



Expert opinion of 372 coral reef scientists and managers from 96 countries and states is that:

- The world has 'effectively lost' 19% of the original area of coral reefs since 1950;
- 15% of coral reefs are in a 'Critical' state with loss possible within the next 10 to 20 years;
- 20% are seriously 'Threatened' with loss predicted in 20 to 40 years; and
- 46% of the world's reefs are regarded as healthy and not under any immediate threat of destruction...except for 'currently unpredictable' global climate threats.

'Effectively lost' means that these coral reefs are not functioning because there are: few live corals and the remaining corals are either broken, diseased or covered in sediment; fish populations are seriously over-fished with very few large predators and algal grazing fish; there is clear evidence of pollution with poor quality, turbid water; and reefs are being over-grown with macro-algae, sponges or other organisms favoured by polluted waters. This also means that the 500 million people dependent on these coral reefs could be deprived of reef goods and services in food, coastal protection and income from tourism in the near future.

Predictions of 'Critical' and 'Threatened' are based on a 'business as usual' scenario assuming that human stresses will continue to increase and no dramatic improvements will occur in coral reef management. Moreover, these predictions do not factor in the threats of global climate change - which are predicted to be inevitable, but without clear timelines.

The global climate change threats of ocean warming, increasing ocean acidification and more intense tropical storms are now regarded by the world's leading scientists and managers as the greatest threats to all of the world's coral reefs and that unless urgent action is taken soon to reverse the rate of greenhouse emissions, we are faced with massive losses of coral reefs around the world. This will mean extinction of species, diminished food supplies, loss of tourism potential and a reduction of coastal protection for low lying areas near coral reefs.

Since the last GCRMN report was issued in 2004, overall the coral reefs of the world have effectively 'marked time' because of a near balance between reef recovery and degradation.

Reefs in the Indian Ocean and western Pacific have recovered well after the climate change induced bleaching in 1998 and human damage. But the Indian Ocean tsunami, more bleaching, and human pressures have slowed or reversed recovery on many of these reefs. Those in the Caribbean have been less fortunate, due to the effects of the 2005 mass bleaching.

The critical issue emerging from the 2008 report is that about 500 million people have some dependence on coral reefs for food resources and supplementary income from fishing, coastal protection, building materials and income from tourism. Of these people about 30 million are almost totally dependent on coral reefs – including those who live on very low lying coral reef islands.

This report on the world's coral reefs in 2008, the International Year of the Reef, contains a mix of good and bad news. Coral reefs were damaged during the Indian Ocean tsunamis in late 2004, and 2005 was the hottest year in the Northern Hemisphere since 1998 with in massive coral bleaching and hurricanes throughout the wider Caribbean.

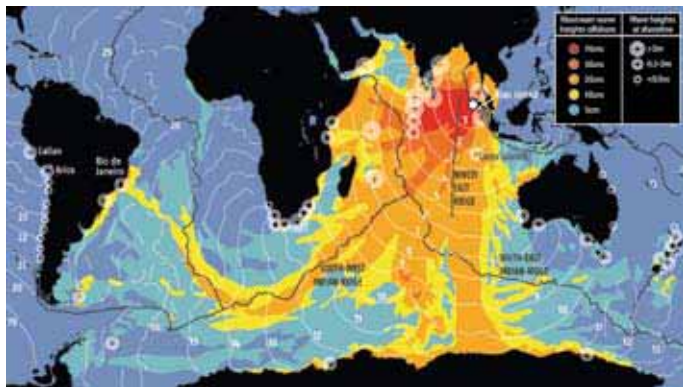
Increasing human pressures are damaging coral reefs near major centres of population, and there is increasing evidence that global climate change is threatening more and more coral reefs through warmer waters and rising ocean acidification.



THE DAMAGING EVENTS

The Indian Ocean Earthquakes Tsunamis of 2004

The largest earthquake for 40 years struck near Sumatra on 26 December 2004 and spread 1300 km to the Andaman Islands of India. Some reefs in Sumatra and the Andaman Islands were thrust out of the water, killing them almost instantly. The resulting tsunamis killed more than 230 000 people in Indonesia, Thailand, the Andaman and Nicobar Islands of India, Sri Lanka and devastated their lands and economies. There was significant damage to reefs in Indonesia, Thailand, the Andaman Islands, Nicobar Islands, Sri Lanka and the Maldives, with much of the damage caused by debris from the land or by dead coral rubble smashing or smothering other corals. Many broken corals have since recovered, but over-fishing and pollution from poor land use and inadequate treatment of wastes remain as the main threats to Indian Ocean coral reefs (from Wilkinson C, Souter D, Goldberg J (2006). *Status of Coral Reefs in Tsunami Affected Countries: 2005. Australian Institute of Marine Science and Global Coral Reef Monitoring Network, Townsville Australia, 154 p.*).



Coral Bleaching and Hurricanes in the Caribbean in 2005

2005 and 1998 were the hottest years, and most devastating, for coral reefs since global records started in 1880. In 1998, the damage was greatest in the Indian Ocean, Western Pacific and the Caribbean. In 2005, damage was confined to the wider Caribbean where coral bleaching and mortality compounded previous bleaching in 1987, 1995 and 1997–1998. Losses were extreme: 51.5% losses of live hard coral cover in US Virgin Islands; more than 50% of coral colonies bleached in Florida, Puerto Rico, the Cayman Islands, St. Maarten, Saba, St. Eustatius, Guadeloupe, Martinique, St. Barthelemy, Barbados, Jamaica and Cuba; up to 20% coral mortality on Barbados; 11–30% in the French West Indies, and Trinidad and Tobago. Also, 2005 was the most severe hurricane season ever with 26 tropical storms including 13 hurricanes, which damaged coral reefs. For example, coral cover was halved around Cozumel, Mexico. Many stressed and bleached corals subsequently died from coral diseases in 2006 and 2007 (from Wilkinson C, Souter D, (2008). *Status of Caribbean Coral Reefs after Bleaching and Hurricanes in 2005. Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville Australia 152 p.*).

Plagues and Diseases: New outbreaks of crown-of-thorns starfish (COTS) are devastating coral reefs in Egypt, Kenya and Tanzania; as well as parts of South-east and East Asia, especially the Philippines, Japan and China; and in Guam, Majuro Atoll (Marshall Islands), Fiji and French Polynesia in the Pacific. Diseases devastated coral populations throughout the wider Caribbean in 2005 and 2006 following mass coral bleaching. This was similar to losses in 1980s and 1990s and particularly affected species of *Acropora* and the *Montastraea annularis* complex with significant losses of coral cover.



"Solomon Islands April 2007: A severe earthquake lifted islands and reefs out of the water, and deprived local villages of their prime fishing areas."



POSITIVE ACTIONS

This 2008 report also highlights good news in major conservation advances:

The **Coral Triangle Initiative** was signed in 2006 by the governments of Indonesia, Philippines, Malaysia, Papua New Guinea, the Solomons and Timor Leste to conserve coral reefs with the highest biodiversity. President Yudhoyono of Indonesia marshalled international assistance to conserve the biodiversity, fisheries and food security potential of the vast marine resources surrounding thousands of islands. This was a response to calls by the Convention on Biological Diversity and the World Wildlife Fund (WWF) to reduce losses in biodiversity and set up networks of Marine Protected Areas. New partnerships are being forged with governments, UN agencies and big NGOs.

The **Micronesia Challenge** arose at the same time when Palau, Federated States of Micronesia, the Marshall Islands, Guam and the Northern Mariana Islands pledged to conserve at least 30% of their marine resources and 20% of terrestrial resources by 2020. They are seeking international assistance to establish new MPAs and strengthen existing ones to conserve 61% of the world's coral species, more than 13 000 species of reef fishes, 85 species of birds, 1400 species of plants; all with considerable cultural significance.

The **Caribbean Challenge** was launched in 2008 with The Bahamas, Dominican Republic, Jamaica, Grenada, St. Vincent and the Grenadines pledging to conserve 20% of their marine and coastal habitats by 2020 because the livelihoods and cultures of 10 million people depend on these resources. Other Caribbean countries are also considering joining to pool their resources and capacity to fund rangers,

patrol boats, scientific expertise and education programs in new and existing MPAs.

The two largest marine protected areas in the world were recently declared in the Pacific. The **Papahānaumokuākea Marine National Monument** was upgraded to highly protected status by the USA to take in the 356 893 km² of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, previously designated in 2000. The Government of Kiribati declared the Phoenix Islands Protected Area (PIPA) with help from major NGOs to make this the largest MPA in the world at 410 500 km². These eclipse the Great Barrier Reef Marine Park established in 1975 and upgraded in 2004 which has 115 395 km² as no-take status out of the total 344 400 km².

In June 2008, the World Heritage Commission listed a large part of New Caledonia for special protection, including 15 743 km² of coral reefs. They acknowledged that these reefs are of global significance with a large concentration of biodiversity resources.

Coral reefs in the Indian Ocean, especially in the Seychelles, Chagos and the Maldives, and Palau in the Western Pacific, have continued to recover from the devastating bleaching of 1998.

Socioeconomic assessments are increasingly being used to improve coral reef management decision making. Through the GCRMN, a series of socioeconomic assessment manuals and guidelines have been produced for many parts of the world and translated into local languages. Local communities are increasing their awareness of the need to protect their coral reefs through community-based management. The Fiji Locally Managed Area (FLMMA) program is leading the way by incorporating traditional systems of temporary closures (or tabus).



STATUS OF CORAL REEFS AROUND THE WORLD

Middle East: Reefs in Red Sea and Gulf of Aden continue to be healthy with high coral cover and only minor damage from coral bleaching and crown-of-thorns starfish; in contrast, reefs in the **Persian Gulf, Arabian Sea and Gulf of Oman** were devastated in 1996, 1998 and 2002 due to climate related stress and the massive cyclone 'Gonu' in mid 2007. Corals have also been destroyed during massive coastal development along the Arabian Peninsula.

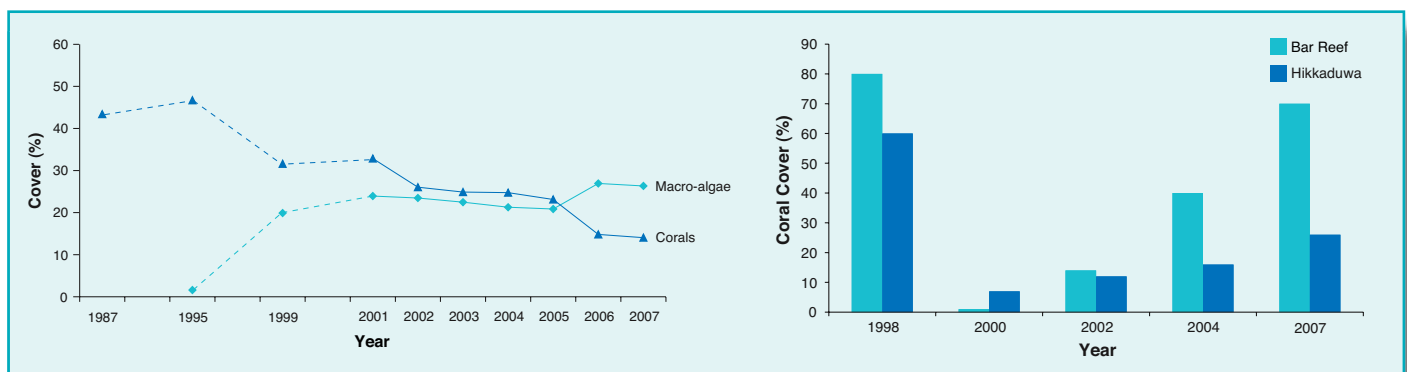
Indian Ocean: Reefs in **Eastern African** recovered well after massive bleaching losses in 1998; however growing populations and coastal developments are slowing recovery, especially outside MPAs. More local communities are now involved in coastal management. **Southwest Indian Ocean Islands** reefs also recovered well after 1998, especially parts of the Seychelles and Comoros; whereas Madagascar and Mauritius continue to lose coral cover due to human pressures. Effective reefs management has aided coral recovery. In **South Asia** there is a mix of reef decline due to human damage, and amazing reef recovery in the western Maldives, Chagos, Lakshadweep Islands of India and on northwest Sri Lanka; some reefs increased from 5% coral cover to 70% in 10 years.

Asia: Reefs in the Coral Triangle Initiative countries in **Southeast Asia** (Indonesia, Philippines, Eastern Malaysia, and Timor Leste) continue to decline due to over-fishing, increasing sedimentation and urban and industrial pollution from the rapid economic development; government and NGO conservation efforts are inadequate and 50% of the mangroves have been lost. Reefs in **Northeast Asia** are also declining under significant human, bleaching and crown-of-thorns starfish pressures. Conservation awareness is increasing as economies develop and regional cooperation increases.

The Pacific and Australia: Reef management in Australia continues as the conservation benchmark, with the Great Barrier Reef being well managed and relatively stable, and rapid increases in management in Western Australia. Climate change, cyclones and poor inshore water quality remain the major threats. Reefs of Papua New Guinea are predominantly

healthy; mainly due to low population pressures rather than good management, with NGOs providing the only effective management with local communities. The outlook is encouraging in **Micronesia** with good reef recovery especially in Palau. More MPAs will be declared via the Micronesia Challenge. Similarly reefs in the **Southwest Pacific** are predominantly healthy, but fishing and coastal developments are increasing. Climate-related bleaching remains the greatest threat, while the Locally Managed Marine Area network in Fiji leads the way with community management based on traditional practices. Most reefs in **Polynesia Mana** are remote from land and human pressures, and may serve as biodiversity reserves with coral bleaching and ocean acidification as the major threats. The US Pacific presents a large contrast; the Northwest Hawaiian Islands are near pristine, whereas reefs around the Main Hawaiian Islands suffer from over-fishing and sediment pollution. Management efforts are increasing rapidly.

The Wider Caribbean: There were massive coral bleaching and hurricane damage in 2005. Reefs of the **US Caribbean** have been intensely researched, monitored and managed, but pollution from the land and over-fishing continue to cause damage. The remote Tortugas and Flower Garden Banks are well managed and healthy. The US Congress is revising the 'Coral Reef Conservation Act' to improve conservation through reef restoration and strengthened international programs. The nearby **Northern Caribbean and Western Atlantic** region has reef recovery and conservation in Bermuda, the Cayman Islands and Cuba, but reefs in the other countries are either unchanged or continuing to decline due to bleaching, diseases and pollution. In the **Lesser Antilles** there was particularly severe bleaching and disease in 2005 with some countries reporting 50% loss of coral cover; all exacerbated by pollution and over-fishing. The Caribbean Challenge may help reduce some human damage. Reefs along the **Mesoamerican Barrier Reef** have continued to decline after severe losses in the 1980s; many reefs lost more than 50% coral cover. Bleaching and hurricanes in 2005 caused considerable local destruction. Major programs have raised capacity and improved MPA management. News is both good and bad in the **Southern Tropical Americas**; reefs close to land continue to suffer from pollution and sediment runoff, however more remote reefs show increasing coral cover.



These two figures show major differences in the world's coral reefs. Corals on Bar Reef and Hikkaduwa marine parks, Sri Lanka have recovered dramatically after coral bleaching devastation in 1998 (left). Whereas corals on French West Indies reefs have declined from a mean of 40 - 45% cover observed in occasional monitoring in 1987 and 1995, to about 15% mean cover after the 2005 bleaching; large macro-algae have increased considerably (right).

CLIMATE CHANGE, CORAL REEFS AND THE INTERNATIONAL CORAL REEF SYMPOSIUM

Serious global climate change threats to coral reefs were confirmed by 3500 of the world's leading coral reef scientists and managers in Florida in July 2008. The news from these scientists was far from encouraging. The major consequences of increasing greenhouse gases will be:

- more coral bleaching from warmer oceans,
- rising ocean acidification from more dissolved carbon dioxide (CO₂),
- more severe storms, and
- rising sea levels that will drown some coral reef nations.

Climate change is proceeding faster than in previous ice-age transitions and coral reefs and corals are falling behind and suffering fever-high temperatures and rising acidity. There are some hopeful signs, but no single, easy remedy.

NOAA satellites reveal tropical oceans have warmed significantly faster rate during the last 10 years, suggesting that there are only 8–10 years left to turn the tide because CO₂ concentrations in seawater above 450 ppm threaten the existence of coral reefs as we know them. Already 33% of the world's coral species are at high risk of extinction following widespread losses since the 1970s. Healthy and resilient coral reefs can respond vigorously to damage; but climate change stresses are eroding that resilience. For example, ocean acidification will prevent juvenile corals from settling and make adults more fragile.

Genetic studies are now showing how reefs and their organisms are connected. Genes have been isolated within new symbionts that make some corals more resistant to temperature extremes and coral bleaching by allowing corals to grow at higher temperatures, or by producing antioxidants to soak up toxic oxygen products. This will assist managers in designing networks of MPAs to incorporate such resilient species. Genes also code for signals to tell other corals when they are ready to spawn, ensuring synchronised activity. The role of microbes is becoming clearer and more important in nutrient cycles, in responding to climate change, and in disease; but many coral reef organisms appear to be developing an immunity to diseases.

Problems for reef managers are increasing as 50% the world's population will live along coasts by 2015, putting unsustainable pressures on coastal resources. The reefs they manage will likely contain less attractive, but tougher corals. Rising food and fuel prices are resulting in over-fishing and serial depletion of fish stocks in many poor countries. 'Healthy Reefs for Healthy People' is a useful theme to link national economics, tourism, livelihoods, food security, cultural and spiritual well-being into reef management, especially via multiple-use Marine Protected Areas linked into networks and managed by all stakeholders (more information is on <http://www.nova.edu/ncri/11icrs/>).

We may be losing some animals from stressed coral reefs. Crinoids (feather stars) and ophiuroids (brittle stars) are disappearing off reefs near Florida and the Netherlands Antilles; while sea snakes are becoming particularly scarce on reefs off Western Australia, where they were once abundant. Is climate change behind these losses?



RECOMMENDATIONS FOR ACTION TO CONSERVE CORAL REEFS

Experts from around the world have made the following high priority recommendations to conserve coral reefs for future generations; more are within the report.

- **Urgently combat global climate change** – unless there are urgent reductions in current rates of emissions of greenhouse gases, climate change will threaten the long-term future of coral reefs. Scientists estimate that the world has 8 to 10 years before galloping climate change will start to devastate coral reefs;
- **Maximise coral reef resilience** (by minimising direct human pressures on reefs) – damaging human activities of over-fishing and destructive fishing, sediment pollution from poor land use, runoff of nutrients and other pollution, and habitat loss through unsustainable development continue to ‘irreversibly’ damage coral reefs. Controlling these threats will improve the resilience of coral reefs to resist climate change losses. Developing countries need assistance to improve local catchment and coastal management through community-based management and to develop alternative livelihoods that take pressures off reefs.
- **Include more reefs in MPAs** – a proven and effective governance approach for conserving coral reefs and promoting sustainable use is to include them in effectively managed marine protected areas (MPAs). These should preferably contain large fishery reserves or no-take areas, and be linked into a network of MPAs with effective management and government support.
- **Protect remote reefs** – in the future, the largest reservoir of coral reef biodiversity will be on coral reefs remote from continental land masses and human populations. If these are protected, they can serve as replacement stocks of juveniles and larvae for damaged reefs. The examples mentioned above in the Pacific can be expanded and developed elsewhere. Developed countries have the best governance and enforcement capacity resources to protect reefs in their national waters.
- **Improve enforcement of MPA regulations** – effective and enforceable governance systems are essential to regulate access to and exploitation in managed ecosystems. Developing countries need assistance to establish effective enforcement systems that are compatible with local cultural values and practices.
- **Help improve decision making with better ecological and socioeconomic monitoring** – increased monitoring is necessary to provide information to natural resource managers and decision-makers on the impacts of imminent climate change threats, so that appropriate actions can be taken to reduce threats to reefs and coastal communities.

Clive Wilkinson, Coordinator

Global Coral Reef Monitoring Network
Reef and Rainforest Research Centre
Townsville, Australia
clive.wilkinson@rrrc.org.au; www.gcrmn.org

Christy Loper, Coordinator

Global Socioeconomic Monitoring Initiative.
NOAA, USA
Christy.loper@noaa.gov ; www.reefbase.org/socmon

Gregor Hodgson, Director,

Reef Check Foundation
Pacific Palisades, California
gregorh@reefcheck.org; www.ReefCheck.org

Jamie Oliver, Senior Scientist,

ReefBase, The WorldFish Center
Penang, Malaysia
J.Oliver@cgiar.org; www.reefbase.org

