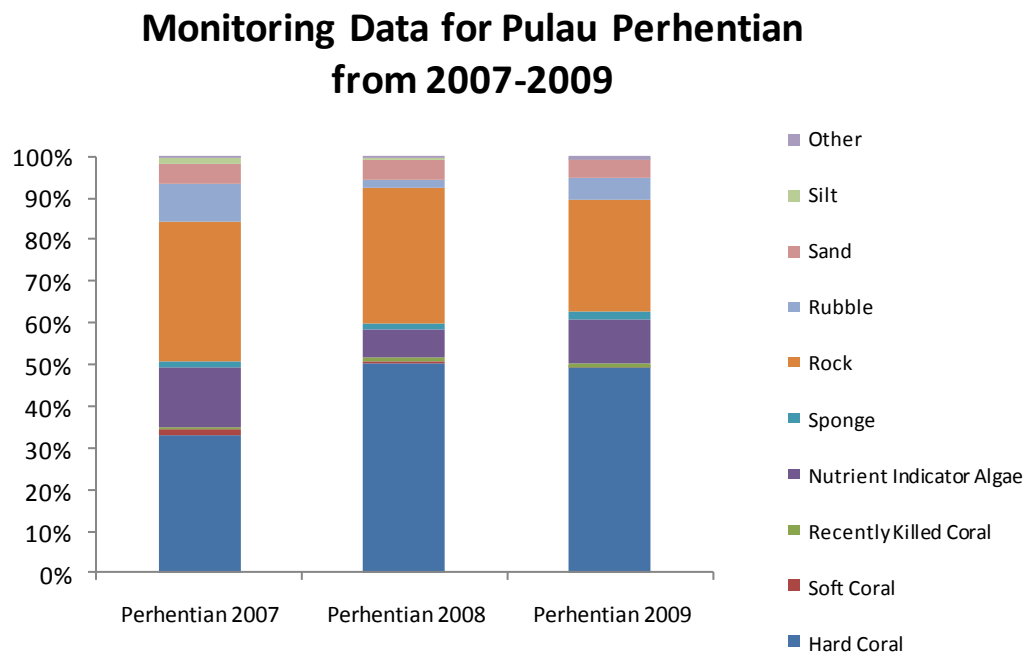




4.5.2 Perhentian Islands

Chart 15 shows an increase of LCC from 2007 of just over 32% to over 50% in 2008, with a slight decline of 1% in 2009. Some of the increase from 2007-2008 can be attributed to additional surveys in 2008 (6 sites in 2007; 10 sites in 2008). However, one site (Tg. Besi) recorded a significant improvement from 2007-2008 as a result of new Hard Coral growth. Most of the 2008 sites were re-surveyed in 2009, indicating that there has been little change in reef health around the islands in the last year.

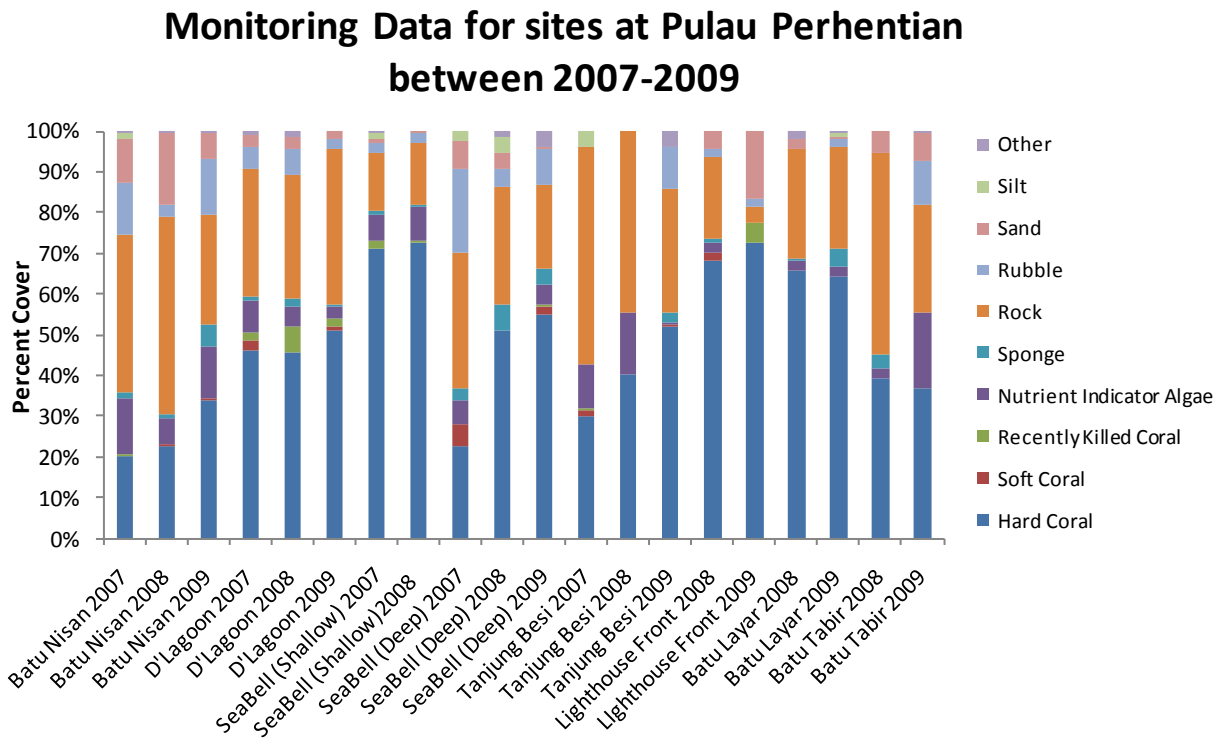
Chart 15: Monitoring Data – Pulau Perhentian



From the surveys conducted at repeated sites over the last three years (see chart 16), we can see that there has been an improvement of LCC on all sites with the exception of Batu Tabir and Batu Layar which recorded a slight decline in Hard Coral (HC) cover between 2008 and 2009. HC cover at Batu Nisan, Tanjung Besi and Lighthouse Front recorded gradual increase from 2007 to 2009, which is a good indication that the reefs there are still not under serious threat. A significant increase of HC cover at SeaBell (Deep) from 2007 to 2008 is likely to be a result of inaccurate positioning of the line when it was laid for the 2008 and 2009 surveys. However, local dive operators reported that there has been an increase in the amount of foliose HC around the area, which could account for some increase in HC cover.

Although the LCC at these sites is largely on the rise, it is important to take note of the increase of Nutrient Indicator Algae (NIA) recorded, especially at Batu Nisan, SeaBell (Shallow) and Batu Tabir. The increased presence of NIA is an indication of nutrient pollution in the water. A continuous monitoring programme, including water quality monitoring, should be established to find the source of pollution and prevent further proliferation of NIA that might otherwise damage large areas of corals in the future.

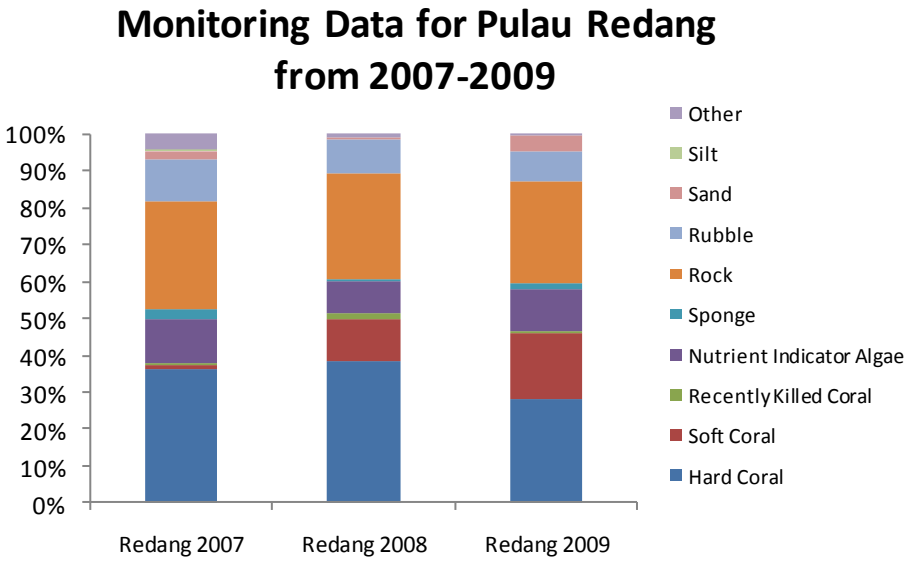
Chart 16: Monitoring Data for Sites at Pulau Perhentian



4.5.3 Redang Islands

The results in chart 17 show that LCC in Pulau Redang increased from 2007 to 2008 but declined slightly in 2009. However, the increase of Soft Coral (SC) and decrease of Hard Coral (HC) needs to be noted as HC, which builds the reef structure, is a more important component for a variety of reef organisms. The presence of soft corals suggests that the reef is recovering from previous damage as soft corals grow much faster than hard corals. Most of the soft corals were observed at Redang Kalong House Reef, where Zoanthids were thriving on broken pieces of branching corals. The damage to these fragile branching corals is likely to be caused by the seasonal monsoon and heavy boat traffic through that area.

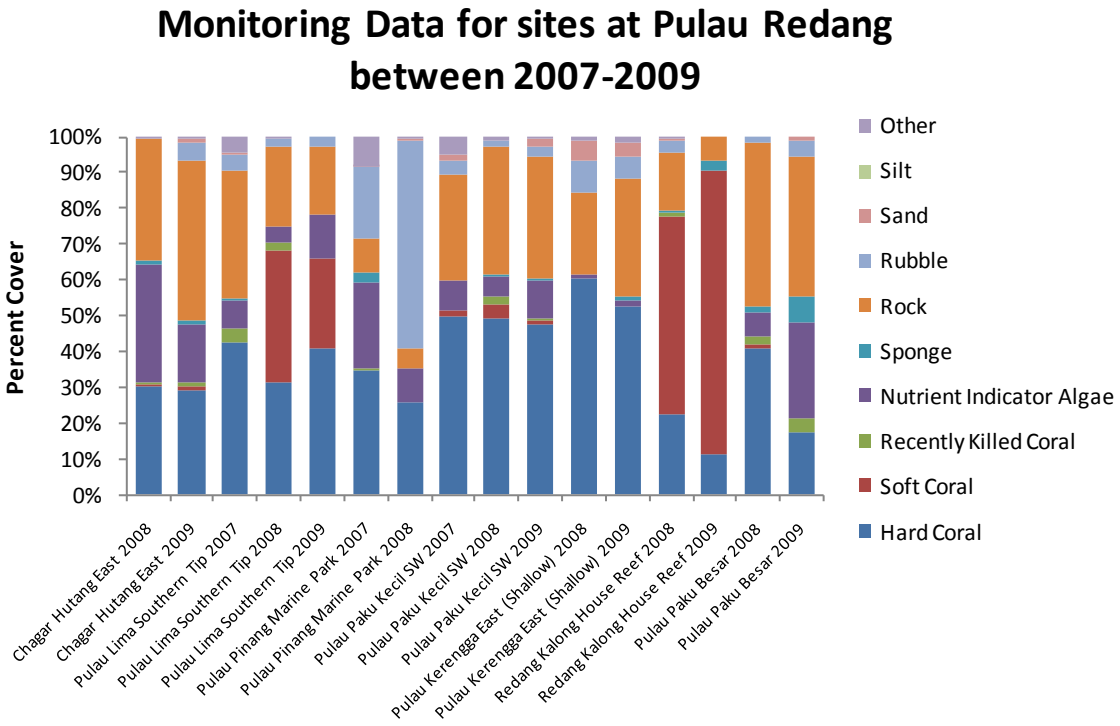
Chart 17: Monitoring Data – Pulau Redang



The relatively high proportion of Nutrient Indicator Algae in Redang, and the increase recorded from 2008-2009, is a cause for concern as further growth of these algae will hinder the recovery of the reefs. Algae that grow on dead corals and rocks reduce the availability of suitable surface for new coral recruitment.

The data compiled from site surveys repeated since 2007 indicate that some sites are degrading at an alarming rate (see chart 18). For example, Pulau Paku Besar, which is just off Long Beach, lost over 23% of HC over the last year and NIA increased from 6.3% to 26.9%. As stated previously, proliferation of algae is linked to the increase of nutrient in the water. As Long Beach is a central tourist area on Redang, where at least 8 big resorts are located, it is likely that the source of nutrient is from these resorts, including from inefficient sewage systems and fertilisers used for landscaping of the resorts. Other sites close to Long Beach, such as Pulau Paku Kecil and Pulau Lima also showed significant increase of NIA in the past year.

Chart 18: Monitoring Data for Sites at Pulau Redang



The increase of Rubble, as recorded at Pulau Pinang Marine Park and Chagar Hutang, is likely to be in part a result of physical damage caused by strong currents during monsoon. However, observations around the Pulau Pinang Marine Park site noted the presence of waste materials in the water, probably from earlier jetty construction. These will subsequently move around in strong currents and roll over and damage corals. The high percentage of Rock cover in most areas is encouraging as this will facilitate new coral growth in the future. However, core issues such as pollution need to be addressed before any regeneration of corals can take place.

4.5.4 Tenggol Islands

The results from the two sites resurveyed in Tenggol show improvement in the condition of the reefs there (see chart 19). Overall HC cover increased from 34.4% in 2007 to 41.4% in 2009 while Soft Coral cover increased from 18.4% to 31.2%. The decline of NIA recorded on the reefs is encouraging as this suggests the reefs around Tenggol are recovering from old damage.

Chart 19: Monitoring Data – Pulau Tenggol

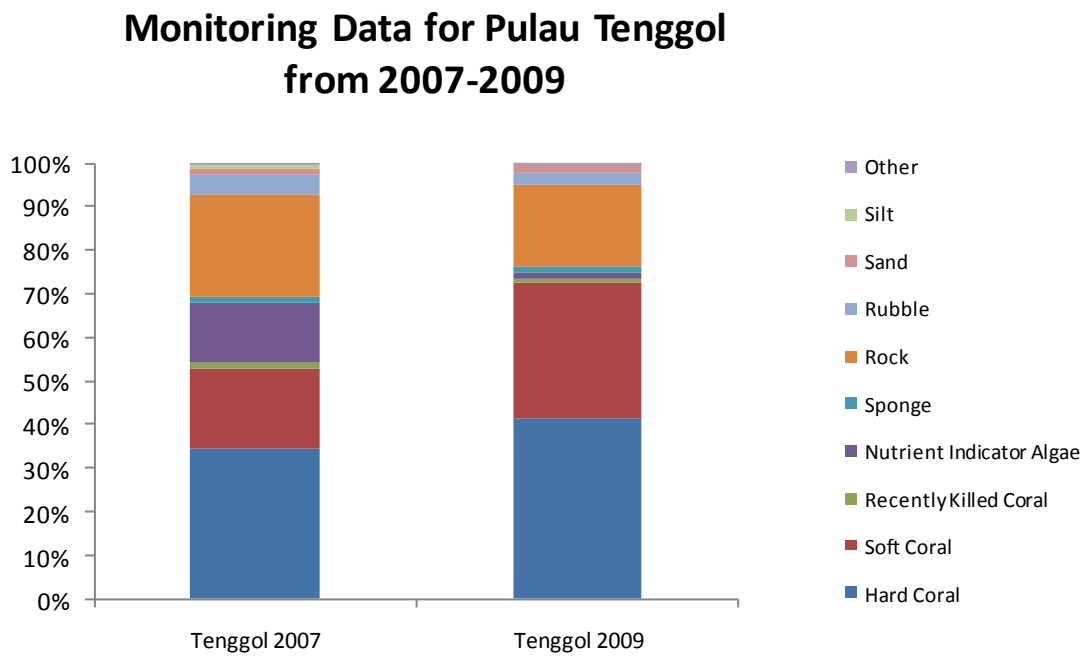
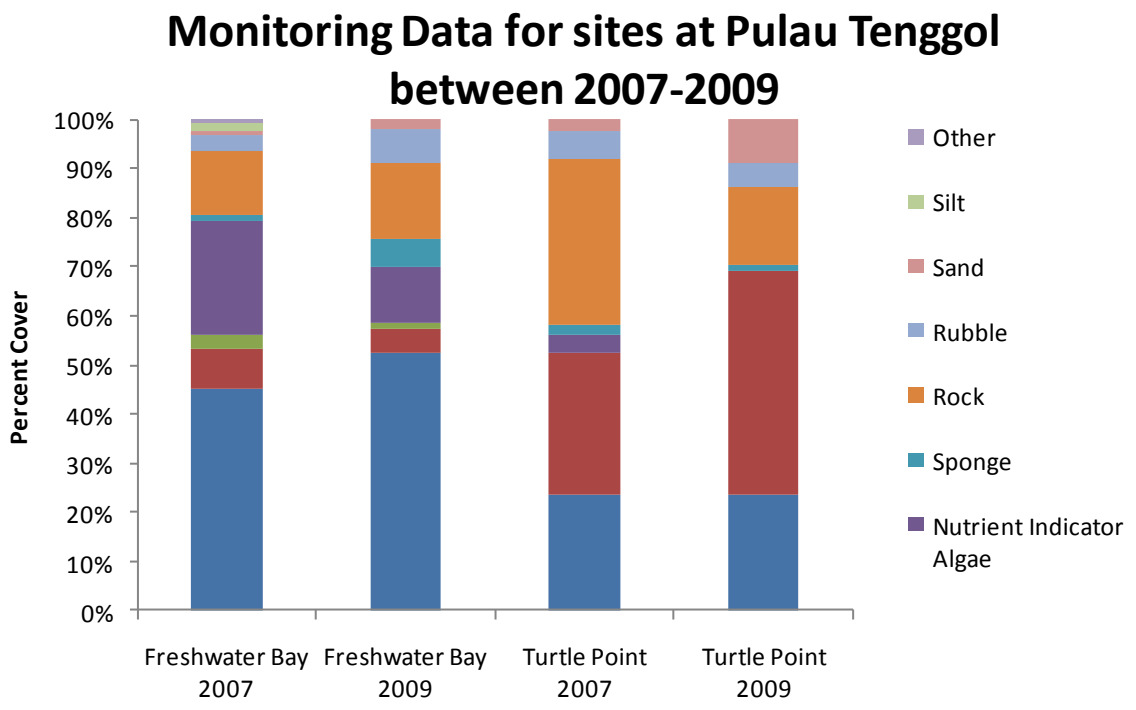


Chart 20 shows the significant decrease of NIA from 23% in 2007 to 11% in 2009 at Freshwater Bay. This decrease of algal cover will reduce competition for space between new coral recruits and algae, increasing the chances of survival of new corals.

At Turtle Point, HC cover has remained largely unchanged over the past three years but the percentage cover of soft corals has increased from over 28% in 2007 to 45% in 2009. This increase suggests that the reef is on the road of recovery as soft corals tend to survive better in waters with currents, such as those around Tenggol. There has also been a decline in NIA on this reef and a continuous effort to conserve the reefs here is needed to ensure this recovery process is successful, including enforcement to address the issue of illegal fishing around the islands, reported by dive operators there.

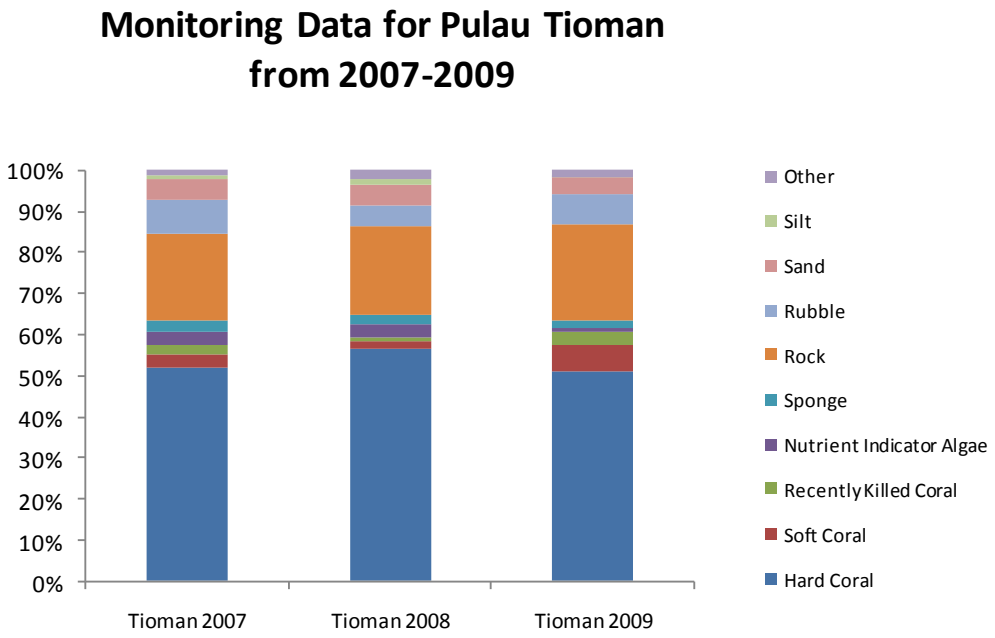
Chart 20: Monitoring Data for Sites at Pulau Tenggol



4.5.5 Tioman Islands

The data from the surveys conducted on Tioman over the last three years show that there have been no significant changes over that period of time (see chart 21). The LCC is above 50%, a rating of "good" according to the Coral Reef Health Criteria. There has been a slight increase of soft corals over the years but it does not significantly change the structure of the reefs around Tioman.

Chart 21: Monitoring Data – Pulau Tioman



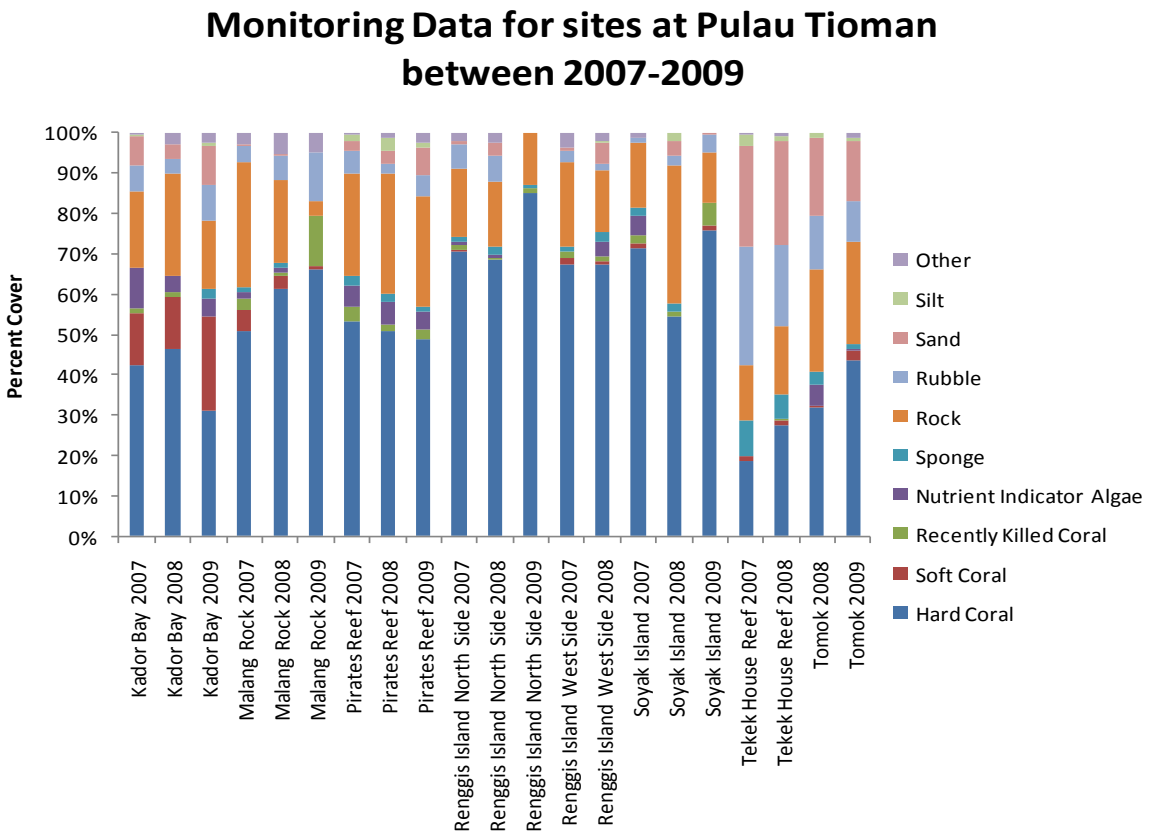
From the surveys conducted at repeated sites over the last three years it appears that the condition of the reefs generally improved over the period, with the exception of Kador Bay and Pirates Reef (see chart 22). There was a significant increase of SC cover of 10% at Kador Bay, and a 15% decline of HC cover between 2008 and 2009, probably due to storms as the site is not used much for diving or snorkeling, but is exposed during monsoon season

The decline in condition at Pirate Reef is likely to be due, in part, to the on-going construction activities in Teluk Tekek. Pirate Reef is close to the main community in Kg. Tekek, and it is likely that it suffers from run-off from nearby rivers as well as the impact of recent construction activities.

Renggis Island continues to have reefs in good condition with the highest LCC among all the sites around Tioman.

Despite the continuing good condition of the reefs in Tioman over the years, continuous monitoring and enforcement is required to prevent any other threats that might destroy large areas of corals. An on-going programme for COT removal is also important as many sites were reported to be infested with COTs, especially in Malang Rock, which has the highest percentage of Recently Killed Coral.

Chart 22: Monitoring Data for Sites at Pulau Tioman



5. Challenges and Recommendations

Each of the five 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 by their Marine Park status, each island presents its own set of challenges which need to be addressed in order for the reef ecosystems to recover and thrive.

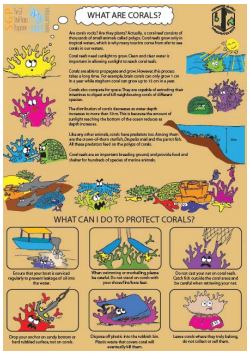
For East Malaysia, only some of the areas monitored have formal protection as gazetted Marine park areas (Gaya, Lankayan), though informal protection exists in others as a result of land/resort ownership or on-going work by NGOs (Mataking, Kudat). These areas therefore present a different set of challenges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

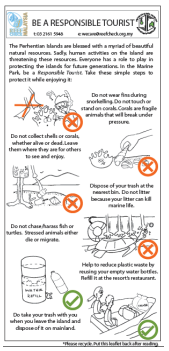
This section outlines a number of recommendations for conservation activities, based on both the objective data collected through the Reef Check surveys as well as based on the subjective, but informed, observations of survey participants. These recommendations are more detailed for the islands off the East coast of Peninsular Malaysia, where more work has been carried out. Only general recommendations are possible for East Malaysia at this time.

5.1 General Recommendations

The following general recommendations apply to all coral reef areas:

- encourage wise usage of fresh water (storing rainwater from roofs, recycling water for watering plants etc.)
- install recycling bins
- install more bins and improve collection of rubbish in all areas
- 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
- install more signs of “do’s and don’ts” in coral reef areas
- 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
- make available handouts to be given to each visitor to coral reef areas (eg. “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.
- support more training for students and adults in the EcoDiver program
- support increased frequency of monitoring to track future changes in reefs.





5.2 Peninsular Malaysia

5.2.1 Aur Island

Aur Island is the furthest away from the mainland of all the islands. There is a very small local population on the island but the diving industry there has expanded rapidly over the past 10 years. As a result of the lack of a local Marine Park centre, combined with the distance from the mainland, enforcement of Marine Park regulations is difficult. With this lack of enforcement, fishing and trawling activities have been reported frequently, especially during the monsoon season.

Diver impact
The number of divers visiting the reefs around Aur Island has increased over the last 10 years. Observations from divers who have been visiting the reefs around Aur mentioned that divers have caused a lot of damage on the reefs. There is a need to monitor and improve the operations of the dive centres on the island to prevent further damage caused by divers. By requiring dive staff to become certified in the EcoDiver program, they would undergo training in the appropriate eco-friendly practices and could be encouraged to pass these along to their clients – both snorkelers and divers.

Illegal net fishing
A local dive operator also mentioned that ghost nets are found at the end of each monsoon season, indicating that illegal fishing (gill nets and/or trawling) is occurring in the Marine Park waters during the monsoon. Monitoring of fishing vessels should be carried out during the monsoon season to prevent illegal fishing.

5.2.2 The Perhentian Islands

The major environmental issue for the islands is the large number of small resorts which have sprung up during the past 12 years on both the “big” island and the “small” island, with the associated impacts.

Sewage treatment
The smaller resorts tend to rely on septic tanks which leach to the sea in highly porous reef rock, can easily overflow and may pollute the surrounding waters. Either a well managed treatment system, such as the “Hi-Clean” system, should be required for smaller resorts, or the state government could study the feasibility of constructing centralised sewage treatment plants which the resorts could use.

Solid waste disposal
Solid waste disposal requires better management. Currently, solid waste from the resorts is stored on floating pontoons on the sea before removal by a barge. During rough seas the rubbish bags fall into the sea. Leacheate from the rubbish can also pollute the sea. At the least, waste should be stored in a proper storage area on land before being transferred to the barge, and an improved, more reliable and regular collection system should be implemented. Options to establish composting systems for organic waste on the islands should be studied, with the potential for biogas generation possibly creating an economic return.

Construction
Construction of new resorts and jetties, some of which are poorly planned, lack the implementation of appropriate mitigation measures to protect the environment. Construction on the island, 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.

Illegal trawling
The Perhentian Islands are the closest to Thailand and as such become a target for illegal trawling. Reef Check surveys are carried out at a maximum depth of 12m and it is possible that some of the damage observed during the surveys in the deeper areas may be due to trawling.

5.2.3 Redang Island

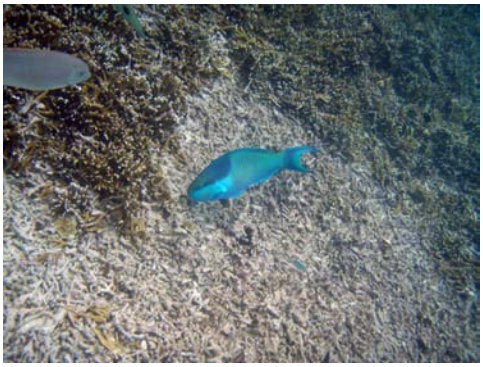
Resort development on Redang Island is almost exclusively confined to three bays; Teluk Dalam, Pasir Panjang and Teluk Kalong. The resorts tend to be large in comparison with the resorts on the other three islands.

Sewage treatment
Several resorts have their own wastewater treatment plants. Other smaller resorts use the septic tank system with a soak away area for overflow.

NIA on reefs surveyed in Redang are indicative of increased levels of nutrient in the water consistent with sewage discharge. Regular monitoring and maintenance of the wastewater treatment systems that are available should be ensured to reduce pollution and the state government should consider the feasibility of constructing a centralized wastewater treatment plant for each bay and locating discharge points far from reefs.

Tourism impact
The fringing reefs of the islands off the main resort area, Pasir Panjang, are popular with divers and snorkelers. However these reefs are showing signs of reduced hard coral cover. This could be due to pollution from the resorts, as mentioned above, and physical damage by snorkelers and divers. The Terengganu state government recently banned the use of fins for snorkelling in the state to prevent snorkelers from inadvertently treading on the corals and damaging them. However, further awareness training is required to reduce the amount of physical damage caused by the large numbers of visitors to the reefs around Redang Island.

The most impacted reef surveyed on Redang Island is that of the Marine Park Centre where most snorkelers are taken and allowed to feed the fish with bread. A type of calcareous algae, *Halimeda* was observed to be overgrowing the branching corals. 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. Fish feeding with bread may encourage a few species of fish to increase, to the detriment of others.



5.2.4 Tenggol Island

Tenggol is the smallest island surveyed off the East coast, and the only one with no local population. Tourism development to date is limited. Impacts are mainly from external sources.

Illegal fishing
There are regular complaints of illegal fishing around Tenggol island, particularly during monsoon season, when the resorts are closed. 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 clean up in November 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

5.2.5 Tioman Island

Tioman Island is the most developed of the Marine Park islands and has better developed infrastructure than the other islands (including a limited road network and a new marina).

Development impact
Beach erosion has been identified as a problem in Tekek village, and a project to replenish the eroding areas with sand is underway. Significant siltation was observed on the two reefs nearest the beach replenishment project. In order to prevent excessive siltation, mitigation measures (such as silt curtains) must be put in place and these measures need to be checked and maintained on a daily basis.

Sewage treatment
Waste management is also an issue on the island. Only the large Berjaya resort has its own wastewater treatment plant, and most resorts and houses rely on a septic tank system which, if improperly maintained, can result in overflow into the sea. A programme of septic tank inspection should be implemented and the state government should consider the feasibility of constructing a centralized wastewater treatment plant for each village. The large number of *Diadema* urchins indicates an imbalance between algae, urchins and fish, and this situation should be closely observed. Regular coral reef surveys should be conducted to monitor algal growth and *Diadema* numbers. In all areas where sewage is suspected of increasing seawater nutrient levels, standard *E. coli* testing can be used to determine the extent of the problem from both the nutrient and human health perspectives.

Solid waste management
Tioman has an incinerator for solid waste disposal but frequent breakdowns of the incinerator result in storage of solid waste nearby. It is likely that there is some leaching of pollutants into the river adjacent to the plant, and into the sea, and given the mixed nature of household waste this could include toxic components such as waste engine oil, battery acid and cleaning agents. Although this problem should be solved once a new, higher capacity incinerator is built, in the short term improved waste storage should be constructed and households educated on waste minimization to reduce pressure on the existing incinerator installation.

5.3 East Malaysia

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

- Coral bleaching was significant in some areas in 2009, the first since 2002. The bleached corals had not recovered by December and coral mortality is likely. The current El Nino condition is predicted to last into 2010 and if the prediction is accurate we may see more bleaching in June 2010.
- 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.
- Dynamite and cyanide fishing are still commonplace in many parts of the coastline of East Malaysia, and urgent efforts are required to combat this before large areas of reef are destroyed beyond recovery
- 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 (eg. storms, disease) and man-made (eg. 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.

5.4 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:

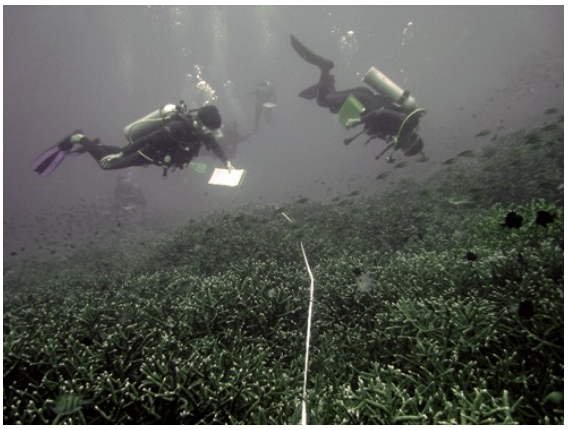
- no standardised method is applied, as a result of which data from different surveys are often not easily compared
- the data are distributed between various institutions, preventing a clear picture from emerging.

Establishing a comprehensive, coordinated monitoring programme which 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.



Acknowledgements

We are grateful to the following sponsors for their support during 2009:

- YTL: Contributed a part of the proceeds from the Climate Change Week Gala Dinner to Reef Check for various programmes over the next two years, including training and surveys, as well as a community outreach programme on Perhentian Islands.
- Alstom Power: through Alstom Foundation, is funding our Rainforest to Reef Programme, targeted at school children from the Marine Park Island schools. The funding will cover the cost of implementing the programme over the next three years.
- HSBC: continued with the Adopt a reef programme and funded the survey on their adopted reef. They also provided partial funding for the Coral Reef Camps which was held on 5 Marine Park Island schools.
- Sime Plantations Sdn Bhd: funded the Sustainable Island Project, a collaborative project by Reef Check Malaysia and Wild Asia to monitor the reefs on five islands off the East coast of Peninsular Malaysia. The data will be used to educate and raise awareness among the local resort and dive operators to encourage their participation in environmentally friendly practices.
- SGP: funding a two year programme of work on the Perhentian Islands to involve the local community in managing the marine resources around the islands
- BP: funded the publication of a book on coral reefs in Malaysia: “Save Our Reefs: Treasures of Malaysia”. They also sponsored events to promote the publication of annual reports.
- KPMG: donated funds from a charity run arranged by staff as part of KPMG community activities; established a Corporate Reef Check team and adopted a reef in Tioman Island; funded a Rainforest to Reef programme for a school in KL.
- Russell Bedford LC & Company: provides *pro bono* company secretarial services for RCM.

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 Tn. Hj.Jamal, En. Kamarruddin and En. Abdul Rahim Gor Yaman for their support, assistance and encouragement.

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

- Watercolours Dive Centre, Perhentian
- Redang Kalong, Redang
- Tioman Dive Centre and Fishermen Dive Centre, Tioman
- Scuba Zone, KL.

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- Achier, Lankayan.
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All data are available from Reef Check Malaysia.
Please contact us if you wish to receive more information:

wecare@reefcheck.org.my

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Appendix 1: Survey Sites (2007-2009)

Table 1: 2007-2009 Survey Sites (Peninsular Malaysia).

Islands	2007 Survey Sites	2008 Survey Sites (*new sites surveyed in italics*)	2009 Survey Sites (*new sites surveyed in italics*)
Aur	-	-	*Atlantis Bay (shallow & deep)*
	-	*Pulau Lang (shallow)*	Pulau Lang (shallow & *deep*)
	-	-	*Gadung Bay*
	-	-	*Teluran Bay (shallow & deep)*
	-	-	*Diver's Lodge House Reef*
	-	*Pinang*	Pinang
	-	*Rayner's Rock*	Rayner's Rock
	-	*Atlantis Bay House Reef*	-
Perhentian	Batu Nisan	Batu Nisan	Batu Nisan
	Coral View Reef	-	-
	D'Lagoon	D' Lagoon	D' Lagoon
	Seabell (shallow & deep)	Seabell (shallow & deep)	Seabell (deep)
	Tanjung Besi	Tanjung Besi	Tanjung Besi
	-	*Lighthouse*	Lighthouse
	-	*Batu Layar*	Batu Layar
	-	*Shark Point (shallow)*	*Shark Point (medium)*
	-	*Batu Tabir (deep)*	Batu Tabir (deep)
	-	*Tukas Laut (deep)*	*Tukas Laut (shallow)*
	-	-	*Tiga Ruang*
	-	-	*Pulau Rawa*
Redang	Chagar Hutang	-	-
	-	*Chagar Hutang East*	Chagar Hutang East
	P. Lima Southern Tip	P. Lima Southern Tip	P. Lima Southern Tip
	P. Paku Kecil SW	P. Paku Kecil SW	P. Paku Kecil SW
	P. Pinang Marine Park	P. Pinang Marine Park	-
	-	*P. Paku Besar*	P. Paku Besar
	-	*Kalong House Reef*	Kalong House Reef
	-	*P. Kerengga East (shallow)*	P. Kerengga East
	-	*P. Kerengga West*	
	-	-	*P. Kerengga Kecil West*
	-	-	*P. Kerengga North West*
Tenggol	*Turtle Point*	-	Turtle Point
	-	-	*Gua Rajawali (shallow & deep)*
	-	-	*Teluk Nakhoda*
	-	-	*Rajawali Reef (shallow & deep)*
	Freshwater Bay	-	Freshwater Bay
Tioman	Teluk Kador	Teluk Kador	Teluk Kador
	Batu Malang (shallow)	Batu Malang (shallow)	Batu Malang (shallow *& deep)*
	Pirates Reef	Pirates Reef	Pirates Reef
	Pirates Reef East	-	-
	Renggis (North side)	Renggis (North side)	Renggis North
	Renggis (South side)	-	-
	Renggis (West side)	Renggis (West side)	-
	Soyak	Soyak	Soyak
	Soyak South (medium)	-	*Soyak South (shallow)*
	Tekek House Reef	Tekek House Reef	-
	-	*Sepoi*	-
	-	*Chebeh (Deep)*	*Chebeh (Medium)*
	-	*Tomok*	Tomok
	-	-	*Ali Baba Rock*
	-	-	*Labas (shallow & deep)*

Table 2: 2008-2009 Survey Sites in East Malaysia.

Location	2008 Survey Sites	2009 Survey Sites *(new sites surveyed in italics)*
Sabah	Kapalai Rock	
	Mataking House Reef	Mataking House Reef
	Mid-Rock	
	Paradise 2, Mabul	
	Treasure Hunt	
	-	*G. Kolam*
	-	*SSR*
	-	*Sand Bar North*
	-	*Edwin Rock*
	-	*Zorro East*
	-	*Sand Bar South West*
	-	*Jawfish*
	-	*Goby Rock*
	-	*Turtle Stop jetty*
	-	*Veron*
	-	*Turtle Stop NE*
	-	*East Reef*
	-	*Malu-malu*
	-	*Reef 38*
	-	*Moray*
	-	*Ken's Rock*
	-	*Froggie Fort*
	-	*Reef 77*
	-	*Buwaning (shallow & deep)*
	-	*Fly Rock (shallow & deep)*
	-	*Gusung gusung (shallow & deep)*
	-	*Limau Jambongan (shallow & deep)*
	-	*Lubani Reef (shallow & deep)*
	-	*Mandidarah East (shallow & deep)*
	-	*Mandidarah South (shallow & deep)*
	-	*Manimpan (shallow & deep)*
	-	*Mantabuan (shallow & deep)*
	-	*Semaggot (shallow & deep)*
	-	*Sipindung Reef (shallow & deep)*
	-	*Straggler's Reef*
	-	*Tahingan (shallow & deep)*
	-	*Malohon 1 (shallow & deep)*
	-	*South Rock 1*
	-	*BR 5*
	-	*House Reef*
	-	*Lycia Garden*
	-	*Rocky Point*
		Pulau Batik (shallow & medium)
		Pulau Larapan (shallow & medium)
		Pasalat Reef (shallow & medium)
Sarawak	-	*Siwa 4*
	-	*Anemone*
	-	*Anemone North*
	-	*Eve's Garden*
	-	*Siwa Penyu*
	-	*Sunday Reef*

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