11TH INTERNATIONAL CORAL REEF SYMPOSIUM
July 7-11, 2008

OUTCOMES OVERVIEW

Synopsis

A defining theme of the 11th International Coral reef Symposium is that the news for coral reef ecosystems is far from encouraging. Climate change is now much faster than in an ice-age transition, and coral reefs continue to suffer fever-high temperatures as well as sour ocean conditions. Corals may be falling behind, and there appears to be no special silver bullet remedy. Nevertheless, there are hopeful signs that we should not despair.

Reef ecosystems respond vigorously to protective measures and alleviation of stress. For concerned scientists, managers, conservationists, stakeholders, students, and citizens, there is a great role to play in continuing to report on the extreme threat that climate change represents to earth's natural systems. Urgent action is needed to reduce CO_2 emissions. In the interim, we can and must buy time for coral reefs through increased protection from sewage, sediment, pollutants, overfishing, development, and other stressors, all of which we know can damage coral health.

The time to act is now. The canary in the coral-coal mine is dead, but we still have time to save the miners. We need effective management rooted in solid interdisciplinary science and coupled with stakeholder buy-in, working at local, regional, and international scales alongside global efforts to give reefs a chance.

Introduction

The 11th International Coral Reef Symposium concluded a marathon week (July 7-11, 2008) with over 3,500 attendees from 75 countries; 1032 oral and 1600 poster presentations; 26 mini-symposia; 3 special sessions; 20 field trips; addresses by 6 distinguished plenary speakers (Malcolm McCulloch, Joan Kleypas, Roberto Iglesias-Prieto, Robert Cowen, Drew Harvell, Daniel Pauley), the Darwin Medalist (Terry Hughes), the ISRS President (Richard Aronson), NOAA Administrator Vadm.Conrad

Lautenbacher, and also by Florida's governor Charlie Crist, US Congressmen Ron Klein and Brian Baird, and Florida representative Ellyn Bogdanoff; 40 sponsorships from diverse government agencies (including Co-Sponsorships from the state of Florida, NOAA, and DOI), academic institutions, NGOs, and private industry; scores of exhibits; and a fine educational center.

The Local Organizing Committee and Super-Chairs of the 26 Mini-Symposia (scientific sessions) provide this overview to highlight outcomes.

Coral Reefs Under Threat: Many Actions Can Help

Over a third of the world's coral species are at elevated risk of extinction. Reefs of the Western Atlantic have generally decreased in living corals since the 1970s, and although reefs of the Great Barrier Reef were resilient until 1996, they are now beginning to struggle. It is good news that reefs far from continents and direct human pressures, including Bermuda in the Atlantic; the Flower Garden Banks in the Gulf of Mexico; American Samoa, Fiji, Palau, and French Polynesia; and the islands of the Andaman Sea, Chagos, and western Maldives in the Indian Ocean are still resilient and able to recover from damage. We still have some time!

The degradation and ponderous recovery of many reefs are due to combination of the global stresses of climate change coupled with regional and local stressors including runoff from agriculture, other land-based sources of pollution, over-fishing, and habitat destruction associated with coastal development.

Climate Change Effects of Warming and Acidification

Many studies have laid down stepping stones to understand ongoing changes in coral and fish community dynamics. A prime driving factor is climate change. NOAA satellites reveal tropical oceans have warmed at a significantly faster rate over the past decade. Coral cover in many locations remains low and is not recovering. This is especially true in areas that have experienced severe bleaching, a phenomenon on the increase with increasing ocean warming. Such changes are not restricted to corals. Coral loss clearly leads to loss of associated organisms; decreasing fish abundance and diversity, for example, go hand in hand with loss of corals and decreasing coral cover.

Ocean acidification and ocean warming can be thought of as the 'evil twins' of climate change. The same carbon dioxide that causes ocean warming is entering the oceans and causing chemical changes (i.e., lowered pH, lowered carbonate ion concentration) that affect marine life. Coral reefs are threatened because carbonate ions, essential for building their calcium carbonate skeletons, become less available. Reef structures are further endangered because lowered pH is likely to reduce resistance to erosion. In the naturally more acidic waters of the eastern Pacific, for example, reefs are less fortified by calcium carbonate cements and experience higher erosion rates than other reefs. It has been suggested that to save reefs, we cannot exceed 450ppm CO_2 in seawater. At the world’s current rate of CO_2 emissions, we have 8-10 years to turn the tide.

There is mounting evidence that acidification can cause a slow down in the growth of corals and in coralline algae, both vital to the reef structure. Results presented at the Symposium show that calcification rates in many corals are already declining from a combination of factors including increasing temperature, decreasing water quality, and ocean acidification. In addition, ocean acidification is now shown to reduce the ability of coral larvae and coralline algae to successfully settle and grow new colonies, which will affect the ability of degraded reefs to recover through reseeding with larvae.

We can expect winners and losers in warmer and more acidic oceans, but the net result will not be stasis. Rather, it is likely that some species will not be able to maintain a foothold in the ecosystem, upsetting the normal day-to-day interactions between coral reef species, as well as the maintenance of the reef structure itself.

Scientific Advances

The Symposium witnessed many new science advances that increase our understanding about coral reef ecosystems. Several scientists used new genetic techniques to show that reefs are connected primarily at a scale of tens of kilometers (km). In contrast with previous thoughts that reefs were highly interconnected at scales of thousands of km, these studies show that only occasional pulses of propagules leave the reef ‘village’. Coral larvae settle in close proximity to their parents, and some fish are homing in to local coral heads after tens of km of travel. Such local connectivity suggests that local protection and management will lead to local benefits. Action and protection also buys time for adaptation. Simultaneously we must not lose sight that important ecological connections and stressors (e.g., migration, larval transport, upwelling, pollution, pathogens, climate change) also exist at the larger ecosystem scale.

Molecular tools are revealing a diverse array of microorganisms living around and in association with reefs and able to adapt subtle environmental shifts. The microorganisms have vital roles in reef health, but if perturbed, these roles can break down in a variety of detrimental ways and lead to infection and disease. Researchers are reporting a link between coral disease and environmental change, and even viruses are now implicated in coral disease and associated coral tumors. Yet, there is also some evidence of developing immunity, whereby *Vibrio* and other bacteria that once caused harm to corals are no longer found in association with the coral-disease. In addition, some Caribbean sea fans, seriously impacted in the first round of disease, seem to build up resistance.

Scientists are also looking at the genes that corals use to acclimate to surrounding conditions to determine how corals react to their environment. Corals can make their own sunscreen proteins and can customize their protection to light level by up- or down-regulating genes that control the protein production. Many other genes are also adjusted by corals in response to environmental cues that lead to spawning. There is a potential role in synchronization of spawning and corals may be ‘talking’ to each other, via chemical messengers, to help synchronize the final stages of spawning.

Some corals manage to thrive in harsh conditions such as extreme temperatures including tidal pools and in enclosed seas. Among various coping mechanisms, they may selectively cultivate particular types of symbiotic algae. The symbiotic algae that live inside corals power the latter's metabolism and skeleton formation. New insights show how the coral-symbiont relationship can improve stress resistance. Corals may be able to expel partners susceptible to heat or uv-stress, and up-regulate the population of more robust partners that were previously cryptic and barely detectable. These new algae keep the corals healthy at the higher than normal temperatures, or produce antioxidants to soak up toxic byproducts of increased chemical activity. The buildup of resilience of some reefs from previous hard knocks illustrates that we must protect not only beautiful reefs from abuse, but also the reefs in marginal conditions that may be less attractive at first sight. These might house the survivors for future generations.

Management

It is instructive that the largest of the 26 mini-symposia of the 11th ICRS was devoted to management topics. Related symposia concentrated on reef restoration, fisheries, and social ecological systems.

By 2015, half the world's population will live along a narrow band of coast, putting unsustainable pressures on coastal resources. There will be coral reefs in our future only to the extent that they are valued by people. Understanding the value of reef ecosystem goods and services can help to promote protection and thwart degradation. Economic benefits, incentives, and cultural values need to align with conservation efforts. Social scientists have much to contribute to this aspect as well as towards environmental use planning within local and regional areas.

Likewise, managing reefs must include managing people's behavior toward reefs. Social science can help us understand the root causes of people's behavior, including poverty, global demand for fish products, and tourism. Rising food and fuel prices can put greater fishing pressure on near-shore reefs, while open access along the coasts of many poor countries is leading to a Tragedy of the Commons and serial depletion of fish stocks. Fisheries catches from many islands are vastly underreported, and fish populations severely depleted and in critical condition. But, through remote sensing, mapping, modeling, and decision support tools, it is possible for stakeholders to better visualize changes in reef resources, and policy makers to understand the impacts of decisions on the vital services that coral reefs provide.

Local action is one key method to achieving management success, and communities and government can be effective stewards of coral reefs once it is understood that it is in the interest of the public and individual good to do so. Linking coral reef conservation to human welfare, Healthy Reefs for Healthy People, is a useful theme to be repeated with ties to tourism, livelihoods, food security, as well as cultural and spiritual well being.

Marine Protected Areas are multiple-use areas, in which various tools, particularly zoning, are used to protected marine resources (marine reserves or no-take areas), define and confine human uses, separate conflicting activities, and consolidate administration to eliminate duplication and overlap. Studies in the Philippines and Guam, for example, show that corals inside MPAs have less disease than fished areas which have large gaps in diversity affecting affect disease transmission. MPAs represent effective management tools and work best when providing interim benefits as well as longer conservation benefits. Scientists reiterated that MPAs are necessary but not sufficient. Protection of as much reef territory as possible (ecosystem based management) recognizes that local efforts can build to regional ones which in turn can build into global ones. Organizational and scientific capacity is needed to establish and maintain marine management areas. In some cases, hybrid designs of no-take and periodically closed areas may better address economic needs of the community and conservation objectives.

Restoration techniques are also advancing and offer promise especially where the original cause of the reef decline has been removed or addressed.

Many stressors including overfishing, run-off, and development must be addressed. A village approach, natural and social scientists, managers and local communities working together, could make it happen. Changes needed to protect the word's coral reefs include: 1) convincing communities that reefs are at risk, 2) enlisting multiple levels of public, industry and government support, 3) providing necessary legislative and regulatory powers, and 4) conducting needed science with sufficient information transfer. In this way effective management rooted in broad interdisciplinary science and stakeholder buy-in, working at local, regional, and international scales, coupled with global efforts to reduce atmospheric CO_2, will give reefs a chance.

Respectfully submitted July 31, 2008:

The 11th ICRS Local Organizing Committee	**Super Chairs of the Mini-Symposia**	**President of ISRS**
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