Of the 670 reefs surveyed for fleshy seaweed, those rated with a high level of sewage pollution had a significantly higher abundance of fleshy seaweed ($p \leq 0.01$) (Figure 4.27). See Figure 4.25 for worldwide relative perceived levels of sewage pollution.

Reefs with no perceived level of sewage pollution had 3.8 ± 8.1% cover of fleshy seaweed, whereas reefs with a perceived heavy level of sewage pollution had a mean 13.1 ± 12.7% cover of fleshy seaweed.

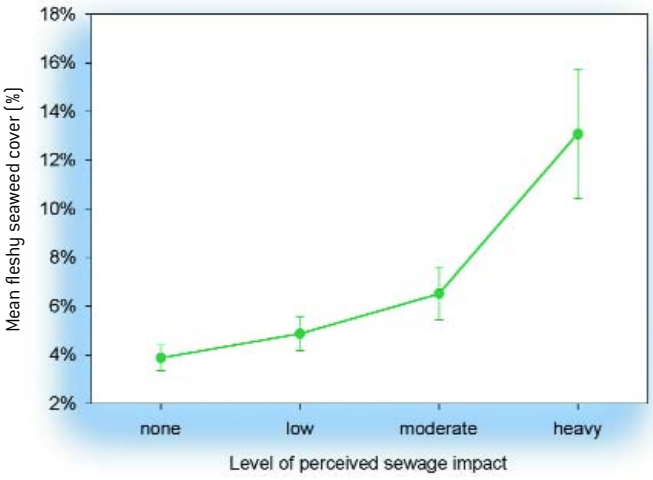


Figure 4.27: Mean fleshy seaweed cover versus level of human impact from sewage.

Marine Protected Areas

For the purposes of this analysis, protected areas are defined as any area that has some legal protection. In some MPAs, the laws do not exclude recreational fishing. Over half of all sites surveyed had some form of protection (Table 4.3).

Year	n	% Protected
1997	256	66%
1998	172	49%
1999	152	30%
2000	189	39%
2001	337	46%
Total	**1106**	**48%**

Table 4.3: Percentage of sites surveyed that had some form of legal protection.

Significantly higher numbers of five fish and one invertebrate indicator organism were found on reefs inside MPAs (Figures 4.28 and 4.29). These indicators include banded coral shrimp, grouper, haemulidae, lobster, parrotfish and bumphead parrotfish. This is a major improvement, over the 1997 results when there were no differences between reefs inside MPAs and those outside. This seems to indicate that management is becoming effective and MPAs are starting to work. However, the mean numbers are skewed by a few, very effective MPAs where high numbers of indicator organisms are found. For example, of the top 5% of sites that have the highest number of indicator organisms, 88% in the Atlantic and 76% in the Indo-pacific, are MPAs.

In the Soufriere Marine Management Area (SMMA), St. Lucia, higher numbers of indicator organisms were found inside the management area than outside. Additionally, fish populations outside SMMA have significantly increased over time (Roberts et al., 2001). According to the SMMA manager, Kai Wulf, the participation

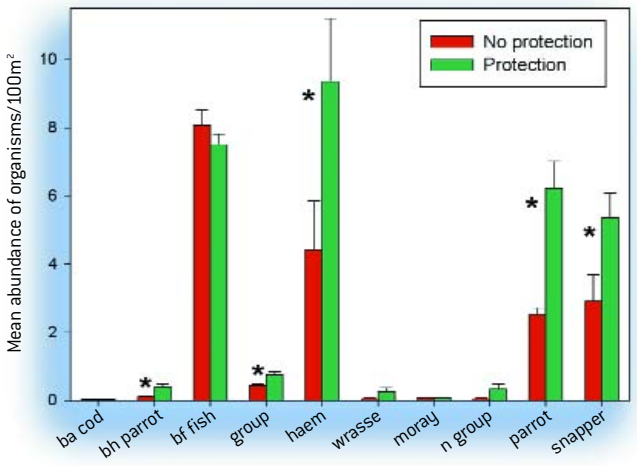


Figure 4.28: Five of ten fish indicator organisms had a significantly higher abundance inside MPAs than outside (bumphead parrot $p < 0.01$, grouper $p < 0.01$, haemulidae $p < 0.03$, parrotfish $p < 0.01$, snapper $p < 0.02$).

of local fishermen in the Reef Check Program helped foster community support and enforcement of no-take areas from the fishing community (pers. comm.)

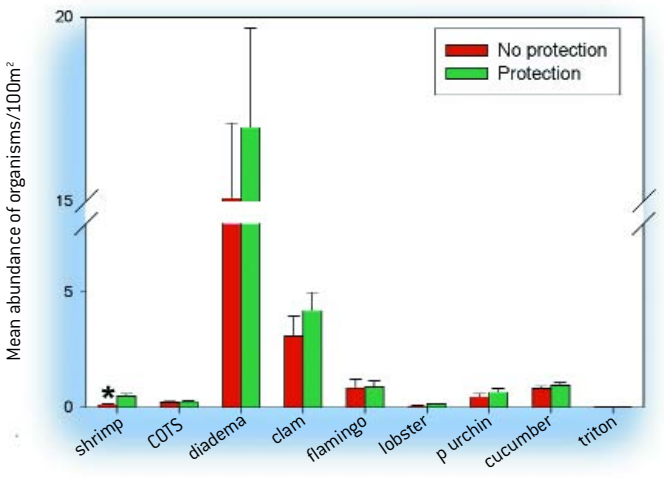


Figure 4.29: Only one of nine invertebrate indicators was significantly higher at MPA reefs (banded coral shrimp p≤ 0.01).

"Reef Check has been used to monitor the condition of the Apo Island Marine Sanctuary yearly since 1998. The ENSO caused widescale mortality of a major spatially dominant species, Galaxea fasicularis. Mortality of this one species has resulted in a significant drop in live coral cover, but has provided additional substrates for new coral recruitment. As Apo Island is well-managed, with little evidence of poaching and other human-induced impacts, it provides an interesting opportunity for long-term study of the response of a relatively pristine reef community to a major bleaching event. Such information in vital to broadening our understanding of long-term impacts of ENSO events, and the nature of reef recovery from such phenomena." -Dr. Laurie Raymundo, Silliman University, Philippines and Reef Check Philippines Coordinator

Perceived Threats to Coral Reefs

Worldwide, out of a possible maximum rating of 3 (for high impact), the mean rating of anthropogenic impacts on reefs was 1.5, halfway between zero impact (0) and high (3).

Over the five-year period the overall anthropogenic impact rating was significantly higher in the Atlantic region than in the Indo-pacific (p≤ 0.01) (Figure 4.30). The ratings for recreational diving impacts and sewage pollution impacts were significantly (p≤ 0.01) higher in the Atlantic region than in the Indo-pacific (Figure 4.31). There was no significant difference between regions for ratings of fishing pressure, harvest of invertebrates, collection of organisms for the aquarium trade, industrial pollution, or "other" impacts. However, the level of blast and poison fishing was significantly (p≤ 0.01) higher in the Indo-pacific than in the Atlantic region. The highest rating for poison fishing was reported in Northern Malaysia and the Philippines; a similar pattern was seen for blast fishing.

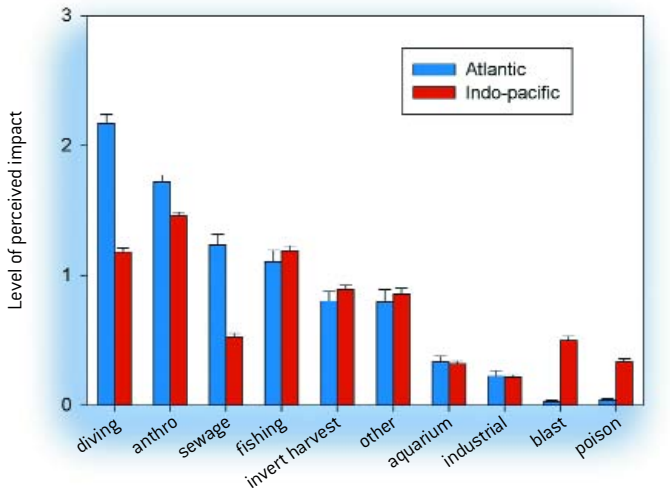
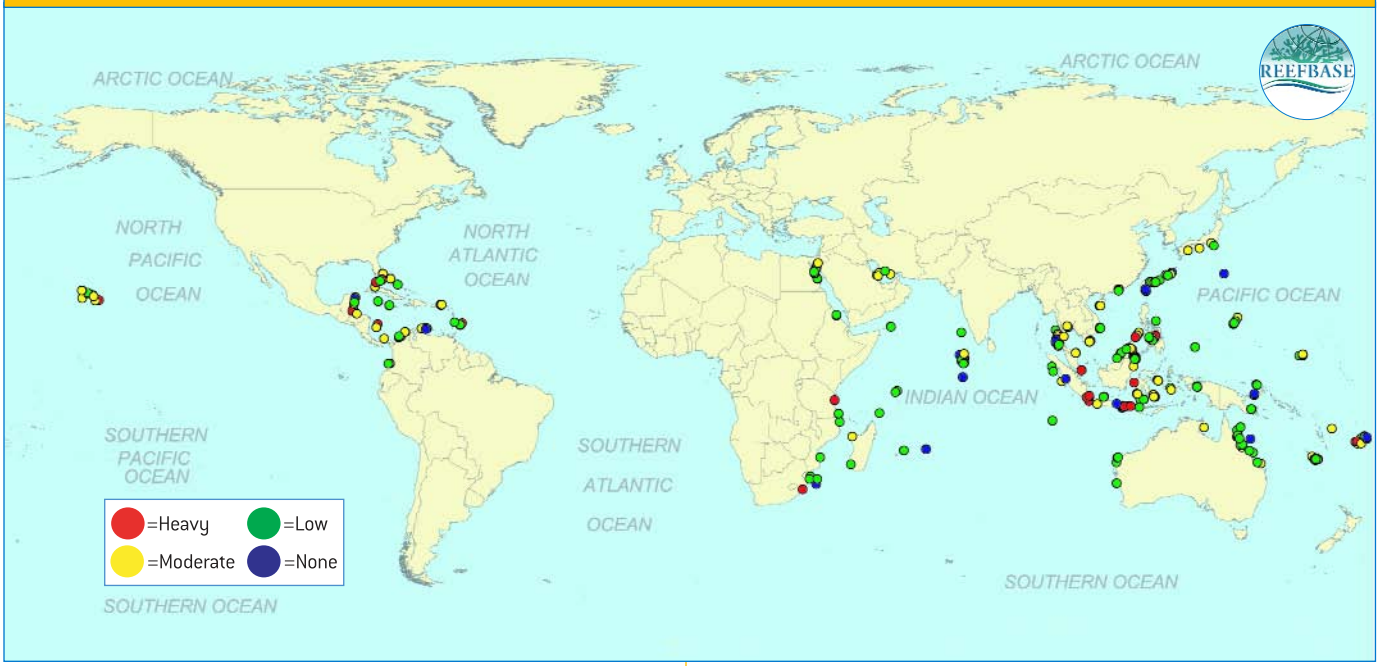


Figure 4.30: The mean level of perceived human impacts in the Atlantic and Indo-pacific 1997-2001.

Figure 4.31: relative overall anthropogenic impact ratings (1997-2001).



Photos courtesy of:
Banded coral shrimp: Jeff Jeffords
Diadema: Gregor Hodgson
Triton: Fabrice Poiraud-Lambert
Butterfly fish: Niki Papakonstantinou
Grouper: Jack Randall
Haemulidae: Jack Randall
Parrotfish: Jack Randall
Moray eel: Niki Papakonstantinou
Snapper: Jack Randall
Above picture: Jeff Jeffords

INVERTEBRATES

INDO-PACIFIC INDICATORS

courtesy of Coral Reef Adventure, MacGillivray Freeman Films

Crown-of-Thorns Starfish

(Acanthaster planci)

The Crown-of-Thorns starfish (COTS) was chosen as a Reef Check regional indicator for the Indo-pacific because it can have a major damaging effect on reef corals through predation during high-population years. In the 1970s, some scientists feared that COTS would destroy the Great Barrier Reef (Sap, 1999). The second reason that COTS was included is the controversy regarding the cause of COTS population explosions has yet to be resolved, and a number of scientists believe these episodes are linked to human activities (Birkeland, 1989). In particular, one hypothesis suggests increased runoff due to poor land use has led to eutrification that facilitates higher survival of COTS larvae and thus outbreaks. Another hypothesis holds that over harvesting of the triton, a predator of COTS, is to blame. On the Great Barrier Reef, it was estimated that 10,000 tritons were collected each year until the 1960s when they became rare (Sap, 1999). The evidence to date indicates COTS outbreaks occurred sporadically in many areas since the 1970s, however, a solid link to human activities has not been clearly established.

Of 884 reefs surveyed, only 22% of reefs had at least one crown-of-thorns starfish (COTS) (Figs. 5.1 and 5.2). The mean abundance of COTS was 0.23 ± 0.99 COTS per 100 m^2. The maximum number of COTS found on one reef was 35.5 per 100 m^2 on Kapikan Reef, Malaysia in September 1999, an abundance of COTS four times higher than recorded on any other reef. Several reefs in Malaysia in July 1997 and in Thailand in July 1998 reported 9.75 COTS per 100 m^2.

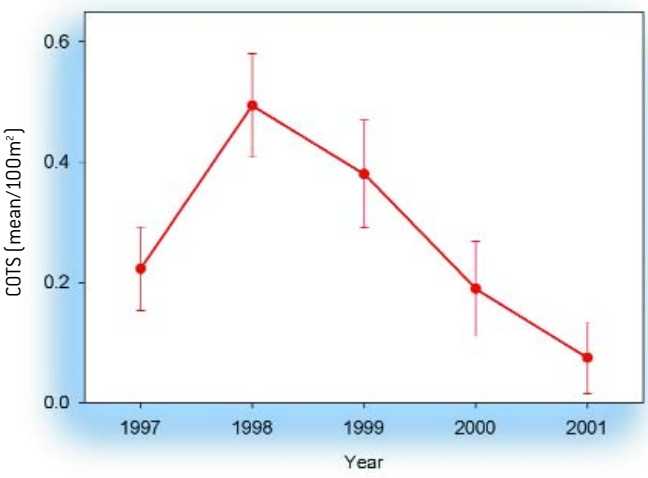
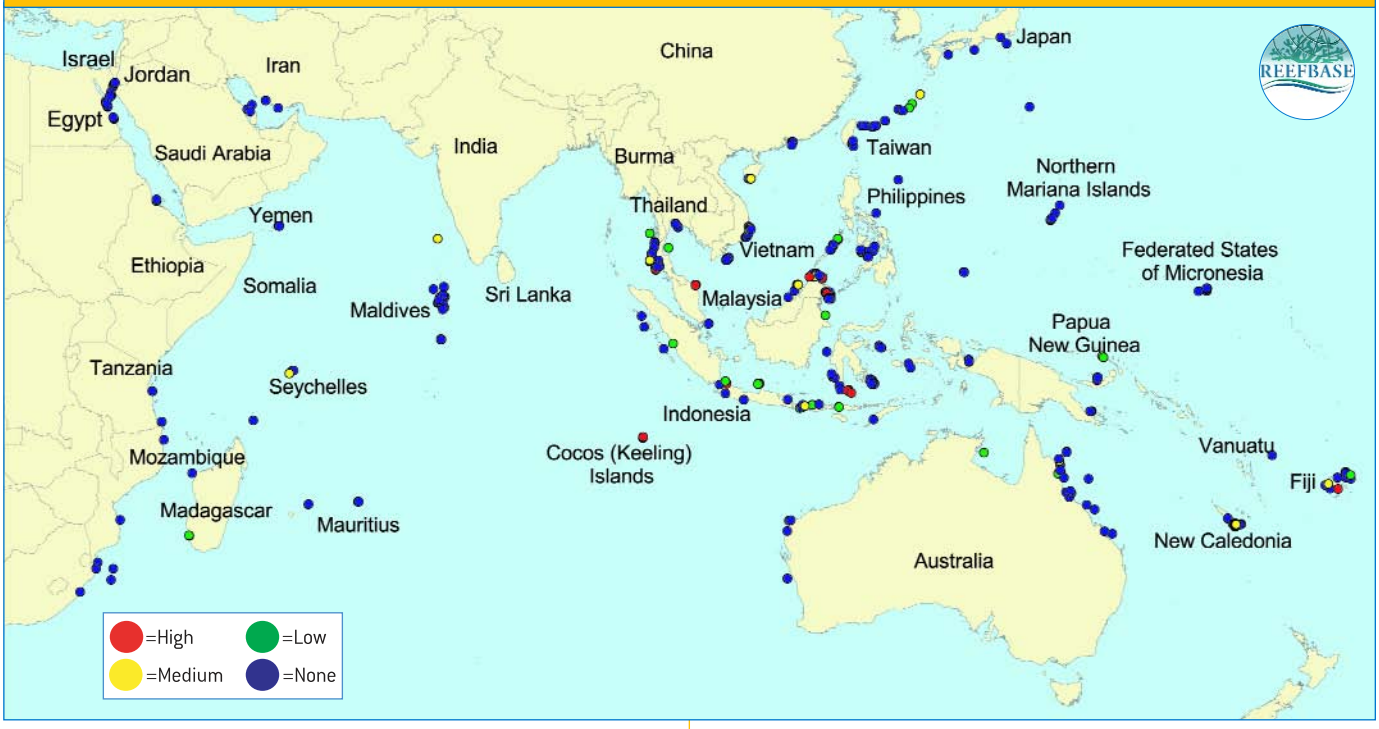


Figure 5.1: Mean abundance of COTS (crown-of-thorns-starfish) per 100 m^2 (1997-2001) on Indo-pacific reefs.

These densities can be compared to those recorded on the Great Barrier Reef as part of the Australian Institute of Marine Science (AIMS) long-term monitoring program. AIMS uses a manta tow survey where towed divers are asked to count COTS in a 10 m wide belt transect during a two-minute tow at 4 km/h. A COTS count of 0.22 per tow is classified by AIMS as an "incipient outbreak" while a count of >1 COTS

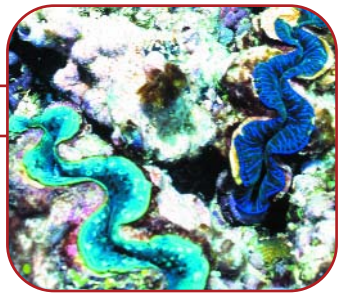
Figure 5.2: Relative abundance of COTS (1997-2001). None = 0; Low=1; Medium= 2-4; High>4



per tow is considered an "active outbreak." Using these numbers, the two classifications can be normalized to 100 m^2 for comparison with the Reef Check data. The results are 0.02 COTS per 100 m^2 as an incipient outbreak and > 0.08 COTS per 100 m^2 as an active outbreak. These numbers are far below those recorded during Reef Check and illustrate the difficulty of comparing results obtained using different methods. According to Ian Miller (per. comm.) Manta tow COTS counts are typically 10 - 35% of those recorded by swimming divers.

Giant Clam

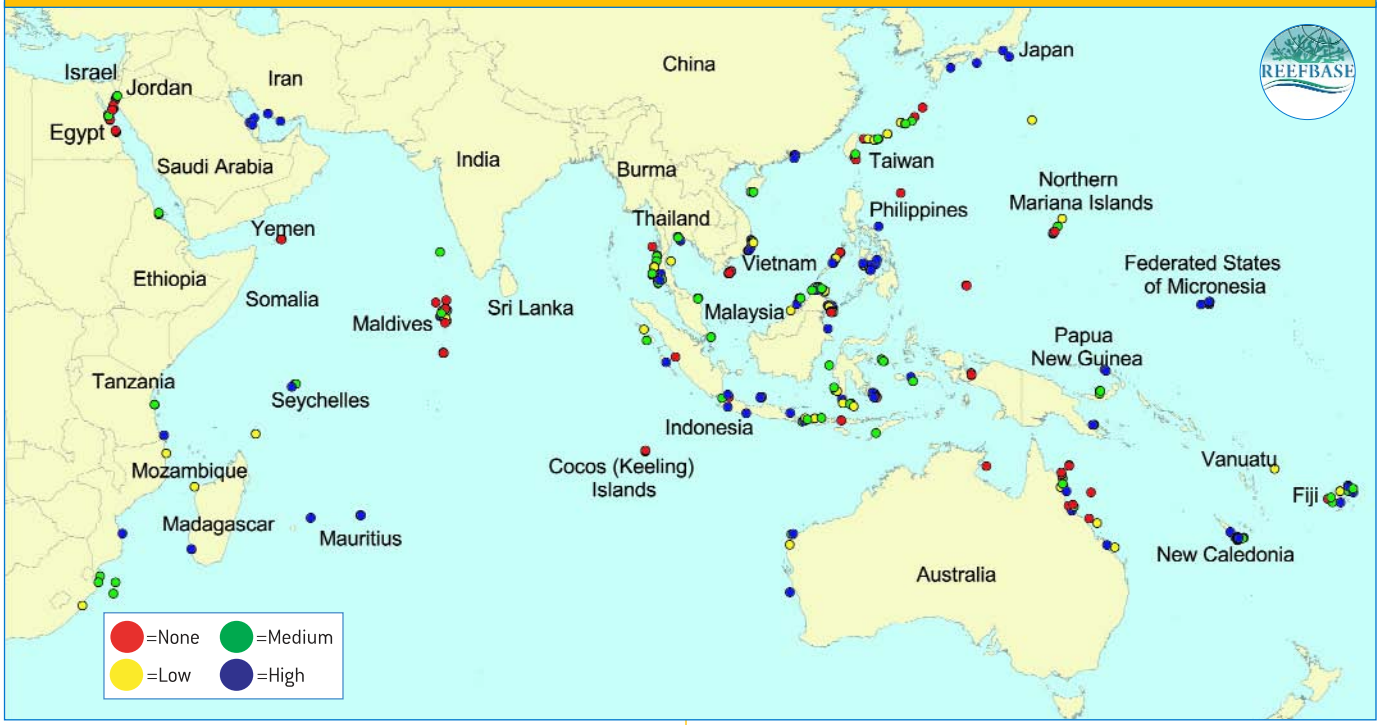
(Tridacna spp.)



Giant clams of the genus ***Tridacna*** were selected as Reef Check indicators because they have long been highly prized both as a food item, as a curio and more recently as an ornamental shellfish for aquarium keepers. There are several species of giant clam and all are included in the Reef Check protocol because all are the target of human predation. The largest clams ***T. gigas*** and ***T. derasa*** reach a maximum shell length of approximately 1.5 m and 0.5 m respectively. ***T. squamosa***, ***Hippopus hippopus***, and ***T. maxima*** may reach 30 - 40 cm, while the burrowing clam, ***T. crocea*** only reaches 15 cm in shell length. Now, large specimens are only seen in museums and in European churches where they often serve as holy water vessels. The long white adductor muscle of giant clams is consumed raw as a delicacy throughout East Asia and commands a wholesale price of $50 per kg of meat. ***Tridacna*** have now been farm raised commercially for over 20 years, and much of the trade in ornamentals is served by aquacultured clams - a true success story pioneered by Gerald Heslinga in Palau (Heslinga and Watson, 1985).

Of the 869 reefs monitored by Reef Check during the period 1997-2001, the mean number of giant clams found per 100 m^2 was 3.9 $\pm$ 19.1. However, there were no giant clams at 29% of all reefs (Fig. 5.3). The distribution of giant clams was very skewed, with a few sites showing high numbers of small (10 - 15 cm wide) specimens of ***Tridacna crucea***. This species lives imbedded in the

FIGURE 5.3: RELATIVE ABUNDANCE OF GIANT CLAMS (1997-2001). NONE = 0; LOW=1-3; MEDIUM= 4-11; HIGH>11



reef and so is more difficult to harvest. For example, four reefs had an abundance of giant clams greater than one per square meter, or over 400 clams per survey. Three of these sites were in Con Dao National Park, Vietnam, where collection of giant clams is illegal, but not strictly enforced. Another remote site in the Chagos Archipelago, which has no legal protection for giant clams, had 249.5 clams per 100 m^2.

A 1989 market survey carried out by Shang et al. (1989) of the University of Hawaii suggested a high demand for giant clams in Asia with a potential market of 240 tons per year in Taiwan alone. Based on interviews with importers they wrote:

> "Because clam fishing is illegal (in Taiwan), the supply of giant clam adductor muscle in Taiwan has come from imports during the past few years. The main source of supply is Indonesia, Papua New Guinea, Australia and Fiji...at least 31 tons in 1987 and 40 tons in 1988 were estimated to have been giant clam adductor muscle. Preferred size is one kilogram per muscle, but in recent times, muscles of this size have been rare. Former clam boat owners indicated that species seem to be preferred in the following order: T.gigas, T. derasa, Hippopus hippopus, T. squamosa and T. crocea."

In contrast, the same study found that in Okinawa, the smaller ***T. crocea*** was the preferred clam for sashimi due to its tenderness, and commanded a price of $50 to $73 per kg.

Reef Check data show that during the time period 1999 to 2001, the number of giant clams inside MPAs was significantly higher than the number of clams outside MPAs ($p \leq 0.01$). This may indicate management is starting to show success for these species.

The abundance of giant clams was correlated with the level of aquarium fishing. Numbers of giant clams were higher (4.2 ± 21.4 per 100 m^2) in areas of no aquarium fishing than levels impacted by aquarium fishing (1.6 ± 3.9 per 100 m^2), however this was not statistically significant ($p=0.11$). A similar trend was seen in the levels of perceived impact from poison fishing.

Giant clam abundance was surveyed at Helen Reef, Palau by Weng et al., (2000) and one ***Tridacna gigas*** per ha was found.

Evidently, the huge clams collected during the late 19th century

are a distant memory. The good news is that aquaculture works well. The challenges remain where the demand is far higher than supply. On most reefs, it is difficult to enforce a ban on collecting such an easily harvested food item. To achieve rehabilitation success on a large geographic scale, technical solutions to aquaculture problems for any species need to be accompanied by socioeconomic solutions as well. A good model is available for locally based management. Richard Chesher established strategically located giant-clam "rings" within traditionally managed MPAs in the 1980s at a time when large clams were almost gone. These have helped to restore the populations (Chesher, 1988).

Sea Cucumbers

(Thelenota ananas, Stichopus chloronotus)

Edible species of sea cucumbers were chosen as Indo-pacific reef health indicators because they are easily collected from shallow waters and have a high economic value. Sea cucumbers perform an important ecological function on the reef, digesting sand and compacting the sediments into pellets that aid in reef formation.

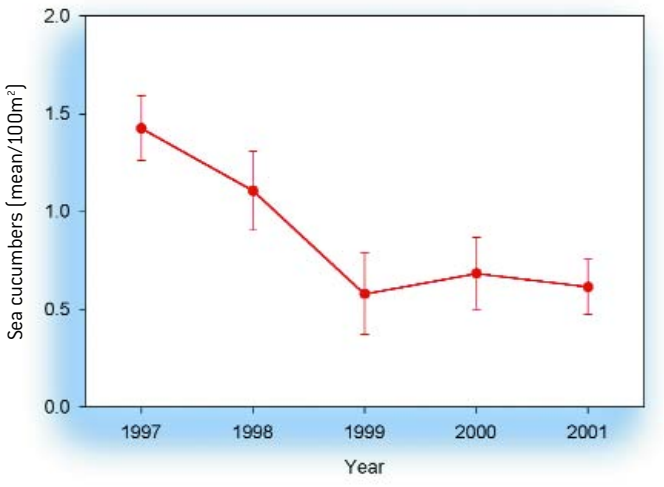


Figure 5.4: Mean abundance of sea cucumbers (***T. ananas*** and ***S. chloronotus***) per 100 m² (1997-2001) on Indo-pacific reefs.

As noted in Chapter 1, Saville-Kent (1893) reported on the fishery. In 1889, at Thursday Island (Australia) alone, there were 100 boats, 20 to 24 men per boat, harvesting 500 to 600 tons per month.

Half of the 874 reefs monitored for sea cucumbers were devoid of both species. The mean number of sea cucumbers per 100 m² significantly and steadily declined from a high of 1.4 ± 2.0 in 1997 to a low of 0.61 ± 2.1 in 2001 ($p \leq 0.01$). The highest abundance of edible sea cucumbers, 23.75 per 100 m², was recorded on a reef in Mauritius in 2001. A high density of 17.25 per 100 m² was found on Double Reef, Guam, USA in 1997 and again in 1998. However, by 1999, that number had declined to 4 per 100 m². By 2001, there were 3.25 per 100 m². Double Reef is not in a MPA and there are no regulations limiting the collection of sea cucumbers in that area. Rapid declines in nearby Rota were noted in an independent fisheries study (Trianni, 2002). There was no difference in the abundance of sea cucumbers found inside and outside protected areas.

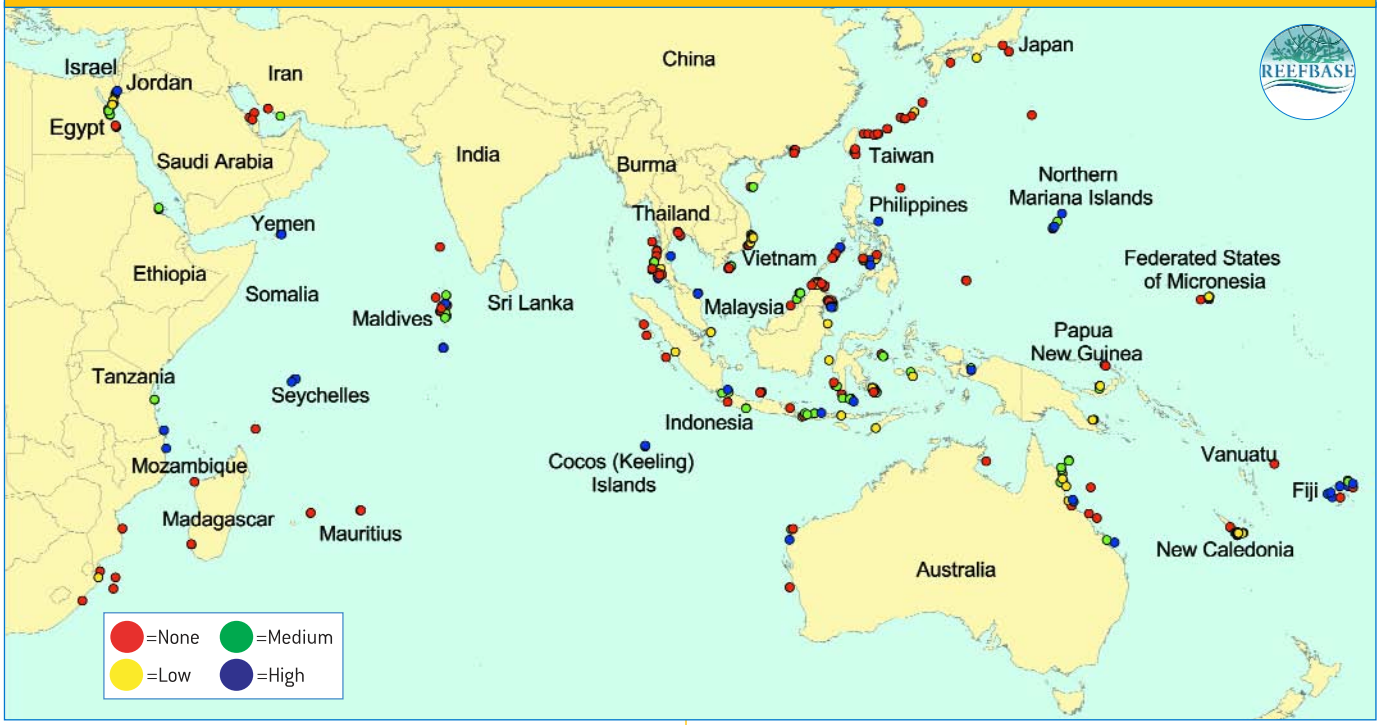
There were significantly more sea cucumbers found in areas where levels of harvest of invertebrates for food was rated as low (1.2 ± 2.9 per 100 m²) compared to areas rated as high (0.71 ± 1.3 per 100 m²) ($p = 0.03$).

Like other reef fishery targets, it appears that edible sea cucumbers are vulnerable to over-exploitation and Reef Check results indicate that most areas of the Indo-pacific have already been cleaned out.

These results are supported by studies reporting recent overfishing affecting the islands near Papua New Guinea. In previous years, edible sea cucumbers were found in localized densities of over 3,000/ha (equivalent to 30/100 m²) in East New Britain, while recent surveys found densities less than 50/ha (0.5/100 m²) (Adams et al., 1992; Lokani, 1992).

McElroy (1990) points out the general reduction in average price for sea cucumbers exported from Fiji and the Solomon Islands over the course of the 1980s, a result of the fishery

Figure 5.5: Relative abundance of sea cucumbers (1997-2001). None = 0; Low=1; Medium= 2-5; High>5



changing from a low-volume, high-value fishery to a high-volume, low-value fishery.

The trends seen in the Western Pacific are now being repeated in Africa. Beginning in 1990, the Madagascar export market for sea cucumber underwent rapid expansion, and in 1994, exports to Singapore and Hong Kong reached a peak of some 650 mt of sea cucumbers (Conand, 1998).

FISH

INDO-PACIFIC INDICATORS

Barramundi Cod

(Cromileptes altivelis)

The barramundi cod, also known as the humpback or panther grouper, is a fish in the family Serranidae. Its unique polka-dotted appearance cannot be mistaken for any other fish. Juveniles are high value aquarium fish, whereas adults fetch a high price in the Chinese live food fish market. Fish reach a maximum length of 70 cm and are widely distributed throughout the Western Pacific, but do not extend into the northern Indian Ocean or Red Sea.

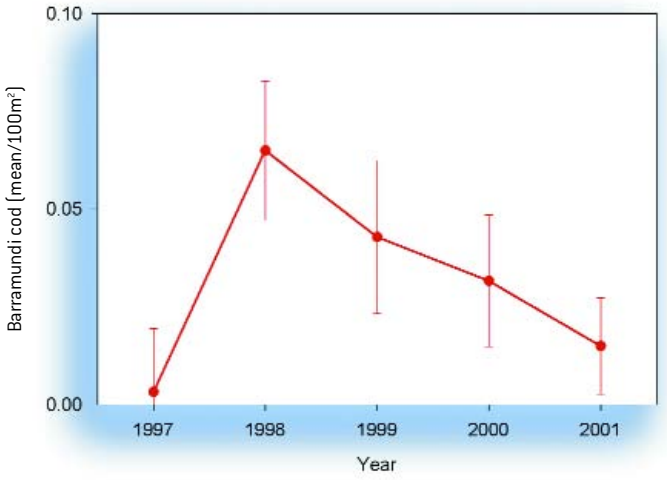


Figure 5.6: Mean abundance of barramundi cod per 100 m² (1997-2001) on Indo-pacific reefs.

Of the 773 reefs surveyed for barramundi cod, 95% reported zero fish and only ten sites had more than one fish per reef. The mean number of barramundi cod per reef over the five-year period was 0.03 ± 0.20 per 100 m^2 reef. Due to the typically low numbers found, the spike seen in 1998 (Figure 5.6) is primarily due to 12 fish per reef recorded at an MPA in the Sunda Islands, Indonesia.

Bumphead Parrotfish

(Bolbometopon muricatum)

The bumphead parrotfish is one of the largest members of the family Scaridae reaching 130 cm in length and up to 50 kg in weight. Due to its large size and schooling behavior, it is vulnerable to spear, net, poison and blast fishing. It is widely distributed throughout the western Pacific, Indian Ocean and Red Sea.

In the Indo-pacific, the mean number of bumphead parrotfish per reef during the period 1997-2001 was 0.25 ± 1.5 per 100 m^2. Of the 793 reefs surveyed for bumphead parrotfish in the Indo-pacific, 89% were devoid of bumphead parrotfish. The area with the highest abundance of bumphead parrotfish was the Karimun Java MPA in the Sunda Islands, just north of Java where fishing is illegal. On Cemara Kecil reef, 12 parrotfish per 100 m^2 were seen during a survey conducted in July 2000. When Reef Check teams returned one year later in July 2001, the number of bumphead parrotfish had increased to 27 per 100m^2.

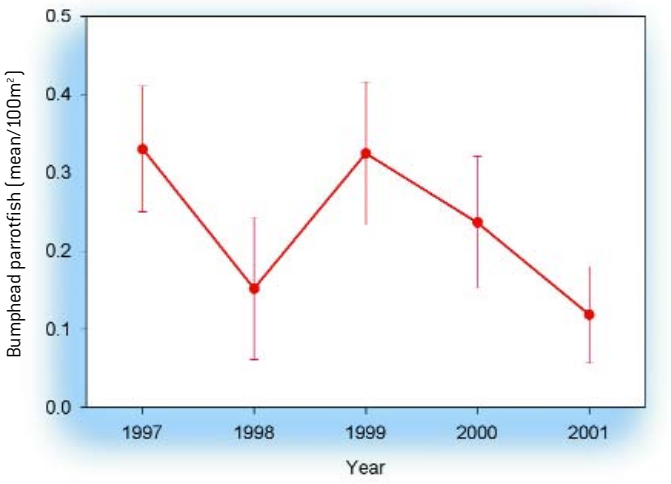


Figure 5.7: Mean abundance of bumphead parrotfish per 100 m^2 (1997-2001) on Indo-pacific reefs.

Humphead wrasse

(Chelinus undulatus)

The humphead wrasse is the most desirable and high-priced fish in the live fish trade. One large fish can be sold retail for as much as $10,000 (Lau and Parry-Jones, 1999). This labrid is widely distributed throughout the western Pacific, Indian Ocean and Red Sea and may reach 230 cm in length and 200 kg. The humphead is a predator and feeds on other fish, shellfish, urchins and crown-of-thorns starfish.

During the period 1997-2001, 88% of the 859 reefs surveyed were devoid of all humphead wrasse. The numbers of fish were consistently low across time (Figure 5.8). The peak seen in 1998 is due to three surveys that recorded relatively high numbers of humphead wrasse. In September 1998, 41 humphead wrasse per 100 m^2 were recorded during a survey done in Apo Marine Reserve, southeast of Negros, Philippines. A survey done one year later in 1999 sighted only three humphead wrasse. Surveys of the same transect in 2000 and 2001 found no humphead wrasse. Two surveys conducted in a National Park southeast of Honshu, on Togahama reef and Igaya-Katanzaki reef in July 1998 found 12-13 humphead wrasse per 100 m^2. Surveys along the same transect in 2001 reported zero humphead wrasse.

The average number of humphead wrasse per reef during the entire period was 0.14 ± 1.6 per 100 m^2. However, of the 465 humphead wrasse counted during the five-year period, 269 of those were found on the aforementioned three reefs. Since 1998, no more than five humphead wrasse have been reported on any one Reef Check survey of an Indo-pacific reef.

During the period 1997-2001, the mean number of humphead

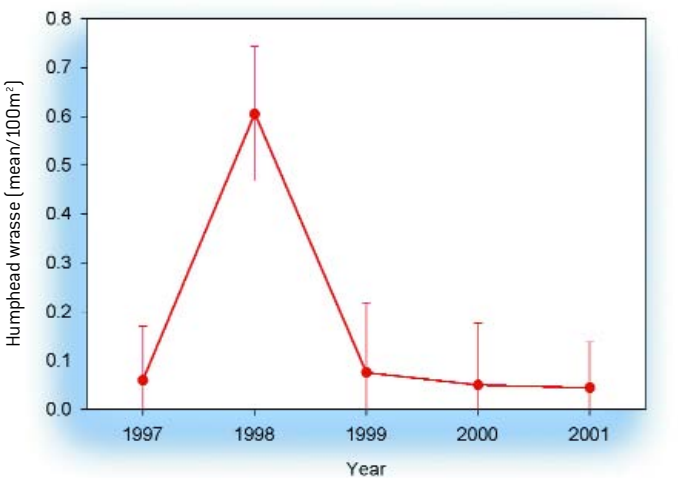


Figure 5.8: Mean abundance of humphead wrasse per 100 m² (1997-2001) on Indo-pacific reefs.

wrasse recorded from surveys of MPAs was 0.25 ± 2.4 per 100 m², whereas the mean number outside MPAs was 0.05 ± 0.22 per 100 m².

These findings may be due to the high value of this fish in the live food fish trade and the expanding range of long distance fishing vessels to even the most remote reefs. This species currently sells for about US $100 per kg in Hong Kong. To supply this market, diving fishermen throughout the region use sodium cyanide to stun and capture live humpheads (Johannes and Riepen, 1995).

On reefs where there was no perceived blast fishing, the numbers of humphead wrasse (0.19 ± 1.9 per 100 m²) were twenty times higher than on the reefs with any level of blast fishing (0.02 ± 0.10 per 100 m²) but this difference was not significant (p=0.18).

A similar relationship was seen between the abundance of humphead wrasse and the perceived level of poison fishing. On reefs without any perceived poison fishing, there was a mean of 0.18 ± 1.9 per 100 m², whereas on reefs with any perceived level of poison fishing, the number of humpheads dropped to 0.04 ± 0.14 per 100 m². There were no correlations between the numbers of humphead wrasse and other impacts.

Steve Oakley and colleagues have carried out very large, detailed surveys of humphead wrasse on reefs in Sarawak, Malaysia, covering hundreds of kilometers of reef front (for details see **http://tracc.org.my/**). In a survey of 44 km of heavily fished reefs, only 0.00007 fish per 100 m² were observed. They found only two sites in Sarawak where viable populations of fish remained, (Pulau Sipadan, 75 fish and Pulau Layang Layang, 350 fish), however, the populations were skewed indicating few young fish were joining the populations. On reefs protected for ecotourism diving operations, 0.075 fish per 100 m² were counted, three orders of magnitude higher than unprotected reefs.

A 1998 survey by Yeeting et al. (2001) in Bua Province, Fiji found four humphead wrasse in an area of 9.75 km².

The humphead wrasse is listed as "vulnerable" by the International Union for the Conservation of Nature (IUCN). This species requires urgent conservation action if it is to survive.

FISH

ATLANTIC REGIONAL INDICATORS

Nassau grouper

(Epinephelus striatus)

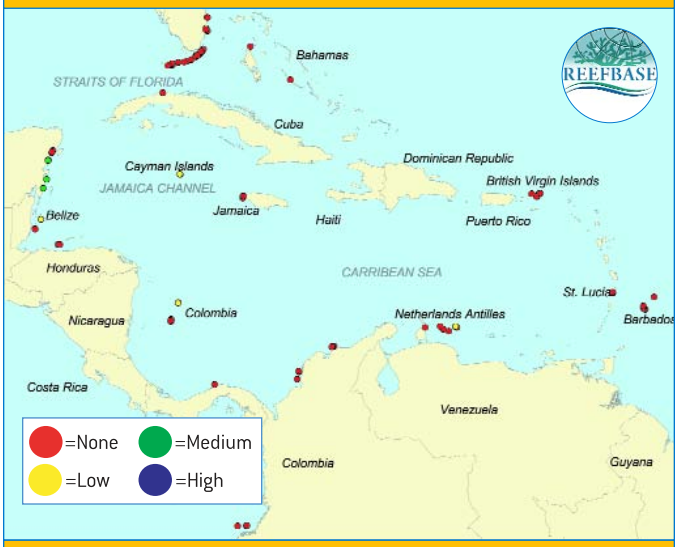
Nassau grouper are top-level predators that can grow up to 1.2 m long and weigh up to 25 kg. Like other grouper, they grow slowly, mature late, and form seasonal spawning aggregations. These life history characteristics, combined with a high value as a food fish, have led to severe overfishing throughout the Caribbean.

Of 162 reefs surveyed for Nassau grouper, 82% were totally missing this species (Figure 5.9). Only eight reefs had more than one fish. Of the 106 total fish counted during five years of

monitoring, 76 were found on two reefs in San Andres World Heritage Site in Colombia. Spearfishing is prohibited on both reefs.

A review of Nassau grouper status by Sadovy et al. (1999) indicated that there were 12 fish per ha in Bermuda in the 1950s, decreasing dramatically to the 1990s.

Figure 5.9: Relative abundance of Nassau groupers



(1997-2001). None= 0; Low=1; Medium= 2; High>2

Gorgonians and Flamingo Tongue

(Cyphoma gibbosum)

In the Atlantic, vast areas of shallow reef are colonized by a mix of gorgonians and hard corals. While such communities exist in the Indo-pacific, they are not as common. Given that hard coral cover has been declining over the past 15 years in the Caribbean, a gorgonian category was added to Reef Check protocols in 1998. The flamingo tongue was added as an indicator of curio collecting. Sufficient sample sizes have not yet been obtained in the region to draw any conclusions about the data. However, preliminary results indicate that flamingo tongue and gorgonia abundances fluctuate proportionally, an expected result given the dependence of the flamingo tongue on sea fans, particularly ***Gorgonia flabellum*** and ***G. ventalina***, as a food source (Figure 5.10).

The highest numbers of flamingo tongue, 16.5 per 100 m^2, were found in 2001 in the British Virgin Islands on Pelican and Spyglass Reefs, within a National Park.

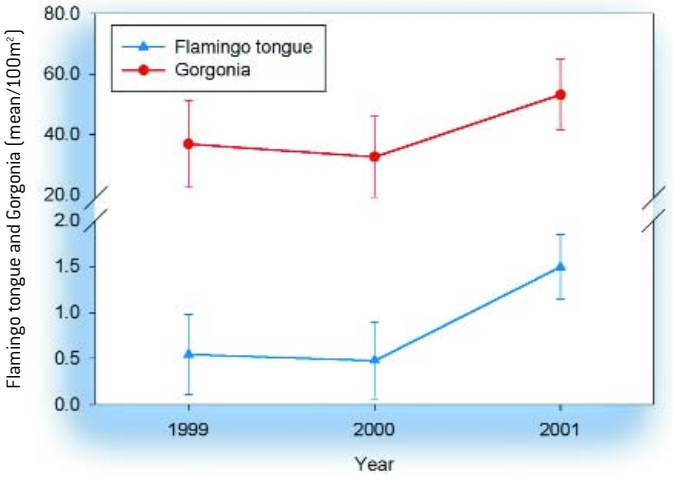


Figure 5.10: Mean abundance of flamingo tongues and ***gorgonia*** per 100 m^2 (1999-2001) on Atlantic reefs.

Photos courtesy of:
Crown of thorns: Jeff Jeffords
Giant Clam: Brian Bielmann for the Crossing, Quiksilver International
Sea cucumber: Gregor Hodgson
Barramundi cod: Ken Leonard
Bumphead parrotfish: Steve Turek
Humphead wrasse: Niki Papakonstantinou
Nassau Grouper: Jack Randall
Gorgonia with flamingo tongue: Claudine T. Bartels

Chapter 6 PUBLIC AWARENESS & EDUCATION

Photo by Jeff Jeffords

A major focus of this report so far was to present the results of five years of coral reef monitoring covered in Chapters Four and Five.

An important aspect of Reef Check is raising public awareness about coral reefs and educating stakeholders about how to monitor and manage reefs from the grassroots level. This chapter is a summary of how Reef Check is implementing the education components.

Reef Check began as a scientific method of tracking global changes in coral reef health, but it quickly developed into an international environmental organization with the broader goals of educating the public about the coral reef crisis, as well as providing training on how to implement solutions.

Reef Check is the only program to define and measure reef health using a standard method on a global scale. Reef Check achieves its goals through scientific research and a public education program, training workshops, presentations at scientific and management meetings, annual events such as press conferences, an international Dive In, and dive expeditions including the Quiksilver Crossing, television and film productions. Each of the education components of Reef Check is discussed below. The target groups are the general public, end-users, politicians and managers, and scientists.

Public Awareness Activities

Prior to 1997, coral reefs were rarely featured in the international press. The successful completion and analysis of the 1997 survey revealed a global coral reef crisis that required immediate attention. Consequently, a press conference was held in Hong Kong to quickly publicize the results to governments and international organizations. The first press release on October 16, 1997 stated, "The preliminary results from about 230 sites are being released today because they reveal such a clear pattern of global damage to coral reefs, particularly due to overfishing and destructive fishing." National coordinators in several countries held simultaneous local press events to publicize their results.

> "In Bahrain, Reef Check provided the only time series data on the condition of local coral reefs. It was the only measurement available for the unprecedented coral bleaching event in 1998."
> – K. Roger Uwate, Ph.D.

This approach successfully attracted a high level of media attention. The results from the first Reef Check survey were featured in most major print media, radio and television around the world in dozens of languages. Media coverage was given by all of the major international television networks including BBC, CNBC and CNN, as well as national networks such as RTK (Japan), CTV (China), NBC (USA), and GBF (Germany). Print media coverage was extensive, and often front-page, in dozens of languages with major stories in publications such as USA Today, The Independent

Media coverage from around the world.

(London), Le Figaro (France), and Sydney Morning Herald (Australia). Since 1997, the global media coverage of Reef Check and the coral reef crisis have expanded. Many other influential publications such as Reefs at Risk (Bryant et al., 1998) have supported the initial results of Reef Check.

Reef Check training programs provide guidance on how to publicize results and activities on the community and local level. As a result, many teams have been very successful in generating media coverage of their activities, ultimately generating public support and funding.

In addition to providing material to the media, Reef Check has sought corporate partners, such as Quiksilver and MacGillivray Freeman Films, in an effort to get the message out to the general public. Reef Check is partnering with other organizations to help produce two public service announcements that focus on the "shifting baseline" problem and the coral reef crisis. These campaigns will direct interested people to the Reef Check website for further information on how to help reefs or to become a member of Reef Check.

Education of End Users

Reef Check provides training workshops and materials to end users, people who are either members of Reef Check teams, or stakeholders. This year, with funding from US AID, Reef Check will be setting up an interactive website that will allow teams to compare their results with previous results from their reef and other locations.

A major goal is to establish regional training centers in the major coral reef regions. Since 2000, a Regional Training Center was established in Phuket, Thailand to serve SE Asia (see page 54). Centers in the Caribbean and East Africa are next in line. Dozens of training workshops have been carried out over the past five years at the national and regional levels throughout the world. These workshops provide training in the Reef Check protocol as well as other more taxonomically detailed protocols as desired by the trainees.

Ideally, after attending a training, the participants would return to their home areas and set up long-term reef monitoring programs. To facilitate this, Reef Check provides seed money for new teams. In addition, the training includes a component on fundraising. Volunteer coordinators donate their valuable time and energies to monitoring and management efforts. In order to ensure that efforts continue in perpetuity, funding is necessary to establish a paid coordinator in each country.

From Left: Thailand RC scientist Niphon Phongsuan, RC Vietnam coordinator Vo Si Tuan, RC Philippines coordinator Laurie Raymundo, RC Indonesia coordinator Abigail Moore, RC Program Manager Jennifer Liebeler, RC Thailand coordinator Pinya Sarasas.

As part of some of the workshops, additional training components have been provided on coral reef and related ecosystem management. This year, a rapid assessment protocol for socioeconomic monitoring is being designed with NOAA and will become a standard part of the Reef Check training course.

Science As Education

One objective of Reef Check is to carry out scientific research on the basic and applied questions affecting reef health, and to publish these results in scientific journals in order to disseminate information to the scientific community (Hodgson, 2000; 2001). In addition, as a major partner of the Global Coral Reef Monitoring Network (GCRMN), Reef Check supplies metadata to regional databases and for use in periodic GCRMN status reports, the most recent being "Status of Coral Reefs of the World: 2000" (Wilkinson, 2000).

A wide array of key scientific questions has arisen during the course of the research. These range across various fields from biology, to education, to socio-economics and include:

- What is the natural population range for indicator organisms in the absence of human predation and other anthropogenic impacts?
- What sample size is "adequate" for long-term monitoring of individual reefs in different areas?
- What are the best indicators for overall reef health?
- What is the best formula to test whether a trainee has learned the methods?
- How to motivate people to act once they have the knowledge about an environmental problem?

Graduate students at several universities are studying these questions.

Reef Check has also provided advice to numerous countries on how to establish long-term monitoring programs. Very detailed and expensive monitoring programs are not feasible in developing countries without large external funding inputs. Neither Reef Check nor any other organization will be able to pay for all the monitoring work that should be done globally to track reef health. Therefore at some point, local private or governmental groups will have to take on this role. The only possible mechanism to sustain a large program is to run it on a volunteer basis. Therefore, a sensible approach for most countries is to start with a modest community-based program, achieve sustainability, and then expand their programs to include more detailed monitoring.

An example of how raising public awareness and providing education to stakeholders can to lead to effective management can be seen at the Gilutongan Marine Sanctuary. The 15-hectare Gilutongan MPA has become one of the most popular diving sites in the Cebu area since being formally established in 1998. In 1999, Reef Check methods were integrated into the monitoring activities for selected MPAs that directly involved the training and participation of local community members. These participants have now seen and realized first-hand the impressive results of protecting their reefs and are helping to enforce protection.

As a result, coral and fish life have improved dramatically since 1999 and the reef is now home to many large target species of fish, such as "jacks" and groupers, that are rarely seen on unprotected reefs in the area. To help support protection, user fees were introduced for divers and snorkelers visiting the sanctuary. These fees, averaging about US $1 per diver, now generate about US $20,000 per year for the local community, which uses the funds to support operation of the sanctuary as well as other related activities identified by the community. In addition to this "direct" source of new community income, an

"indirect" source of income was introduced by helping to organize the local fishermen into a cooperative that helps to enforce the sanctuary rules while also serving as vendors to the visiting tourists.

Raising public awareness and educating stakeholders will continue to be a major priority for Reef Check. New ways of getting the word out are continually being sought, and this depends on establishing partnerships.

Reef Check runs education programs for all age groups. Here a preschooler from Los Angeles, California gets her first look at a starfish. Photo by Jennifer Liebeler.

Reef Check Regional Training Center, Phuket Marine Biological Center

The Reef Check Southeast Asian Regional Training Center has been in operation at the Phuket Marine Biological Center (PMBC) since early 2001. Funded by a grant from the US Agency for International Development, East Asia Pacific Environment Initiative, the center hosted its first group of international trainees in June 2001. Participants in this workshop included representatives from Indonesia, Cambodia, China, Vietnam and Thailand. Dive shop operators from Thailand, Indonesia,

Sporting their new "Reef Check Thailand" caps, workshop participants gather in front of the R/V Chakrathong Thongya, about to embark on a 3- day mission to survey the reefs in Thon Sai Bay. Photo by Jennifer Liebeler.

and Malaysia also attended, along with volunteers from England, Canada, and the USA.

During this first workshop, PMBC senior scientist, Dr. Hansa Chansang, Thai RC coordinator Pinya Sarasas, and RC Thailand scientist Niphon Phongsuwan, received awards from RC Program Manager Jennifer Liebeler for their dedication and work in setting up the regional training center.

Subsequent training programs have followed the model tested during this first training. Workshop participants spend two days in the classroom, where they learn the basics of Reef Check methodology and organism identification. On the second day, each participant presents a short discussion about coral reef ecology and conservation in their country or region. Following the classroom sessions, participants spend three days in the field, conducting Reef Check surveys on snorkel and SCUBA. This time is used to discuss training techniques and identify and correct any knowledge deficiencies. At the end of the five day training program, participants who have mastered the techniques are certified as Reef Check trainers and are required to train at least five people in their home regions and conduct at least ten Reef Check surveys over the course of the next year. This method has proved very effective in expanding Reef Check monitoring, education, and management programs in Southeast Asia.

In Thailand itself, national level training has also been carried out at PMBC and the number of Thai surveys has increased ten fold, a direct result of the training workshops held at PMBC.

Chapter 7 PARTNERSHIPS

courtesy of Coral Reef Adventure, MacGillivray Freeman Films

REEF CHECK IS DEFINED BY ITS PARTNERSHIPS WITH GOVERNMENT AGENCIES, THE PRIVATE SECTOR AND NON-PROFIT GROUPS. THIS DIVERSITY OF PARTNERSHIPS IS THE STRENGTH OF THE PROGRAM AND CAN ALSO BE A WEAKNESS.

Government Partnerships

At the international level, Reef Check partners with the International Coral Reef Initiative (ICRI) , an umbrella organization for coral reef activities that provides a forum for groups and nations interested in coral reef issues. The current ICRI Secretariat is shared by Sweden and the Philippines. Within ICRI there is the GCRMN, led by Clive Wilkinson and funded by several governments, the United Nations International Oceanographic Commission and NGOs.

In 1998, the GCRMN chose the Reef Check protocol to serve as its community-based monitoring program. The present arrangement for collaboration is that GCRMN collects metadata, publishes status reports on global reef health, and networks with governments to try to set up coral reef monitoring initiatives.

From the perspective of GCRMN, the role of Reef Check is to:

1. organize regional training centers and run regular training programs in all aspects of coral reef monitoring and management;
2. facilitate the establishment of a global network of community-based monitoring teams;
3. support and assist the collection, management and storage of coral reef monitoring data using the standardized Reef Check method, and
4. analyze and report on the monitoring results.

By linking the two programs under ICRI, a complementary partnership was formed. In practice, this means that the network of national coordinators is shared, and all GCRMN training starts with Reef Check methods and proceeds to more detailed methods of use to highly trained government technical teams. In the future, each coral reef country will have a large number of Reef Check sites, monitored by local residents as well as other stakeholders, with smaller numbers of sites monitored in more taxonomic detail by government teams. The Reef Check network thus acts as an "early warning" system.

Reef Check also has partnerships with international organizations such as UNEP Regional Seas (Caribbean, East Africa and SE Asia), PERSGA, SACEP, UNESCO, World Bank, and UNDP to name a few. In general, these organizations respond to requests from countries for assistance in setting up coral reef monitoring training workshops and provide the funding to allow Reef Check to facilitate the activities using local trainers.

NGO Partnerships

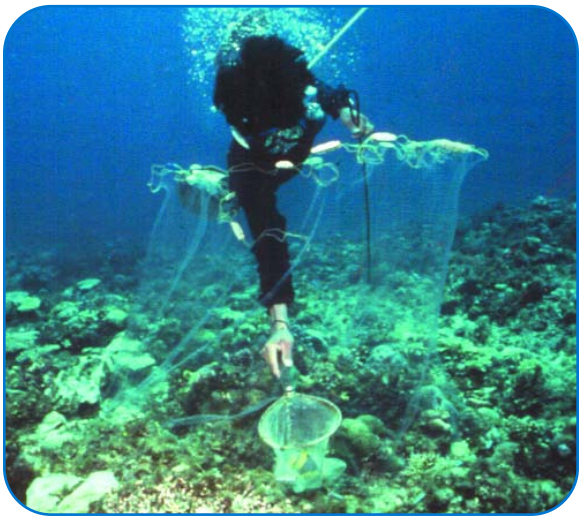
Several existing bilateral coastal management projects and numerous national government agencies and NGOs have incorporated Reef Check into their monitoring and management work. This institutionalization of Reef Check has occurred with the help of the US Agency for International Development, NOAA/NOS, US Peace Corps and numerous non-governmental organizations such as Worldwide Fund for Nature (WWF), the Coral Reef Alliance (CORAL), Coral Cay, Reefkeeper, CANARI, Frontier and many others.

A specific example of such an alliance is a partnership created with the Marine Aquarium Council (MAC) to carry out the basic science and monitoring needed to manage the aquarium trade in a sustainable manner. MAC is an international, not-for-profit organization that brings marine aquarium animal collectors, exporters, importers and retailers together with aquarium keepers, public aquariums, conservation organizations and government agencies. MAC's mission is to conserve coral reefs and other marine ecosystems by creating standards and educating and certifying those engaged in the collection and care of ornamental marine life (**www.aquariumcouncil.org**).

MAC has stepped in to provide a form of self-regulation within the industry to prevent the regulatory challenges that might arise should severe restrictions force the aquarium trade underground. Using the rational behind the "green" certification within the timber industry, MAC expects to use the certification process to create a sustainable industry by providing consumers with the option of buying a certified fish. The goal is that over a period of several years, certified companies will supply higher quality fish that will dominate the market and the demand for certified fish will prevent the sale of cheaper, uncertified fish.

Through its programs, MAC is working to raise public awareness about the industry's role in conservation and establish independent standards and certification of "best practices". By providing objective and accurate data on the marine ornamental trade and ensuring the health and quality of marine life through responsible collection, handling, and transportation practices, MAC hopes to ensure quality and sustainability in the aquarium industry.

In order to test how MAC certified collectors are affecting the sustainability of coral reefs and associated organisms, Reef Check has reviewed information on aquarium trade organisms, collection levels, and source areas and drafted both a set of monitoring protocols and a list of organisms to be used in the monitoring program. Two workshops have been held to review the monitoring methods and species included in the preliminary stages of the certification and monitoring. The workshops in Jakarta, Indonesia (April 2001) and in Honolulu, Hawaii (July 2001) resulted in The Marine Aquarium Trade Coral Reef Monitoring Protocol and species list (MAQTRAC). MAQTRAC was field tested in the Maldives and Indonesia during summer 2001 and is currently being implemented in Indonesia, the Philippines, and Fiji to establish a series of management plans for reefs subject to aquarium trade collections.



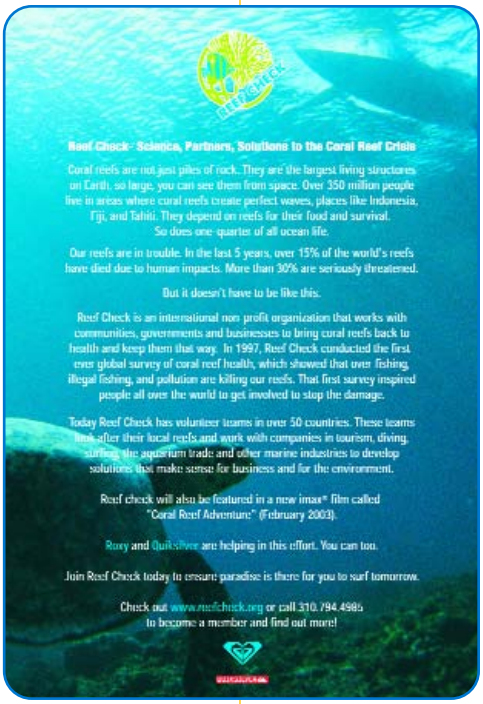
Aquarium fishermen collect using nets. Photo courtesy of Lynn Funkhouser.

Corporate Partnerships

Recently, Reef Check has established the first in a series of strategic partnerships with the private sector. The advantage of these collaborations is the potential for co-marketing.

Quiksilver, a leading clothing and surf brand, and MacGillivray Freeman Films (MFF), the innovative producer of IMAX films, have joined forces with Reef Check to form a powerful coalition. These marketing and film innovators are sending an urgent message to their audiences to preserve and restore the world's coral reefs as well as the overall wellness of our ocean planet. Through a series of Reef Check supported special events, promotions, and educational programs, these corporations are maximizing their combined reach to convey the need to protect the health of the planet with a simple marketing slogan, "***How Good Is This?***" In essence, coral reefs and the life and beauty they support are worth saving.

Quiksilver's continuing desire and commitment to give back to the communities that have hosted the surfing culture has resulted in a company-wide initiative named "The Crossing". "The Crossing" is the circumnavigation by a 72-foot exploratory vessel, ***Indies Trader***, to find remote surf spots. By providing a berth for a Reef Check scientist on several legs of this trip, Quiksilver has established a floating research station. The vessel has allowed the company and researchers to access previously unreachable reefs, as well as an audience that may have never thought about what is beneath the surf (See Box "In Search of Pristine Reefs"). Quiksilver has also designed a line of limited edition t-shirts to promote Reef Check to its customers, supporting coral reef conservation amongst a younger and more diverse audience. MFF succeeds in transporting its audience underwater in their newest IMAX film, ***The Coral Reef Adventure***. Following release in 2003, the Quiksilver Crossing and Reef Check will be highlighted on the IMAX screen. This film is one of the best available mechanisms to deliver a coral reef conservation message to the general public. Reef Check's message will also be distributed in the form of educational materials that will be placed in museums and schools across North America. Reef Check helped to develop a museum research guide, a teacher's guide, a family fun guide and interactive website material as one of the primary scientific contributors.



This postcard is being distributed worldwide as part of a partnership between Reef Check, Quiksilver, and MacGillivray Freeman Films and provides an example of how co-marketing can be used to help get the message out.
Image by Dianne Young.

In Search of "Pristine" Reefs
The Reef Check/Quiksilver Partnership

By Craig Shuman

The Indies Trader anchored off-shore a remote island. The Trader has made an excellent platform for Reef Check scientists to survey remote reefs. Photo courtesy of Jeff Hornbaker, for The Crossing, Quiksilver International.

A fundamental problem facing coral reef managers is determining the ecological goals of management. What balance of species and abundances should the well-managed reef have? Ideally, nearby pristine reefs that have not been influenced by humans could be used as a model. Unfortunately, pristine reefs are rare, and recent work suggests that humans have had a much greater impact on diverse marine systems for far longer than had previously been believed (Jackson et al. 2001).

Despite the long history of human exploitation of coral reefs, there may exist isolated pockets that have been spared from most human impacts giving a glimpse of what "once may have been."

If they exist, these "near-pristine" reefs must be few in number, small in size, isolated from anthropogenic activities and thus, difficult to identify. If an attempt were made to mount a standard scientific expedition to find such reefs, the risks and costs would be enormous. An alternative would be to find a "ship of convenience" on which to hitch a ride, much like the ***Indies Trader***.

After leaving Papua New Guinea in 1999, the ***Indies Trader*** crisscrossed the South Pacific and surveys were carried out at numerous remote reefs. During this time, Reef Check scientists began to truly understand the far-reaching effects of human impacts, a realization that would become increasingly clear through the voyage. In Fiji, for example, a series of seemingly non-impacted reefs were surveyed under the assumption that their distance from population centers would result in high overall species densities. However, only one of these reefs was found to contain high densities of fish and invertebrate indicators.

The summer of 2001 was spent throughout the Indian Ocean and continued to provide information on the extent of coral recovery from the catastrophic 1998 bleaching event (thought to be caused by a coinciding El Niño event), effectiveness of management activities employed by different countries, and the location of remote "pristine" reefs.

The living corals were found to face some surprising threats. For example, the widespread forest fires on the island of Sumatra in Indonesia may have resulted in a large-scale coral die off as a result of increased sedimentation and an algal bloom induced by nutrient enrichment. Reefs in the Maldives experienced extensive bleaching, which has been linked to the elevated seawater temperatures observed in the area. Overall, reefs in Indonesia and the Maldives had similar live coral cover while those in Madagascar were spared the effects of the 1998 El Niño. Surprisingly, the remote reefs located in Chagos and the Seychelles displayed higher hard coral cover despite being in the region that was influenced by elevated seawater temperatures. Densities of fish and

invertebrates tended to show a more consistent pattern. Remote reefs in Chagos and the Seychelles exhibited the highest density of almost all fish and invertebrate indicators.

The high mobility of this research platform has also allowed comparisons over broad geographic areas to help determine what factors may be responsible for the ecological trends detected by the surveys. Although uninhabited, the reefs in Chagos were not as free from human impacts as would have initially been expected, and in this case, being remote may have increased the extent of exploitation. The absence of infrastructure to ensure fishing activities were sustainable or in accordance with local regulations allowed large-scale commercial dory fishing operations to harvest live grouper at alarming rates. Consequently, observed grouper densities were relatively low, while densities of other indicators, such as giant clams, were extremely high. A series of reefs in the Seychelles provided an example of how the fine balance between remoteness and enforcement may be the most effective way to protect coral reef resources. The high abundance of most indicator organisms observed on these reefs was most likely due to the protection afforded to them by the small local population residing on the nearby islands. With a total population of 25, the inhabitants exerted minimal pressure on reef resources for subsistence while being able to alert government authorities to the presence of illegal commercial fishing operations.

Since the inception of the "The Crossing" in 1999, 117 reefs have been surveyed by eleven different marine biologists. This voyage has been and will continue to provide Reef Check scientists the opportunity to scour the globe in search of "pristine" reefs. Once identified, these reefs can be revisited by scientists for research purposes. In addition, identification of such reefs can lead to protection from long-range commercial fishing fleets that are concurrently searching the globe to exploit marine resources. In addition to providing valuable scientific data, the presence of Reef Check scientists onboard "The Crossing" has greatly extended the education and awareness of coral reefs. Many of the world's leading surfers have participated in Reef Checks during the voyage and have now become spokespersons for the conservation and awareness of threats to coral reefs.

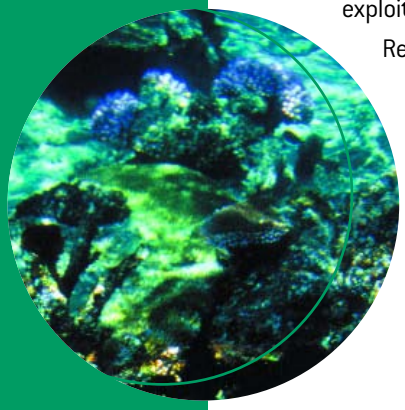


Photo courtesy of Brian Bielmann for The Crossing, Quiksilver International.

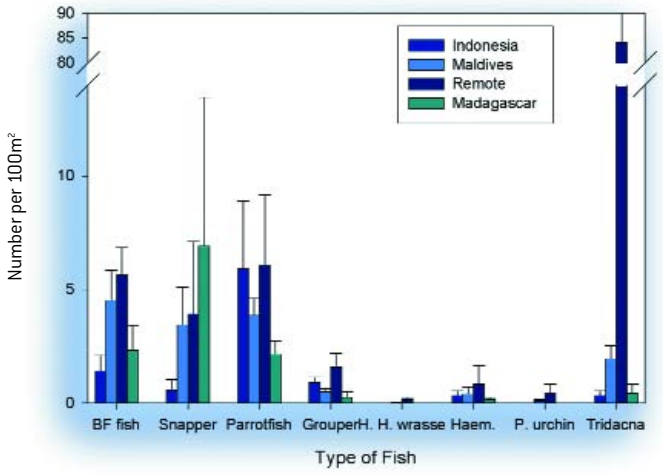


Figure 7.1: Abundance of RC indicators.

Quiksilver has recently announced the extension of "The Crossing" for an additional five years to complete a circumnavigation. Due to the unique scientific opportunities available during such a voyage, Quiksilver will continue to provide a berth to a Reef Check scientist for the duration of the journey. This distinctive marriage between private sector corporate resources and science, combined with the thirst for exploration, will continue to help marine scientists answer the important question: What are the characteristics of a well-managed reef?

For more information regarding "The Crossing" go to: **www.quiksilver.com**. "The Crossing"

Photo courtesy of Don King for The Crossing, Quiksilver International.