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NATIONAL REPORT

on

Coral Reefs in the Coastal Waters of the South China Sea

MALAYSIA

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MALAYSIA

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INTRODUCTION

Malaysia's coral reefs extend from the renowned "Coral Triangle" connecting it with Indonesia, Philippines, Papua New Guinea, and Australia. Coral reef types in Malaysia are mostly shallow fringing reefs adjacent to the offshore islands. The rest are small patch reefs, atolls and barrier reefs. The United Nations Environment Programme's World Atlas of Coral Reefs prepared by the Coral Reef Unit, estimated the size of Malaysia's coral reef area at 3,600sq. km which is 1.27 percent of world total coverage (Spalding *et al*., 2001).

Coral reefs support an abundance of economically important coral fishes including groupers, parrotfishes, rabbit fishes, snappers and fusiliers. Coral fish species from Serranidae, Lutjanidae and Lethrinidae contributed between 10 to 30 percent of marine catch in Malaysia (Wan Portiah, 1990). In Sabah, coral reefs support artisanal fisheries but are adversely affected by unsustainable fishing practices, including bombing and cyanide fishing. Almost 30 percent of Sabah's marine fish catch comes from coral reef areas (Department of Fisheries Sabah, 1997). However, landings in Sabah have declined since the 1980s due to destructive fishing, particularly, blast fishing (Cabanban, 1999).

The supply of live reef fish from Sabah to Hong Kong is dependent on wild stocks. The Trade Record Analysis of Flora and Fauna in Commerce (TRAFFIC) reported that Hong Kong is the largest importer of live reef fish, consuming 25,000 tonnes annually and re-exporting another 5,000 tonnes to mainland China (TRAFFIC, 1999). In 2001, the International Marine Life Alliance (IMA) recorded a total of 3,212kg of Napoleon wrasse imported to China from Malaysia. According to IMA, this data may represent under reporting of total catches from the area because many vessels operating in the area are from Hong Kong and do not declare their landings. Cyanide fishing, which is hazardous to coral reef ecosystems, is probably used in catching the live coral fish.

Coral reef related tourism provides revenue for the national and state governments in Malaysia. A significant work force is engaged in this tourism sub-sector and associated activities such as hotels and resorts. Marine recreational activities that consist of diving and snorkelling have great value in the coral reef tourism industry. In 2003, a informal report estimated that Conservation Charges collected for entrance to Malaysia's Marine Parks amounted to RM1 million . The same report also revealed that the marine parks attracted 778,482 foreign and 820,116 local tourists. Realising the potential pitfalls of ecotourism, some marine parks such as the Sabah Parks applies the multiple-use concept to attract tourism in marine parks. This concept promotes different uses of the marine park depending on the environmental quality and tourist interest (Cabanban and Nais, 2003).

Fragile coral reefs are threatened by man-made and natural phenomenon. Sedimentation, pollution, indiscriminate anchoring, and destructive fishing are the major anthropogenic causes of damage in coral reef areas. In Malaysia, destructive fishing such as fish bombing and cyanide fishing are rampant in Sabah. Trawling which is equally destructive to coral reef occurs in Mersing.

Natural causes of coral reef damage are diseases, predators and global climate change. To date, no research has been carried out to determine the occurrence of coral diseases in Malaysia. However, yellow and white band diseases have been observed respectively in Langkawi and Port Dickson (The Star, 2005; Berita Harian 2005; Yang Amri, pers. com.). Another harmful biological agent is the notorious coral predator, the crown-of-thorn starfish (*Acanthaster planci*), which is reported to have caused significant damage to coral reefs in Pulau Redang in the late 1970s.

Global climate change has been identified as the most recent and significant threat to coral reef ecosystems. The Global Coral Reef Monitoring Network (GCRMN) provides data on coral reef status linked to global climate change for research and monitoring purposes. It was reported that 16 percent of the world's coral reefs were affected by rising sea temperature during the extreme El Niño Southern Oscillation (ENSO) event between 1997 and 1998 (Wilkinson, 2002). Slight temperature anomalies of 1- 2◦C above or below the normal threshold can cause coral bleaching. During the 1998 ENSO, sea

surface temperature in the South China Sea increased by 2-3◦C above the normal threshold (Wilkinson, 2002). Consequently, coral reef areas in Pulau Payar on the west coast of Peninsular Malaysia, as well as coral reef areas in East Malaysia have been impacted by coral bleaching (Pilcher and Cabanban, 2000).

This national coral report aims to review the status of coral conservation in Malaysia based on the national coral reef meta-database, updated information, and management perspectives.

CORAL REEF DISTRIBUTION

Of the 3,600km^2 of coral reefs area in Malaysia, important coral reefs are found in Sabah and the east coast of Peninsular Malaysia. Almost all of the islands in southeast, central, northeast and western Sabah have corals. Coral reefs are however limited in Sarawak where they are only found in the offshore islands northeast and southeast of Sarawak. Coral reefs in the Straits of Malacca show very poor development and are restricted to the northwest and southeast of the Peninsular. Coral diversity is relatively low here due to high turbidity and muddy substrates (Chua and Charles, 1980).

Figure 1 and 2 shows all the islands and islets (or rocks) that are located adjacent to the South China Sea where coral reefs can be found. Most of the islands within the States' coastal waters are within the marine parks. There are also many shoals and ocean reefs in the South China Sea that are rich in corals but are not protected.

BIODIVERSITY

Coral species

Surveys conducted on 64 percent of Malaysia's coral reefs since the 1980s show an overall live coral cover of between 25 and 50 percent (Ridzwan, 1994). Veron estimated that 70 genera of coral may be found in Malaysia (Veron, 1998). The UNEP World Atlas of Coral Reefs estimated that at least 346 species of scleractinian corals may be found in Malaysian waters (Spalding *et al*. 2001). Data obtained in Malaysia shows the lists of 519 coral species that can be found in waters of Terengganu (Pulau Redang), Pahang (Pulau Tioman), Johor (Pulau Tinggi), Sabah (Taman Tunku Abdul Rahman, Turtle Island Park and Barvey Bay), Sarawak (Sibuti Reef and Miri Reef) and Pulau Layang Layang which were recorded between 1980 to 2000.

The acroporids are commonly found adjacent to most islands in Malaysian waters and are dominant along the east coast of Peninsular Malaysia. The coral species in the family Acroporidae consists of 71 species of genus Acropora, 3 species of genus Anacropora whereas massive coral species from the family Poritidae, Mussidae and Faviidae typically make-up coral reefs on the west coast of Peninsular Malaysia.

Associated marine biota

Estimates of number of coral reef fishes in Malaysia is 909 species (Allen, 2004). Pristine coral reefs may show a higher number of fish species. For example, research in the 1980s showed that coral fish diversity in a pristine area like Pulau Layang-Layang was higher than along Peninsular Malaysia. The number of coral reef fish species recorded in research conducted between 1980s-2000s are 210 at Redang, 219 at Tinggi, 355 at Taman Tunku Abdul Rahman, and 263 at Miri Reef (Wood, 1986; Allen, 1992; Department of Fisheries, 2003). Of all the coral reefs surveyed, Tunku Abdul Rahman Park showed the highest number of fish species.

Fish from the Chaetodonidae family are typically associated with coral reef environments. A comparative study conducted at Pulau Payar Marine Park and Pulau Singa located on the west coast of Peninsular Malaysia showed that the former had high numbers of Chaetodonidae (butterflyfish). . It has been hypothesised that butterflyfish can be a bio-indicator for coral health (Reese, 1981). Hence, decreased numbers of butterflyfish could be caused by coral reef degradation (Sano *et al*., 1987).

Of the nine giant clam species, seven from the genera *Tridacna* and *Hippopus*, exist in waters surrounding the islands of Malaysia. A total of four species have been observed on the east coast of Peninsular Malaysian, whilst seven species have been observed in Sabah (Tan and Zulfigar, 1995; Tan and Zulfigar, 1996; Tan *et al*., 1998). Giant clams on the east coast Peninsular Malaysia, such as adjacent to the islands of Terengganu, Pahang and Johor, include the species of *T. squamosa*, *T.*

maxima, *T. crocea* and *H. hippopus*. Sipadan Island has all seven species including *T. derasa*, *T. gigas*, and *H. porcellanus*. Despite giant clam being classified as an endangered marine species under the Fisheries (Control of Endangered Species of Fish) Regulations 1999 of the Fisheries Act 1985, giant clam populations face over-exploitation, particularly in Sabah.

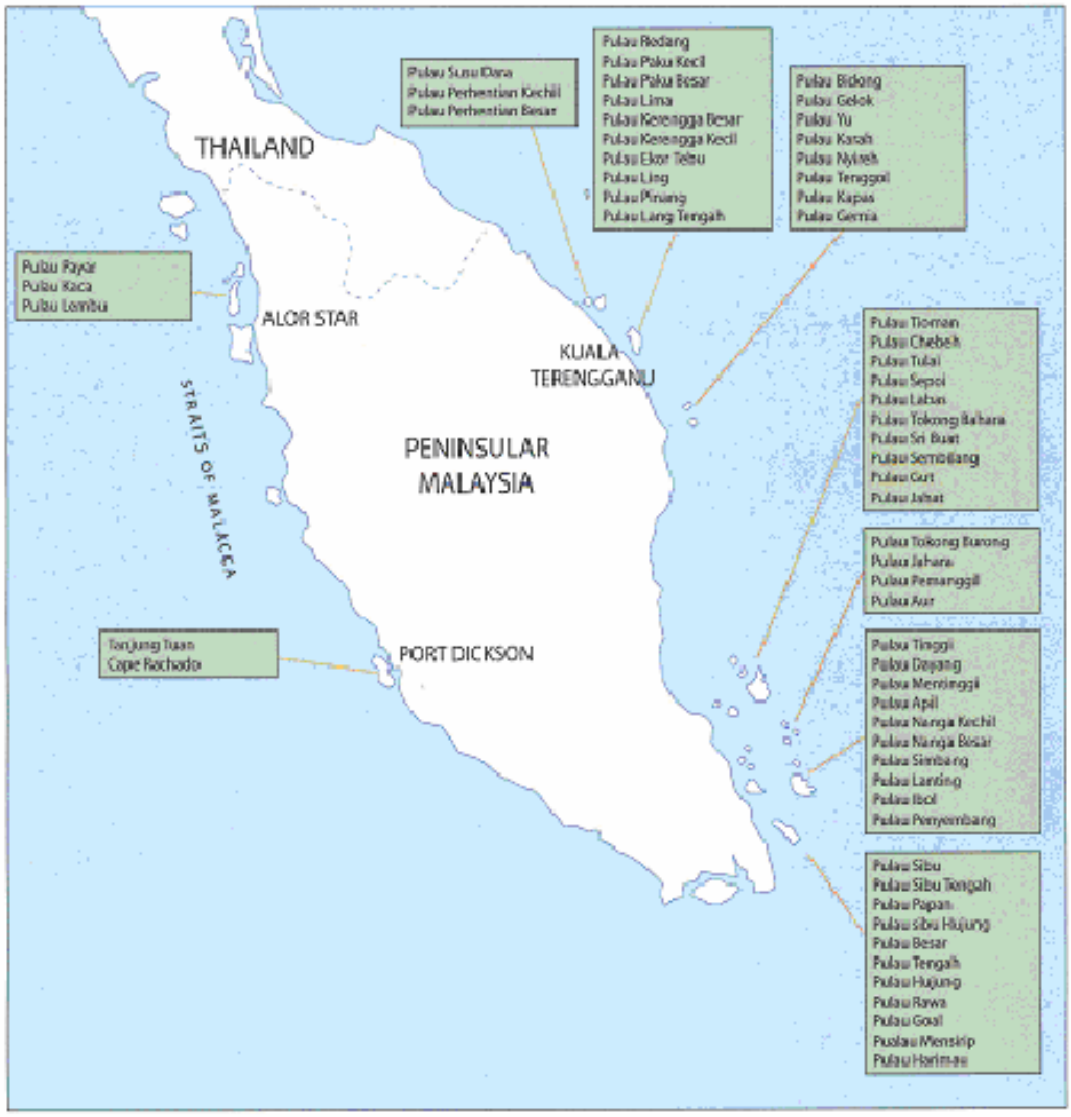


Figure 1 Distribution of coral reefs in Peninsular Malaysia.

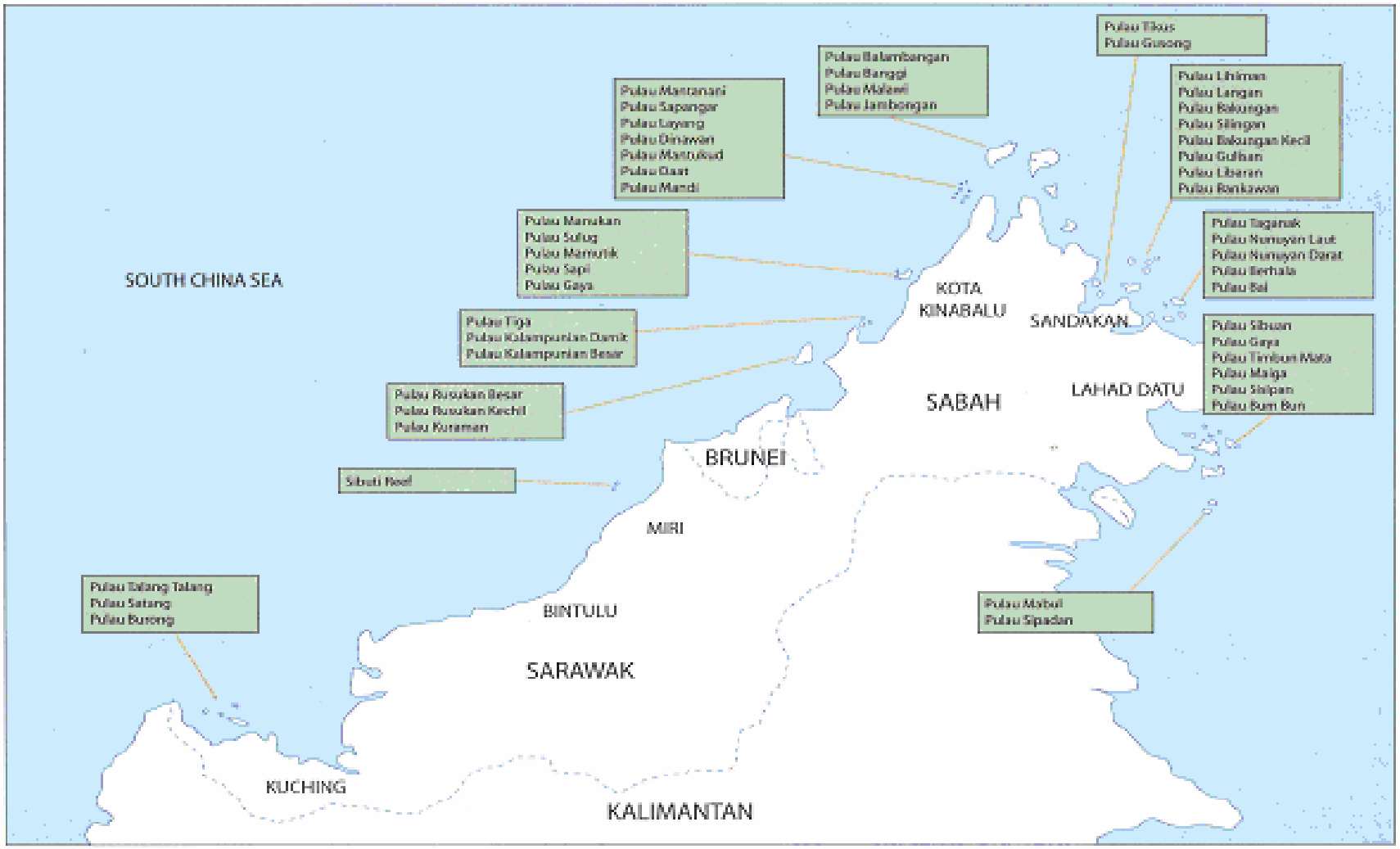


Figure 2 Distribution of coral reefs in Sabah and Sarawak.

Research on the distribution of other coral reef associated species is still incomplete in Malaysia. Therefore few publications exist, particularly relating to gorgonians, sponges, and nudibranchs. Hence, identification of non-coral species such as sponges is difficult due to the scarcity of taxonomic records (Zainuddin *et. al.*, 2000) Intensive research has mainly focused on species of economic and pharmaceutical importance, such as sea cucumber. Many research projects have been carried out on sea cucumbers (Holothuridae and Stichopodidae) as they are used in traditional medicines. About 44 species of sea cucumber are recorded from coral reefs in Malaysia's marine parks (Forbes *et al.*, 1999).

In Malaysia, Sabah is the only state to have extensively harvested coral reef products, including coral reef fishes, sea cucumbers, and molluscs (Wood and Wood, 1978). Coral reef fish catches in Sabah made-up between 7.26 and 22.63 percent of total fisheries landings during the period of 1980 to 1990 (Cabanban and Biusing, 2000). Hong Kong is the main importer of live reef fish for food from Sabah. However, this is believed to be underestimated because of the underreporting of live reef fish capture (Lau and Parry-Jones, 1999). This happens because licensed fishing vessels and licensed live fish transporters in Hong Kong are exempted from declaring live reef food fish imports. Furthermore, the Hong Kong Marine Fish (Marketing) Ordinance (Chapter 291) does not categorise live fish as 'marine fish'.

Marine endangered species

No reliable data regarding the use of Malaysia's coral reefs by endangered marine mammal species exists. Available information is largely from anecdotal sources and occasional sightings made by researchers.

The Leatherback, Green, Hawksbill and Olive Ridley are the four turtle species that nest along Malaysia's coastal areas and islands (Figures 3 and 4). Of the four species, the hawksbill and green are associated with islands and reefs. The highest concentration of green turtles can be found in the islands of Pulau Redang, Pulau Perhentian, Sabah's Turtle Island and Talang-Satang National Park (Talang-Talang Besar, Talang-Talang Kechil and Satang Besar) (Ali *et al.*, 2004). There are also small numbers of green turtle nesting sites reported on the islands of Pulau Pinang, Pulau Telur (Kedah), and groups of islands in the Johor Marine Park consisting of Pulau Mertang, Pulau Lima, Pulau Pemanggil and Pulau Simbang (Mortimer, 1990).

Major hawksbill turtle nesting sites are located at Sabah Turtle Islands and Pulau Upeh (Malacca). In Sarawak, nesting sites were reported at Pulau Satang Besar (Bali, 1998). Although records of hawksbill turtle nesting on islands are occasional, this species has been observed to utilise waters of islands in West Johor and Terengganu (Liew, 2002). Islands and reefs are the key habitats for turtles to live and forage. Thus, turtles are regularly observed in coral reef areas around islands and coral reef associated ecosystem such as seagrass. There are also several records indicating that the Olive Ridley turtle utilise the islands of Sabah, Sarawak and Terengganu for nesting.

THREATS

Coral reefs throughout the world are facing unprecedented threats, particularly human induced threats. Despite their worth, coral reefs are continuously being impacted on by human activities such as pollution, coastal development, over-fishing, destructive fishing, and tourism related activities. Over 85% of the corals reefs in Malaysia are threatened and the type of threats facing Malaysian reefs differ by location (Burke et al., 2002). Table 1 shows the type and scale of threats to coral reefs in Malaysia.

Sedimentation

Coastal development often results in the destruction of corals due to increased sedimentation or removal of coral reef substrate. Growing populations, expanding industrial economies, and emerging tourism markets are the key factors in the increasing demand for coastal space and the construction of infrastructure. The Reefs at Risk in Southeast Asia (RRSEA) project estimated that 23 percent of corals in Malaysia are affected by coastal development and sedimentation from upland sources. Coral reefs that have been affected by coastal development are more prevalent along the coast of Peninsular Malaysia, rather than in Sabah or Sarawak.

In East Malaysia, the reefs of Sarawak are at greater risk from sedimentation compared to those in Sabah. Some notable examples are the reefs near the Miri River and the reefs of the Talang-Talang Islands. According to the Miri-Suai Integrated Coastal Zone Executive Plan, sediments from the Miri and Baram rivers are threatening reefs that lie within 8-9 km of the mouth of these rivers. Sediments from the Lundu and Sematan rivers also affect the coral reefs of the Talang-Talang Islands (Pilcher and Cabanban, 2000). In Sabah, coral reef degradation due to increased sediment loads associated with land clearing, mangrove destruction, and reclamation can be seen in the Tunku Abdul Rahman Park.

Table 1 Threats to coral reefs in Malaysia.

Threats	West Coast of Peninsular Malaysia	East Coast of Peninsular Malaysia	East Malaysia
Fishing Intensity	4	3	5
Fishing Damage	3	3	5
Fish Blasting	2	2	4
Gleaning	2	1	3
Boat Scouring	2	3	4
Population Pressure	4	3	4
Sedimentation	5	3	3
Domestic and Agriculture Pollution	3	2	4
Industrial Pollution	3	1	1
Oil Spill	2	1	2
Disease and Predation	2	4	3
Dredging	2	1	2
Coral Mining	1	1	3
Tourist Activities	1	2	2
Coral Bleaching	1	1	1

The Scale Values: 1 = None to Rare; 2 = Very Low Concentration; 3 = Some Damage, Some Stress; 4 = Medium to High Damage; 5 = Very High, High Stress, Very Damaging.
Source: Malacca Straits Environmental Profile, 1997

The World Resource Institute Report (Burke et al., 2002) presented the percentage breakdown of reefs at risk in Malaysia ranging from low threat index (13% of total area), medium (44%), high (38%) to very high threat index (4%). The total area of reefs at medium or higher threats occupy 87% of the total coral reef area.

Visitor Pressure

Snorkelling is one of the most popular recreational activities among visitors to Malaysia's marine parks or coral reefs. Seventy percent of the survey respondents on Visitor Experiences and Perceived Conditions of Tioman Island Marine Park identified snorkelling as one of the activities that they usually engaged in while visiting the island (Ahmad, 2002). Snorkelling is an anthropogenic impact that threatens corals in the shallow waters as inexperienced snorkellers tend to either trample or stand on the reefs. Corals are also subject to damage by divers. Evidence of coral breakage in areas frequently used by SCUBA divers exists, but conclusive data or case studies for Malaysian coral reef sites that correlate the two are either scarce or unavailable.

Effluent Discharges

The issue of effluent discharges as a result of the introduction of tourism within the marine protected areas of Malaysia and further compounded by pollution discharge from households is indeed very common. Sewage, oil and grease, and grey water are among the long-standing pollution problems affecting the corals. A threat analysis study conducted at Redang, Tioman and Sibu-Tinggi islands showed that the three islands are affected by these problems. There are many cases of hotels, resorts and chalets discharging untreated sewage directly into the ocean. In Pulau Redang for example, the majority of small chalets on the island are using sub-standard sewage systems. The houses are also equipped with the same sub-standard facility in which concrete culverts are buried in the ground to hold the wastes. A water quality study of Pulau Redang coastal waters between 1995 and 2000 indicated some sewage contamination (Law *et al*., 2001). The major source of contamination was from fishing settlements. The sewage treatment facility for Pulau Sibu-Tinggi in Johor and Tioman in Pahang is poorly developed and is inaccessible to most of the local population.

Accidental leakage of oil from passenger boats or ferries is another tourism issue that is affecting the health of corals in the marine parks of Malaysia. The problem is evident at the jetties and in areas where there is heavy boat traffic. There is also the problem of cooking oil and grey water being discharged directly into the river system from the adjacent business and residential premises. Sungai Lalang in Tioman is an example of river system being heavily polluted with these discharges.

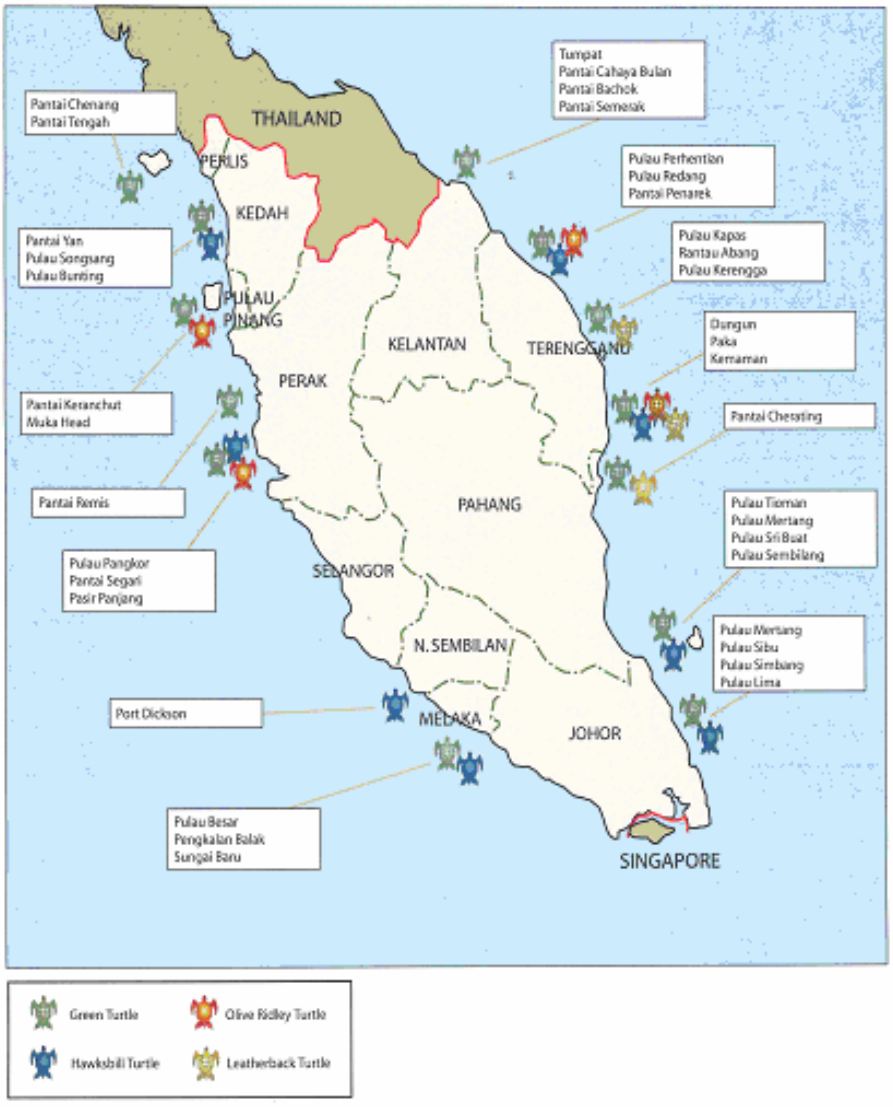


Figure 3 Distribution of turtle nesting sites in Peninsular Malaysia.

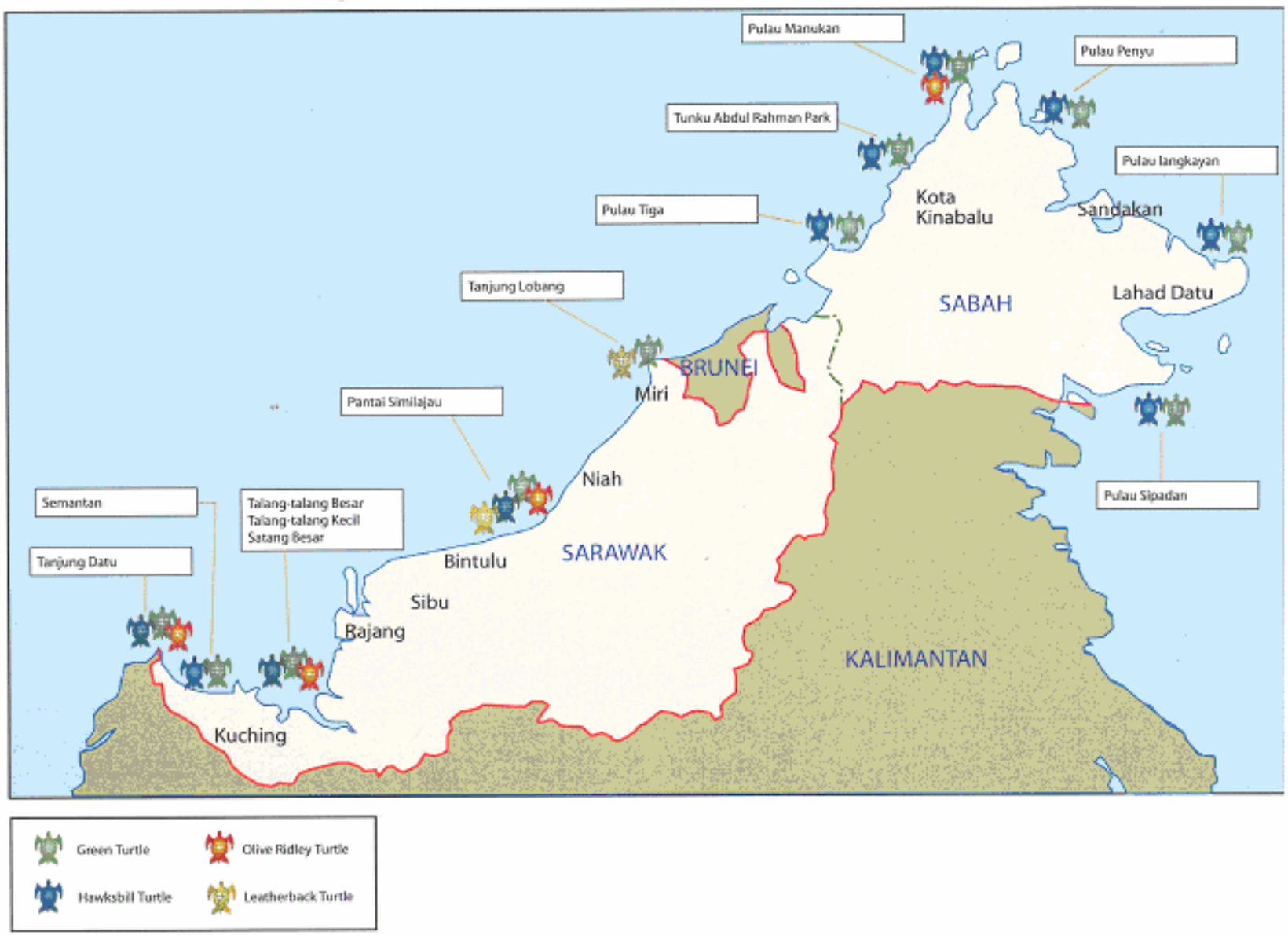


Figure 4 Distribution of turtle nesting sites in Sabah and Sarawak.

Destructive Fishing

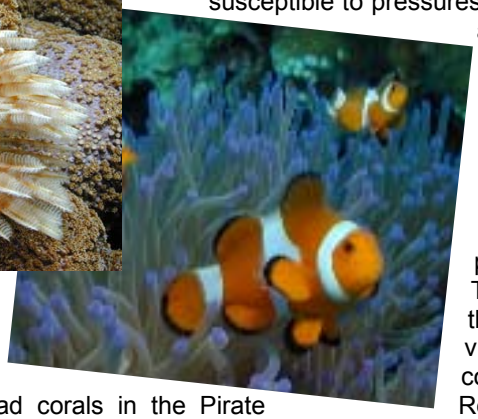
Corals reefs are also subjected to threats from destructive fishing techniques such as blast and poison fishing. The notable effects of these two fishing techniques are the destruction of corals reefs and the contribution towards overfishing of economically important fish and unintended exploitation of other species (Burke et al., 2002). The problems of destructive fishing practices are more prevalent in East Malaysia, particularly in Sabah. The Reefs at Risk project estimated that blast and poison fishing is affecting 68 percent of Malaysian reefs. This estimate is based on data relating to the occurrences of dynamite and cyanide fishing, and the opinion of project experts.

Blast fishing is used to maximise catch and it usually occurs over or near coral reefs where fishes congregate. It is practiced along nearly the entire coast of Sabah, particularly at Labuan, which had resulted in the destruction of coral reefs and removal of various fish species. A thirteen-year (1980-1993) data set on coral fish landings from Sabah illustrated a drastic decline in the number of several important fish species (Figure 5). The decline is believed to be attributed to blast fishing (Figure 6) (Pilcher and Cabanban, 2000).

Cyanide fishing is used to catch high priced fishes like snappers, groupers and wrasses for the lucrative live fish trade industry. Cyanide fishing occurs at Kudat, extending out of Marudu Bay in the Northeast of Sabah to Banggi Island, as well as Labuan. In Kudat, there are several holding facilities to house the fishes awaiting trans-shipment. Humphead Wrasse, Barramundi Cod, and the coral groupers are sold for US$2.4 per kg to traders in Kota Kinabalu (Pilcher and Cabanban, 2000). The price soars 10 times higher for every kilo in the Singapore, Taiwan and Hong Kong markets.

SCENARIO

The closer the proximity of corals to human activity, the higher the likelihood of them being impacted on by human activities. Pressures can result in lower levels of biodiversity or at the extreme end – mortality. In April 2002, a resource survey was conducted at 12 locations in Pulau Tioman. At the best live coral sites, nearly 27% of dead corals were observed at Pirate Reef, 10% at Pulau Renggis, and 7.4% at Batu Malang. The three locations are close to human activities which make the corals within these areas more susceptible to pressures. Pirate Reef is located in the port area of Kampong Tekek which consists of two villages – Kg Tekek and Kg Air Batang. Kampong Tekek is known as the heart of Pulau Tioman. Among all the villages in Tioman, Kampong Tekek has the highest number of residents. In 2000, the total population of Kampong Tekek was recorded at 1,871. The community is heavily involved in tourism with 80% of the household heads engaged in it. Effluent from the villages, boats and tourism activities in the area could be contributing to the high percentage rate of dead corals in the Pirate Reef area. Pulau Renggis was ranked second and Batu Malang third with regard to coral mortality rates. Their close proximity to humans could be the reason for it. Pulau Renggis is located less than 1 km from a 5 star resort and it is frequented by tourists whereas Batu Malang is a popular dive and snorkelling site.



Note: 1. Feather duster worms on the shallow reefs of Tioman
2. Anemonefishes in Pulau Renggis
Photos Source: http://www.rossum.com/tioman00/tioman1.htm,
Underwater photographer: Dave Rossum

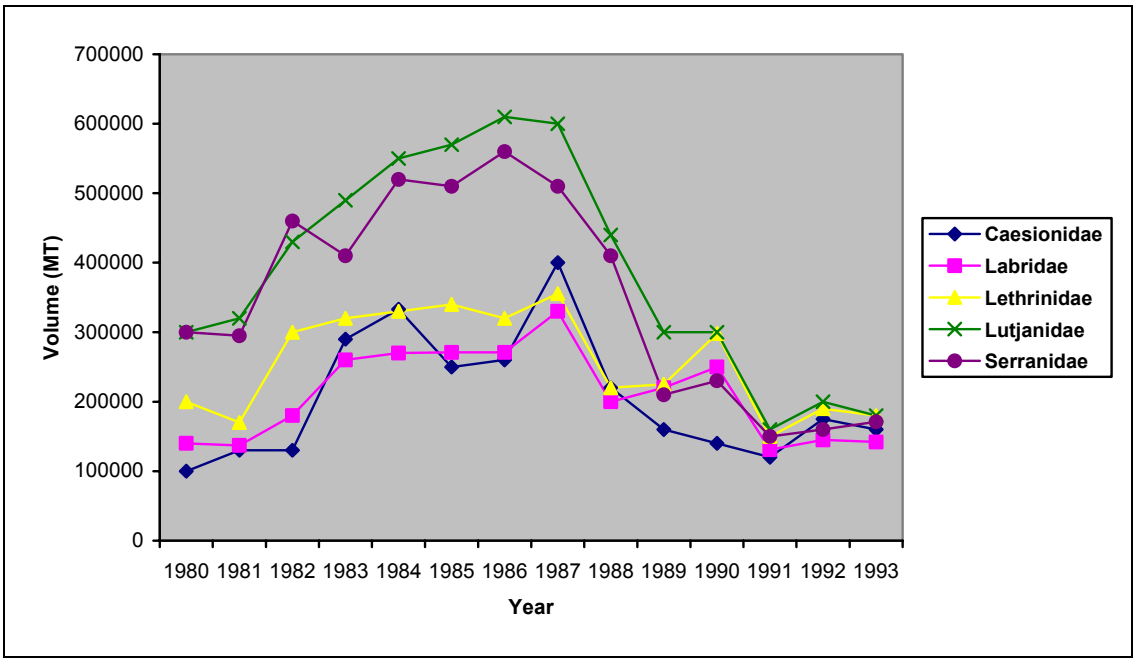


Figure 5 Landings of Coral Reef Fishes from Sabah Waters. (Cabanban and Biusing, in press)

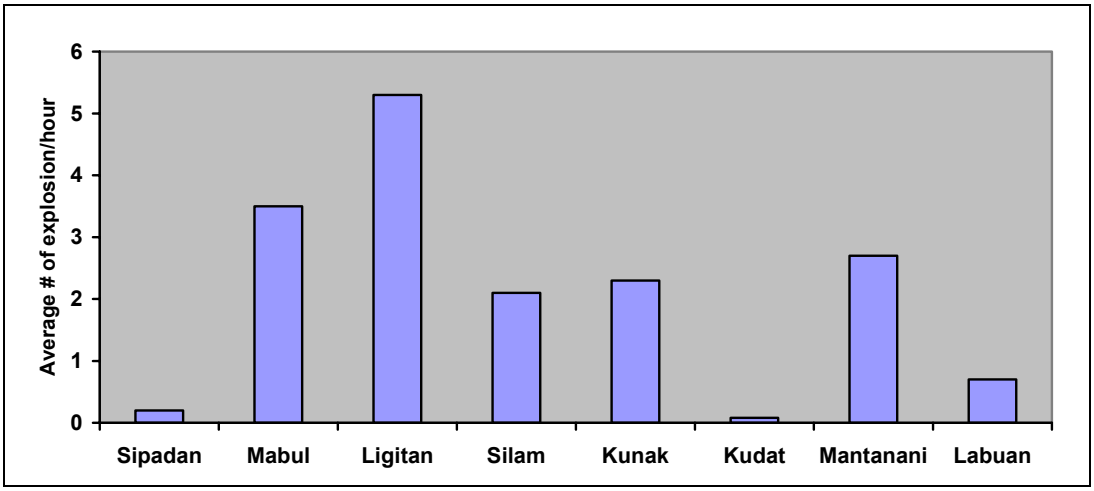


Figure 6 Average Blasts Per Hour Recorded at Various Coral Reef Sites Around Sabah. (adapted from Pilcher & Oakley, 1997)

SOCIO-ECONOMIC VALUATION

Corals reefs have significant socio-economic value. They are a vital source of food and income for coastal communities of Peninsular Malaysia and East Malaysia. Coral reefs are also effective in the prevention of shoreline erosion and the protection of mangrove and seagrass communities. They are also potentially valuable to the pharmaceutical industry for their biochemical properties. Coral reefs also contribute to the growth of the tourism industry. The coral reefs in the Malacca Straits have been valued at approximately US$563 million in terms of benefits associated with tourism, shoreline protection, fishery resources, and research potential (Burke and Spalding, 2002).

Tourism

Coral reef related tourism activities, particularly in protected areas, have gained popularity in tourism marketing and amongst visitors. The protection status of the distinctive and remarkably diverse coral reef ecosystems in Malaysia has set a platform for the tourism sector to develop. Aggressive tourism

promotions of the natural assets of coral reefs have led to annual increases in the number of visitors to Malaysia's marine parks. Table 2 shows a high number of visitors to four coral reef sites in Malaysia from 1999-2002.

The economic importance of coral reefs to the tourism industry is indeed significant. Coral reefs are known to economically benefit more than 100 countries with their recreational values (Bryant *et al.*, 1998). In 2002, a report on the feasibility study of the Miri-Sibuti reefs had projected the potential revenue of diving activity for the reef area[4]. Assuming that 11, 984 divers on a 3 days/2 nights diving package will visit the Miri-Sibuti reefs by the year 2005, it is estimated that the potential tourism value for diving activity alone will generate a potential revenue of RM15,456,244.16 (Elcee Instrumentation Sdn. Bhd., 2002). Figure 7 shows the projection curve of divers visiting the Miri-Sibuti reef. The curve is projected based on the recorded figures from 1995-2001.

Table 2 Total number of tourists to Pulau Tioman, Pulau Payar, Turtle Islands Park, and Tunku Abdul Rahman Park 1999-2002.

Year	Pulau Tioman	Pulau Payar	Turtle Islands Park	Tunku Abdul Rahman Park
1999	184,954	83,203	8,732	171,919
2000	200,527	106,784	10,131	205,852
2001	243,052	125,485	8,250	198,576
2002	213,172	133,775	8,450	147,188

Sources: Department of Fisheries and Sabah Parks

Capture Fisheries

Another aspect of the socio-economic importance of coral reefs relates to their critical role in the life-cycle of many economically important fish species. Corals are known to provide sheltering habitat essential for nursing and as a breeding ground for a variety of fish species. It is believed that approximately 40 percent of the commercial fish in Malaysia caught within the 30 nautical miles from the shore originate from or make use of the coral reefs (Phang, 1999). In 1999, for example, the coral reef capture fishery value for Miri was believed to be approximately RM40,080,684 (Elcee Instrumentation Sdn. Bhd., 2002). Miri also accounted for the largest volume of fish landings for the state of Sarawak in that year, 40 percent of which were economically important coral reef fish. In terms of the value of capture fisheries production, Sabah's coral reefs contributed to between 7.8% (RM3.3 million) of total value in 1992 to 11.5% (RM4.98 million) of total value in 1981 (Pilcher and Cabanban, 2000).

Socio-Economic Benefits

Recreational or tourism use of coral reefs will indirectly result in improved social conditions and commercial services in the given area. In January 2002, for instance, Pulau Tioman was accorded a duty-free island status; Malaysia's third duty-free island after Langkawi and Labuan. The Tioman Development Authority (TDA) had received approval to begin selected infrastructure projects such as the upgrading of roads and construction of a new airport. The infrastructure development in Tioman will be done in stages and will include the construction of low cost houses, retail space in Tekek (the island's main village), construction of a cargo jetty and several other road projects.

The ReefMap Report of Miri-Sibuti reef areas highlighted the likelihood of the villages gaining benefits if the reef area is promoted for eco-tourism. Among others are the infrastructure development, tourism amenities development, and enhancement of the hygiene system. The intangible benefits that would result from the promotion of the reef area as recreational or tourism destination are employment opportunities and/or employment security.

[4] *The report was prepared for the Sarawak State Government's consideration to gazette the Miri-Sibuti reef as a marine park and to promote eco-tourism in the area.*

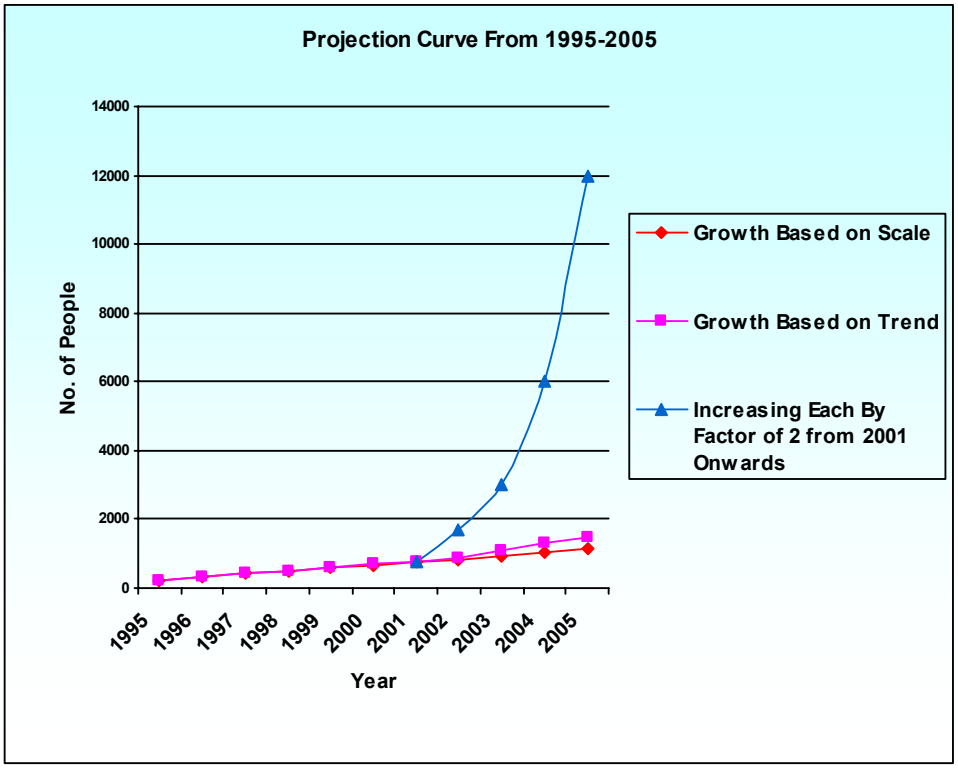


Figure 7 Projection Curve for Divers Visiting Miri-Sibuti Reefs.

MANAGEMENT

National initiatives to conserve coral reefs

In Malaysia, the protection, conservation and management of coral reefs and its associated fauna and flora is largely achieved through the establishment of marine protected areas (Marine Parks in Peninsular Malaysia and National Parks in Sabah and Sarawak). Malaysia has designated 136 marine protected areas (MPAs) including non-fishing areas, marine parks and marine reserves. Seven percent of these MPAs include by coral reef ecosystems (Ho, 2003). Malaysia established its first MPA in 1983 when Pulau Redang was declared the first MPA of Peninsular Malaysia under the Fisheries (Prohibited) Areas Regulations 1983. This regulation established a fisheries prohibited area in the 8km of maritime waters surrounding Pulau Redang. According to the Fisheries Act 1985, the Fisheries Department is the main government agency with direct responsibility for marine park management.

Another 21 islands were added to the list of fisheries prohibited areas under the regulation in the proceeding years. The Fisheries (Prohibited Areas) Regulations 1985 (Amendment), however, reduced the surrounding waters to 3 nautical miles (nm). The Fisheries (Prohibited Areas) 1988 (Amendment 1994) added three more islands off Sarawak (Pulau Talang Talang Besar, Pulau Talang Talang Kechil and Pulau Satang Besar) thus protecting a total of 25 islands. This regulation superseded the Fisheries (Prohibited Areas) Regulations 1983 which gazetted maritime waters within 8km off Pulau Redang. Since some fishing activities are destructive to coral reefs, all marine parks are protected from fishing activities. This regulation stated that, “No person shall collect shells, molluscs or corals within prohibited areas” and “No person shall kill or capture any fish within the fisheries prohibited area unless he holds a license issued under section 11 of the Act stating the respective location specified in column (1) of the Schedule as the fishing base.”

Since 1998, 40 offshore islands have been gazzetted as Marine Parks under the Establishment of Marine Parks Malaysia (Amendment) Order 1998. These include some of the fisheries protected areas mentioned above. Table 5 shows the list of islands that are grouped into five Marine Parks:

1. Pulau Redang Marine Park in Terengganu;
2. Pulau Tioman Marine Park in Pahang;
3. Mersing Marine Park in Johor;
4. Pulau Payar Marine Park in Kedah; and
5. Labuan Marine Park in Federal Territory of Labuan.

The Fisheries (Establishment of Marine Parks Malaysia) Order 1994, further reduced the coverage of the marine park areas to 2nm for all the marine parks except 1 nm for Pulau Kapas.

Sabah and Sarawak, which are autonomous in terms of managing their natural resources, have established their own MPAs and have State bodies for MPA management. The Sabah Parks Board of Trustees established under the National Parks Ordinance 1962 is responsible for the Sabah State Parks, including Marine Parks. The Board has been established directly under the Sabah's Ministry of Tourism, Environment, Science and Technology. Sabah Parks legally owns the marine parks and has mandate to control both the activities on the land area and in the water column. The Sabah Parks Board of Trustees also manages the collection of entrance fees to the Sabah Parks.

There are three State Parks in Sabah that have been established in the last 20 years, namely Turtle Island Park, Tuanku Abdul Rahman Park and Pulau Tiga Park. Pulau Tiga Park was gazetted in 1978 and is comprised of Pulau Tiga, Pulau Kalampunian Damit and Kalampunian Besar. The Pulau Tiga Park was established as a MPA because the area is comprises of a distinct mix of mud volcanoes, good coral reef, and sea snake nesting habitat on Pulau Kalampunian Damit (Wood and Wood, 1987). The Tunku Abdul Rahman Park located off Kota Kinabalu was established as an MPA in 1974 with the aim of conserving the diverse range of marine life at the site.

Several State agencies, namely the National Parks and Wildlife Office of the Sarawak Forestry Department, Sarawak Museum, and the Department of Fisheries manage marine ecosystems and their associated fauna and flora in Sarawak (Table 3). The National Parks and Wildlife Office is responsible for the implementation of the National Parks Ordinance (1956) and the Wildlife Protection Ordinance (1958, Amendment 1990), which conserve wildlife and their habitats including marine ecosystems. Since Pulau Talang-Talang Besar, Pulau Talang-Talang Kechil, and Pulau Satang are turtle nesting beaches, these islands are designated as turtle sanctuaries by the Turtle Board Trust and the Sarawak Museum. With this designation, the coral reef ecosystems of these islands are also protected.

Non-governmental organisations such as the World Wide Fund for Nature (WWF) Malaysia play an active role in the establishment of marine protected areas in Malaysia. For many years, WWF-Malaysia has been advising the Government to protect the vast maritime waters in the seas of northern Sabah, which borders the Sulu Sea in the East and the South China Sea in the South. In 2003, the Sabah State Cabinet endorsed the establishment of this area as the Tun Mustapha Marine Park. This will be the largest marine park in Asia, covering an area of 1,028,000 hectares and consisting of at least 50 islands off Kudat, Kota Marudu and Pitas districts.

The protection measures for some of the islands in Malaysia are not, however, specifically designed for the conservation of coral reefs. For example, despite its unique atoll reef of Pulau Sipadan, it is gazetted as the Sipadan Bird Sanctuary. Under this designation, coral reef and the maritime water of Pulau Sipadan are not provided any legal protection. To protect the marine ecosystem, Sabah's government is considering further management action and feels that the island should be listed as "World Heritage Area" under the United Nations Educational, Scientific and Cultural Organization (UNESCO) and as a "Particularly Sensitive Areas (PSSA)" under the International Maritime Organization (IMO). In April 2004, Government issued notices evicting dive resorts by the year end. Another possible listing as UNESCO's "world heritage area" for Sabah's reef is the Tun Mustapha Park.

Regional initiatives for coral reef conservation efforts

Regional co-operation in protecting transboundary coral reef areas can be achieved through the Large Marine Ecosystem (LME) concept. Malaysia is currently involved in two such initiatives namely, the Bay of Bengal Large Marine Ecosystem (BOBLME) and the Sulu-Sulawesi Marine Ecoregion (SSME). Malaysia is among the eight littoral countries in the Indian Ocean participating in the Bay of Bengal Program (BOBP). Under this program, studies on resource mapping (Lee, 2000) and carrying capacity assessment (Li, 1998) have been carried out in Pulau Payar.

Table 3 List of Islands Gazzeted as Marine Parks under the Establishment of Marine Parks Malaysia (Amendment) Order 1998.

	Name of Island	***State (Marine Parks)***
1.	Pulau Redang	Terengganu (Pulau Redang Marine Park)
2.	Pulau Perhentian Kecil	
3.	Pulau Perhentian Besar	
4.	Pulau Lang Tengah	
5.	Pulau Susu Dara	
6.	Pulau Lima	
7.	Pulau Ekor Tebu	
8.	Pulau Pinang	
9.	Pulau Nyireh	
10.	Pulau Tenggol	
11.	Pulau Kapas	
12.	Pulau Tioman	Pahang (Pulau Tioman Marine Park)
13.	Pulau Labas	
14.	Pulau Sepoi	
15.	Pulau Gut	
16.	Pulau Tokong Bahara	
17.	Pulau Chebeh	
18.	Pulau Sembilang	
19.	Pulau Seri Buat	Johor (Johor National Park)
20.	Pulau Rawa	
21.	Pulau Rawa	
22.	Pulau Hujung	
23.	Pulau Tengah	
24.	Pulau Besar	
25.	Pulau Tinggi	
26.	Pulau Aur	
27.	Pulau Pemanggil	
28.	Pulau Harimau	
29.	Pulau Goal	
30.	Pulau Mensirip	
31.	Pulau Sibu	
32.	Pulau Sibu Hujung	
33.	Pulau Mentinggi	
34.	Pulau Kaca	Kedah (Pulau Payar Marine Park)
35.	Pulau Lembu	
36.	Pulau Payar	
37.	Pulau Segantang	
38.	Pulau Kuraman	The Federal Territory of Labuan (Pulau Labuan Marine Park)
39.	Pulau Rusukan Besar	
40.	Pulau Rusukan Kechil	

The LME of Sulu-Sulawesi Sea lies between the South China Sea and the waters of the Indonesian archipelago. The initiative to conserve the SSME is to be undertaken by three countries, namely Malaysia, the Philippines, and Indonesia through the Conservation Plan of the SSME. The coral reef triangle of the SSME has been identified as a priority conservation area. The islands of Tun Mustapha Park are also located within the SSME.

Besides the LME concept, Malaysia is also involved in a Transborder Marine Protected Area initiative known as the Turtle Islands Heritage Protected Area (TIHPA). This transborder marine protected area was established by a Memorandum of Understanding between Malaysia and the Philippines in 1996 as a result of initiatives of the World Wide Fund for Nature (WWF). The Turtle Island Park in Sabah consists of Pulau Bakkungan Kechil, Pulau Gulisan and Pulau Selingan. The park was established in

1977 to protect the green turtle (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricate*). The Turtle Island group has coral reefs at nine islands of the Sulu Sea. The Philippine islands consist of six islands, namely Boan, Langaan, Lihiman, Great Bakungan, Taganak, and Baguan.

Research for coral reef conservation
In support of coral reef management and conservation initiatives, research has also been undertaken on corals and coral reefs in the South China Sea region. These activities include:

I. Malaysia participated in the Living Coastal Resources (LCR) project under the ASEAN-Australia Economic Cooporative Programme on Marine Science. This ten-year project consisted of two phases. In Phase I (1984-1989), reef surveys and fish census was conducted at selected islands in Malaysia. During Phase II (1989-1994), the project was focused on monitoring the impact of tourism and development in Pulau Redang.

II. Collaborative surveys carried out by the Fisheries Department and WWF-Malaysia with financial support from Canada Fund Malaysia. This baseline data was used to prepare the Marine Park Island Management Conceptual Plan for Peninsular Malaysia (1994).

III. Through the United Nations Development Programme (UNDP), Global Environment Facility (GEF) funded field survey at Pulau Redang Marine Park, Pulau Tioman Marine Park and Pulau Tinggi Marine Park. The Malaysian government is planning to design a biodiversity conservation project on these marine parks.

IV. The David Emily Packcard Foundation for the status report of coral reef in Eastern Malaysia (2000).

V. With the support from World Resource Institute (WRI), the Town and Regional Planning Department (TRPD) in Sabah and the Borneo Marine Research Institute of the Universiti Malaysia Sabah carried out Reefs at Risk in Sabah. As part of the project outcome, coral reefs around the islands and along the shoreline of Sabah have been mapped and assessed for risks from threats, i.e. destructive fishing activities and sedimentation.

The above-mentioned surveys were aimed at providing information on the status, health and biodiversity of the Malaysian coral reefs, especially within the existing MPAs. The information is the basis for action to restore or to improve the existing management of the ecosystem. Decision making on the establishment of new MPAs is also supported by outcomes of research. For example, the decision of the Sarawak government to gazette the Miri-Sibuti reef as a state National Park was supported by a study on a profile of the reef through reef mapping exercises (ReefMap) and biodiversity assessments (Sarawak State Planning Unit, 2002).

More research on coral reefs will add to the knowledge-base of this important resource and assist in its protection. For example, the Scientific Expedition to the Seas of Malaysia (SESMA) of the University of Malaya's Maritime Research Center (UMMReC) has revealed that Pulau Perak off Kedah's coast is worthy of protection as an MPA, partly because of its unique island wall reef. However, the state government of Kedah would like to convert the island into a fishing paradise. In early 2004, there was also a proposal to partially protect Pulau Sembilan's coral reef in Perak's water from fishing activities. The Fisheries Research Institute of Malaysia carried out a study on the biodiversity of the island in support of the proposal but the decision on the gazettement of the reefs as MPA is still pending. It is worthwhile to note that Pulau Sembilan is considered as a rich fishing ground for Perak fishermen.

Pulau Layang-Layang, located off Labuan and within the Continental Shelf and Exclusive Economic Zone of Malaysia is not categorized as an MPA. However, the status of the island as a restricted area accords the reefs around Layang-Layang a high degree of protection. Research on baseline data of reef fauna and flora was carried out in within 20 nautical miles of the island has been carried out from the1980s until 2000. In 2003, the Department of Fisheries with cooperation from the Implementation Coordination Unit of the Prime Minister's Department (ICU, JPM) built the Marine Research Station Pulau Layang Layang (MARSAL). Short research expeditions to collect baseline information of its reef fauna and flora have been carried out in Pulau Layang Layang. Coral mining in the island for the construction of a seawall and an air strip, however has caused adverse impact on the coral reef. In the affected areas, live coral reef has reduced to 9.5% as compared to 30.9% in 1998 (Mohamed & Abdullah, 2004).

Many efforts have been made to restore and rehabilitate the corals, which include the artificial reef projects, coral transplantation and coral culture. Malaysian Universities, the Fisheries Research Institute and corporate bodies are involved in coral protection and propagation work. Such coral transplanting projects have been carried out in Pulau Perhentian and Pulau Tioman in 1999 and 2001, respectively. The internationally known Reefball project is another example of coral propagation using artificial reefs. This artificial reef was deployed in Pulau Talang-Talang off Sarawak. In 2004, with the help from the Department of Fisheries of Sarawak, PETRONAS, Shell and Sarawak Tourism Board, the Sarawak government has expanded its conservation effort through the "Rigs to Reef" project. Abandoned oil rigs in surrounding waters of Baram were relocated to Siwa. Here the rigs are transformed into artificial reef (Figure 8). Although this is a first in Malaysia, the project is not new because it has taken place in the Gulf of Mexico and Brunei since 1980s.

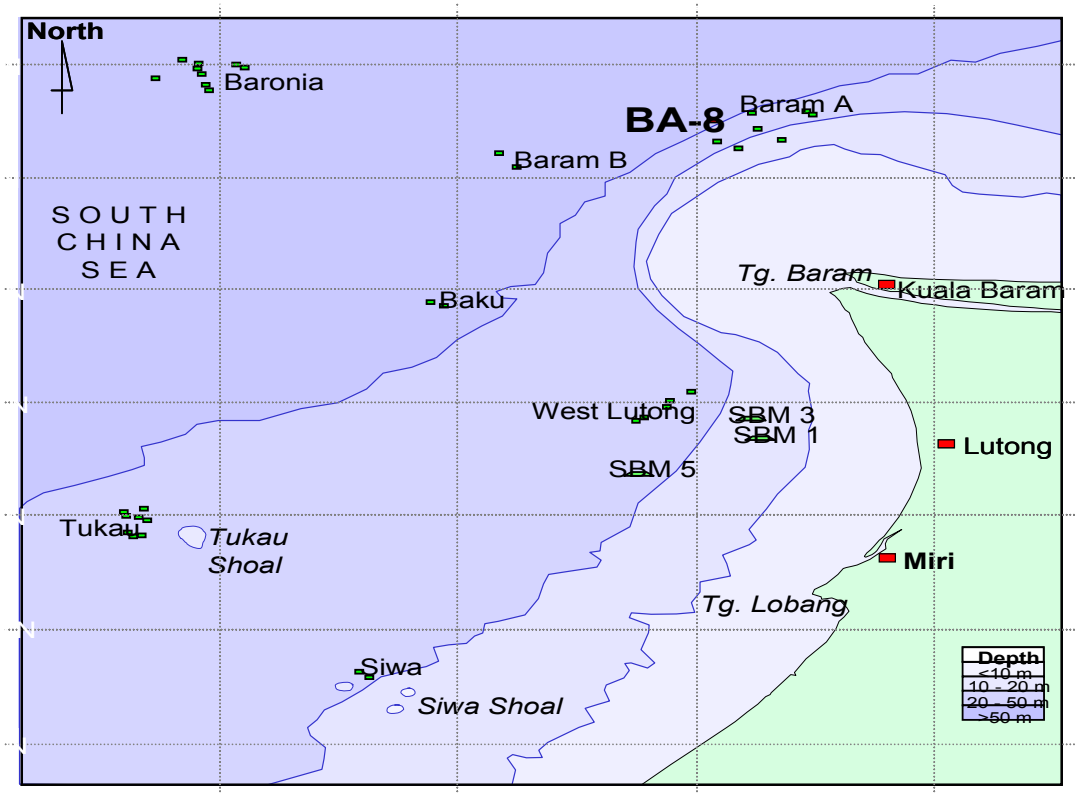


Figure 8 Artificial reefs of the "Rigs to Reef" Project. (Source: Department of Fisheries of Sarawak)

REFERENCES

Ahmad, A.R. (2002). 'Visitor Perceptions in Tioman Island Marine Park, Malaysia', MIMA unpublished report.

Allen, G. R. 1992. Marine Fishes of Sabah, Northern Borneo, Department of Aquatic Vertebrates, western Australia Museum, 28p. *In* D.M. Timothy (ed.) Tunku Abdul Rahman Park environmental evaluation for expanded tourism development, Conbata Asia PTY. LTD. A report of the Sabah Parks, Kota Kinabalu, Sabah, Malaysia.

Allen, G.R. 2004. The Heartland of Biodiversity. Paper presented at Seminar on Ecotourism as a Viable Tool for Conservation and Sustainable Management of Marine Biodiversity and Resources. 29-30 July, 2004.

Ali, A, Talib, Z., Basintal, P., Bali, J. 2004. Conservation and Enhancement of Sea Turtles in the Southeast Asian Region. Talib, Z., Ali, A., Ku Yaacob, K.H., Md. Isa, M. (eds). Marine Fishery Resources Development and Management Department – Southeast Asian Fisheries Development Center.

Bali, J. 1998. The Sarawak Forestry Department's Turtle Rookery Conservation Programme: 1995 – 1998. Hornbill 2. National Parks and Wildlife. Forest Department Sarawak. pp. 22-38.

Berita Harian. 18 February 2005. Karang Langkawi dijangkiti penyakit.

Burke, L., Selig, E., and Spalding, M. (2002). 'Reefs At Risk in Southeast Asia', World Resource Institute Report.

Cabanban, A. S. 1999. Coral reef resources of Darvel Bay: An analysis of coral reef fish data from 1981-1990 and report diversity from a market study in Lahad Datu. In Ekspedisi Galaxea '98: A study of living marine resources of Darvel Bay, Sabah, Malaysia (De Silva, R. W., Ridzwan A.R., Saleem, M., and A.S. Cabanban, Eds.) Borneo Marine Research Unit, Kota Kinabalu: 85-196.

Cabanban, A.S. and Nais, J. The Roles of Marine Protected Area in Sabah with Emphasis of Tourist. Sabah Parks Nature Journal. Vol. 6 (2003): 65-77.

Cabanban, A. S. and Biusing, R. E. 2000. Coral Reef Fisheries in its Contribution to Marine Fish Production in Sabah. http://www.enaca.org/Grouper/Research/Coralreef/2000/081.htm

Chua, T.E. and Charles, J.K. (eds.) 1980. Coastal Resources of East Coast Peninsular Malaysia. Universiti Sains Malaysia, Penang. Pp. 507.

Department of Fisheries Sabah (DOFS). Annual Fisheries Statistic of Sabah.1997.

Department of Fisheries Malaysia. 2003. Status Report on the Coral Reefs of the East Coast of Peninsular Malaysia 2000. A Consultancy Report Prepared for the UNDP-GEF Project Development Facility Block B Document for the Conservation of Marine Biodiversity in the Marine Park Islands in Peninsular Malaysia.

Elcee Instrumentation Sdn. Bhd. (2002). 'An Integrated Approach to a Reef Management Program (ReefMap) for the Miri-Sibuti Reefs Sarawak : Final Report'.

Forbes, R., Ilias, Z., Baine, M., Choo, P.S. & Wallbank, A. 1999. A taxonomic Key and Field Guide to the Sea Cucumbers of Malaysia. Herriot-Watt University. 62pp.

Ho Sin Chye. 2003. Islands and Reefs: Responsible ecotourism and challenges of sustainability. Seminar on "Islands and Reefs: Towards Conservation and Sustainable Management". 15-16 August 2003. Kuala Lumpur.

Lau, P.F. and Parry-Jones, Rob. 1999. The Hong Kong Trade in Live Reef Fish for Food. TRAFFIC East Asia and World Wide Fund for Nature Hong Kong.

Law, A.T., Japar, S.B., Mohamed, M.I., NoorAzhar, M.S., Lim Li Ching, and Mohd. Nasir Abdul Salam. (2001). 'Some General Water Quality in the Coastal Waters Off Pulau Redang and Terengganu', Proceeding of the National Symposium on Marine Park and Terengganu Islands. 12-13 Feb. 2001. Dept of Fisheries, Kuala Lumpur and KUSTEM, Kuala Terengganu. Malaysia.

Liew, H.C. 2002. Status of Marine Turtle Conservation and Research in Malaysia. In Kinan, I. (editor). Proceeding of Western Pacific Sea Turtle Cooperation Research Management Workshop, 5-8 February, Honolulu, Hawaii, USA. pp 51-56.

Mortimer, J. A. 1990. A Report on Turtle Population of the Island off East Coast of Johor and Suggestion of their Management. WWF Project. 3868p.

Mohd. Ibrahim b. Hj. Mohamed and Mohamed Pauzi b. Abdullah. 2004. Coral Reef Studies of Pulau Layang-Layang Malaysia. Marine Biodiversity of Pulau Layang-Layang. Department of Fisheries, Malaysia.

Pilcher, N. and Cabanban, A. 2000. The Status of Coral Reefs in Eastern Malaysia. Global Coral Reef Monitoring Network (GCRMN) Report. Australia Institute of Marine Science Network, Townsville.

Reese, E.S. 1981. Predation on coral by fishes of the Family Chaetodontidae, implication and management of coral reef ecosystem. Bull. Mar. Sc. 31: 594-604.

Sano, M., Shimizu and M., Nose, Y. 1987. Long term effect of destruction of hermatypic corals by Acantaster plankii infestation on reef fish communities at Iriomote Islands, Japan. Mar. Ecol. Prog. Ser. 37: 191-199.

Sarawak's State Planning Unit. 2002. Final Report for an Integrated Approach to a Reef Management Program (ReefMap) for the Miri-Sibuti Reefs, Sarawak.

Spalding M., C. Ravilious & E.P. Green, 2001. World Atlas of Coral Reefs. United Nations Environment Programme World Conservation Monitoring Centre, 425p

Tan, S. H. & Zulfigar, Y. 1995. Giant clams: A preliminary survey on their distribution and reproductive condition. Paper presented at the "International Symposium and Workshop on Conservation Biology: Molecular, Biotechnological and Conventional Approaches". Kuching, Sarawak, Malaysia. 19-23 November, 1995.

Tan, S.H. & Zulfigar, Y. 1996. Giant clams: A preliminary survey on their distribution, abundance and reproductive condition in Pulau Pemanggil. Poster presentation in "World Aquaculture '96, Bangkok, Thailand. 29 January – 2 February, 1996.

Tan, S.H., Zulfigar, Y., Ibrahim, S. & Abdul-Aziz, Y. 1998. Status of giant clams in Pulau Tioman, Malaysia. Malayan Nature Journal. 58 (3 & 4): 205-216.

The Star. 8 February, 2005. Death threat to stress reef.

TRAFFIC. 1999. "The Hong Kong Trade in Live Reef Fish for Food". Published by TRAFFIC East Asia and WWF Hong Kong. 17 June 1999.

Veron J. E. N., 1998. Corals in space and time. The biogeography and Evolution of the Scleractinia. VNSW press.

Wan Portiah, W.H. 1990. Conservation of fisheries resources through the establishment of marine parks and artificially created habitats. *In* the Status of Nature Conservation in Malaysia. Malayan Nature Society, Petaling Jaya.

Wilkinson C., 2002. Coral bleaching and mortality – the 1998 event 4 year latter and bleaching to 2002. State of Coral Reefs of the World. Australiain Institute of Marine Science.

Wood, E. 1986. Ecological Study of Coral Reefs. pp. 224-273. Sabah Society Journal. Vol. VIII, No. 2. The Sabah Society, Kota Kinabalu, Sabah, Malaysia. 310p.

Wood, A. and E. M. Wood. 1987. The Coral Reef of Bodgaya Islands (Sabah, Malaysia) and Pulau Sipadan. Malayan Nature Journal. 40: 285-310.

Zainuddin, I., Pauzi, M.A., Abdul Razak, L. and Yazid, M.Y. 2000. Preliminary Study on the Diversity and Distribution of Sponges at Pulau Layang-layang, Sabah, Malaysia. Malayan Nature Journal. 2000, 54: 2, 77-86.