Reef Check Malaysia

Coral Reef Monitoring Report

2008

Contents

Executive Summary

1. A total of 58 Reef Check surveys have been completed in 2008, a 43% increase over 2007.
2. The surveys were carried out by "citizen scientists" trained and certified in the global standard Reef Check method. The surveys took place on four islands off Peninsular Malaysia's East coast inside established Marine Protected Areas, and off Semporna in East Malaysia.
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 2008 was a good year for coral recovery, a continuing 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, 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 fisheries laws. In particular, the government is asked to support more education for schools and training for citizen scientists, 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 particularly 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 have completed the EcoDiver programme, and 58 surveys have been 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 second annual report, and details the results of Reef Check surveys carried out during 2008, the International Year of the Reef. 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. Background on Threats to Coral Reefs

According to "Reefs at Risk in Southeast Asia" (Burke *et al*, 2002), 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 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 (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
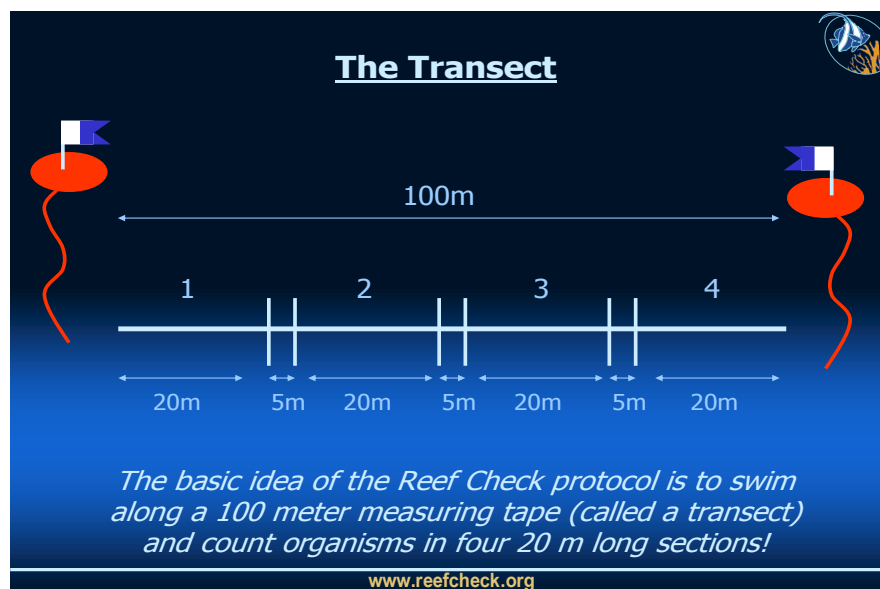
Four types of data are collected:

- 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 2008, a total of 48 surveys were conducted at 32 sites in Peninsular Malaysia. These sites were located at 4 islands on the East coast of Peninsular Malaysia, namely Aur, Perhentian, Redang and Tioman. In East Malaysia, 10 surveys were conducted at 5 sites around Semporna, Sabah.

Twenty eight surveys were conducted under the Sustainable Island Programme which was funded by Sime Plantations Sdn Bhd. This project saw a collaborative effort by Reef Check Malaysia and Wild Asia to monitor the reefs and work with local resort and dive operators on the islands to tackle issues that are threatening 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 and Table 2 below. The sites were selected based on Reef Check's 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: 2007/08 Survey Sites (Peninsular Malaysia).

Island	Sites surveyed in 2007	Sites surveyed in 2008	Perceived Impact (using Reef Check criteria)
Aur	-	Atlantis Bay House Reef	High
	-	Pinang	Medium
	-	Pulau Lang	Medium
	-	Reyner's Rock	Medium
Perhentian	Batu Nisan	Batu Nisan	High
	-	Batu Layar	Medium
	-	Batu Tabir	Medium
	Coral View Reef	-	High
	D'Lagoon	D'Lagoon	Medium
	-	Lighthouse Front	Low
	Sea Bell Shallow	Sea Bell Shallow	Low
	Sea Bell Medium	Sea Bell Medium	Low
	-	Shark Point	Medium
	Tanjung Besi	Tanjung Besi	Medium
	-	Tukas Laut	Medium
Redang	Chagar Hutang	-	Low
	-	Chagar Hutang East	Low
	-	Pulau Kerengga East	Medium
	-	Pulau Kerengga West	Medium
	Pulau Lima Southern Tip	Pulau Lima Southern Tip	Medium
	-	Pulau Paku Besar	Medium
	Pulau Paku Kecil SW	Pulau Paku Kecil SW	Medium
	Pulau Pinang Marine Park	Pulau Pinang Marine Park	High

		Redang Kalong House Reef	Medium
Tioman	-	Chebeh	Low
	Kador Bay	Kador Bay	Medium
	Malang Rock	Malang Rock	Medium
	Pirates Reef	Pirates Reef	High
	Pirates Reef East	-	High
	Renggis Island North Side	Renggis Island North Side	Medium
	Renggis Island South Side	-	Medium
	Renggis Island West Side	Renggis Island West Side	Medium
		Sepoi	Low
	Soyak Island	Soyak Island	Low
	Soyak Island South	-	Low
	Tekek House Reef	Tekek House Reef	High
		Tomok	Medium

Table 2: 2008 Survey Sites in East Malaysia.

No	Site Name
1	Kapalai Rock
2	Mataking House Reef
3	Mid-Rock
4	Paradise 2, Mabul
5	Treasure Hunt

4. 2008 Survey Results and Analysis

The results below are from 48 surveys conducted during 2008 on 4 islands in Peninsular Malaysia and 10 surveys conducted in East Malaysia. Even though this is the second year of an extensive survey programme, Reef Check Malaysia is still in the process of gathering baseline data on the status of reefs on the East Coast of Peninsular Malaysia, as demonstrated by the fact that 17 of the 32 sites surveyed this year were new sites not surveyed previously.

Only 15 of the 21 sites surveyed last year were repeated due to limitations of resources and time. The results from these 15 surveys can be used to track changes that have taken place on those reefs within the past year.

4.1 Peninsular Malaysia – 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.

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 reef corals on the East Coast of Peninsular Malaysia is "good", based on average live coral cover (Hard Coral + Soft Coral) from all the surveys of 52.3%. Importantly, the level of Recently Killed Coral is less than 1%, a very low number indicating that the combination of human and natural damage to reefs was relatively low in 2008 at the surveyed sites. High levels of both Sponge and Soft Coral can indicate recent disturbance, hence the relatively low levels of these indicators are also reassuring. While high turbidity is a well-know problem in many areas of Malaysia, the low level of actual silt measured at the RC sites indicates that this was not a major problem during the surveys. These reefs also include a high percentage of Rock (over 27% cover), a proportion of which is old dead coral.

Average Percentage of Substrate Type Cover per 20m at 4 East Coast Islands of Peninsular Malaysia in 2008
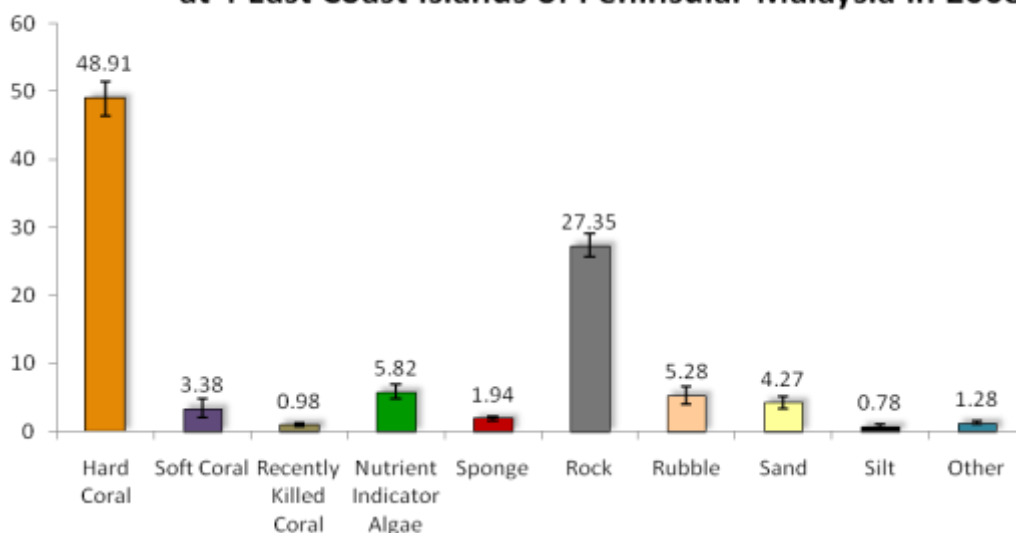
However, the level of Nutrient Indicator Algae found during surveys is high, at an average of 5.8%. This suggests that the amount of nutrient in the sea is sufficiently high to encourage algal growth, and that the organisms that eat algae are insufficient to keep them in check. These algae usually grow on rocks (including old dead corals), reducing the surface for potential coral recruitment, and blocking light from successful recruits and juvenile corals. The proliferation of algae on reefs can kill corals over a period of time as they compete for space and sunlight.

Nutrient runoff from land-based human activities, including effluent from inadequate or improperly maintained and operated sewage treatment systems, could be a source of nutrient that might encourage proliferation of algae. This problem was highlighted during workshops carried out with resort and dive operators on Perhentian and Tioman islands, as part of the Sustainable Island Project. Participants recognised that sewage treatment systems on the islands might be inadequate. Improvements to sewage treatment systems might reduce the likelihood of effluents entering the sea and damaging coral reefs.

In summary, although percentage of living coral on the reefs surrounding the East coast islands is relatively high, there is still plenty of available space for live coral cover to increase. Given the relatively high algal cover, it would be helpful to try to determine whether nutrient availability in these waters could be enhancing algal growth, and if so, to determine the origin of the nutrients. Since observations indicate that sewage is one suspected source of nutrients, sampling for *E.coli* bacteria might be the most cost-effective tracer to determine whether sewage may be influencing nutrient availability. This indicator is also important to evaluate possible human health threats. The increasing number of marine park officers in each state office should enhance enforcement of Marine Park regulations around the islands, which should lead to improvements in coral reef health. A further improved and effectively implemented management plan will also continue to improve the conditions of the reefs within the Marine Parks in Malaysia.

4.1.2 Fish

One criterion to select the Reef Check indicator fish is their desirability for various types of fishing. The numbers of indicator fish varieties that are fished for the food trade (including parrotfish and groupers) are low in most areas. For example, less than one grouper (over 30 cm) was observed per 20 m long replicate transect (500 m^3 of water volume surveyed). On healthy reefs in the region, up to 5 groupers of this size can be observed.

Average Number of Target Fish Species within 500m³ at 4 East Coast Islands of Peninsular Malaysia in 2008
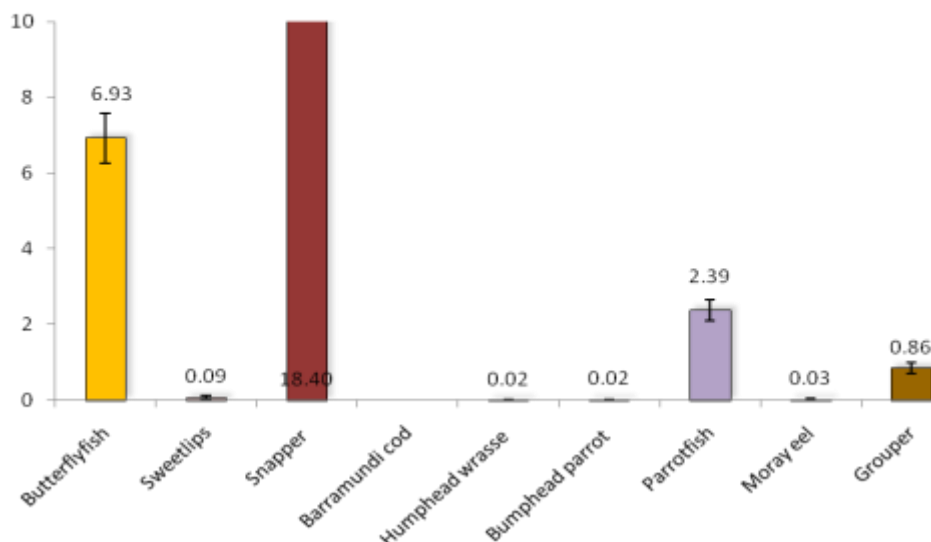
Prized fish such as Barramundi cod were not observed at all throughout the 48 surveys, while Sweetlips and Humphead wrasse were rarely sighted during the surveys. Both the Sweetlips and Barramundi are extremely "tame" fish that are easily speared by fishermen and also caught by line fishing. Small Sweetlips are also targeted for the aquarium trade. The Humphead Wrasse is one of the most valuable fish for the live fish trade to supply restaurants. A single large fish may be worth US$10,000. While few data are available from previous decades, it is likely that these food fish have been overfished in the past, and populations have yet to recover. This is most likely to have taken place before the islands were gazetted as Marine Parks. However, with a continuous monitoring programme, and increasing enforcement, it will be possible to track the recovery of fish populations in the coming years due to the successful Marine Parks. In fact, the relatively high numbers of the fast reproducing and growing snapper suggest that this process is already under way.

The presence of butterflyfish in most survey sites is a good indication that there is low collection pressure on these fish, a popular item in the aquarium trade. The high numbers of butterflyfish at some survey sites also reflects the fairly healthy status of reefs on the East coast of Peninsular Malaysia as they thrive on reefs with healthy corals because they mainly feed on coral polyps. High diversity of butterflyfish varieties is also commonly used as an indicator of a healthy reef as each species of butterflyfish feeds on polyps of specific corals.

4.1.3 Invertebrates

The invertebrate indicators have been selected due to being high-value target organisms for fishing and/or collection. Although long 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 and pencil urchin) indicates that the small population of these invertebrates have been fished out of the reefs in the past. These invertebrates are prized either as food, as decorative "curio" pieces at home or for the aquarium trade. Older fishermen in these areas tell stories of previously high numbers of lobster on some reefs.

Average Number of Target Invertebrate Species within 100m² at 4 Islands of Peninsular Malaysia in 2008
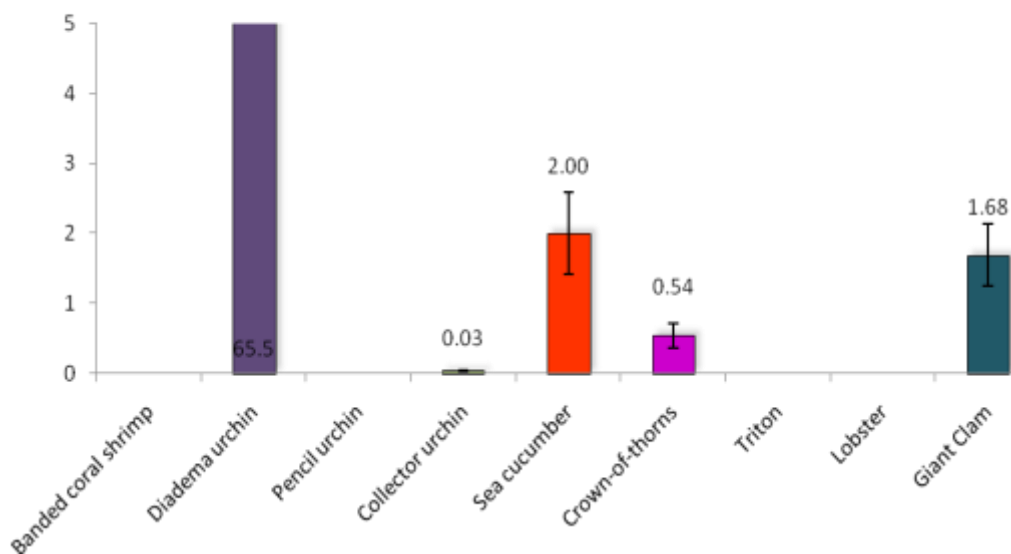
Long-spined black sea urchins *(Diadema* spp.), have been found in abundance, particularly in Tioman Island (see section 4.2.3). These urchins can reproduce rapidly in areas where their main food source (micro- and macroalgae – seaweed, which proliferate in nutrient rich water) is abundant. When the reef ecosystem is in balance, the numbers of *Diadema* urchins, in combination with herbivorous fish, keep algal growth in check as they feed on these algae. This appears to be the case on the reefs of Tioman Island where Nutrient Indicator Algae cover is lower and the number of *Diadema* urchins is much higher compared to the numbers on reefs of the other three islands. Unfortunately, if the numbers of *Diadema* increase too much, bioerosion by the hordes of scrapers can damage the living corals. The reef structure could be damaged and face degradation if the bioerosion rate exceeds the rate of coral growth. Therefore, while algal growth can be partially controlled by urchins, this must be in combination with balanced levels of herbivorous fish such as parrotfish and surgeon fish. Furthermore, the fertilizing effects of nutrient pollution must be controlled.

The numbers of giant clams and edible sea cucumbers, also highly sought after for decoration and food, are relatively low, presumably due to past over collection. This suggests that enforcement by Marine Park officers to stop collection of these invertebrates is essential to the recovery of populations of these organisms. The low number of coral-eating crown-of-thorns starfish may be due to lack of large-scale outbreaks and the control measures taken (clean-ups) by Marine Parks and other organizations.

4.2 Comparison of East Coast Islands

The results below show the comparisons made between the four 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 Perhentian 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 Aur Island are in the "fair" category, with Aur Island having a significantly lower LCC of 28.3%. Even though the soft coral cover in Redang Island is significantly higher at 11.4%, most of the soft coral recorded were from two sites, Pulau Lima Southern Tip and Redang Kalong House Reef, both of which consist mainly of zoanthids that grow on broken corals. Most of these corals are branching *Acropora* corals damaged by storm and strong currents during the monsoon season. Zoanthids are able to grow and proliferate over these broken corals due to their fast colonization, high growth rate and tolerance towards marginal environments.

Table 3: Percentages of Substrate Type Cover According to Islands in Peninsular Malaysia.

Island	Hard Coral	Soft Coral	Recently Killed Coral	Nutrient Indicator Algae	Sponge	Rock	Rubble	Sand	Silt	Other
Aur	26.41	1.88	0.63	11.09	2.50	44.53	8.28	3.91	0.63	0.16
Perhentian	50.23	0.51	0.97	6.59	1.65	32.61	1.93	4.60	0.40	0.51
Redang	38.33	11.39	1.39	9.17	0.56	28.33	9.10	0.97	0.00	0.76
Tioman	56.33	1.88	0.90	3.23	2.53	21.47	4.86	5.46	1.30	2.04

The average cover of Nutrient Indicator Algae (NIA) in Aur and Redang Islands is relatively high compared to Perhentian and Tioman Islands. However, the lower cover of NIA in Perhentian and Tioman Islands correlates negatively with the abundance of *Diadema* urchins – Tioman with the highest followed by Perhentian – which feed on micro-algae and seaweed. This suggests that the most balanced reef system is Tioman, with Aur exhibiting an imbalance among nutrient inputs, sea urchin and herbivorous fish abundance. The relatively low levels of silt measured indicate that terrestrial runoff was not a major factor at the sites surveyed at the time of the surveys.

Average Percentage of Substrate Type Cover per 20m at Each Island, 2008
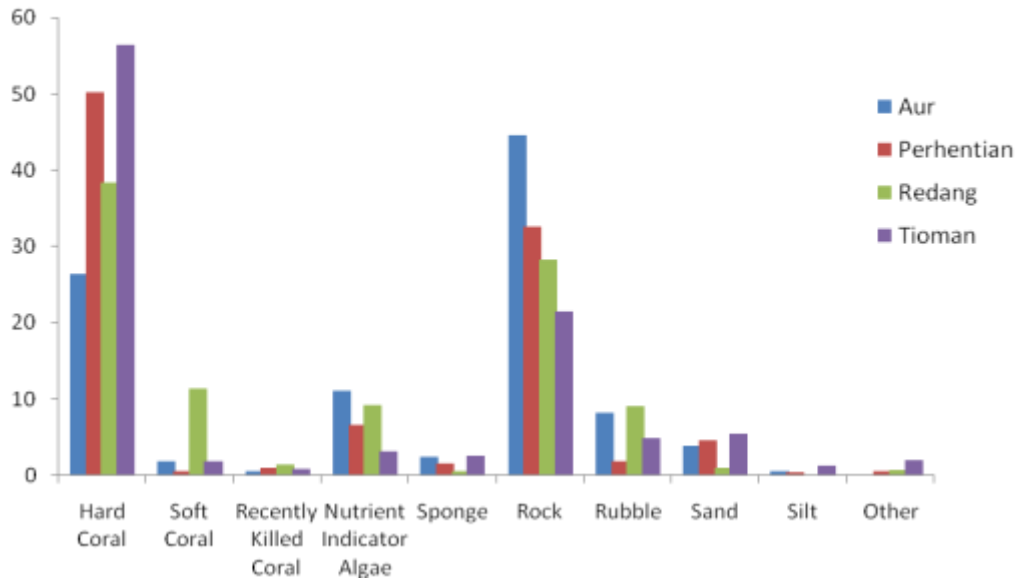
During surveys carried out in P. Aur, the problem with NIA was observed to be particularly acute in one area, between P. Aur itself and the nearby P. Dayang. The channel between the two islands (less than 200 m across) is largely free of healthy coral, has sloping, sandy sides, and is covered in many areas by large amounts of NIA. As noted above, on islands such as this, proliferation of NIA could be enhanced by excessive nutrient, for example from poorly treated sewage effluent. The local population on P. Aur is very small (significantly smaller than the other islands surveyed) and is very unlikely to be causing this problem. Most accommodation on the island is specifically for divers, and it appears that these resorts have limited sewage treatment systems, which could be contributing nutrient into nearby waters.

There were very few observations of Recently Killed Corals (RKC) on the four islands at the time of the surveys. Some limited coral bleaching was observed in Tioman Island in the second half of the year, after the surveys were completed. Local informants suggested that the bleaching event may have been caused by high turbidity and silt released into the water from an on-going development project on the island. Most of the bleached corals have subsequently recovered and there is minimal residual damage on the reef. However, this example demonstrates the importance of proper site protection, such as the use of silt curtains, and monitoring of construction in such sensitive areas, and the need to improve on reporting mechanisms to the relevant parties should such incidents occur again in the future.

There is potential for all four islands to have higher live coral cover due to the availability of uncolonised "bare" rock surfaces for juvenile coral larvae to settle onto – a key factor in reef regeneration. However, further increases in NIA cover or silt on the reefs could reduce the potential for new coral recruitment and increase the potential for overgrowth of algae and subsequent reductions in coral cover. A more frequent monitoring programme is needed to track such improvements in reef health. More frequent monitoring would also provide valuable information on other changes due to bleaching, crown-of-thorns or *Drupella* snail outbreaks.

4.2.2 Fish

The fish populations on all the islands, except for P. Aur, exhibit relatively low abundance, with the exception of Butterflyfish and Snapper. The low abundance of all types of fish in Aur is likely due to a long history of heavy fishing pressure, and possibly more recent poaching. The lack of a Marine Park centre on the island makes it difficult for Marine Parks officers to enforce regulations, as P. Aur is located furthest away from the mainland of all the islands surveyed.

Table 4: Number of Target Fish Species According to Islands in Peninsular Malaysia.

Island	Butterfly fish	Sweetlips	Snapper	Barramundi cod	Humphead wrasse	Bumphead parrot	Parrotfish	Moray eel	Grouper
Aur	4.75	0.00	0.00	0.00	0.00	0.00	2.50	0.13	0.44
Perhentian	5.34	0.18	25.41	0.00	0.00	0.00	2.16	0.00	1.07
Redang	3.72	0.11	51.33	0.00	0.03	0.03	2.22	0.03	0.81
Tioman	9.43	0.05	4.76	0.00	0.02	0.03	2.56	0.03	0.85

The number of food fish targeted was very low at all 4 islands, with the exception of three large schools of snappers recorded at Perhentian and Redang Islands. Populations of groupers, a highly sought after food fish, are likely to be affected by previous fishing activities as the number of mature groupers observed during the surveys was low. However, the presence of some mature groupers, together with the observation of many juveniles, gives hope to the possible recovery of the grouper populations in these islands.

Average Number of Target Fish Species within 500m³ at Each Island, 2008
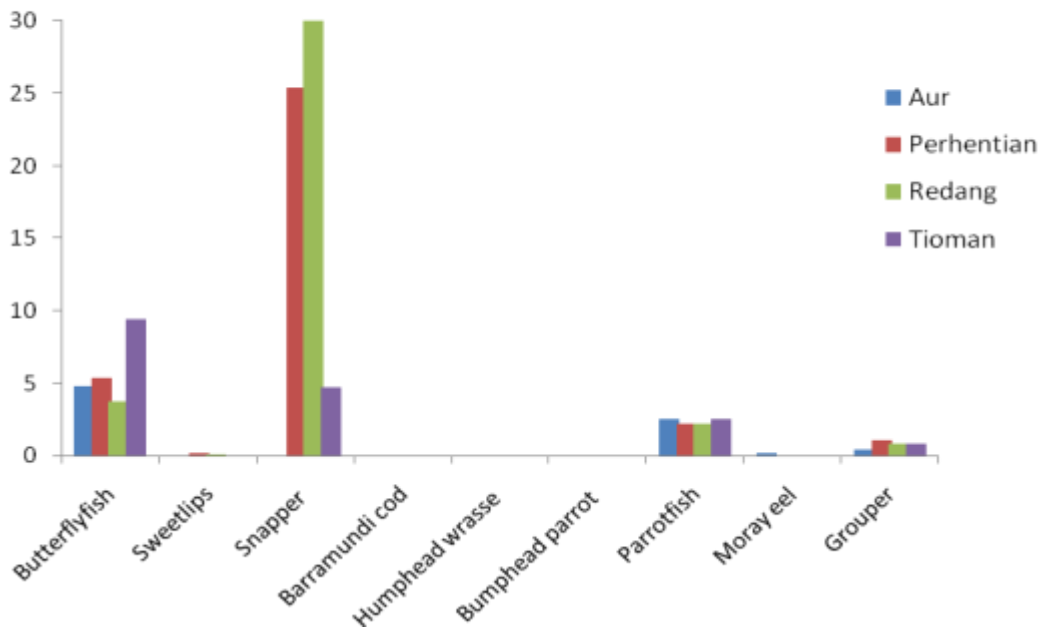
Overfishing in previous years is also probably the cause of the rarity of other prized food fishes such as sweetlips and humphead wrasse. No barramundi cod were observed on any of the four islands and humphead wrasse were only recorded at Redang and Tioman Islands during the surveys. Although fishing 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.

The presence of parrotfish at all four 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 some species feed on hard corals. The abundance 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

Invertebrates that are highly sought after for the aquarium or food trade, as well as for decorative purposes, (such as banded coral shrimp, lobster, triton shell and pencil urchins), were absent from all the surveys conducted. Although known to be uncommon in the areas surveyed for many years, their total absence from these reefs suggests that these populations may only recover slowly since the recovery will be dependent on reseeding from elsewhere. Artificial reseeding could speed the process for some of these organisms such as Giant Clams.

Table 5: Number of Target Invertebrate Species According to Islands in Peninsular Malaysia.

Island	Banded coral shrimp	Diadema urchin	Pencil urchin	Collector urchin	Sea cucumber	Crown-of-thorns	Triton	Lobster	Giant Clam
Aur	0.00	0.44	0.00	0.00	2.63	0.00	0.00	0.00	0.44
Perhentian	0.00	21.61	0.00	0.07	2.64	0.18	0.00	0.00	2.48
Redang	0.00	1.78	0.00	0.06	1.78	1.36	0.00	0.00	1.42
Tioman	0.00	125.34	0.00	0.00	1.66	0.48	0.00	0.00	1.63

The high density of *Diadema* urchins in Tioman Island is a cause for concern due to potential bioerosion. However, these urchins help keep algal growth under control in the absence of sufficient herbivorous fish.
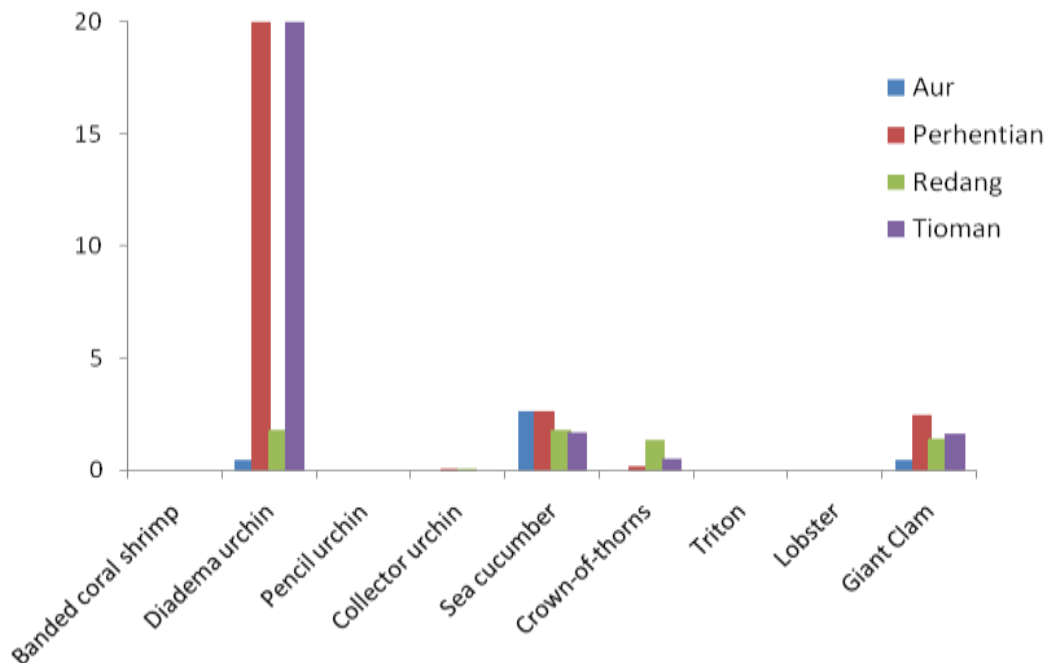
The number of giant clams and edible sea cucumbers, both indicators of harvesting activities, were low at all the four islands. This suggests that harvesting activities of the edible sea cucumbers for food and medicinal purposes is still taking place, especially during the monsoon season. Giant clams are harvested

for food as well as for their shells. An increased effort in education and enforcement is needed to prevent further harvesting of these invertebrate species, especially during the monsoon season.

4.3 East Malaysia

In early 2008, RCM conducted an EcoDiver training programme for dive operators around the Semporna islands of East Malaysia. Subsequently, as part of a WWF programme, these divers have conducted Reef Check surveys at 5 sites, with two surveys at different depth at each of the sites.

4.3.1 Substrate

According to the survey results (shown below), the average LCC gives the reefs around the Semporna islands a "poor" rating according to the Coral Reef Health Criteria. Only 1 of the 5 sites has reefs with LCC more than 25%. Large portions of the reefs consist of rubble, which is a cause for concern as it suggests that corals have been damaged and broken into small pieces. It is possible that the damage is caused by natural causes such as storms. However, it might be due to dynamite fishing, which local informants indicate is a common practice in this area, though very difficult to document. Further information is required on this issue before meaningful conclusions can be drawn.


Average Percentage of Substrate Type Cover within 20m at 5 Sites Around Semporna
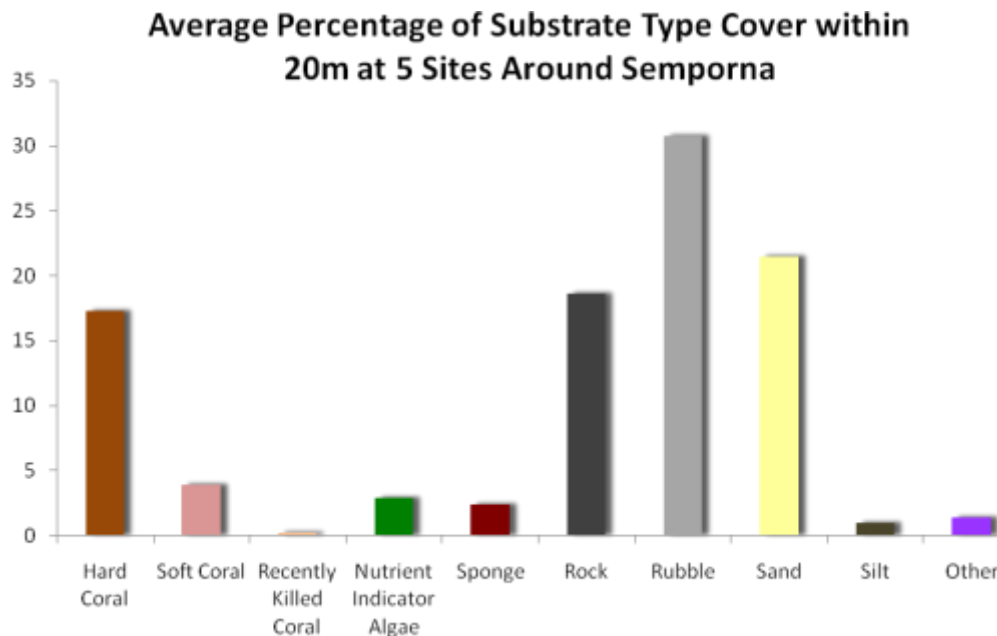
NIA cover was generally low with the exception of the shallow Mataking House Reef with over 20%. This is a concern as the presence of such a large amount of algae indicates that there is sufficient nutrient to stimulate this growth and insufficient herbivory to balance it. Any further growth of algae on the reef could kill corals, (if this is not happening already). It would also reduce the space for coral attachment.

4.3.2 Fish

The reefs around Semporna islands exhibited a more diverse fish and invertebrate community than at the sites in Peninsular Malaysia. Many food fish indicators such as groupers, snappers and parrotfish were observed, albeit in low numbers. Higher value fish such as Barramundi cod and Humphead wrasse were absent during the survey. The numbers of butterfly fish suggests that fishing for the aquarium trade is minimal, if any, in that area.

Average Number of Target Fish Species within 500m³ at 5 Sites Around Semporna
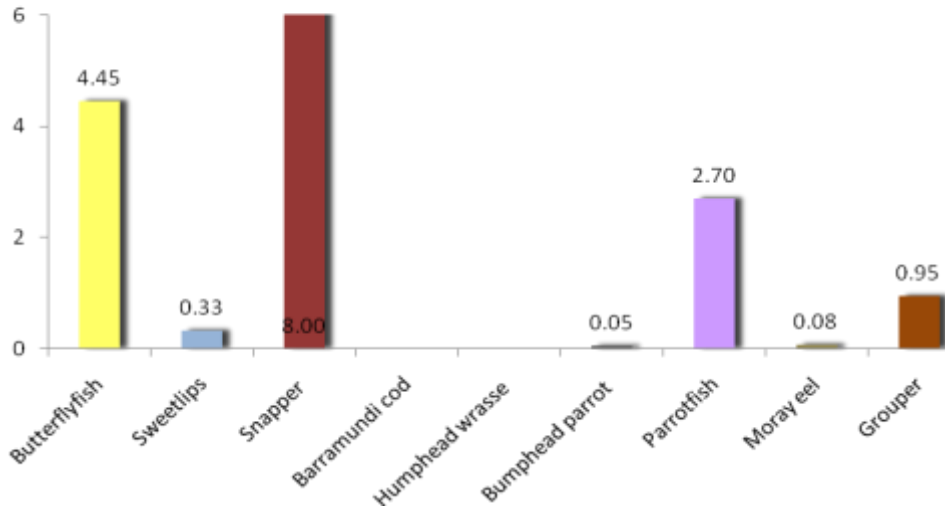
4.3.3 Invertebrate

The invertebrate survey recorded some of the rare indicator species that have not been observed during surveys in Peninsular Malaysia (such as banded coral shrimps, pencil urchins and lobsters). These are good signs as their presence increases the possibility of the population recovering in this area. The absence of collector urchins and triton shells suggests previous over collection and it is possible that collection continues e.g. for the curio trade. Edible sea cucumbers, which are harvested for food by the local communities, were also absent during those surveys.

Average Number of Target Invertebrate Species within 100m² at 5 Sites Around Semporna
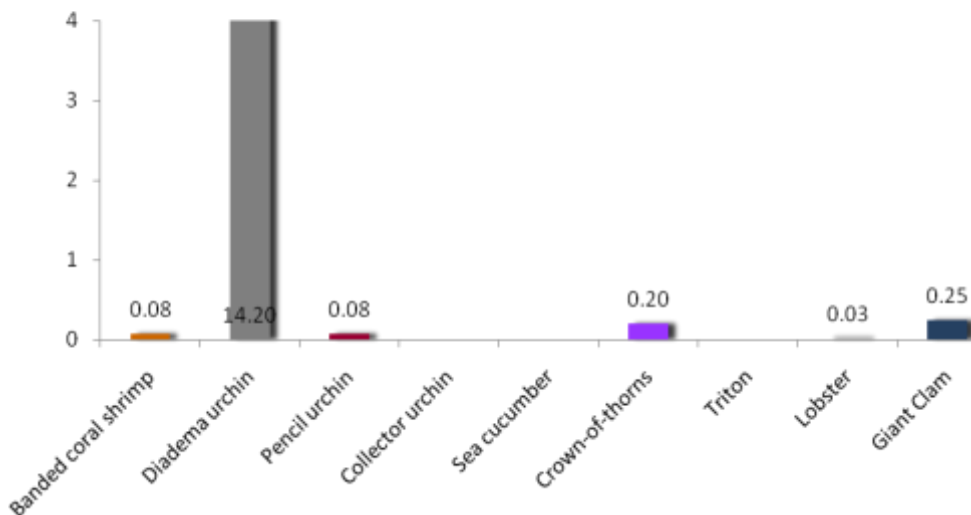
4.4 Analysis of 2007 and 2008 Reef Check Surveys

4.4.1 Comparison of Islands

Even though this is only the second year of an extensive survey programme conducted by Reef Check Malaysia, the results can still be used to establish the baseline data for the status of the reefs on the East coast of Peninsular Malaysia, as more than half the sites surveyed this year were new sites. Due to limitations in time and resources, the sites in Tenggol Island were not surveyed this year. The substrate data will be used for the analysis as it gives a better indication of changes that took place on the reef compared to Fish and Invertebrate abundances as these animals are more mobile.
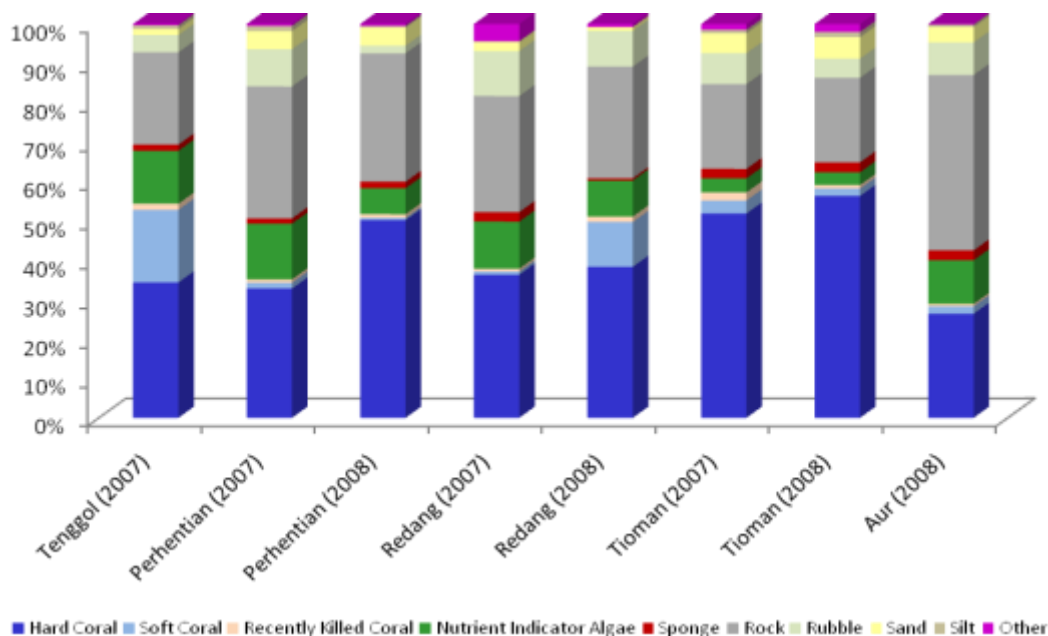

Three sites showed an increase in living coral cover (Hard Coral) during the one year period. However, much of this increase at Perhentian, and to a lesser extent Redang, is an artefact of higher Hard Coral recorded at the new sites surveyed this year. The increase of Hard Coral (HC) cover in the Perhentian Islands is contributed by the reefs at Batu Layar, Lighthouse Front, and Tukas Laut which all had HC cover more than the total average of all the surveys. Meanwhile in Redang Island, the LCC cover increase were mainly contributed by the increase of Zoanthids – which are categorized under Soft Coral (SC) by Reef Check – at two sites, namely Redang Kalong House Reef and Pulau Lima Southern Tip.

The minimal cover of Recently Killed Coral indicates that there has been little, if any, mortality due to bleaching that can be caused by increased seawater temperatures linked to global warming. The regular reef clean-ups and crown-of-thorns removal programmes organised by the Department of Marine Parks Malaysia and other organisations have also proven helpful in reducing predation and damage to the reefs around these islands.

4.4.2 Comparison of Repeated Sites

As mentioned previously, the limited number of surveys conducted can only give an approximate picture of how the conditions of the reefs are changing. Replication of these surveys several times per year and over a period of several years will give a more accurate picture of the health of these reefs over time.

Sites at Redang Island
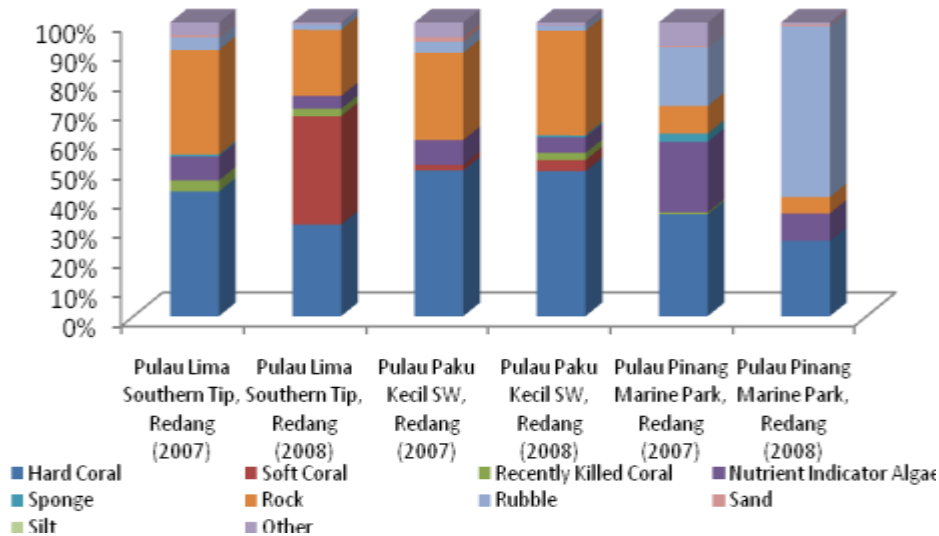
Overall, the condition of some reefs has improved, but there is still much room for improvement, likely to be closely linked to the improvement of enforcement of fishing restrictions and effective management of the Marine Parks. Out of the 15 repeated sites, 8 of them recorded an increase of LCC whereas 7 others showed some decline. One of the significant increases was recorded at Pulau Lima Southern Tip in Redang Island. However, this increase was contributed by the high cover of Zoanthids, which are recorded under Soft Corals in a Reef Check survey.

Sites at Perhentian Island
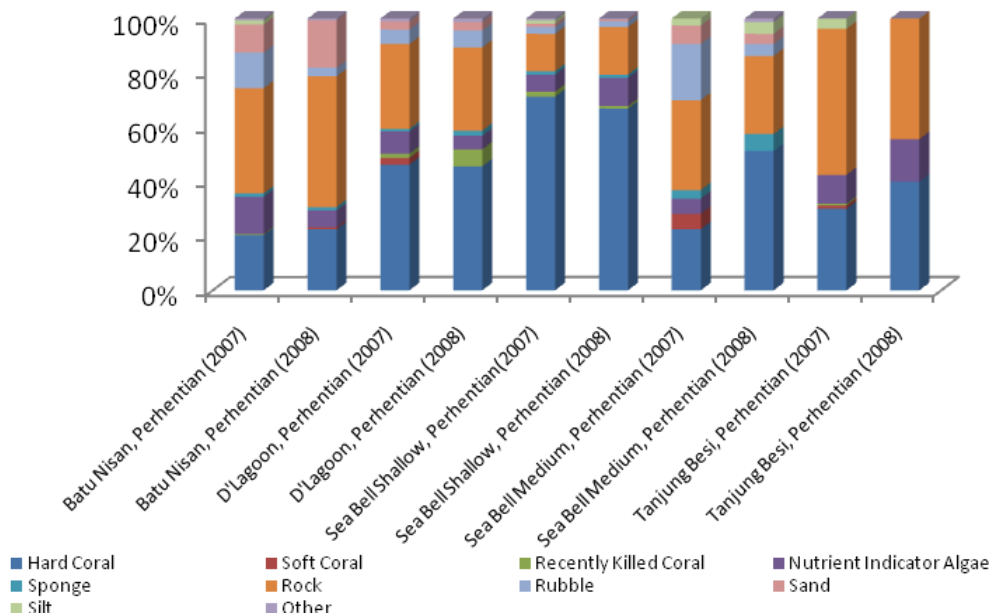
The high overall percentage of rock on these reefs continues to provide opportunities for coral larvae to settle and grow. There were significant increase in NIA cover at two reefs, Sea Bell Shallow and Tanjung Besi, both at Perhentian Islands. This is a cause for concern as further proliferation of algae on these reefs could kill corals and reduce potential substrate for new coral recruitment. It is important to monitor these changes and address the causes before further damage takes place.

Sites at Tioman Island
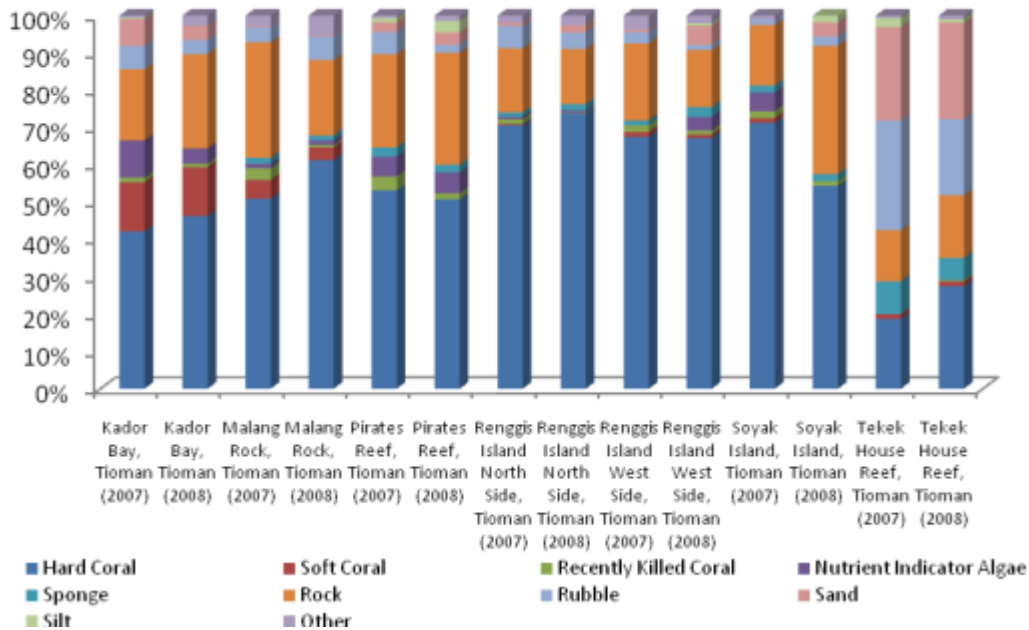
The percentage of coral rubble has also decreased in most of the reefs but there was a significant increase of rubble at the Pulau Pinang Marine Park reef in Redang Island. Most of the coral damage there is likely to be caused by wave action during storms and by snorkelers in the shallow areas, subsequently transported to deeper waters. There is a need to monitor snorkelling activities on this reef as large numbers of unsupervised snorkelers visit this area. Observation suggests that up to 1,000 snorkelers per day on a school holiday are not properly briefed on safety and eco-friendly practices prior to snorkelling. It is important to educate snorkel guides and resort operators to brief their guests and teach them to be responsible snorkelers. Reef Check offers the EcoDiver certification course as one way to educate students about responsible snorkelling and diving.

4.5 Historical Trends

4.5.1 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	2008
No. Of surveys	6	6	7	11	15	11	2	33	48
Islands	Redang	Redang	Redang	Tioman	Perhentian Redang	Redang Tioman	Tioman	Perhentian Redang Tenggol Tioman	Aur Perhentian Redang Tioman

The table shows that very few Reef Check surveys, for which information is available, have been conducted prior to 2007. Looking at Recently Killed Coral, the peak in 1998, was caused by the major global bleaching event that occurred in 1997-8 during an El-Nino event, with a concomitant increase in Rock cover (Wilkinson and Hodgson, 1999). The positive news is that this has not occurred again. However, as global warming continues, coral reefs are clearly one of the most sensitive indicators available due to coral's small range of thermal tolerance.
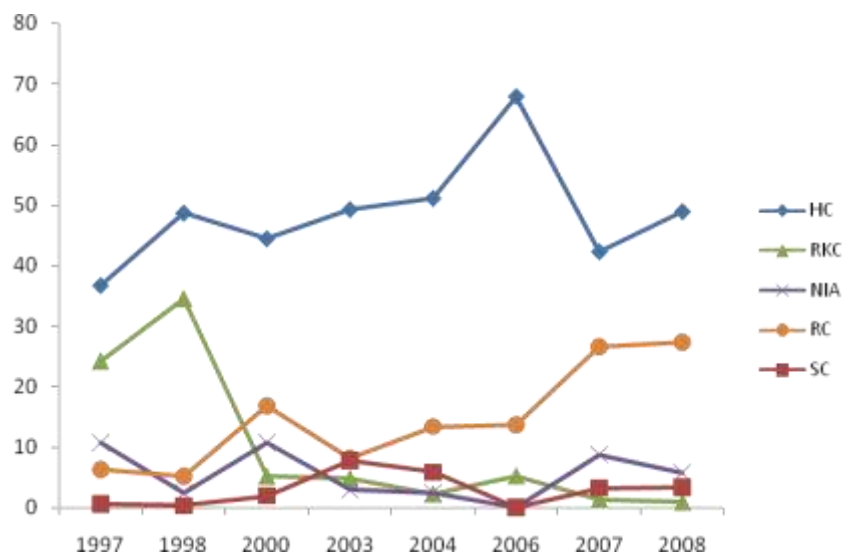
The data for Hard Coral suggest that the reefs surveyed during this period have maintained a relatively high coral cover, well above the 30% regional average. Coral cover is known to fluctuate dramatically over time due to natural impacts such as storms. Therefore these numbers are encouraging, suggesting that despite the problems with overfishing and harvesting, the surveyed reefs have maintained a relatively healthy coral population.

5. Challenges & Recommendations

Listed below are a number of recommendations based on both the objective data collected through the Reef Check surveys as well as based on subjective observations of Reef Check participants over the past decade.

Each of the four islands where reefs were monitored 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.

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 handouts to be given to each visitor (eg. "do's and don'ts" and how and where to report any offense observed)
- implement more education and awareness campaigns and talks by Marine Parks staff all around the island for visitors and operators alike.
- Support more training for students and adults in the EcoDiver program
- Support increased frequency of monitoring to track future changes in reefs, especially due to global warming.

5.2 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.

5.3 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.

5.4 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.

5.5 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.

5.6 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 regular monitoring of the same reef areas.

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

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- 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, will fund 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 which was a collaborative project by Reef Check Malaysia and Wild Asia to monitor the reefs on three islands of 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.

- BP: funded part of the Coral Reef Camps that were conducted on 5 Marine Park island schools. They also sponsored the launch of Reef Check Malaysia event where the first annual report was published.

- 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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