

Understanding Coral Bleaching Across Four Oceans



Bleaching

Connectivity

Disease

Modeling

Remote Sensing

Restoration

Introduction

Coral bleaching is rapidly developing as a major problem for the health of coral reefs worldwide and is projected to rise rapidly over the next 50-100 years. Unfortunately, major gaps exist in our knowledge of the basic biology of coral bleaching. Filling these critical knowledge gaps is important if we are to build the tools and management practices that will minimize the impacts of coral bleaching.

Climate change, coral bleaching and the future of reefs?

Coral bleaching is a response to stress and involves the loss of the symbiotic algae that live living in the tissues of reef-building corals. These algae create the abundant energy that is needed to power the rapid calcification of corals. If corals lose their symbiotic algae, their ability to build the framework that creates the habitat for an estimated 1 million animal, plant and protist species is severely compromised. Recent mass bleaching events have destroyed coral reef habitat in many regions of the world.

Different types of environmental stress can trigger bleaching. However, increased sea surface temperature of 1-2°C above long term summer averages is the main driver. Events of this nature are increasing in frequency—in 1998 alone (a very warm year), mass coral bleaching extinguished an estimated 16% of the world's coral populations.

Predicted increase in sea surface temperature suggests coral mass bleaching will become a regular phenomenon within few decades. At present, we are ill-equipped to respond to the management challenges associated with this trend.

The physiological mechanisms and the longer-term ecological impacts of coral bleaching are still poorly understood. One central question is: can corals adapt to rapidly increasing sea temperatures? Other unknowns relates to the rate of reef decline, the after-effects, and longer-term implications for society. From a human perspective, we need to know how these changes to coral reef ecosystems will affect the many millions of people (and the billion dollar industries) that depend on coral reefs for survival.

International expert group on coral bleaching

In response to this situation, an group of international experts (IOC/UNESCO Working Group on Coral Bleaching and Local Ecological Responses) was formed in September 2000 to identify and fill critical knowledge gaps. Four areas are being emphasized within this project:

1. Investigation of the basic mechanisms that underpin coral bleaching and mortality on coral reefs

2. Discovery of basic tools and biomarkers (molecular to ecological) for identifying and tracking changes in the quality and quantity of stress on coral reefs.
3. Map the ecological ramifications of the changes on coral reefs immediately preceding, during and following mass coral bleaching. As part of this, to understand if corals and the reefs they build have any chance of acclimating or adapting to the changes being forced upon them.
4. Model long-term changes in coral reefs and project the corresponding socio-economic ramifications.

The effort is being developed in partnership with the GEF/World Bank Coral Reef Targeted Research program and will generate new insights and management tools to help mitigate the impacts of coral bleaching and other threats to the sustainability of coral reefs.

Critical questions

The Coral Bleaching Working Group is addressing a number of critical questions, such as

- Are coral reefs resilient in the face of projected climate change over the next 100 years? If not, how will they change and how fast?
- Is a primary factor such as temperature affected by secondary factors such as light, water quality and ecological status?
- Why are some corals more tolerant than other species?
- What mechanisms underpin the ability of reefs to recover from mass coral bleaching?
- Are the phase shifts that have been seen so far on coral reefs permanent?
- What are the socio-economic ramifications of increasing sea temperatures and declining carbonate ion concentrations on the human populations that depend on coral reefs for their existence.

Global targeted research

Research pursued with the Coral Bleaching Working Group (BWG) will be focused within four regions—allowing key hypotheses be tested thoroughly. The work plan will involve researchers, managers and students within these regions, engendering increased capacity within these regions for research activity to underpin decision making and management reform. A full program of research workshops and seminars, training courses and postgraduate fellowships will ensure a broad interaction and exchange between local and foreign researchers in each region.



The development of new tools is a core activity within the BWG. The program in this respect will generate tools and techniques applicable to a wide range of problems facing both developed and developing nations.

Some examples of the tools that are planned include:

- Molecular markers that will rapidly and easily distinguish heat stress from other types of stresses (e.g. sedimentation, metal contamination, nutrient stress) on coral reefs.
- Cellular markers that will enable users to accurately anticipate and monitor the advent of coral bleaching or recovery.
- Genetic markers that will enable insight into the tolerance and resilience of communities of reef-building corals.
- Ecological markers that will enable users to monitor impacts of coral bleaching and to project how the changes are likely to impact on local ecosystem function.

Other outputs of this BWG will involve predictive models and scenarios that will test notions of the future under different climate scenarios. These models will enable better projections of the potential impact of climate change on coral reefs, and allow better forecasting of the potential impacts on human communities relying upon them for their livelihoods.

Capacity Building:

Global collaborative research will focus to build research expertise and management capacity at institutions in developing countries, with joint field sites being established at institutions in representative ocean areas. In this regard, the program will provide:

- Training-through-research opportunities
- Graduate scholarship for developing country scientists
- Seminars and training courses to spread new knowledge and techniques
- Technology transfer and skill development
- Strengthened national research and management capacities through new expertise and skills.

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This project is part of a major initiative of the World Bank, with support of the Global Environmental Facility, to provide the best available scientific information on coral reef response to environmental disturbances and climate change. The "Coral Reef Targeted Research and Capacity Building for Management" project aims to conduct specific, targeted research to fill critically important information gaps in the fundamental understanding of coral reef ecosystems so that management and policy interventions can be strengthened globally.