Global Coral Reef Monitoring Network – Status of Coral Reefs of the World: 2000

Clive Wilkinson [1]

THE Global Coral Reef Monitoring Network (GCRMN) is the monitoring arm of the International Coral Reef Initiative. At the 9th ICRS, the GCRMN released its second status report on the coral reefs of the world. Below is a summary of that report.

Photo: GCRMN

A diver assessing coral cover on a reef along a transect line placed at a constant depth along the contour of a reef. The diver notes the position of all items under the tape to estimate percent cover of live and dead coral as well as other organisms

The Crisis With Coral Reefs

The coral reef science and management community has been noting a continual decline in coral reef status since the awareness of the fragility of these systems to human activities developed in the early '80s. The first attempt to document reef status was by Susan Wells and colleagues in the three part series *Coral Reefs of the World* published by UNEP and IUCN in 1988. An attempt to quantify the status was made by Clive Wilkinson at the 7th International Coral Reef Symposium in 1992, suggesting that 10 percent of the world's reefs were effectively lost and estimating that 30 percent were under immediate threat (severe degradation in 10 to 20 years) and a further 30 percent were under longer term threat (20 to 40 years). In 1998, the *Reefs at Risk* analysis by the World Resources Institute, found that 27 percent of the world's reefs are under high risk of damage from human activities and a further 31 percent were under medium level risk.

The latest assessments from the GCRMN in late 2000 are that 27 percent of the world's reefs have been effectively lost, with the largest single cause being the massive climate-related coral bleaching event of 1998. This destroyed about 16 percent of the coral reefs of the world in 9 months during the largest "El Nino" and "La Nina" climate changes ever recorded. While there are signs that many of the 16 percent of damaged reefs will recover slowly, probably half of these reefs will not adequately recover within the next 50 years. These will add to the 11 percent of the world's reefs already lost due to human impacts of sediment and nutrient pollution, over-exploitation, and destructive fishing, mining of sand and rock, and development on and 'reclamation' of coral reefs.

These new assessments show that the problems are most severe in:

- Middle East – 35 percent lost mostly in the Arabian/Persian Gulf, with low chances for short-term recovery
- Wider Indian Ocean – 59 percent lost with reasonable chances of recovery for the remote reefs not affected by human pressures
- Southeast and East Asia – 34 percent lost with reasonable chances for slow recovery on the remote reefs, and dire predictions for the future of the remaining reefs
- Caribbean/Atlantic Region – 22 percent lost due mostly to previous human stresses, hurricanes, bleaching and coral diseases.

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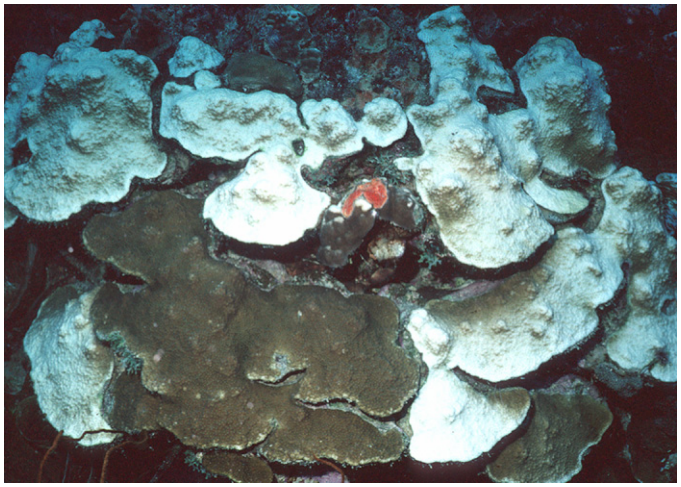

Photo: Andy Bruckner

Montastraea faveolata bleaching, Caribbean

In contrast, the extensive reefs in the Pacific and off Australia are in reasonably good health with a positive outlook, unless global climate change events like those of 1998 strike these areas. Indications are that bleaching may recur with severe, localized bleaching mortality near Fiji and the Solomon Islands in early 2000 and again in 2001.

Coral Bleaching and Mortality in 1998

The massive coral bleaching and mortality event of 1998 devastated large parts of the Indian Ocean, Southeast Asia, and the far western Pacific. The most affected reefs were in the Arabian/Persian Gulf; Kenya, Tanzania, the Seychelles; Maldives, Chagos Banks, Sri Lanka, and India in the wider Indian Ocean; parts of Southeast Asia, especially Vietnam, the Philippines, Taiwan, southern Japan, and Palau. Many areas reported coral losses of 60-95 percent over large areas and often down to 30 meters or more. In the wider Caribbean and parts of the Great Barrier Reef, there was minimal mortality after extensive bleaching, and many severely bleached reefs recovered almost fully. There was no bleaching over vast areas of the Pacific. The bleaching was caused by the combination of extremely calm conditions during the 1997-98 "El Nino-La Nina" events, coupled with a steadily rising baseline of sea surface temperatures in the tropics (increasingly attributed to greenhouse warming). These drove temperatures in parts of the tropics above records for the past 150 years, and bleaching was indiscriminate; impacts were equally severe on relatively pristine, remote reefs as on reefs already under major human stresses.

It may be several decades before we can state that reefs will recover, or whether there will be local losses of species, including some rare endemic species. Reef recovery will depend on few or no repeats of the extreme events of 1997-98, and even then, it will take 20 to 50 years before reefs recover to ecological structures resembling those before the bleaching. Recovery will often depend on reducing human pressures through sound management.

Coral reef experts from around the world compiled these losses and predictions of potential losses under a 'business-as-usual' scenario with little effective conservation. They stressed that many reefs lost in 1998 should recover, with some clear evidence of slow recovery.

Regions of the World	Percentage of Reef destroyed pre 1998	Percentage of Reef destroyed in 1998	Percentage of Reef in critical stage, possible loss in 2-10 yrs	Percentage of Reef threatened, possible loss in 10-30 yrs
Arabian Region	2	33	6	6
Wider Indian Ocean	13	46	12	11
Australia and PNG	1	3	3	6
Southeast & East Asia	16	18	24	30
Wider Pacific Ocean	4	5	9	14
Caribbean Atlantic	21	1	11	22
Status 2000 Global *	**11**	**16**	**14**	**18**

** Mean values adjusted for the proportional area in each region of the global total of coral reefs; PNG – Papua New Guinea.*

Two Parallel Agendas to Conserve Coral Reefs

The events of 1998 indicate that there are two necessary actions to conserve coral reefs:

- direct management to reduce human stresses of land-based pollution, shoreline and reef modification, and over-exploitation, including damaging practices like blast and cyanide fishing. The best mechanisms are through integrated coastal management combining policy, legal and economic mechanisms and the establishment of more effective Marine Protected Areas
- global action to study the impacts of global climate change on coral reefs and reduce emissions of greenhouse gases.

Coral reefs are ideal models for management and conservation as they are often discrete with water barriers separating them from the sources of land-based pollution and exploitation. Reefs have high 'charismatic appeal' and the public demand their conservation. There are no large economic or political lobbies

Photo: Mark Erdmann

A coral rubble field – a result of blast-fishing

opposing conservation, and the massive reef-based tourism and transport industries support conservation. Reefs are strategically important for about 20 members of the United Nations, which have few natural resources other than reefs; and another 70 countries or states have coral reefs, which expand their economies and Exclusive Economic Zones. Coral reefs are frequently major discussion topics at meetings of the Conventions on Sustainable Development, Biological Diversity, and the Asia Pacific Economic Co-operation.

International efforts to monitor, research, manage, and conserve coral reefs have expanded recently with the formation of the International Coral Reef Initiative (ICRI) in 1994 and the Global Coral Reef Monitoring Network (GCRMN) in 1996. ICRI has compiled the coral reef problems and needs of almost 90 countries during global and regional meetings from mid-1995 to early 2000. The Call to Action and Framework for Action were produced in 1995 and the Renewed Call to Action in 1998, along with many regional recommendations for action to conserve coral reefs (http://www.icriforum.org). Major Government and agency donors participate in ICRI with the running of the global Secretariat being undertaken by the United States from 1995-96, Australia from 1997-98, France from 1999-2000 and by a partnership of Philippines and Sweden for 2001-02. There are two new ICRI networks to conserve reefs: the International Coral Reef Information Network (ICRIN), established in 1999 to raise awareness about coral reefs, particularly targeting senior decision-makers; and the International Coral Reef Action Network (ICRAN) with funding from the UN Foundation to establish demonstration sites around the world showcasing successful MPA conservation projects and serving as major training facilities. The U.S. Coral Reef Task Force was formed in response to President Clinton's Executive Order 13089 in June 1998 to conserve the coral reefs under U.S. jurisdiction and assist in international activities.

Calls for Assistance from Coral Reef Countries

Many countries asked for the following assistance:

- Coral reef monitoring should be expanded with more training and employment of staff and funding for logistics, monitoring and databases. Monitoring should be encouraged in communities and volunteers to foster ownership.
- Greater coordination of existing monitoring is needed to ensure that data and information are delivered in a timely manner to the world. The GCRMN will assist with such coordination.
- Small marine protected areas are often successful, but surrounded by devastation. These need to be networked to include multiple users and communities, to address catchment area and trans-boundary problems and to accommodate industrial and tourism development along with traditional uses.
- Coral reefs are generally self-repairing systems, however, practical and low-cost rehabilitation methods may be warranted where recovery is not proceeding normally. Such methods must be effective at the scale of the damage, and not logistically expensive gimmicks that operate only at small scales.
- Where traditional rights and management practices exist, they should be recognized and incorporated into state laws to allow for co-management of coastal areas. Many effective traditional, conservation practices are being eroded under state and international law and 'western' influences.
- Many countries requested legal assistance to balance conservation and development. Many laws from colonial times focused on sectoral rather than integrated management; for example, optimized fish or forest harvesting. Countries need to redraft statutes to remove multi-sectoral overlaps in jurisdiction over coastal resources and promote sustainable use, including establishing MPAs.
- Many countries are concerned that global climate change may destroy their coral reefs, and they requested assistance in assessing future climate change impacts and alternative energy programs. Coral reef countries strongly urged developed countries to curb greenhouse gas emissions, to save their coral reefs and countries.

Future Predictions for Coral Reefs

We suggest that 40 percent of the world's coral reefs will be lost by 2010, and another 20 percent in the 20 years following unless urgent management action is implemented. While these figures are alarming, recent events show that they may be conservative. The continuation of severe anthropogenic stresses from growing populations and economies and the shock that came with the 1998 mass bleaching event all indicate that urgent action is essential to conserve coral reefs.

Photo: Steve Turek

A pair of black, white, and yellow Bannerfish against a background of hard coral, Malaysia

The major human threats to coral reefs can be managed by providing alternative livelihoods and educating people about the stresses that degrade coral reefs. If increases in greenhouse gas emissions are confirmed as the trigger for global climate change, then events like the "El Nino-La Nina" of 1997-98 will recur with increased severity and frequency, and reverse any coral reef recovery. We cannot predict where or when the next bleaching event will occur, but we know that coral bleaching can obliterate pristine, remote reefs as well as reefs under human stresses. Poor management of human activities on reefs will slow any recovery; for example, over-fished reefs are overgrown with large fleshy algae that prevent coral recruitment.

Already 11 percent of the world's coral reefs have been lost and a further 16 percent are severely damaged. Some should recover; others will not and the worse is yet to come with probable significant reductions in coral cover and biodiversity. However, large areas of Pacific and Australian coral reefs, are under no immediate threat, except for climate change.

Useful References and Resources

This paper is partially based upon presentations at the 9th ICRS, Mini-Symposium D1, *Global Coral Reef Monitoring Network and Reef Check: Joint Symposium on Education, Monitoring and Management.*

Bryant, D., L. Burke, J. McManus, and M. Spalding. 1998. *Reefs at Risk: A Map-Based Indicator of Threats to the World's Coral Reefs.* World Resources Institute, Washington D.C. Web site: www.wri.org

English, S., C. Wilkinson, and V. Baker. 1997. *Survey Manual for Tropical Marine Resources 2nd Edition.* Australian Institute of Marine Science, Townsville, 390 pp.

Wilkinson, C. 2000. *Status of Coral Reefs of the World: 2000.* Global Coral Reef Monitoring Network and Australian Institute of Marine Science, Townsville, 363 pp.

ReefBase is the official database for the Global Coral Reef Monitoring Network, and is maintained by ICLARM - The World Fish Center. ReefBase provides online access or links to the to the published "Status of Coral Reefs of the World:2000" reports, regional and country reports, and to several unpublished reports which were used as the source material for the publication. In the future, users will be able to query interactively the GCRMN data to create custom tables and reports for a region or issue of interest. The Web site can be found at: www.reefbase.org/

The GCRMN is also supported on the NOAA coral reef home page at: http://coral.aoml.noaa.gov/gcrmn/

Details of monitoring methods are available from the AIMS Web site www.aims.gov.au

Reef Check is a global volunteer monitoring program and is a component of the GCRMN. Survey results from 1997 and 1998 are available for query at: www.reefcheck.org.

Reef Check – Status of Reef Health Indicators

Gregor Hodgson [1] and Jennifer Liebeler [2]

THE Reef Check program was established in 1997 to provide volunteer divers and local communities around the world with the tools needed to monitor the health of coral reefs. Now in its fifth year of operation, the volunteer program is active in over 60 countries and territories, and regularly offers regional training courses in the Caribbean and Pacific. In 1998, Reef Check became an official partner of the Global Coral Reef Monitoring Network, and was a major contributor of information for the *Status of the Coral Reefs of the World: 2000*.

Reef Check defined coral reef health based on a set of carefully chosen indicator organisms (please visit: http://www.ReefCheck.org). The organisms were chosen to be eco-holistic, representing a broad spectrum of key reef organisms sensitive to anthropogenic impacts. Indicators include spiny lobster, grouper, humphead wrasse, bumphead parrotfish, sea cucumbers, banded coral shrimp, algae and giant clams. Many of these organisms are destined for export and international trade. In 1997, the results of the first global survey of coral reefs provided the first scientific evidence of the global extent of the coral reef crisis. Subsequent Reef Check surveys of hundreds of reefs by thousands of divers each year have documented a dramatic decline in coral reef health. These results have been reported through standard scientific publications as well as via international and national press conferences.

Worldwide Reduction in High-Value Reef Organisms

During the 1997 survey, approximately 100 volunteer scientists trained and led over 750 volunteer divers in surveys of more than 300 reefs in 31 countries. The results revealed a dramatic worldwide reduction in high-value reef organisms due to overfishing and the use of damaging fishing methods. Most organisms selected as reef health indicators were completely absent from a high proportion of surveyed reefs.

Surveys have continued annually since 1997. The analysis of the data collected during 1998 and 1999 show similar patterns in abundance of key indicator organisms on reefs.

Photo: Reef Check

Volunteer conducting Reef Check survey

The results presented below were collected by over 300 marine scientists who trained and led more than 8,000 volunteer divers in surveys of over 1,000 coral reefs from 1997 to 1999. There is clear evidence of widespread damage to reefs due to overfishing, pollution, and coral bleaching linked to global warming.

Missing in Action – Reef Health Indicators

Lobsters

Lobsters were not found on 72 percent of the reefs surveyed from 1997-1999. Popular among commercial and recreational fisherman, lobsters were once ubiquitous on most reefs. Although lobsters are nocturnal, it is unlikely that many lobsters were missed, as the survey protocol requires searching crevices and lobster's long antennae typically extend outside the crevices and are easily identified.

Large Groupers

Large groupers (that is, larger than 30 centimeters) were missing from over 50 percent of the reefs surveyed. Large groupers are heavily fished throughout the tropics. Grouper were most common in the Red Sea, specifically at sites where no poison or dynamite fishing (common methods for fishing grouper) has occurred. Nassau grouper, the highly prized and previously abundant fish, was only found at 15 percent of the sites surveyed in the Caribbean.

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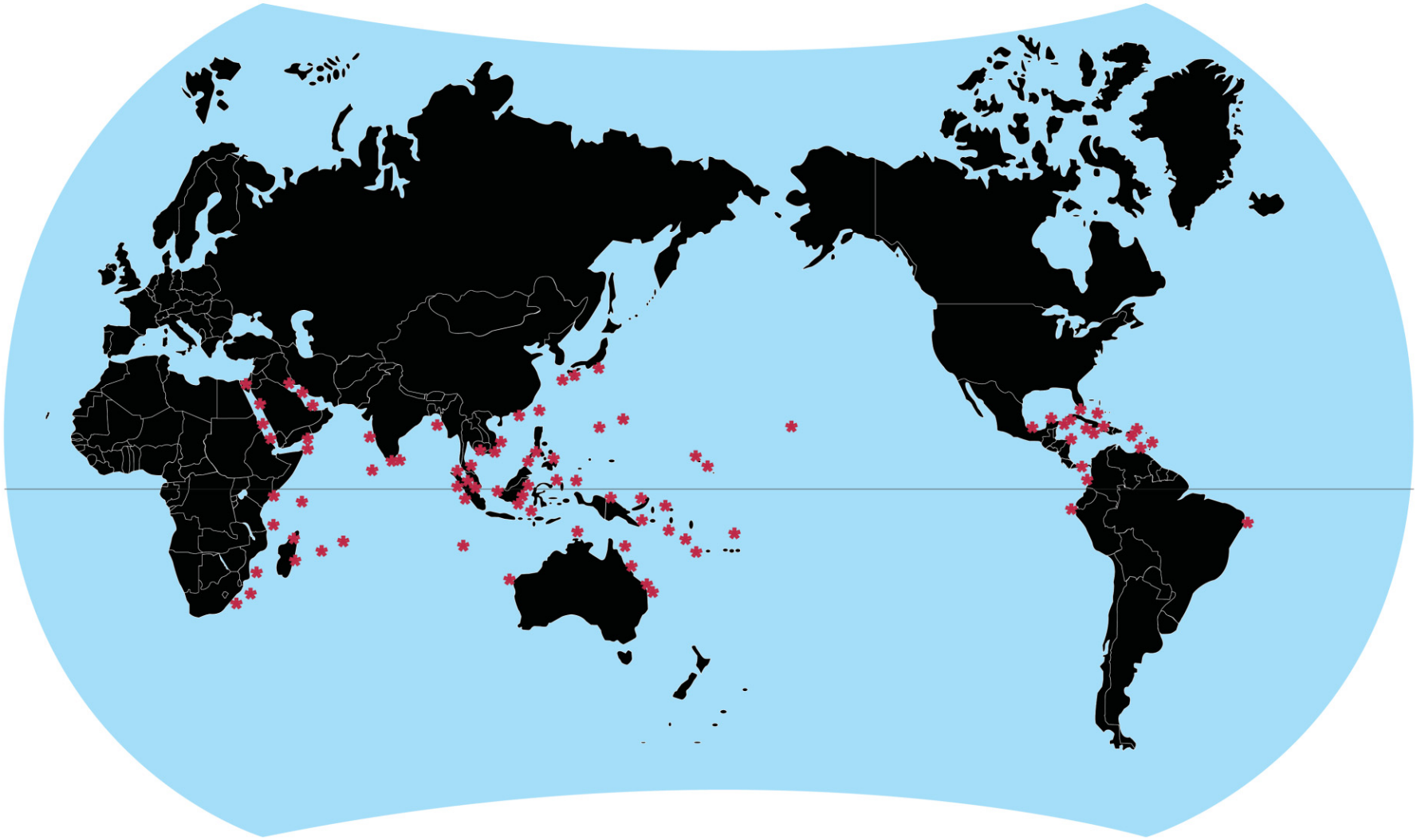
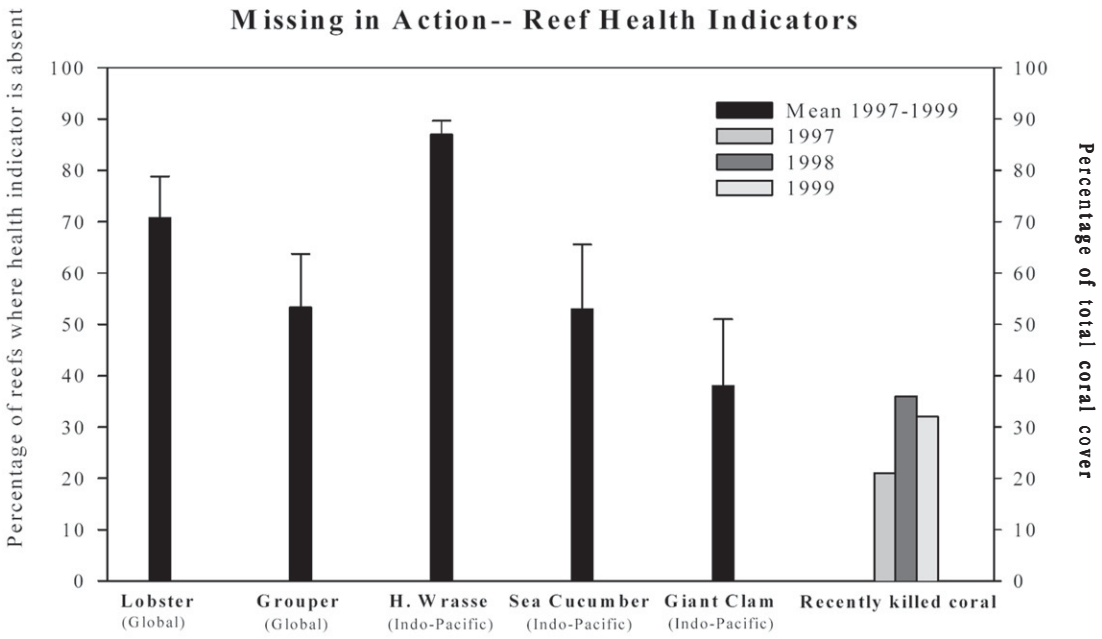
Reef Check Sites



1500 Reefs, 62 Countries and territories



Sweetlips fish

The Indo-pacific and Red Sea results for sweetlips (family Haemulidae) revealed similar abundance patterns, with a mean of less than 1 fish per survey site. There were more Haemulidae found in the Caribbean, with a mean of 2-10 fish per reef reported from almost half of the Caribbean sites. Biological differences among the different genera, as well as different levels of fishing pressure, may be responsible for the greater abundance of Haemulidae in the Caribbean than in the other regions.

Butterfly fish

Butterfly fish (family Chaetodontidae) also showed clear differences in abundance based on site. There was a higher percentage of sites with a low butterfly fish abundance in the Caribbean when compared to the Indo-Pacific or the Red Sea. Of all sites in the Caribbean, 48 percent had less than two butterfly fish per site, as compared to 13 percent in the Indo-Pacific and 3 percent in the Red Sea. However, the number of species of butterfly fish in the Caribbean and the Red Sea are five to ten times lower than in the Indo-pacific. More than 25 species of butterflyfish are collected for the marine aquarium trade; in some areas, overfishing is a major problem. A longer time series may help clarify these results.

Humphead wrasse

Over the three-year period, Humphead wrasse (*Cheilinus undulatus*) were only found at 14 percent of all reefs surveyed in the Indo-pacific. This may be a direct consequence of the high demand for these fish for international live fish trade – a full-grown Humphead wrasse can sell for up to US $10,000 in SE Asia.

Giant clams

On average, giant clams (*Tridacna* spp.) were completely absent from 40 percent of reefs surveyed in the Indo-pacific region over the three-year period. However, this indicator showed major differences between years — with no giant clams found at 23 percent of reefs in 1997, 53 percent in 1998, and 30 percent in 1999. Taken together, these results clearly indicate that another previously common reef dweller is now quite rare – especially large specimens which can only now be seen in museums.

Living Coral Cover

One component of reef health is the percentage of substrate covered by live coral. During 1997-1999 surveys, the mean percentage of living coral cover on reefs at the global scale has been relatively constant, at 33 percent (± 5 percent), over the three years. There were major regional differences. The Caribbean, which has been subjected to a high incidence of overfishing, the death of the long spined black sea urchin and subsequent algal overgrowth, has consistently recorded significantly lower living coral cover (21 percent ±15 percent) than the other two regions (Indo-pacific – 35 percent ± 17 percent; Red Sea – 31 percent ±13 percent, $p < 0.001$). Taken by itself, however, live coral cover can vary due to a variety of local factors such as percentage of sandy bottom found between coral patches. Therefore, a more meaningful component of reef health is the ratio of living coral cover to coral that has

recently died. The Red Sea has continued to have a higher ratio of live to dead coral (6:1) than the Caribbean (2.8:1) or the Indo-Pacific (3.5:1), showing that these coral reefs are among the healthiest in the world.

Recently Killed Coral

The percentage of coral that has died in the past year (recently killed coral/total coral cover) increased from 1997 (14.6 percent ± 24.6 percent) to 1998 (31.3 percent ± 39.9 percent). This was a result of the 1998 coral bleaching and mortality event that devastated reefs throughout all tropical oceans. That year, bleaching was reported at 30 percent of survey sites, with high mortality (up to 90 percent) in the Indian Ocean and parts of Asia. The severity of the event was illustrated by the death of 1000-year old corals in Vietnam and on the Great Barrier Reef. At the time, it was estimated that approximately 15 percent of the world's reefs died due to this one event in 1998. Using satellite tracking of temperature measurements provided by U.S. NOAA, Reef Check was able to follow global changes during and after this event using the standard Reef Check method throughout the world. Follow up surveys conducted in 1999 revealed that 30 percent of the corals that were reported dead in 1998 following the bleaching event had in fact recovered.

One of the more disturbing findings was that remote reefs, far from any city, are in just as bad shape as reefs near cities due to long distance fishing. For example, Pratas Reef (Dongsha) lagoon, (South China Sea) was a relatively healthy reef until it was decimated in 1998 by a fleet of several hundred blast and poison fishing boats from China and Hong Kong.

Although there is much natural inter- and intra- reef variation in the abundance of reef organisms, especially fish, the low numbers of organisms counted during three years of surveys at hundreds of the worlds "best" reefs confirm that overfishing and exploitation of reef organisms are problems on a global scale.

Over the next five years, the global network of enthusiastic volunteer divers and scientists will begin to disseminate information on how to manage the reef problems that have been identified. This type of community-level monitoring and management supported by Government efforts, may be the only realistic hope of saving the world's reefs from a downward spiral of overexploitation and damage.

Useful References and Resources

Hodgson, G. 1998. "Reef Check and sustainable management of coral reefs." Pp. 165-68. In: C.Wilkinson (ed) *Status of Coral Reefs of the World: 1998*. Australian Institute of Marine Science, Townsville, Australia 184 p.

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Wilkinson, C., O. Linden, H. Cesar, G. Hodgson, J. Rubens, and A. E. Stong. 1999. "Ecological and socioeconomic impacts of 1998 coral bleaching in the Indian Ocean: an ENSO impact and a warning of future change?" *Ambio* 28:188-196.

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