REEF CHECK MALAYSIA

Malaysians Sustainably Managing Reefs

2007

REEF CHECK
MALAYSIA

Annual Survey Report

Executive Summary

1. Coral reefs are a valuable economic and biological resource. They are the foundation of a significant proportion of the global tourism industry and are a major source of biodiversity. One estimate puts the potential economic value of well-managed coral reefs in South East Asia at around US $ 12.7 billion per annum (source: "Status of Coral Reefs of the World: 2004").

2. Reef Check is a coral reef monitoring methodology used worldwide to assess the health of coral reefs. Developed in 1993 in California, and established in 1997 as a non-profit organisation, Reef Check surveys have since been conducted around the world and demonstrated that coral reefs have been damaged on a global scale. Reef Check is active in over 82 countries worldwide and there has been a National Coordinator in Malaysia since 2001. In 2007, Reef Check Malaysia Bhd (RCM) was registered as a non-profit company (Company Limited by Guarantee) to develop a more active Reef Check programme in Malaysia.

3. Scientists now recognize that coral reefs around the world are under threat from a variety of pressures, including:

- Coastal development
- Sedimentation and pollution from land based sources
- Overfishing.

Most of these pressures are evident from the results of the surveys conducted during 2007.

4. During 2007, Reef Check Malaysia (RCM) conducted 33 Reef Check surveys, covering 21 sites around the islands off the East coast of Peninsular Malaysia. The results of the surveys show that:

- The reefs are in only "fair" condition, with 42% hard coral cover
- The numbers of fish species targeted for food consumption are low in most areas, but fish species targeted for the aquarium trade are relatively abundant
- The numbers of invertebrates targeted for food consumption and the souvenir trade are low in all areas.

5. The surveys showed that the worst reef conditions are found in the Perhentian Islands. Live Coral Cover is only 34%, and there are also high levels of Nutrient Indicator Algae (which is also true of 2 of the other 3 islands). The highest live coral cover is in Tioman Island, with Tenggol a close second.

6. All the islands on the East coast face a number of pressures which are having negative impacts on their coral reefs. Key issues are:

- Perhentian Islands: rapid development of tourism facilities, principally resorts, is increasing sewage pollution, leading to the spread of coral-smothering algae. Solid waste management is poor
- Redang Island: large visitor numbers are causing significant physical impacts to the reefs
- Tenggol Island: lack of sewage treatment is resulting in algal growth
- Tioman Island: development pressures (for example the recently completed marina and the ongoing beach replenishment project) are resulting in increased siltation, which could smother some reefs on the island.

7. Although some Reef Check surveys have been carried out in previous years, there is insufficient data to accurately identify trends in the status of coral reefs in the East coast islands. An extended survey programme is required.

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REEF CHECK MALAYSIA

KEMENTERIAN SUMBER ASLI DAN ALAM SEKITAR

MARINE PARK MALAYSIA

1. Introduction

1.1 Why Are Coral Reefs Important?

Coral reefs provide a number of important services to human society, among which are:

- **Food**: coral reefs are a key source of food for coastal communities around the world
- **Fisheries**: reefs are a breeding ground for an estimated 25% of fish species, and home to one third
- **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.

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, two 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
- 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 millions of people around the world who most 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.

First carried out on a large scale in 1997, it 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.

In August 2002, Reef Check released its five-year report, The Global Coral Reef Crisis – Trends and Solutions. 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 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 82 countries and territories throughout the world.

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 biodiversity. Coral reefs therefore represent an economically important ecosystem and are the foundation of a significant percentage of the country's tourist industry. There are some 4,000 km2 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, Reef Check Foundation appointed a National Coordinator for Malaysia, to promote Reef Check and carry out training and surveys. While there were some successes, lack of funding and support prevented the coordinator from having a major impact on marine conservation in Malaysia.

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.

This report is the first annual report on the survey activities of Reef Check Malaysia. It documents the findings of the surveys conducted in peninsular Malaysia during 2007, highlights key concerns and identifies some steps that need to be taken to contribute to the conservation of Malaysia's coral reefs.

2. Survey Methodology and Sites

Coral reefs are complex ecosystems with many interactions. 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.

2.1 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).

Reef Check is a monitoring methodology. It allows scientists and managers to track changes to coral reefs over time. By surveying reefs on a regular basis, changes can be highlighted early, before they become problems. This gives managers the opportunity to intervene and reverse the change before permanent damage is done to the reef.

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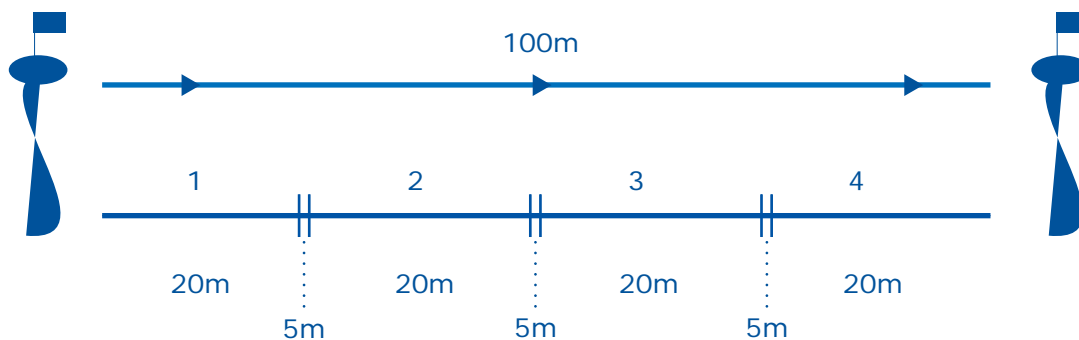

Figure 1 : The Transect
The basic idea of the Reef Check protocol is to swim along a 100m measuring tape (called a transect line) and count organisms in four 20m sections.

Five 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 20m x 5m x 5m corridors
- second is the invertebrate survey during which divers count the indicator invertebrates along the four 20m x 5m 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.
- information on the substrate is collected by the Point Intercept method whereby the substrate category is noted every 0.5m
- the Site Description is an assessment of the local environment around the site and provides information on possible impacts on the reef, mainly from human activities.

2.2 Survey Sites

During 2007, a total of 33 surveys were conducted at 21 sites. These sites were located at 4 islands on the East coast of Peninsular Malaysia, namely Tioman, Tenggol, Redang and Perhentian.

Twelve sites were selected to monitor a forecast "El Nino" event, which it was anticipated could cause coral bleaching. These surveys, sponsored by HSBC were conducted twice at each site, in April and September, to track changes caused by bleaching, if any, on the reefs.

Additional sites were chosen as "adopted" sites for corporate sponsors including Sime Plantations, KPMG, HSBC and The Lions Club of Kota Budaya. Other sites were selected by Reef Check Malaysia for monitoring purposes.

The list of sites at which Reef Check surveys were conducted is shown in table 1 below. The sites were selected based on the Reef Check site selection criteria to choose the "best" reef in the area, which should have the highest hard coral cover and reasonable densities and diversity of fish and invertebrate communities. Subsequent survey sites were selected to be representative of different levels of perceived human impact, i.e., a highly impacted reef, a medium impact reef and a low impact reef.

Table 1: 2007 Survey Sites (Peninsular Malaysia)

Island	Site	Perceived Impact (using Reef Check criteria)
Perhentian	Batu Nisan	High
	Coral View Reef	High
	D'Lagoon ("best" reef)	Low
	Sea Bell	Low
	Tanjung Besi	Medium
Redang	Chagar Hutang	Low
	Pulau Lima Southern Tip	Medium
	Pulau Paku Kecil SW ("best reef")	Medium
	Pulau Pinang Marine Park	High
Tenggol	Fresh Water Bay	High
	Turtle Point ("best" reef)	Low
Tioman	Kador Bay	Medium
	Malang Rock	Medium
	Pirates Reef	High
	Pirates Reef East	High
	Renggis Island North Side ("best" reef)	Medium
	Renggis Island South Side	Medium
	Renggis Island West Side	Medium
	Soyak Island	Low
	Soyak Island South	Low
	Tekek House Reef	High

3. Threats to Coral Reefs

According to "Reefs at Risk in Southeast Asia" (Burke et al, 2002), the coral reefs of South-east 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.

3.1 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 eco system, 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.

3.2 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.

3.3 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.

3.4 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 of 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.

3.5 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.

4. 2007 Survey Results and Analysis

The results below are from 33 surveys conducted during 2007 on 4 islands. They are compiled to form a baseline picture of the status of reefs on the East Coast of Peninsular Malaysia.

4.1 Overall Results

For this section the survey data from all the sites were compiled to show average percentages representing the East coast of Peninsular Malaysia. It should be noted that the survey sites are all within marine parks, which are protected. Thus any generalization of positive or negative results might therefore be an overestimate or underestimate respectively of the actual status of the reefs on the East coast.

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 health of the reefs on the East Coast of Peninsular Malaysia is "fair", based on average live coral cover from all the surveys of 42%. These reefs also consist of a high percentage of rock (over 25% cover), a high proportion of which is probably a result of monsoon storm damage. However, some damage could also be a result of trawling activity, particularly during the monsoon season, and predation by crown-of-thorns starfish and Drupella snails.

It should be noted that a high percentage of rock cover could naturally provide good opportunities for recruitment of new corals, as rock provides a suitable surface for juvenile coral to attach to, contributing to reef regeneration. However, it should be noted that high sedimentation levels will cover rock surfaces, preventing coral recruitment.

**Mean Percentage of Substrate Type Cover per 20m
For East Coast of Peninsular Malaysia, 2007**
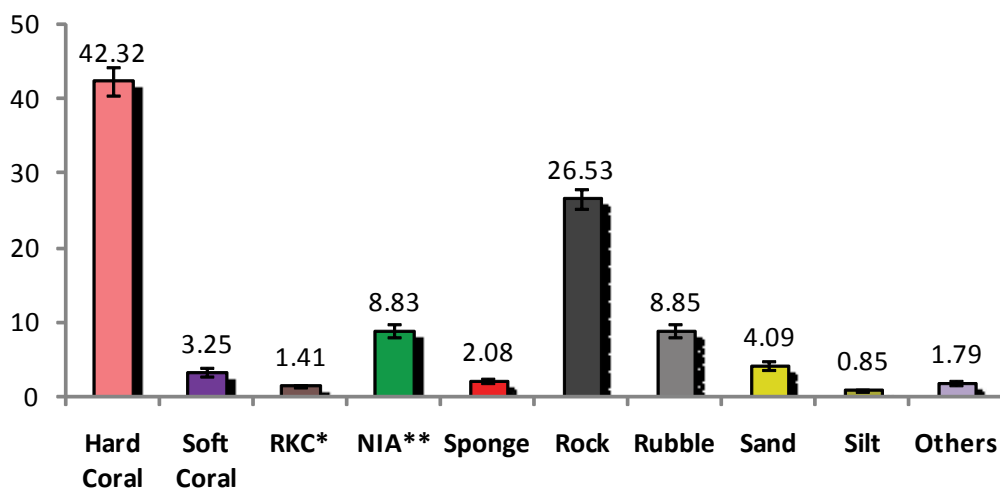

* - Recently Killed Coral
**- Nutrient Indicator Algae

The average cover of Nutrient Indicator Algae (NIA) is also relatively high (8.83%). This suggests that the amount of nutrient in the sea is high enough to encourage algal growth. The main source of nutrient pollution on the East coast islands is probably from poorly managed sewage systems (resorts and households). Anecdotal observation suggests that many resorts and hotel operators have inadequate or improperly maintained systems, resulting in the discharge of sewage – or improperly treated effluent - into the sea.

In summary, although the reefs surrounding the East coast islands are in "fair" condition, the live coral cover is relatively low, especially taking into account that all of the sites surveyed are within Marine Parks. This points to the need for an improved and effectively enforced management plan. The data are only for one year, so it remains to be seen whether conditions improve in future, but increasing the number of marine park officers in the parks should contribute to improved enforcement of Marine Park regulations around the islands.

4.1.2 Fish

The numbers of various indicator fish types that are fished for the food trade (including parrotfish and groupers) is low in most areas. For example, less than one grouper was observed per segment. Prized fishes such as sweetlips and humphead wrasse were a rare sight during the surveys. No barramundi cod were observed during any of the surveys. This is an indication that these fishes have been overfished in the past, and populations have yet to recover. Although there are insufficient historical data available to confirm this, these indicators were selected by Reef Check for the very reason that populations are declining due to overfishing.

Mean Number of Target Fish Species per 500m^3
**For the East Coast of Peninsular Malaysia, 2007**
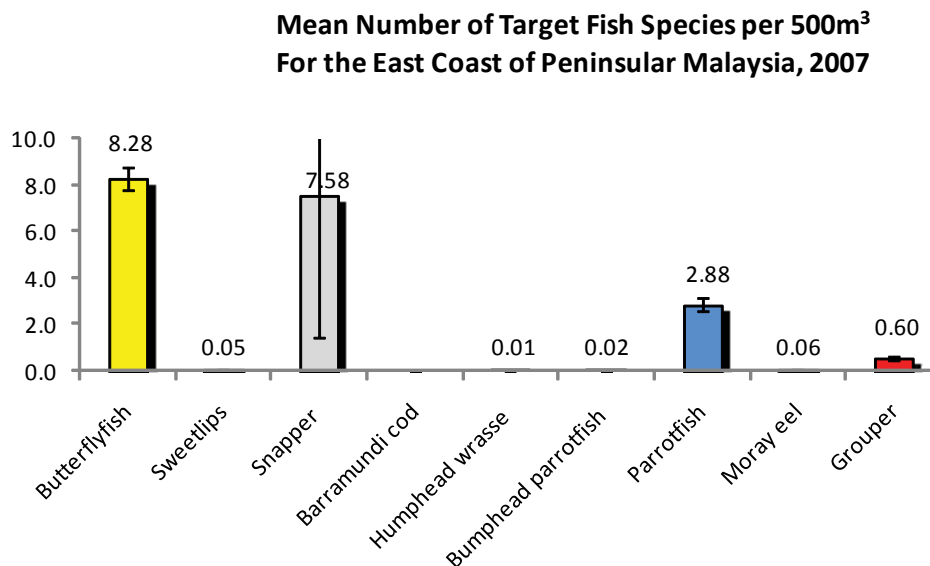
The presence of butterflyfish in most survey sites is a good indication that there is low collection pressure for these fishes, a popular item in the aquarium trade. High diversity of butterflyfish varieties is commonly used as an indicator of a healthy reef. The high numbers of butterflyfish at some survey sites reflects the fairly healthy status of reefs on the East Coast of Peninsular Malaysia, as butterflyfish mainly feed on coral polyps and are therefore able to thrive here.

4.1.3 Invertebrates

Although known to be uncommon on the reefs of the East coast of Peninsular Malaysia, the complete absence during the surveys of highly sought after invertebrates (including lobster, triton shell, banded coral shrimp, collector urchin and pencil urchin) indicates that these invertebrates have been fished out of the reefs. These invertebrates are prized either as food or as decorative pieces at home or for the aquarium trade.

High numbers of Diadema urchins were observed during the surveys, with particularly high numbers found in Tioman Island (see section 4.2.3). This is an indicator of pollution in the sea, as these urchins will reproduce rapidly in places where there are abundant micro-algae and seaweed, their main food source. The presence of Diadema urchins can act as a control on algal growth, as reflected in Tioman Island, where there is a significantly lower cover of Nutrient Indicator Algae but higher numbers of Diadema urchins compared to the other islands. Therefore while algal growth is kept in check by the high number of Diadema urchins, pollution is evidently a problem. An unseen problem with high numbers of Diadema urchins in a coral reef ecosystem is that of bioerosion. If the numbers of the urchins are too high then the rate of bioerosion would be higher than the rate of coral growth. This would lead to reef structural damage and degradation.

Mean Number of Target Invertebrate Species per 100m² For the East Coast of Peninsular Malaysia, 2007
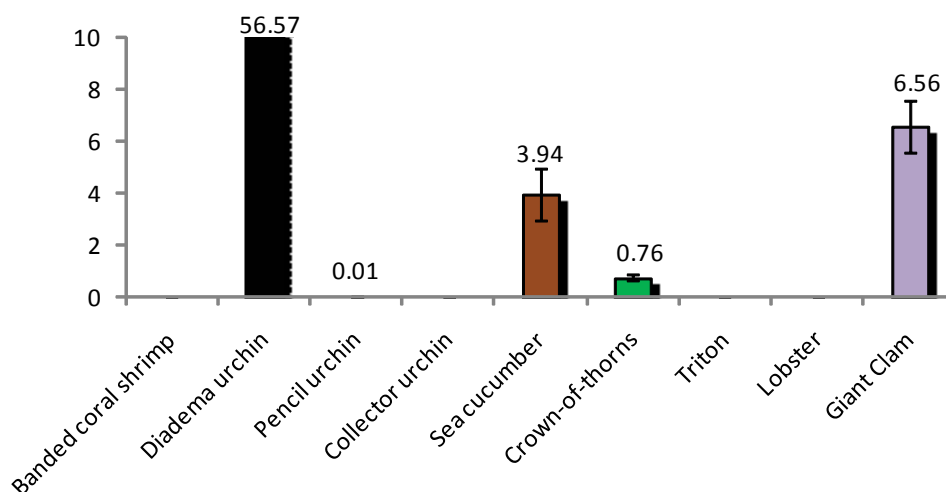
Meanwhile, the presence of giant clams and edible sea cucumbers is a good sign, as these are also highly sought after for decoration and food. This suggests that enforcement by Marine Park officers to stop collection of these invertebrates is showing some results. It is hoped that future surveys will record higher numbers.

The low number of coral-eating crown-of-thorns starfish could also be attributed to the control measures taken (clean-ups) by Marine Parks and other organizations.

4.2 Comparison of Islands

The results below show the comparisons made between the 4 islands where Reef Check surveys have been conducted this year.

4.2.1 Substrate

According to the Coral Reef Health Criteria, the reefs in Tioman Island and Tenggol Island are in "good" condition with over 50% live coral cover (LCC – includes both hard and soft corals) while Redang Island has LCC of just below 50%. Both Redang Island and the Perhentian Islands are in the "fair" category. All the islands except for the Perhentian Islands have a LCC above the average of 45.57% for the east coast of Peninsular Malaysia. The Perhentian Islands have a low LCC with an average of only 34.29%. Unlike the other islands, which have very high hard coral cover with less than 5% of soft coral cover, the composition of LCC in Tenggol Island consists of 34% of hard coral and 18% of soft coral cover. The difference is most likely caused by the stronger currents and granitic rock substrate in Tenggol Island, which is more suitable for soft coral growth.

The average cover of Nutrient Indicator Algae (NIA) in Perhentian, Redang and Tenggol Islands is relatively high compared to Tioman Island. However, the low cover of NIA in Tioman Island is reflected in the abundance of Diadema urchins, which feed on micro-algae and seaweed. This suggests that the waters around all 4 islands are suffering from an influx of nutrient pollution, possibly from ineffective sewage treatment systems.

Island	Hard Coral	Soft Coral	Recently Killed Coral	Nutrient Indicator Algae	Sponge	Rock	Rubble	Sand	Silt	Other
Perhentian	32.81	1.48	0.86	14.14	1.33	33.52	9.45	4.61	1.33	0.47
Redang	47.95	1.47	0.63	13.35	1.96	38.39	10.80	3.35	0.18	3.35
Tenggol	34.38	18.44	1.56	13.44	1.56	23.44	4.38	1.56	0.94	0.31
Tioman	51.88	3.30	2.05	3.57	2.41	21.52	7.86	5.04	0.89	1.47

**Mean Percent Cover of Substrate Type per 20m
for 4 Islands in the East Coast of Peninsular Malaysia, 2007**
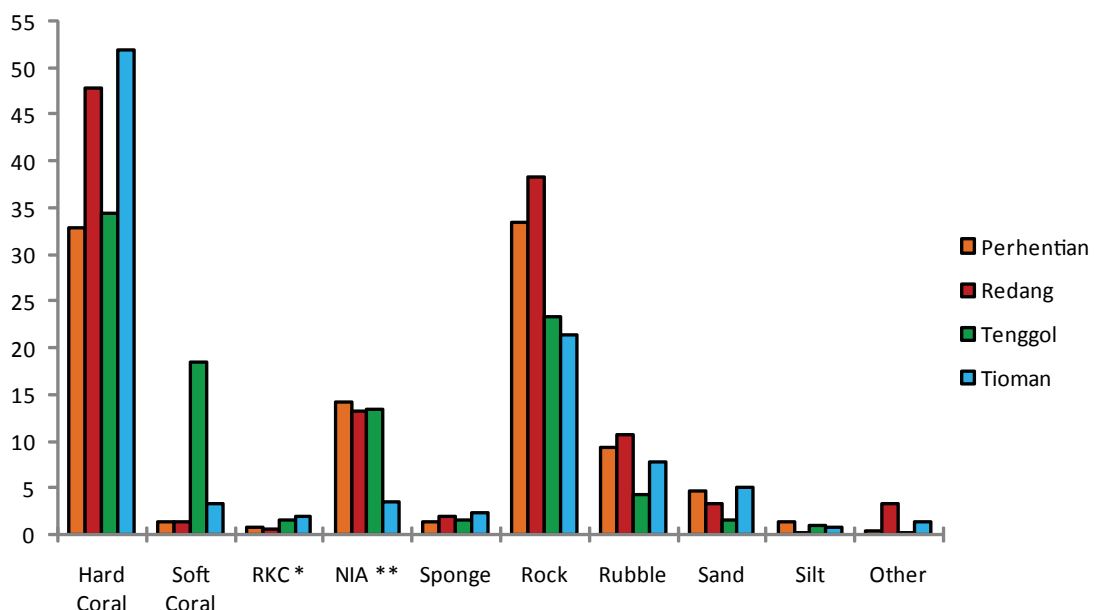
* - Recently Killed Coral
**- Nutrient Indicator Algae

There were also very few observations of Recently Killed Corals (RKC) on the 4 islands, indicating minimal damage caused by the predicted 2007 El Nino bleaching event. These RKC are mainly caused by Drupella snails and crown-of-thorns starfish, which feed on living corals. The relatively high abundance of Drupella snails which, while not an indicator species are nevertheless noted at survey sites, is an indication that the reefs are under stress. This observation is consistent with the high NIA levels (which suggests high nutrient levels), high Diadema abundance and the amount of siltation observed.

There is a great potential for all 4 islands to have better live coral cover as there are plenty of rock surfaces for juvenile coral polyps to attach onto, a key factor in reef regeneration. However, a proper monitoring programme needs to be implemented to keep track of the changes happening on the reefs, as further increases in NIA cover or silt on the reefs in Perhentian, Redang and Tenggol Islands would reduce the potential surface for new coral recruitment. The monitoring programme would also provide valuable information on the changes should there be any event of bleaching, crown-of-thorns or Drupella snail outbreaks.

4.2.2 Fish

Very few indicator fishes targeted for food consumption were observed at any of the 4 islands, with the exception of a large school of snappers seen on the Perhentian Islands.

Groupers, especially of reproductive age, are highly sought after as a food source. Previous fishing activities on these islands could have contributed to the low numbers of groupers. The number of groupers of reproductive age in the Perhentian Islands is exceptionally low and probably caused by the poor coral cover as groupers tend to live in between hard corals. However, the presence of some mature groupers, together with the observation of many juveniles, gives hope to the possible recovery of the grouper's population in these islands.

Island	Butterfly fish	Sweetlips	Snapper	Barramundi cod	Humphead wrasse	Bumphead parrot	Parrotfish	Moray eel	Grouper
Perhentian	6.06	0.03	29.19	0.00	0.00	0.00	2.88	0.09	0.28
Redang	5.41	0.00	0.31	0.00	0.03	0.06	3.09	0.00	0.72
Tenggol	3.00	0.00	0.63	0.00	0.00	0.00	4.25	0.00	0.63
Tioman	11.70	0.10	0.85	0.00	0.00	0.00	2.58	0.08	0.70

Mean Number of Target Fish Species per 500m³ for 4 Islands in the East Coast of Peninsular Malaysia, 2007
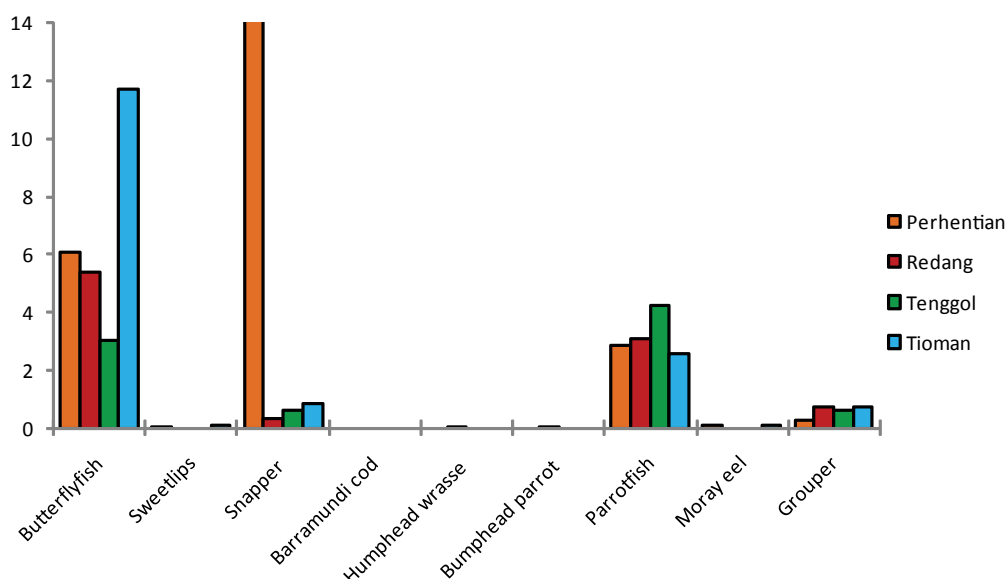
Overfishing in previous years is also probably the cause of the rarity of other prized food fishes such as sweetlips and humphead wrasse. No barramundi cod were observed on any of the 4 islands and humphead wrasse were only recorded at Redang Island during the surveys.

The number of sweetlips is also very low with observations only recorded in the Perhentian Islands and Tioman Island. Although fishing activities have been significantly reduced within the Marine Parks in recent years, previous overfishing has depleted stocks and the rarity of sightings shows that recovery of the ecosystem is a long process.

However, the presence of parrotfish at all 4 islands will help control algal growth, as they are mainly herbivorous. The high number of butterflyfish observed in Tioman Island is a reflection of the high hard coral cover, as they feed on hard corals. The low number of butterflyfish in Tenggol Island also reflects the low hard coral cover on those reefs. The presence of these fishes is an indicator that there is minimal, if any, fishing activity for the aquarium trade on all 4 islands.

4.2.3 Invertebrates

There were no observations of those indicator species that are highly sought after for the aquarium or food trade, as well as decorative purposes. Although known to be uncommon in the areas surveyed, invertebrates such as banded coral shrimp, pencil urchin, collector urchin, triton shell and lobster were absent on all these reefs, suggesting that they have been fished out in the past and that populations have yet to recover.

Island	Banded coral shrimp	Diadema urchin	Pencil urchin	Collector urchin	Sea cucumber	Crown-of-thorns	Triton	Lobster	Giant Clam
Perhentian	0.00	20.69	0.00	0.00	5.22	0.09	0.00	0.00	17.00
Redang	0.00	1.19	0.00	0.00	0.75	0.88	0.00	0.00	1.88
Tenggol	0.00	2.63	0.00	0.00	0.88	0.00	0.00	0.00	0.50
Tioman	0.00	112.43	0.00	0.00	5.37	1.15	0.00	0.00	4.30

**Mean Number of Target Invertebrate Species per 100m^2
for 4 Islands in the East Coast of Peninsular Malaysia, 2007**
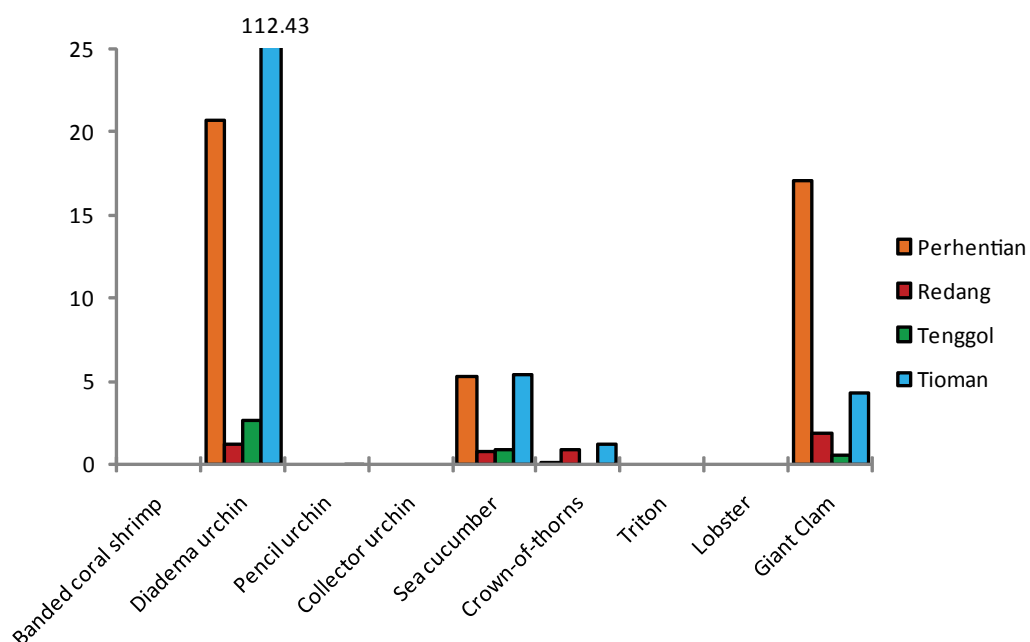
The high numbers of Diadema urchins in Tioman Island is a cause for concern, as their abundance is an indicator of nutrient pollution in the sea. However, the algal growth caused by pollution is kept in check by these Diadema urchins as they feed on micro-algae and seaweed. Survey sites on other islands with low numbers of Diadema have higher levels of NIA, supporting the observation that these reefs are being affected by pollution.

In the Perhentian Islands, even though the abundance of Diadema urchins is relatively high (particularly compared to Redang Island and Tenggol Island), the NIA cover in the Perhentian Islands is still the highest. There is a possibility that the pollution level in the Perhentian Islands is reaching a level beyond which it can be kept in control by Diadema urchins, which is potentially disastrous for the reefs in these Islands. This is indicative of the need for well designed and maintained sewage treatment facilities that meet Department of Environment standards.

The presence of giant clams, mostly smaller than 40cm in length, in all 4 islands is a good indicator that the giant clam population is recovering. Numbers were particularly high in the Perhentian Islands, possibly a reflection of the large proportion of Rock substrate. There is also a high number of edible sea cucumbers in the Perhentian Islands and Tioman Island, indicating low harvesting of these invertebrates for food and medicinal purposes. The reef structure at these 2 islands is also suitable for sea cucumbers as they are usually found on sandy bottoms.


4.3 Historical Trends

4.3.1 Reef Check Surveys

The number of surveys conducted for each year since 1997 for which results are available is listed below.

Year	1997	1998	2000	2002	2003	2004	2006	2007
No. Of surveys	6	6	7	11	15	11	2	33
Islands	Redang	Redang	Redang	Tioman	Redang Perhentian	Redang Tioman	Tioman	Redang Perhentian Tenggol Tioman

The table shows that very few Reef Check surveys have been conducted over the last few years. Perhaps the only meaningful observation that can be made is that RKC cover was very high during 1997 and 1998, following the major bleaching event that occurred at the time. This subsequently dropped after the El-Nino event, with a concomitant increase in Rock cover.

Mean Percent Cover of Substrate Type From Historical Data (1997 - 2007)
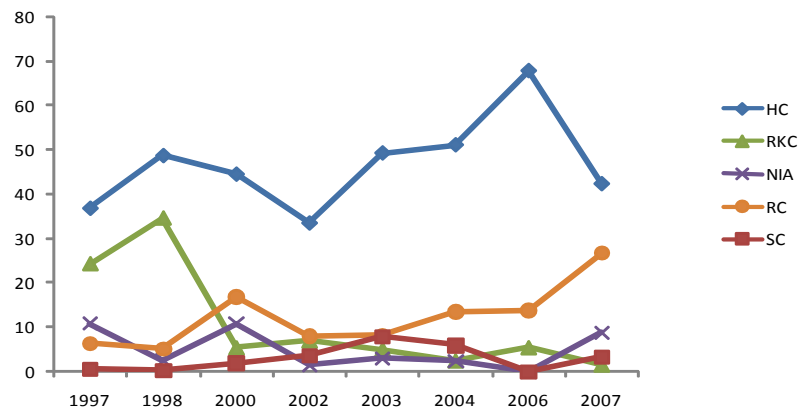
Apart from this, few conclusions can be reached. For example, the data for Hard Coral are insufficient to accurately determine changes over the survey period, as the sites and islands where surveys were conducted are not consistent. This is demonstrated by the fact that the 2 relatively good sites surveyed recently in Tioman Island have an average coral cover of 70%, much higher than some other sites that were surveyed previously.

4.3.2 Other Survey Data

A study on the status of the coral reefs in Pulau Tioman was conducted on 22 sites by scientists from University Malaya (Affendi Yang Amri and Badrul Huzaimi Tajuddin) in 2007, under the Limits of Acceptable Change (LAC) Project by Maritime Institute of Malaysia (MIMA),. From these sites, 11 were surveyed in the previous LAC study in 2002. The graph below compares the substrate cover of the 11 sites between 2002 and 2007.
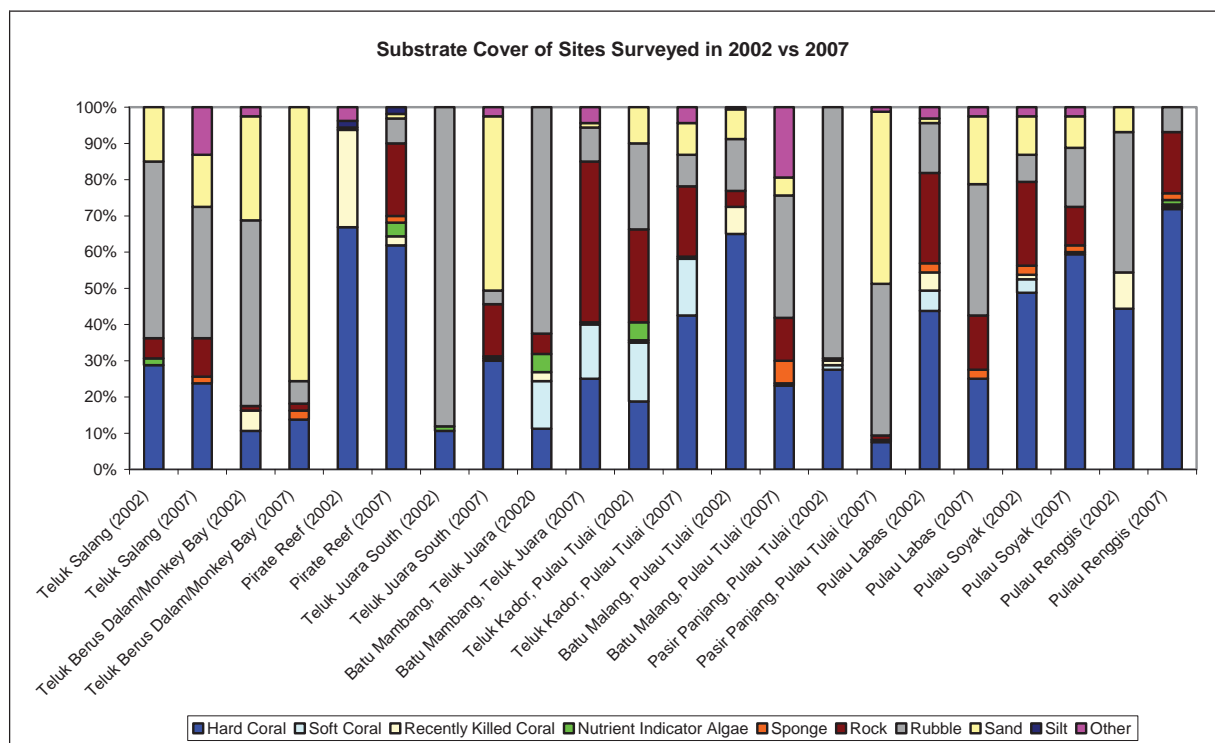

Figure taken from Status of the Coral Reefs in Pulau Tioman, Limits of Acceptable Change Project, Maritime Institute of Malaysia, 2007.

The results of the surveys from both years showed changes to the substrate cover on the reefs. These changes were consistent with anecdotal observations of the changes that have taken place on land as well as in the water, whether through natural occurrences, human activity or effective management of the Marine Park.

For example, the degradation of hard coral cover from 64% in 2002 to 23.1% in 2007 at Batu Malang, Pulau Tulai is most likely a result of impacts from high volume of divers and snorkelers, as well as crown-of-thorns starfish (COTS) outbreaks. Control measures to minimize impacts from divers and snorkelers (eg. improved education), as well as continuing COTS removal programmes, is likely to improve the hard coral cover of this, and other impacted reefs, in the future.

Meanwhile, the increase of hard coral cover in Pulau Soyak and Pulau Renggis from 2002 to 2007 is most likely a result of effective management by Marine Park officers, for example in setting up mooring buoys and encouraging boats to stop further away from the reefs. Such measures should be enforced in other dive sites to reduce impacts from dive and snorkelling boats

Through a monitoring programme like Reef Check, changes to the coral reef ecosystem can be tracked through time to help stakeholders and managers to execute appropriate action plans. Condition of the coral reefs should be monitored carefully, and suitable actions should be taken to address problems or replicate effective management interventions that result in reef improvement.

5. Challenges & Recommendations

Each of the four islands where reefs were monitored are gazetted as Marine Parks, meaning that most practices that have an adverse impact on reefs, such as fishing, trawling, anchoring and collection of any marine life, are prohibited. However, despite the 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.

General recommendations are made below, followed separately by specific recommendations for each island.

5.1 General Recommendations

The following general recommendations apply to all islands:

- encourage wise usage of fresh water (toilets using seawater, storing rainwater from roofs, recycling water for watering plants etc.)
- install recycling bins
- install more bins and improve collection of rubbish on the islands
- install better signage 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 Marine Parks
- establish a rating system for resorts operating in Marine Parks, to provide information to customers on the degree to which operators care for the environment
- make available more materials to be given to each visitor (eg. "do's and don'ts" and how and where to report any offense observed)
- implement more awareness campaigns and talks by Marine Parks staff all around the island for visitors and operators alike.

5.2 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 difficulties this creates.

Sewage treatment.
The smaller resorts tend to rely on septic tanks which can easily overflow and pollute the surrounding waters. Either a well managed treatment system, such as the "Hi-Clean" system, could be used for smaller resorts, or the state government should study the feasibility of constructing centralised sewage treatment plants which the resorts can use.

Solid waste disposal.
Solid waste disposal is another issue that 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. Leachate from the rubbish can also pollute the sea. Ideally, waste should be stored in a proper storage area on land before being transferred to the barge. An improved, more reliable and regular collection system is also required.

Construction.
Another issue is the construction of new resorts and jetties, some of which are poorly planned and 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.

5.3 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 by 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.

Despite the existence of some sewage treatment, levels of NIA on reefs surveyed in Redang are higher than would be expected, which is indicative of high levels of nutrient in the water consistent with inadequate sewage treatment. Regular monitoring and maintenance of the wastewater treatment systems that are available should be ensured to prevent pollution and the state government should consider the feasibility of constructing a centralized wastewater treatment plant for each bay.

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 stress as the hard coral cover is lower than would be expected. This is probably 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 snorkeling 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.

5.4 Tenggol Island

Tenggol Island is the smallest of the Marine Park islands where reefs were surveyed and as such does not have a local island population and only limited resort development. It is also the only island surveyed that does not have a Marine Park Centre and therefore the enforcement of Marine Park regulations is limited.

Sewage treatment.
Again the issue of sewage management is a problem due to the lack of a wastewater treatment plant, as indicated by high levels of NIA. Proper sewage treatment would prevent nutrients from entering the sea and causing excessive algal growth which smothers corals. This was observed on one of the reefs surveyed and needs to be monitored before further damage is caused.

Illegal trawling.
A local dive operator also mentioned that ghost nets are found at the end of each monsoon season indicating that illegal fishing 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.

5.5 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 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 some kind of nutrient pollution and this situation should be closely observed. Regular coral reef surveys should be conducted to monitor algal growth and Diadema numbers.

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.

5.6 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, as described in section 4.3 of this report. 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 proper monitoring of the reefs. Only by surveying the same sites every year will it be fair to make conclusions about changes that are happening on the reefs.

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- Sime Plantations Sdn Bhd: established a Corporate Reef Check team and adopted a reef in the Perhentian islands.

- 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.

- Russell Bedford LC & Company: provides pro bono company secretarial services for the registration of RCM.
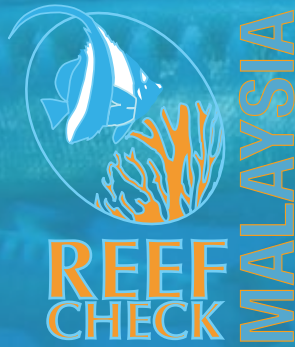
- Lions Club of Kota Budaya: sponsored a Reef Check survey in the Perhentian Islands.

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