Research Update 08

New frontiers of remote sensing for reef management

Remote sensing provides valuable information that resource managers can use at all stages of coral reef conservation. The Remote Sensing Working Group of the Coral Reef Targeted Research & Capacity Building for Management (CRTR) Program has been working to enhance remote sensing tools to better enable coral reef management.

Measuring stress on coral reefs

Photo: Kathryn Rosell

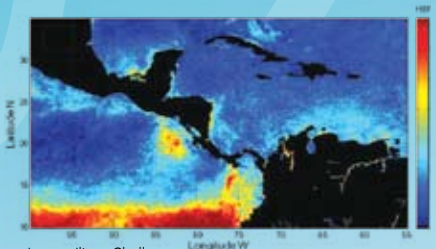

Image: Iliana Chollett

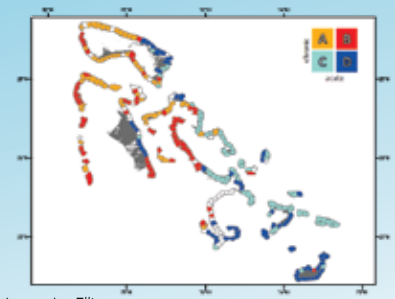

Image: Ian Elliott

Photo: Ernesto Weil

Detecting coral bleaching events

Satellite-based measures of sea surface temperature (SST) can be used to predict the occurrence of bleaching events. The methods used to predict bleaching are currently being improved by adding measures of sunlight that should provide better prediction of coral mortality in the near future. Direct observation that reefs have bleached might be possible from space in areas of high coral cover (>40%) and during severe bleaching events.

Upwelling areas as refuge from coral bleaching

The cool waters generated by coastal upwelling have been heralded as possible refugia from bleaching. However, an analysis of major upwelling systems in the Americas reveals that opportunities for managing bleaching threats are limited. Upwelling tends to occur from January to March which does not coincide with the summer period of major thermal stress in the Caribbean. A few exceptions occur, such as in Colombia where a second period of upwelling occurs in summer. Bleaching-like conditions can occur at any time of year in the eastern Pacific which means that winter upwelling is unlikely to be a reliable mitigator of thermal stress.

Mapping effects of coral bleaching

The level of warming reefs experience during a coral bleaching event varies from one reef to another. These patterns can be mapped and included in the design of marine reserves. For example, areas that usually experience warm conditions in summer but relatively weak warming during bleaching events are likely to fare better in the future and can be located by analysing satellite measures of sea surface temperature. Satellite-derived global maps of such bleaching refugia will be available by the end of 2010.

Forecasting disease events

Understanding the relationship between both summer and winter ocean temperatures may allow us to provide managers and decision makers with an advance indication that major outbreaks of coral disease are either likely or unlikely. Using satellite monitoring of ocean temperatures, new warning products should become available from NOAA's Coral Reef Watch (http://coralreefwatch.noaa.gov) in the near future.

The Coral Reef Targeted Research & Capacity Building for Management Program (CRTR) is a leading international coral reef research initiative that provides a coordinated approach to credible, factual and scientifically-proven knowledge for improved coral reef management.

The CRTR Program is a proactive research and capacity building partnership that aims to lay the foundation in filling crucial knowledge gaps in the core research areas of Coral Bleaching, Connectivity, Coral Diseases, Coral Restoration and Remediation, Remote Sensing and Modeling and Decision Support.

Each of these research areas are facilitated by Working Groups underpinned by the skills of many of the world's leading coral reef researchers. The CRTR also supports four Centres of Excellence in priority regions, serving as important regional centres for building confidence and skills in research, training and capacity building.

The CRTR Program is a partnership between the Global Environment Facility, the World Bank, The University of Queensland (Australia), the United States National Oceanic and Atmospheric Administration (NOAA) and approximately 50 research institutes and other third parties around the world.

May 2009

Product code: CRTR 001/2009

Mapping reefs and spatial decision making

Mapping reef habitats

Relatively subtle differences in reef habitats can be mapped by combining traditional satellite or airborne remote sensing with boat-based towed sonar systems. Sonar systems discriminate the roughness and depth of the seabed and help distinguish reef habitats that differ in their structural complexity such as branching coral habitats, massive coral heads (e.g. *Porites* bommies), *Montastraea*-dominated reefs, and gorgonian plains. These methods can improve the detail of habitat maps, particularly for deeper forereef areas (to a maximum depth of about 15 metres).

Monitoring reef complexity

Boat-based sonar systems can be used to map and monitor the structural complexity (also known as "rugosity") of reefs rapidly and over large areas. Areas of high rugosity tend to have higher biodiversity and declines in rugosity (caused by forces like coral mortality or increased bioerosion) pose a problem for the recruitment of many reef species as well as their ability to live within the reef structure.

Finding good habitat for reef fish

Maps of rugosity and microhabitat distribution from boat-based sonar systems provide sufficient detail so that the quality of habitat for juvenile and small-bodied reef fish can be mapped in both the Caribbean and Indo-Pacific. These maps can be used to locate areas likely to have high fish recruitment and help in the design of monitoring programs so that similar habitats are compared among sites (e.g. between reserve and non-reserve areas).

Mapping reef biodiversity

Marine reserves often aim to include representative portions of each habitat as part of a strategy to conserve marine biodiversity. Studies from the Caribbean have quantified the biodiversity of various reef types and found that they differ dramatically in their overall biodiversity. For example, *Montastraea* reefs can harbour around 70% of all fish and macrobenthic species on Caribbean reefs, and are a priority for inclusion in reserves. To represent 100% of reef fish species, the reserve network should include representative portions of all reef, mangrove and lagoon habitats. Patterns of reef fish diversity among habitats are easy to measure in the field and form a reasonable surrogate for other (benthic) species in the system.

Image: Peter Mumby

Photo: Ian Sotheran

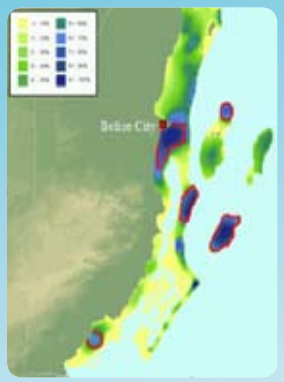

Image: Peter Mumby

Photo: Peter Mumby

In other words, field data on reef fish diversity are reasonably representative of the wider reef diversity for Caribbean marine systems.

Designing marine reserves for coral bleaching and larval connectivity

The design of marine reserves is often aided by reserve selection software such as Marxan (www.ecology.uq.edu.au/marxan.htm). New algorithms have been developed for use in Marxan that allow potential networks of reserves to be identified based on the likely response of reefs to future coral bleaching, levels of larval connectivity among reefs, and the degree to which the reserve system supports fisheries production or biodiversity conservation.

Spatial patterns of reef resilience

Reef algae tend to grow more slowly in areas that are sheltered from waves because they receive lower nutrient supply. Ecological models predict that reefs located in such environments are less likely to experience blooms of macroalgae, providing that herbivores are managed wisely. Areas with higher wave energy are potentially more vulnerable to algal blooms, especially if herbivores are depleted and/or coral cover drops to low levels. Wave energy can be modelled on reefs using two remote sensing products: (1) free Landsat TM imagery that allows the fetch to be calculated for a reef (i.e. the distance over which waves can build up before breaking on a reef), and (2) QuikSCAT data on wind direction and speed.

Easy access to data & new training products

An online directory of satellite data products relevant to reef management is now available at http://coralreefwatch.noaa.gov/satellite/education/index.html. All satellite data involved in predicting coral bleaching events can now be downloaded directly over the Internet and products can be viewed on Google Earth. Training lessons on using remote sensing for habitat mapping and coral bleaching prediction are available for use with the free software Bilko for Windows.

Produced by the CRTR Remote Sensing Working Group with colleagues in the Coral Disease, Coral Bleaching and Connectivity and Large-Scale Ecological Processes Working Groups.

For further details see: www.gefcoral.org

Further Information

Remote Sensing Working Group
Chair: Prof. Peter J Mumby
University of Exeter
Email: p.j.mumby@exeter.ac.uk

Co-Chair: Dr Laura T David
University of the Philippines
Email: ldavid@upmsi.ph

Project Executing Agency:
Coral Reef Targeted Research & Capacity Building for Management Program
C/- Centre for Marine Studies
The University of Queensland
St Lucia QLD 4072
Australia

Telephone: +61 7 3346 9942
Facsimile: +61 7 3365 4755
Email: info@gefcoral.org

GEF

The University Of Queensland AUSTRALIA

www.gefcoral.org