

Over one-half
of the world's population lives
within **100 kilometres**
of the sea.



Coral Reef Targeted Research & Capacity Building for Management Program

2006 Annual Report

Technical & Financial Progress Report 4

(1 April 2006 - 30 September 2006)



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- ❖ Professor Peter Mumby, Chair – Remote Sensing Working Group
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- ❖ Emeritus Professor Ed Gomez – Southeast Asian Centre of Excellence
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Further Information

Information used in this report has been collated from the individual Working Group and Centres of Excellence 2006 Annual Reports, and from the communication products produced during the year. Additional information has been produced with the input of the Management Team.

Further information regarding this report and/or to request copies of the individual Working Group and Centre of Excellence Annual Reports can be requested from the Executive Officer, Melanie King (m.king4@uq.edu.au).

“...Until now, management of coral reefs, where it exists, has been reactive rather than proactive...”

“With coral reefs entering a time of even greater stress, it is mandatory that managers develop more proactive approaches, strongly embedded in science...”

***Prof. Peter Sale, CRTR Program
Connectivity Working Group***

The CRTR Program aims to bridge gaps in our knowledge of coral reefs through targeted research to improve the management of coral reefs in key developing countries



Future generations will continue to rely on coral reefs

All Working Groups and Centres of Excellence have forged important links with management and policy stakeholders in 2006

Executive Summary

The Coral Reef Targeted Research & Capacity Building for Management (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, coral reef connectivity, coral disease, remote sensing, restoration and remediation and modelling and decision support, to provide scientifically credible information to the management and policy communities, and to support these proactive approaches and decisions. Each of these research areas are facilitated by Working Groups underpinned by the skills of many of the world's leading coral reef researchers.

Supporting this science base are four Centres of Excellence in priority regions (Mesoamerica, East Africa, Southeast Asia and Australasia/South Pacific), which serve as important regional hubs for building confidence and skills in research, training and capacity building.

This 2006 Annual Report provides a snapshot of progress during the past year along with extended Program activities all working at building the science knowledge base and linking the findings and information products into the management and policy communities. Further details on the technical progress of the Working Groups and Centres of Excellence can be found in the detailed reports for each Working Group and Centre of Excellence at Annex A.

In building the knowledge base regarding the six key areas surrounding coral reef ecosystem health, the Working Groups have continued to undertake their research activities with some early results already being produced.

All Groups are establishing strong collaborative networks not just within the broader CRTR group, but also externally with other researchers, the management community, and policy-makers. These networks will continue to be developed and will have a significant impact for the Program in the later years as the research findings and outputs start to be communicated to these groups.



Over 40 students from 16 universities world-wide are now associated with the CRTR Program

CRTR Program 'Reef Restoration Guidelines' due to be released in December

CRTR Program regional planning models are being tested by managers in Meso-America

'Colour cards' have been developed with CRTR Program support to help detect coral bleaching

Science has been found to be often lacking in management decisions. CRTR Program researchers are focusing on building relationships with managers to improve awareness and uptake of research outcomes

In addition to these networks, the Working Groups have all established CRTR scholarships for students from developing countries. This is a major focus under Components One and Two in building the next generation of coral reef scientists and to ensure that skills, expertise and knowledge are exchanged across a range of countries and cultures.

Even more significant is the success that Working Groups have had in attracting highly skilled students whom are funded from other sources outside of the CRTR scholarship funds, and who are providing valuable input into the work being undertaken by the CRTR research groups. A full listing of all students is available at Appendix A.

As can be seen below, the efforts of CRTR Program members have already seen some significant findings and outputs, including:

- ❑ A guide entitled "Reef Restoration Concepts and Guidelines: making sensible management choices in the face of uncertainty" has been produced by the Restoration & Remediation Working Group Chair and Co-Chair.
- ❑ The Modelling & Decision Support Working Group is developing its first local model for Chinchorro Bank, Mexico, and the regional models for the Meso-American Barrier Reef System. These are currently being tested with stakeholders for refinement.
- ❑ The production of colour cards used for quantifying the detection of changes in coral colour. This methodology will allow managers a non-invasive and simple technique to measure the amount of stress in their coral populations. These cards were distributed in conjunction with the Manager's Guide to Bleaching at the International Tropical Marine Ecosystem Management Symposium (ITMEMS) conference in October 2006 in Cozumel, Mexico.
- ❑ Through their work with managers in the Meso-American region, the Connectivity Working Group is finding that there is an enormous gap between the development of science-based procedures for guiding management decisions, and the actual creation of effective environmental management in these countries. That gap will not be bridged by doing more science; however, the building of effective relationships between scientists and managers must become an important part of the solution. This gap appears to exist despite the willingness of many scientists to work with managers.



Several highly successful training and capacity building workshops were facilitated by CRTR Program in target regions

The Local Government Initiative has had a significant impact on raising awareness of coral reef management issues with Mayors in high priority regions

The CRTR Program was a key supporter of ITMEMS 3 in Mexico, connecting program researchers with over 250 delegates

- ❑ The Australasian Centre of Excellence hosted a successful policy & management study tour by Cook Islanders sponsored by NZAID. The tour looked at the impacts of management and policy decisions on coastal ecosystems and how policy worked in practice to provide the participants with some valuable insights into the practicalities of policy decisions on the environment. These insights and information gained during the study tour are now being incorporated into policy frameworks being developed for the Cook Islands to protect their coastal and marine environment.
- ❑ The Disease Working Group and East African Centre of Excellence collaborated on a successful regional workshop on coral disease. The workshop trained 25 regional scientists and managers in the identification of disease and the impacts.
- ❑ The Southeast Asian Centre of Excellence hosted the second Stakeholders Consultation on 9 August 2006, together with the Launch of the Philippine Environment Monitor 2005 (PEM 2005) and the Pre-testing of Best Practices for Coral Reef Management of the Local Government Initiative. This workshop involved the participation of four mayors of the municipalities of Anda, Bani and Bolinao and of the City of Alaminos, as well as representatives from various local government units (LGUs), national government agencies, non-government organizations, academe and the media.
- ❑ The CRTR Program participated in the 3rd International Tropical Marine Ecosystem Management Symposium in October 2006 with a large contingent of members attending. The Program hosted a special sponsored CRTR event presenting the activities of the Program, and supported the Local Mayors Panel which successfully produced a Statement outlining local government commitment to the conservation of coral reefs.
- ❑ The Local Government Initiative, funded by the World Bank/DGF contribution to the CRTR, is underway, addressing how to 'green' policies for activities which impact on coral reef ecosystems across the four regions.

Overall, it has been a year of implementation, consolidation, establishing networks and ensuring that the research and capacity building activities of the CRTR Program are relevant to target audiences.

As can be seen in this report (and in the individual Annual Reports), progress has been steady with some early outputs and impacts already generated.

The expectation is that this will increase in 2007 with some major, synthesised knowledge products being produced and disseminated in order to enhance coral reef sustainability and their important contribution as natural capital to developing countries.

Component One: Addressing Knowledge & Technology Gaps

Component Summary

The Program is organised around six key themes, investigated by interdisciplinary Working Groups of developing and developed country scientists. The Working Groups are:

1. Coral Bleaching & Local Ecological Responses
2. Connectivity & Large-scale Ecological Processes
3. Coral Disease
4. Restoration & Remediation
5. Remote Sensing
6. Modelling & Decision Support.

The Working Groups are producing credible research through a series of targeted research studies addressing the most significant gaps in global understanding of how major drivers and stressors affect the structure and function of coral reefs (from the cellular level to the ecosystem level).

These studies will also reveal how improved knowledge and information can be used to design more effective management tools and techniques. The new knowledge and management tools produced should help coral reef managers understand and address both chronic and acute forms of stress.

BLEACHING WORKING GROUP

The Bleaching Working Group (BWG) is focused on filling critical information gaps with respect to coral bleaching and mortality with the aim of supporting management responses for climate change.

The BWG has identified four major research themes into which it is putting its efforts. These themes are interconnected and are aimed at improving the scientific basis upon which management responses will be developed as the climate warms and carbonate ion concentrations in our oceans decline.



BWG Training activities



The BWG has generated significant public awareness in 2006

The BWG has been pivotal this year in discoveries related to coral bleaching impact on the associations between corals and a wide variety of organisms

We now have a clearer understanding of what causes coral bleaching, and the factors that may determine recovery

Overall, the Group's technical and capacity building activities are progressing well and the BWG has delivered on their stated milestones including delivery of a large number of outputs as planned. During 2006, the members of the BWG have produced in association with the project, over 80 newspaper articles, TV interviews and documentaries featuring the work of BWG members; 53 papers (including ten review articles and ten in high impact journals); given 38 talks and plenary addresses; been cited over 1490 (for work done since 2001), and; supervised 35 postgraduate students from countries including: Australia, Venezuela, India, Israel, Italy, Kenya, Mexico, Netherlands, Sweden, Tanzania, Thailand, United Kingdom and the United States.

The BWG has also established a strong collaborative network which now extends well beyond the discrete membership of the Working Group and is focused on linkages and synergies between developed and developing countries. This is a substantial output for a group of ten scientists and these achievements, along with the research findings, will continue to be built upon and expanded during the forthcoming year.

Activities & Implications for Management

The BWG continues to bring together and lead the formerly fragmented research efforts in the area of coral bleaching and ecological change research. Some of the key activities and outcomes (and their management implications) that have occurred during 2006 include:

- ❑ Discoveries through BWG research relating to the associations corals have with a wide variety of organisms such as bacteria and endolithic (skeleton-dwelling) algae are providing important information for both the scientific and management communities on the reasons for bleaching and the factors that may determine recovery following bleaching events.
- ❑ This information will allow managers to have a clearer understanding of the causes and effects of bleaching and to assist in management decisions to mitigate bleaching impacts.

***Permanent study sites
are now established in
target regions***

***Understanding the
causes, and impacts, of
bleaching have been a
priority in 2006***

***Simple to use colour
cards have been
supported by BWG to
detect changes in coral
colour.***

***The 'tipping point' for
coral reefs is at
atmospheric
concentrations of
500ppm of CO₂. This is
when ocean
temperatures rise and
major bleaching occurs***

- The BWG has established permanent study sites within three of the CRTR regions (Zanzibar, Puerto Morelos and Heron Island) for investigating community dynamics underpinning coral bleaching and mortality. Understanding how changes to reproduction, mortality and other aspects of coral populations is important to detect and understand the changes that are occurring on coral reefs around the world and for establishing better projections of the future trends and scenarios. This project is working with students and staff from these regions to assist in identifying the conditions associated with the impacts of coral bleaching and mortality on coral population dynamics.

- One of the problems that often face reef managers and policy makers is that they are confronted with reefs in which damage has occurred but the reasons are less clear. In this respect, determining changes due to climate change per se versus declining water quality can have important implications on which direction a reef manager may take. Having tools by which to distinguish these different stresses is critical for reef management. The BWG is currently investigating and developing technologies for managers so that stress can be detected earlier so that response timing and options can be improved.

One of these investigations by the Group has been a partnership to develop the use of colour cards for quantifying the detection of changes in coral colour. The project is developing a new approach using inexpensive colour and a careful protocol to assess the extent of coral bleaching within the major CoE regions. These cards were distributed in conjunction with the Manager's Guide to Bleaching at the International Tropical Marine Ecosystem Management Symposium (ITMEMS) conference in October 2006 in Cozumel, Mexico. This methodology will allow managers a non-invasive and simple technique to measure the amount of stress in their coral populations.

- One of the conclusions that is rapidly becoming evident from research done by the BWG and other groups is that the tipping point for coral reefs is at atmospheric concentrations of 500 ppm of carbon dioxide (CO₂). At this concentration of carbon dioxide, the BWG expects that ocean temperatures will increase by 2°C, which has been confirmed by the Bleaching Working Group and other research groups as being well above the threshold for major bleaching and mortality events. This information has significant implications for climate change responses in coastal and marine systems worldwide.

Synergies between thermal stress and rising ocean acidification need to be considered

Reduced levels of certain organisms in reef ecosystems result in lower calcification rates, impairing the ability coral reefs to grow and resulting in erosion

The BWG facilitated a regional workshop in late 2006 to develop management strategies in response to climate change

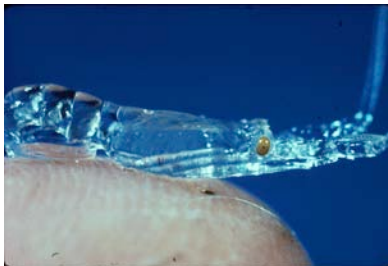
- ❑ There are now suggestions that the synergies between thermal stress and that arising from ocean acidification need to be considered.

Ocean acidification has the potential to threaten the functioning of marine ecosystems, fisheries, and carbonate-based coastlines. For example, rising CO₂ levels in the ocean will impact on a broad range of organisms through reduced calcification rates or acidosis – the build up of carbonic acid in body fluids, which will impact metabolism, respiration, and reproduction. Lowered calcification rates will impair the ability of coral reefs to grow their carbonate skeletons, leading to slower growth of the reef and a more fragile structural support, making the reef more vulnerable to erosion.

Managers will need to know issues such as the impact of ocean acidification, what are the major pathways and modes of propagation of ocean acidification impacts that will affect most ecosystem services upon which human communities rely, and if marine biota can adapt to these changes without significant disturbance to the marine ecosystem. Combined with thermal stress, this may accelerate ecosystem change.

- ❑ The BWG is also making progress toward technologies that will support management and policy. Later this year, the BWG is hosting a meeting to explore how coral and fish communities vary with the abundance of corals in the Western Indian Ocean (entitled “Meso-scale effects of coral bleaching”). This will deliver insights into management strategies in response to climate change such as mass bleaching and mortality events. The meeting will be held from 28th – 30th November 2006 at the Institute of Marine Science in Zanzibar. It is anticipated that this meeting along with the work being done by Mebrahtu Ateweberhan and Tim McClanahan will identify which features of reefs maintain fish populations, for example, and will suggest how management might protect these features.

Marine Protected Areas (MPAs) are a management tool holding great promise, but managers must consider the role of connectivity in guiding MPA design and implementation



A tiny postlarval stage of the Caribbean spiny lobster sitting on a finger. This is the larval stage that enters reef habitat, and the stage that recruits to collectors used in Project 6

CONNECTIVITY WORKING GROUP

“Until now, management of coral reefs, where it exists, has been reactive rather than proactive. With coral reefs entering a time of even greater stress, it is mandatory that managers develop more proactive approaches, strongly embedded in science.”

The use of connectivity information to accurately assess linkages between coral reefs, and local demographic capabilities of various species will be essential if we are to have management programs that are capable of sustaining coral reefs. For example, Marine Protected Areas (MPAs) are a management tool holding great promise. Realising that promise requires connectivity science as an essential tool for guiding the design and implementation of MPAs. If we are to be successful in maintaining coral reefs into the future, we must incorporate much more information on connectivity into management plans and procedures.

The Connectivity Working Group (CWG) is providing and testing new methods for building the connectivity knowledge base that effective management will use. The CWG is undertaking demonstration projects in the Mesoamerican region that will develop tools and apply them to determine connectivity patterns for selected species in that region. Work is being done collaboratively with local management agencies; students from the region are receiving advanced education, and; efforts are being made to use the projects and results to inform local communities and show how connectivity data can be obtained, and used effectively in management planning.

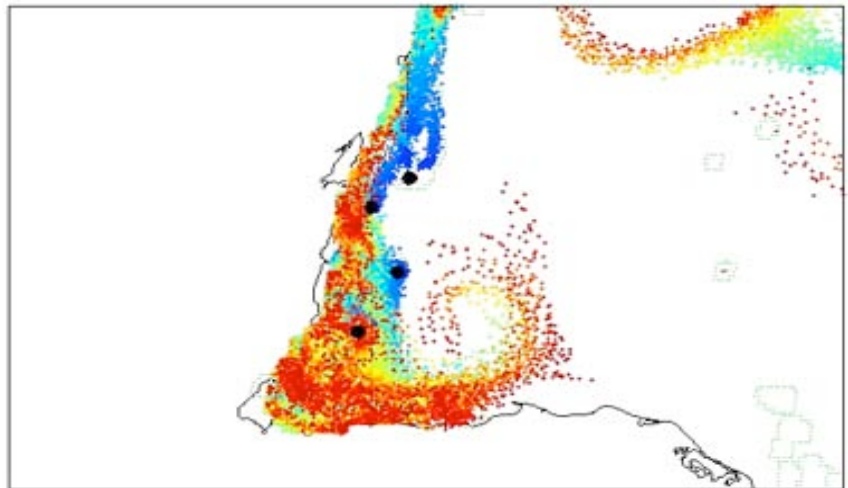
Activities & Implications for Management

The Connectivity Working Group developed an ambitious program including seven distinct research projects that tackled connectivity issues from various directions, and used fish, corals or lobster.

During 2006 these projects have continued their research activities, and there has been a continued approach to management agencies and individuals in order to embed connectivity into their knowledge and information sets and ultimately, their management plans. Key activities and outcomes for the CWG during the past year include:

**CRTR Program
Connectivity Working
Group research has
found that up to 70% of
newly settled corals die
during the first year,
which has implications
for recruitment, growth
and survival of adult
coral on reefs**

- ❑ Five graduate students are now in place and performing well. All are from the Caribbean basin, two are completing M.Sc. degrees at U.S. institutions, and three are completing M.Sc. or Ph.D. degrees at regional institutions, but with significant opportunities through secondments to U.S. or Canadian institutions. In addition to the students recruited and supported through CRTR fellowships, a number of other graduate students are participating with support from other sources. These include Canadian, U.S., Irish, Australian and French students.



Model run showing possible pattern of dispersal of larval snapper from known spawning sites in Belize during May 2004. Red represents greatest number of larvae while blue represents fewest Belizean larvae arriving at that location after 30 days of larval life.

- ❑ Several Working Group members will participate in a day-long symposium on connectivity being scheduled for the 2006 Gulf and Caribbean Fisheries Institute (GCFI) meeting in Belize City in November.
- ❑ Project Three (Post-settlement bottlenecks in coral recruitment): To date our results show that up to about 70% of newly settled corals die during the first year. Monitoring has been accomplished at Glovers, Carrie Bow Caye and Turneffe Atoll. To date results show that 77% of the juvenile corals survived over the past year. More analyses are necessary but the ontogenetic change in mortality rates is becoming clear and should allow the trajectories of recruitment for each of the study areas to be determined. The growth rate allows determination of how rapidly corals transit through this vulnerable juvenile stage and recruit as adults on reefs.

Global warming and climate change is potentially reducing coral connectivity

High ambient seawater temperatures in the Caribbean (30°C) reduce larval and post-settlement survival



Attaching settlement plates to monitor recruitment of coral larvae for Project 3.

- ❑ Project Four (Coral Connectivity): Larval development and behaviour: During years 1 and 2 researchers developed time courses of development of swimming and settlement behaviour for five of the major species of Caribbean reef coral: *Montastraea faveolata*, *M. annularis*, *M. cavernosa*, *Acropora palmata* and *Diploria strigosa*. Development time-courses vary significantly among species suggesting some species may have greater dispersal potential than others. Results show that at currently high ambient seawater temperatures in the Caribbean (30°C), both larval and post-settlement survivorships are reduced relative to rearing at lower temperatures. Thus, global warming/climate change is potentially reducing coral connectivity.
- ❑ Project Seven (Modelling lobster larval dispersal) involves determining whether stage-specific differences in larval behavior may affect vertical distribution. The CWG tested in laboratory experiments the response of different stages of development of the spiny lobster larvae, *Paniluris Argus*, to light wavelengths and intensities that mimicked day and night illumination at depths of 0 – 50m, 50 – 75m, and 75 – 100m. Results suggest that early larval stage *P. argus* are positively phototactic (the influence of light on movement) and remain near the surface (< 75m deep) during the day until they are about four months old. After that, the late stage larvae are negatively phototactic; at night, all stages are more active which presumably promotes greater vertical dispersal in the water column. This information has important implications for the connectivity trends of an important Caribbean-wide fishery, because it helps determine the distance this species is likely to travel and when settlement is most likely to occur.
- ❑ The CWG is attempting a different form of capacity building by working with a cadre of junior management agency personnel, who are staff biologists involved in environmental monitoring as part of their management responsibilities. Annual workshops are being used to raise their understanding of recruitment and connectivity issues, and they are expected in turn to undertake recruitment monitoring at their home locations. The Group is also taking the first steps in bringing the Connectivity program to the notice of more senior management agency personnel and NGO representatives from within the Region, all of which assists in providing a considerable profile for the Connectivity program in the region.

The CWG is attempting a non-traditional form of capacity building by working with junior management agency personnel, who are staff biologists involved in environmental monitoring as part of their management responsibilities.

The CWG has determined that environmental monitoring is not being used to guide management decisions

Building effective relationships between scientists and managers must become an important part of the solution

- ❑ The third workshop at Centro Ecologica Akumal ((CEA) Akumal, Mexico) was conducted in April 2006. Sixteen participants attended from management agencies and environmental NGOs with monitoring or management responsibilities in Mexico, Belize, Guatemala, and Honduras. Nine of the 16 had participated in previous CWG workshops. The workshop included presentations and discussion on the use of recruitment information in management decisions, field recalibration exercises to ensure accurate recruitment monitoring in the coming year, presentation of research results from the first year of the project, and discussions of problems encountered in year one and possible ways to resolve them.
- ❑ Three training workshops with personnel from the region have now been held. These have been targeted to junior-level staff (i.e. field biologists), conducting environmental assessments. This program has been explained to senior management staff and has their support (or no objection). Limited CWG funding has been made available to support such staff in the monitoring effort. Despite considerable efforts to mentor the agency personnel, both during, and between workshops, it has proved difficult to get this monitoring program under way (fish monitoring data are now in hand for just 7 of 11 sites, for example). The reasons appear to be a) turnover of junior personnel, b) lack of real commitment by individual employees, c) change or reduction in the support originally proffered by senior staff.
- ❑ The extent of the difficulty has been both surprising and disappointing, considering that the CWG chose to work with the same individuals and agencies that have participated in the region-wide monitoring program mounted by the MBRS project, and in many earlier monitoring programs. The fact is that, at least in this region, environmental monitoring is not being used to guide management decisions, there appears to be scant appreciation for how such data might be of local use, and the resources allocated to management of designated areas are woefully inadequate. Rather than take people thought to be experienced in environmental monitoring and then train them to monitor recruitment, the CWG is finding it necessary to first build a basic appreciation of participants and their bosses of the value and need for monitoring and its relationship to supporting development indicators.



Searching a collector for lobster larvae. Technique used in monitoring lobster recruitment in Project 6

Strategies for dealing with coral disease outbreaks are currently non-existent

Understanding the specific ways in which coral diseases can alter reef function will allow better predictive power for conditions under which outbreaks may occur

- ❑ The need to build real commitment for a routine and committed monitoring program may well be beyond the capability of the CRTR Program, or could use additional assistance to convince coastal governments of its importance in assessing the status and processes affecting the resource base. Given the considerable effort that has been devoted by World Bank, NGO, and other programs, over many years, to improving environmental management in these waters, the evidently poor capacity still present is of concern.
- ❑ There is an enormous gap between the development of science-based procedures for guiding management decisions, and the actual creation of effective environmental management in these countries. That gap will not be bridged by doing more science; however, the building of effective relationships between scientists and managers must become an important part of the solution. This gap appears to exist despite the willingness of many scientists to work with managers. The CWG efforts described above are attempting to bridge this gap.

DISEASE WORKING GROUP

Coral diseases potentially impact both well-managed and unmanaged reefs indiscriminately. However, strategies for dealing with disease outbreaks are currently nonexistent. The increasing frequency with which diseases influence and alter reef communities necessitates their consideration and incorporation in management plans.

The Disease Working Group (DWG) is undertaking research addressing this need by providing the scientific background to formulate recommendations for managers and policy makers. For example, links between the role of coral community structure and diversity in maintaining productive fish and invertebrate populations is generally unstudied. As many MPAs are established specifically with the goal of protecting the fishery in mind, diseases that alter a reefs' ability to support a diverse fish population is of concern.

Understanding the specific ways in which coral diseases can alter reef function will allow better predictive power for conditions under which outbreaks may occur, and the rationale to apply pressure to policy makers and local government to improve waste water treatment, solid waste disposal and land use practices.

Baseline disease surveys at most Centres of Excellence have now been completed.



DWG surveys revealed new coral disease syndromes at each of four Centers of Excellence, which will provide managers with new information regarding coral disease in these regions and knowledge necessary to develop strategies to monitor disease.

Using satellite technology the DWG found a highly significant relationship between the frequency of warm temperature anomalies and the emergent disease White Syndrome

Significant advances have been made across all goals of the Disease Working Group (DWG). For example, in year one and two, the DWG established baseline disease surveys at all Centres of Excellence except East Africa, with permanent transects established along the Yucatan Peninsula and Great Barrier Reef, Australia. The Group demonstrated for the first time, links between disease and warm temperature anomalies in Australian and Caribbean reefs.

The DWG has preliminary evidence for effects of nutrients as facilitators of some coral disease syndromes and has made significant advances in epidemiology, notably through molecular studies of black band disease, yellow blotch, and *Aspergillois*. Substantial inroads in uncovering enzymatic mechanisms of resistance to disease have been made whilst a new frontier has been opened investigating potential for phage therapy of coral disease.

The Disease Working Group's scholarship program is supporting four graduate students and one postdoctoral fellow from the Philippines, Palau, Venezuela, and Mexico. Workshops have been conducted on the Microbiology of Coral Disease in Mexico, Australia, Palau, and East Africa. The most ambitious of these is the regional scale workshop run at the Institute for Marine Studies, Zanzibar, funded in part by the Living Oceans Foundation.

Activities & Implications for Management

- ❑ Following efforts from the previous year, in 2006, the DWG surveys revealed new coral disease syndromes at each of four Centers of Excellence (MesoAmerica, the Philippines, Australia, and East Africa). This effort will provide managers with new information regarding coral disease in these regions and will ultimately provide them with the information necessary to develop strategies to monitor disease.
- ❑ Whilst investigating the relationship between temperature and coral disease, the DWG used a new high-resolution satellite dataset of ocean temperature and six years of coral disease and coral cover data from annual surveys of 48 reefs to investigate whether the frequency of warm temperature anomalies was positively related to coral disease frequency across 1,500 km of Australia's Great Barrier Reef.

One increasing priority area is the attempt to link ecosystem and coral health with management actions through a test of the hypothesis that MPAs have lower levels of coral disease

Results with phage therapy are showing one potential, ecologically sustainable frontier for treating coral disease in target regions

- ❑ The Group found a highly significant relationship between the frequencies of warm temperature anomalies and white syndrome, an emergent disease of Pacific reef-building corals. The DWG and members of the RSWG (Mark Eakin and William Skirving) will now apply these same methods to disease levels followed at sites in the Caribbean. Similarly, colleagues are developing Pacific-wide disease surveys that will allow additional tests of the climate as a facilitator of coral disease hypothesis.
- ❑ One increasing priority area is the attempt to link ecosystem and coral health with management actions, through a test of the hypothesis that Marine Protected Areas (MPAs) will have lower levels of coral disease. This is an extremely complex hypothesis to test due to variability in effectiveness and longevity of MPAs. However, it is also an absolutely critical issue because we currently have no implementable management approaches to coral disease and MPAs remain one of our most important management tools to sustain coral reefs.
- ❑ Success in demonstrating an increase in coral health inside MPAs would be an important advance. DWG members are submitting a paper on preliminary work in Palau, and next year will report on progress in the Philippines. Work is underway to address components of this hypothesis in Mexico.
- ❑ The DWG continues to work to uncover diverse elements in coral resistance to disease. Eugene Rosenberg's results with phage therapy are very interesting in showing one potential, ecologically sustainable frontier for treating coral disease. Phage therapy is undergoing a resurgence (for example in the meat-packing industry, where phage is used to control bacterial growth on consumer products), and does indeed have some potential in natural ecosystems.
- ❑ A major regional scale workshop on Microbiology of Coral Disease was held at the Institute for Marine Studies, Zanzibar, funded in part by the Living Oceans Foundation. Twenty-five East African scientists from Mozambique, Tanzania, Zanzibar, Kenya, and the Seychelles participated in a five day workshop that included coral taxonomy, coral microbiology, and coral disease survey methods. Dr Harvell also gave the keynote address at the 2006 US Coral Reef Task Force meeting about links between climate warming and coral disease outbreaks.

CRTR Program 'Reef Restoration Guidelines' due to be released in December 2006



Restoration trials using nursery cages to rear young corals

RESTORATION AND REMEDIATION WORKING GROUP

Coral reefs worldwide are suffering degradation from a number of disparate natural and man-induced causes. Tackling the root causes of degradation through effective coastal management measures is likely the best way both to reduce further damage and to allow reefs to return to viable healthy states. Nevertheless, there can also be opportunities for direct intervention to actively restore degraded coral reefs.

Three tenets of coral reef restoration were published in the Society for Ecological Restoration, 2004, which are important to managers. These tenets are:

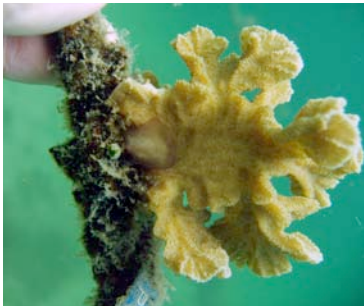
- Coral reef restoration is in its infancy. We cannot create fully functional reefs.
- Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.
- Improved management of reef areas is the key to their health. However, within an overall management plan, active restoration offers managers a useful and potentially powerful tool for assisting recovery of degraded reefs.

Given these tenets, the research being carried out by the Restoration & Remediation Working Group (RRWG) is seeking not only to address many of the knowledge gaps which hinder restoration but also to channel advice to the management community so that restoration projects can be undertaken in a more informed way and with better chance of success.

The RRWG has continued to develop its research program and has made significant inroads during the past year. The Working Group's capacity building activities during 2006 worthy of note includes the continuation of scholarship support, workshops and the development of products for managers.

Of particular note has been the development of a guide entitled "Reef Restoration Concepts and Guidelines: making sensible management choices in the face of uncertainty". These guidelines have been produced by the Chair and Co-Chair and based on discussions and comments from the RRWG. A PDF version, which is updated as new knowledge becomes available, will be downloadable from www.gefcoral.org by the end of 2006.

Three types of coral nurseries have been established to investigate the enhancement of recovery of corals by culture and transplantation



Rope nursery reared fragment of coral

Activities & Implications for Management

During 2006, the Restoration & Remediation Working Group has advanced significantly in their research and capacity building activities. Major activities and outcomes for the year include:

- ❑ The scholarship program under the RRWG continues to move forward with currently four Philippines graduates, working for MSc degrees, being trained by the RRWG at the Southeast Asian Centre of Excellence with scholarships wholly or partially supported by the CRTR Program. Further to this, one recent Philippines PhD has been appointed from September as a CRTR postdoctoral fellow to carry out RRWG research at Bolinao and Palau. A Tanzanian PhD student, supported by a scholarship from the East African CoE, is engaged in restoration research under the direction of Dr Rinkevich of the RRWG. Two Research Assistants at the Palau International Coral Reef Center have been trained by RRWG members and are assisting in RRWG research there. For one of these Prof. Omori was able to obtain \$17,500 of JICA funding for two months additional training at Akajima Marine Science Laboratory, Okinawa. The fieldwork costs of four developed country students (2 MSc, 2 PhD) are funded by the RRWG.
- ❑ In August, 2006 a five-day workshop for all students and research assistants working with the RRWG and funded under the CRTR Program was held in conjunction with EC REEFRES project postdoctoral fellows based at the South East Asian CoE. The workshop was rated as a valuable experience for all concerned and assisted in building the peer networks of these researchers.
- ❑ Three types of coral nurseries have been set up close to the Bolinao Marine Laboratory (Philippines) looking at the enhancement of recovery of corals by culture and transplantation. These include one floating nursery, one bottom-attached nursery and one low-cost experimental rope nursery. Initial results are:
 - The floating nursery has the advantage that corals are held at a constant depth (the nursery moves up and down with the tide), and can be moved to greater depths if ocean temperatures warm.
 - The bottom-attached nursery is cheaper to make but the water depth varies with the tide.
 - The experimental rope nursery is very cheap as coral fragments are just slipped between the strands of a rope and allowed to grow.

Faster growing species have already grown into small colonies in the nurseries and many hundreds of these have now been transplanted to degraded bommies (large coral heads)

- Approximately 10,000 nubbins belonging to nine species have been reared for about one year. Results show that there is about 10% mortality and 6% detachment of coral fragments.
- Preliminary results show not only significant differences between species in terms of growth and survival, but also between different genotypes (inheritable traits) of the same species. Faster growing species have already grown into small colonies in the nurseries and many hundreds of these have now been transplanted to degraded bommies (large coral heads) to see how they will survive.

In parallel, a series of degraded bommies have had coral fragments transplanted to them directly at two different densities to compare survival and growth of directly transplanted common coral species. Initial results are promising with about 86% survival overall after 5 months.

REMOTE SENSING WORKING GROUP

The Remote Sensing Working Group (RSWG) is quantifying the limitations of coral reef remote sensing by combining modelling and field experiments. Models predict the ability of a given remote sensing instrument to detect the subtleties of bottom reflectance that distinguish reef habitats or the cover of corals and macroalgae within habitats. Remote sensing is also needed to identify habitat type and possibly predict the cover of corals and algae on a reef. Methods used to identify this will highlight which areas of the coast have undergone the greatest change and help managers quantify the rate of change in reef habitats and to identify areas where management efforts may be better focused.

Recent remote sensing research has improved the detail of reef habitat maps but the interpretation and uses of these products for management has received relatively little attention. Specifically, what do habitat maps mean in terms of biodiversity and reef function and how should they be used for conservation planning? Outputs from the RSWG will enable managers to monitor the effectiveness of reserves effectively by stratifying their sampling by both habitat type and local habitat complexity, both of which affect the densities of reef fish.



Remote Sensing workshop in Manila

Managers will have the ability to monitor the effectiveness of reserves better through stratifying their sampling by both habitat type and local habitat complexity, both of which affect the densities of reef fish

Maps of habitat complexity may also identify the location and extent of critical fish habitat which will guide MPA site selection and help understand the connectivity of fish populations.

The second year of the RSWG has proceeded largely as expected. A few changes occurred such as member Eric Hochberg leaving the Group and the failure to acquire airborne hyperspectral data in Palau (due to airport closure).

However, the RSWG is overcoming these set-backs by creating a new PhD scholarship for a student at UQ (probably from the Philippines and to work on use of hyperspectral data for monitoring coral cover) and conducting an alternative airborne campaign at Heron Island in 2007.

The research of all project students is progressing well. Sonia Bejarano has already made an empirical link between acoustic remote sensing and the density of particular reef fish species, and the management implications are discussed in the detailed RSWG report.

The oceanic remote sensing team (William Skirving, Al Strong, Mark Eaking and Laura David) have had two workshops in the Philippines and the Working Group held a broader, group-wide workshop in Mindoro (Philippines) in November.

Activities & Implications for Management

Major activities and outcomes for the Remote Sensing Working Group in 2006 include:

- ❑ The RSWG scholarship program is continuing apace with the project taking on two Filipino, one Colombian, one Singalese and one Palauan student, and a further PhD scholarship will commence later this year. The students have worked in Belize, Bolinao and Palau as part of intensive field activities at each location.
- ❑ A month-long field campaign was undertaken in Bolinao and Palau throughout April which extended into May for several students. Studies were divided into several complementary categories:
 - ◆ habitat mapping surveys;
 - ◆ detailed studies of reef and lagoon microhabitats including their rugosity, 3-dimensional structure, species composition and associated fish communities;
 - ◆ studies of the effects of reef structure on grazing by herbivorous fishes;

A cost-effective and easy-to-use radiosity-based model for predicting light distribution over structural benthos will be made available once fine-tuning for accuracy is completed

The RSWG has now completed the world's first thorough global survey of Inherent Optical Properties (IOP) data which will provide critical information for managers using the 'Reef Observer' expert system

Video clips sourced from the RSWG supported 'ReefVid' website have been used in Al Gore's film 'An Inconvenient Truth'

- ◆ discrimination of reef structure using high resolution optical data (Quickbird imagery) and acoustic sensors (though a collaboration with Dr B. Riegl at NOVA Southeastern University);
 - ◆ prediction of relative reef fish density and grazing through combination of acoustic and optical remote sensing;
 - ◆ measurement of inherent optical water properties (the first set of data from Pacific reefs with strong gradients in water quality);
 - ◆ measurement of apparent optical water properties;
 - ◆ testing a new automated system for extracting coral cover from towed video data.
- John Hedley's radiosity-based model for predicting light distribution over structural benthos has been completed and is currently being fine-tuned for accuracy. This will improve the ability to detect and identify coral reef features from satellite data. As an additional output of the project, the model will be made available as a cost-effective and easy-to-use alternative to HydroLight© for managers and students interested in the light environment of the water column and benthos.
- In April 2006, Inherent Optical Properties (IOP) data (beam attenuation, total scattering and back-scattering) were collected for around 40 locations in Bolinao, Philippines and around 20 locations in Palau. Together with the Belize IOP data from 2005 this constitutes the first-ever thorough global survey of IOPs of coral reef waters, and encompasses a wide variety of water conditions, including unique situations such as water pollution due to overfeeding near fish farms in Bolinao. All of the raw IOP data has been processed ready for use in the models mentioned above. The data combined with RSWG models will have direct management application: 1) for guiding remote sensing campaigns as part of our planned "Reef Observer" expert system, and 2) in photobiology applications, for example in assessing the effect of fish farm pollution on benthic light levels and photosynthesis.
- John Hedley and Peter Mumby created the website www.Reefvid.org which is housed on the Project server. The site offers over 500 free video clips of coral reef phenomena for educational purposes, several of which were filmed during Project field work. ReefVid's popularity is growing rapidly with over two thousand registered users, and we anticipate that it will become one of the premier online coral reef educational resources.

- ❑ The ReefVid site has been featured in Science (Netwatch, August 2006) and clips have been used for Al Gore's DVD, 'An Inconvenient Truth', and for educational DVD-Roms in the British Virgin Islands and in Australia.
- ❑ Stuart Phinn has been involved in a project developing educational materials such as an on-line toolkit for selecting suitable image data and mapping techniques to use for mapping and monitoring coral reefs, seagrass beds and water quality (<http://www.gpa.uq.edu.au/CRSSIS/tools/rstoolkit/>). The aim of this toolkit is to show managers, scientists and technicians working in coastal marine environments how images collected from satellites and aircraft (remote sensing) can be used to map and monitor changes to indicators of coastal ecosystem health. We recognise that "coastal environments" encompass a broad range of ecosystems, however, this toolkit focuses on coastal water bodies, seagrass, coral reefs, and mangroves.
- ❑ A priority for future work is to extend the toolkit to cover all other coastal ecosystems. This toolkit focuses on sensors that measure reflected sunlight (passive systems), for more detail on active systems (e.g. acoustic technologies) refer to <http://www.coastal.crc.org.au/cwhm/toolkit/>.

MODELLING & DECISION-SUPPORT WORKING GROUP

Modelling is an important management technology that allows decision makers and reef users to see the dynamics of the whole system – the biophysical and the socio-economic parts. Models can be organised so that the results of scenarios of 'what if' questions can be computed and visualized immediately. The Modelling & Decision Support Working Group (MDSWG) is developing modelling resources to enable reef managers to work with simulations for their own areas, better understand the links between local, regional and global processes and access realistic scientific and economic data over the internet.

The 2006 year – the second year of the Modelling & Decision Support project – has seen progress against the Working Group's goals. In the current year, the Group has elaborated its fundamental modelling framework to the point where it can be used to develop particular models.

Modelling is an important tool for managers, allowing the results of 'what if' questions to be visualized immediately

The MDSWG has developed its first local and regional models incorporating both biophysical and socio-economic dynamics

It has developed its first local models (of Chinchorro Bank, Mexico) and regional models (of the Meso-American Barrier Reef System) which incorporate both biophysical and socio-economic dynamics. In developing these models, the Group has built relationships with reef managers, involving them in workshops during the development and testing. The MDSWG shared the regional model with managers and policy makers at the ITMEMS conference in Cozumel and at the annual meeting in Akumal in October.

The Group has received some external support through two doctoral scholarships (College of London and University of Tasmania). It has also formed links with clients through participatory workshops and site visits held thus far.

Activities & Implications for Management

In the ten months of the current year (to September 2006), the Group has made significant progress against its goals:

- ❑ The Group has further elaborated the fundamental mathematical framework – it now includes the ecological dynamics of the reef benthos and fish as well as the socio-economic dynamics of fishing and tourism.
- ❑ The Group has built a regional model of the Yucatán reef system suitable for role-playing scenarios – this was launched at the ITMEMS meeting, and was be the basis for a special workshop with regional managers in Akumal following ITMEMS (Oct. 23rd-27th, 2006).
- ❑ The local model of Chinchorro Bank has been tested with web-based data feeds through a GIS interface.
- ❑ The MDSWG project is proceeding through five parallel, and interacting, streams of work:
 - The first is work on the fundamental mathematical structures. These structures will underpin all the models – they are the basis for the Group’s high-level frameworks. They describe the key interactions (such as phase shifts in reefs or economic choices between resources) between and within the reef ecosystem and the socio-economic system. Through a process of stepwise refinement, the Group has analysed and is now satisfied with the elements of the dynamics.

A regional model of the Meso-American Barrier Reef System was demonstrated during ITMEMS 3 as a 'hands-on' tool for managers to develop and test scenarios

The MDSWG has commenced work on linkages between the global economy and the world's reefs

- The second is work on local models. The MDSWG has built and tested the first elaborations of the fundamental mathematical structures as agent-based models. The Group transformed the equations into 'stocks-and-flows' systems dynamics models and then from these into ABM models, checking at each stage that the basic dynamics could be reproduced. The models are now being parameterized with real data from Chinchorro Bank in the Meso-American Barrier Reef System. Work on the Lingayen Gulf is also starting with associated project funding initiatives together with the socio-economic survey undertaken by the Philippine COE.
- The third is work on regional models. This work was made a high priority at our March 2006 workshop following the request from the Executive Committee to make a significant contribution to the ITMEMS meeting. The MDSWG decided that it should offer a workshop that would present a regional model of the Meso-American Barrier Reef System, and use such a model as a hands-on tool to allow managers to develop and test scenarios.

A prototype ABM model of the MBRS from Belize to Cancun has been built on a ca 5 km grid, using the CORMAS modelling system. The dynamics of this model follow the fundamental mathematical structures. It captures basic ecology (corals, algae and fish), basic connectivity (ocean currents for recruitment, land-sea connections for nutrients and pollution), and basic economics (fishing, tourism, land-based development and pollution) in an integrated, visual and interactive way.

- The fourth stream is work on global models. At the March 2006 workshop the group sketched a way to handle the linkages between the global economy and the world's reefs. This work is still embryonic and will draw extensively on global futures and scenarios developed in other contexts.

- The fifth stream is work on linkage between scales and on data management and processing issues. This stream of work was seriously explored for the first time at the workshop in March 2006. Some web-based approaches were discussed as ways to ensure that both models and data could be accessed by all stakeholders. The Group now has some preliminary results in applying web-based workflow methods to the ABM models for Chinchorro Bank. This stream of work gave rise to two workshops at ITMEMS: one on the problems of scale for management, and the other on the impact of the future Web 2.0 on management.



The MDSWG is developing models that enable managers to work with simulations for their own areas

Component Two: Promoting Scientific Learning & Capacity Building

Although most coral reefs are located in developing countries, the majority of coral reef research is currently based in universities and research institutes in the developed world. Rectifying this global imbalance in knowledge and capacity is a key mission of the CTR program. The program is building or enhancing the capacity of institutions at sites in at least three developing countries within the first phase so that they can function as regional Centres of Excellence. These three sites will be supported by a fourth site based in Australia.



The Centres of Excellence are:

1. *Southeast Asia*: Marine Science Institute of Bolinao, University of the Philippines.
2. *East Africa*: Institute of Marine Sciences, University of Dar es Salaam, Zanzibar, Tanzania.
3. *Mesoamerica/Western Caribbean*: Unidad Academica Puerto Morelos, Universidad Nacional Autonoma de Mexico, Mexico.
4. *Australasia/South Pacific*: Heron Island Research Laboratory, Centre of Marine Studies, The University of Queensland, Australia.



CRTR Program Centres of Excellence continue to facilitate strong engagement with local and regional management and policy stakeholders

The Australasian CoE is building capacity in Indonesia and the Western Pacific countries

Each Centre of Excellence (COE) is intended to become a sustained regional resource with responsibility for engaging stakeholders throughout each region and serving as a hub for research, capacity building, and information exchange. This is the first step in what will be a long-term effort.

In support of the Working Group efforts, the Centres of Excellence have also continued to build their resources through both research implementation and infrastructure in order to engage regional stakeholders and to support the work of the Working Groups. In particular, there has also been strong engagement with the local and regional management and policy communities.

AUSTRALASIAN CENTRE OF EXCELLENCE

The Australasian Centre for Excellence has continued to build its resources and presence in the Australasian and Western Pacific region.

The Centre has also pursued its objectives to build capacity within the Australasian region and is now firmly focused on Indonesia and the Western Pacific countries. In this regard, the project has attracted two students (from Thailand and Indonesia) to undertake PhD programs within the Centre.

The Australasian Centre for Excellence intends to expand its linkages and activities in 2007. In this regard, the continual focus on Indonesia and the Western Pacific will be a priority, but will also expand its contributions to selected countries in the wider Indo-Pacific region.

Activities & Implications for Management

The Australasian Centre of Excellence has made some significant inroads in its workplan during 2006 and has made advancements both with training and scholarship. Specific key outputs and outcomes for the year are as follows:

- ❑ Following the completion of infrastructure improvements at Heron Island Research Station, the CoE has hosted workshops for both the Bleaching Working Group (2) and the Disease Working Group (2). These Groups were also initial users of the new equipment purchased to support the research activities of the CRTR Working Groups.

- ❑ The Centre for Marine Studies (UQ) has successfully positioned Heron Island Research Station as part of the integrated Ocean Observing System via the Australian National Competitive Research Infrastructure (NCRIS) Scheme. This has linked the activities and capability of Centre for Excellence into the Great Barrier Reef Ocean Observing System (GBROOS). The central aim of this GBROOS project (now funded) is to further enhance our research capacity to understand climate change on the southern Great Barrier Reef. This will provide much needed information and connectivity of the southern Great Barrier Reef into the broader regional environmental trends and understanding. This development will be synergistic with a large ARC Linkage project with NOAA, which has been approved to start on Sep 30, 2006. This project will focus on developing new technologies for monitoring and projecting change on coral reefs.
- ❑ The project has attracted two students (from Thailand and Indonesia) to undertake PhD programs within the CoE. While the students are based in Australia, their field work will be conducted in Thailand and Indonesia with the idea of building stronger capacity and linkages within these countries. The CoE has also sponsored a PhD student from James Cook University in Australia who is focused on the role of effective coral reef governance in coral reef management.
- ❑ The CoE also ran a short course for research students from the University of Diponegoro in central Java, Indonesia, leading to several students applying to do graduate work through AusAID with Centre researchers.

- ❑ The Centre has established a relationship with New Zealand Aid (NZ Aid) Cook Island Marine Resources Institutional Strengthening Project (CIMRIS) as part of a broader Pacific initiative. As part of this relationship, the Centre organised and hosted a study tour for senior staff on policy and management in practice. The focus for the tour included: policy and its role in the management of natural resources; policy and how it is developed, and; policy in action. Further plans are underway to send a small team to the Cook Islands in 2007 to undertake monitoring and assessment of long-term changes in the health of the Cook Island reef systems.

Cook Islands look to Australasian CoE for coastal policy insights

A delegation of senior coastal environment managers from the Cook Islands visited Australia to learn the keys to successful marine conservation and sustainable economic development policy first-hand from some of the world's leading researchers.

The small nation of just 20,000 people spread across 15 separate islands is rapidly emerging as a 'must see' tourism destination in the Pacific. With such growth inevitably comes pressure on the Cook Islands' natural resources – and the coastal and marine environment in particular – so developing sound policy for management to keep up with the expected growth is becoming critical.



One of the visiting Cook Islanders, Paul Lynch, a lawyer with the Cook Island National Environmental Services, said that with nearly 80 per cent of the country's exports derived from fish products and pearls, and the increasing focus on the islands as tourism hot spot, the delegates were keen to strengthen the capacity of their country's policy developers and law makers to guide the long-term management of its relatively pristine marine resources.

Infrastructure improvements have significantly improved the capacity of the East African CoE



The East African CoE scholarship process has commenced with the recruitment of three PhD students

EAST AFRICAN CENTRE OF EXCELLENCE

The Eastern African CoE served as a hub for research and started to build its capacity and that of the Eastern African region as planned. The CoE has provided support to several members of the Working Groups, e.g. Prof Rob van Woesik and Tim McClanahan of the Bleaching Working Group. Regionally important coral reef research was undertaken under three subprojects. The CoE continued to build its capacity through the acquisition of some field and laboratory equipment. Included in this was the upgrade of its internet band-width and the stabilizing of the electrical power supply with the installation of a new standby power generator.

The CoE supported the Disease Working Group with their field work and collaborated on the holding of a regional workshop on coral disease. Other members of various Working Groups had an opportunity to work with the CoE in planning and implementing various CRTR Program activities.

Further to this, the CoE has recruited three PhD students and will support them during Phase One; a National Advisory Group of experts has been established to provide advice and guidance, and; various collaborative activities have been initiated, such as the CoE-MACEMP-WIOMSA collaboration.

Activities & Implications for Management

The East African Centre of Excellence has continued to work towards its goals in the research and capacity building areas. Key outputs during 2006 include:

- ❑ The CoE has provided support to several members of the Bleaching Working Group, e.g. Prof Rob van Woesik and Tim McClanahan. A collaborative research project between the CoE and Drs. McClanahan and van Woesik is progressing well. This collaboration has resulted in a joint coral reef research sub-project on assessing reef health conditions and climatic change impacts.
- ❑ The CoE, jointly with the Disease Working Group, organised and conducted a regional workshop on the microbiology of coral disease on 3rd – 7th April 2006 in Zanzibar. Twenty-five East African scientists from Mozambique, Tanzania, Zanzibar, Kenya, and the Seychelles participated in a five day workshop that included coral taxonomy, coral microbiology, and coral disease survey methods.

The indigenous knowledge project on coral reef management has found even where some forms of traditional management strategies exist in the study area, these are of decreasing effectiveness in protecting fishing habitats and marine resources in general

The East African CoE has become an important hub for encouraging linkages and collaboration between research and management

- ❑ The Centre of Excellence scholarship process has commenced with the recruitment of three PhD students. These students (Mbije, Suleiman and Jones) are currently in the admission and registration process within and outside Tanzania.
- ❑ Remote Sensing Working Group activities in the region have already started. Through the RSWG Chair, the CoE has received Ikonos Satellite images for Unguja (Zanzibar) Island. These images will be analysed and will serve as demonstrations to the upcoming Remote Sensing and GIS workshop to be held in September 2007.
- ❑ The CoE hosted a regional meeting of the Indian Ocean Global Ocean Observation Systems (IOGOOS) on 10th – 12th October 2006.
- ❑ A GIS expert, Dr. Laretta Burke, of the World Resource Institute, Washington DC visited. The purpose of the visit was to provide technical guidance to the GIS unit including performing a basic informal user needs assessment, establishing good basic GIS practices, and helping to prepare for a GIS training workshop in 2007.
- ❑ In July 2006, the CoE hosted a collaborative meeting between CRTR, WIOMSA and MACEMP. The objective of the meeting was to discuss how MACEMP, CRTR, and WIOMSA could establish more linkages and collaboration as well as create enabling mechanisms for continuous and fruitful partnership in research and management.
- ❑ Through the sub-project looking at indigenous knowledge on coral reef management, the CoE has already come to some early conclusions. They state that even where some forms of traditional management strategies exist in the study area, these are of decreasing effectiveness in protecting fishing habitats and marine resources in general. They conclude there are two reasons for this. The first relates to population increase within the fishing community, and an intensification of fishing effort because of more efficient gear and increasing exports of fish. The other relates to the arrival of increasing numbers of immigrant fishermen who are overwhelming local communities even where they use legal techniques and conform to local customs (and frequently they do neither). For reasons such as these, there is little doubt that fishing habitats (including coral reefs) will be threatened and catch per unit effort will decrease significantly.

MESO-AMERICAN CENTRE OF EXCELLENCE

The Mesoamerican CoE at Puerto Morelos is hosted by the Unidad Académica Puerto Morelos (UAPM) of the Instituto de Ciencias del Mar y Limnología (ICML) of the Universidad Nacional Autónoma de México (UNAM).

The activities of the Mesoamerican CoE are centered on the following four main objectives: a) To conduct research activities linked with the Working Groups, b) to conduct local research activities, c) the development and implementation of capacity building activities and finally d) the linkage of the scientific results to local management and policy decision-makers. Although meeting the benchmarks has been delayed as a consequence of the late approval of the sub-grant Agreement by UNAM, significant progress has been achieved in all four objectives:



Development in the Meso-American region continues to put pressure on coral reef systems

The Meso-American CoE is focusing on two major research outputs relating to the development of a circulation model and a groundwater model for understanding these major water fluxes that influence the region

Coral reefs in the area are under the influence of two major water fluxes, on the ocean side the Yucatan Current and on the continental part, and the drainage of groundwater through the karstic geology characteristic of the zone. Considering the major objectives of the project, the CoE has identified the study of these two fluxes as the local research priorities. The Centre of Excellence is currently focusing on two major research outputs relating to the development of two models (a circulation model and a groundwater model) for understanding these major water fluxes that influence the region.

The dynamics of the Yucatan Current greatly influences the water fluxes in the interior of the reef lagoon. On the other hand the quality and volume of the freshwater inputs may have a profound effect on the health of the fringing reef. The CoE has selected a 6 km section of the reef in front of ICML-UNAM facilities in Puerto Morelos as a study site. The development of a hydrodynamic model for the lagoon and the description of the ground water fluxes will generate important information for both scientists and managers of the protected area. Furthermore, this information can be important for coral reef stakeholders in other geographic areas.

In addition to the research activities, the CoE has, during the last year, hosted the continuous operation of some of the Bleaching and Disease Working Groups and initiated a collaboration with local managers and the Restoration & Remediation Working Group. The CoE has also offered two graduate courses as part of the capacity building activities with the participation of 29 students from seven countries.

The development of a hydrodynamic model for the lagoon and the description of the ground water fluxes will generate important information for both scientists and managers and that can be applied to other regions

Activities & Implications for Management

Significant outputs for 2006 under the Centre of Excellence activities include the following:

- ❑ The development of a hydrodynamic model for the lagoon and the description of the ground water fluxes will generate important information for both scientists and managers. Products will have direct applications for management, such as: a) an early coral bleaching warning system for the local fringing reefs, that currently are not well covered by the current NOAA satellite products, and b) a model describing the dispersion in the reef lagoon of pollutants introduced into the watershed. Although it is too early to release both products, they have the potential to be useful management tools.
- ❑ The Centre of Excellence provided six students from around the region (Cuba, Mexico, Venezuela and Colombia) to attend courses in Marine Protected Areas and Light & Photosynthesis on Coral Reefs. The two courses were attended by 19 and 10 students respectively and have provided valuable insight and knowledge to the participants which can be used in their home countries.

SOUTH-EAST ASIAN CENTRE OF EXCELLENCE

This second annual report covering the period from 1st September 2005 to 31st August 2006 represents the first full year of normal operations of the Philippines/Southeast Asia Center of Excellence (CoE). Activities within the CoE are now well under way and described below.

The coordination office continues to support the CoE activities, and provides some assistance for the linked research activities of CRTR Working Group members, both local and foreign, who are conducting research activities in the Philippines.

Two doctoral students and three master's degree students are now engaged in the research projects of the CoE, plus another two doctoral and five master's level students supported at the CoE from funds from projects of WG members.



South-East Asian CoE Graduate students at work

In addition to formal, ongoing training, coral taxonomy workshops were held in February and August while a training course on coral diseases/marine microbiology was held from April-May 2006.

The three local research projects (improvement in coral taxonomy, coral disease and the connectivity and rearing of rabbitfish) continue to make progress. In contrast to last year's reports which primarily covered organizational aspects, the present period indicates more substantive activities from collection of specimens to initial analysis and characterization of microbiological and genetic materials.

Activities & Implications for Management

Major outputs for the Centre of Excellence in 2006 are as follows:

- ❑ A workshop on the Development of a Communication and Capacity Building Strategy for the Philippines/Southeast Asia CoE was held on 22-23 May 2006 at the Marine Science Institute in Diliman. This was attended by the principal investigators of CoE-assisted projects, members of Remote Sensing Working Group and Modelling and Decision Support Working Group, the CoE Coordinator (also RRWG member) and staff and the Project Executive Officer. The workshop was aimed at developing a communication and capacity building workplan and action plan within a Philippine context.
- ❑ The Second Stakeholders Consultation was held on 9 August 2006, together with the Launch of the Philippine Environment Monitor 2005 (PEM 2005) and the Pre-testing of Best Practices for Coral Reef Management of the Local Government Initiative. The PEM 2005 is a project of various Philippine agencies with funding from the World Bank. The Best Practice for Coral Reef Management project is a component of the Local Government Initiative of the World Bank executed by the Research Institute for the Subtropics (RIS) of Okinawa, Japan.



The second Stakeholders Consultation attracted Mayors and other representatives from various government and non-government organisations, together with researchers and representatives of the media



A new long-range dive boat has allowed more efficient field trips for the CRTR Program researchers operating in partnership with the South-East Asian CoE

- ❑ Four mayors participated in the event from the municipalities of Anda, Bani and Bolinao and of the City of Alaminos, as well as representatives from various local government units (LGUs), national government agencies, non-government organizations, academia and the media. A summary of the feedback from the LGUs regarding best practices for coral reef management, obtained through the questionnaire provided by Dr. Seiji Nakaya of the RIS is provided in the detailed CoE report.
- ❑ The CoE has received a large amount of media exposure during 2006. In April 2006, the CRTR Program was featured in three national daily newspapers, namely: The Philippine Star, The Manila Times and Business World. The articles focused on the overall objectives and significance of the CRTR Program, both in the international and national context. It should be noted that the Philippine Star is the second most widely read daily newspaper in the country. These different articles were based on an expanded article initially published in the January-February 2006 issue of the UP Forum, a publication of the UP Information Office circulated within the UP System nationwide. A PDF file of the article may be obtained from <http://www.gefcoral.org>.
- ❑ The Second Stakeholders Consultation, held on 9 August 2006, was featured in a news article posted on the website of the City Government of Alaminos City, Pangasinan (<http://www.alaminoscity.gov.ph/news/>). In the beginning of this year, an article on the First Stakeholders Consultation workshop was published in the Philippine Daily Inquirer, the paper with the largest circulation.
- ❑ The purchase and completion of infrastructure and equipment has continued in order to build the capacity of the research institute. Some examples include: the installation of the PABX telephone system (which has made telephone communication between researchers and administrative staff in UPMSI at Diliman and BML much easier); the purchase of a new boat for CRTR research project use in Bolinao, and; construction of a new coral museum at the third floor of BML, Pangasinan was completed as well as repainting and renovation of the coral museum at UP MSI in Diliman.
- ❑ The CoE has been lending support to the activities of the EU INCO-DEV Reef Restoration Project (REEFRES). Two work programs are being undertaken in Bolinao by two members of the RRWG (E. Gomez and A. Edwards).

- ❑ The Bolinao-based COE subproject on coral disease is still soliciting collaborative input from international experts in coral disease pathology including histology and enzymology. Close collaborative links with international members of the DWG are indispensable. The forthcoming DWG workshop to be held at Bolinao in January 2007 is viewed as an important milestone for further progress.
- ❑ Informal contacts have been made with the Seagrass Demonstration Site personnel at the Bolinao Marine Laboratory which is a component of the GEF/UNEP South China Sea Project. Discussions have related to common concerns about conservation of coastal resources and linkages with stakeholders, especially the local governments and the schools in the region. Further collaboration is expected.

Component Three: Linking Scientific Knowledge to Management and Policy

2006 has seen the research activity of the Working Groups, Centres of Excellence and the Program as a whole, being firmly linked to the management and policy audiences. As evidenced in the sections for Components One and Two, each Working Group and Centre of Excellence is making excellent progress towards ensuring that their research outputs are being linked early in the process and to the respective target audiences. This has been occurring through a series of capacity building and communication forums i.e networking opportunities (meetings, workshops, and training sessions), and the development of products targeted specifically for the audience and training sessions.

During the past year specific activities have commenced at not only the Working Group or Centre of Excellence level, but also at the strategic Program level, which have been designed specifically for linking outputs and information to the management and policy audiences.

During the past year specific activities have commenced at Working Group, Centre of Excellence and at the strategic Program level, specifically to link outputs and information to the management and policy audiences

The most prominent of these activities include the following:

- The Local Government Initiative has been developed to link local governments and communities at chosen sites in the four regions to the Program, and to provide information to assist local communities in their management practices to reduce the impacts on the coral reefs;
- The development and release of the compilation of reef-friendly practices designed to assist managers, policy-makers and local governments with case-studies showing effective management of coral reefs;
- The compilation of a technical baseline compendium has been developed that establishes the state of our knowledge of coral reefs at the commencement of this Program, and later will be used as the baseline against which future knowledge and progress can be measured, and;
- The CRTR Program provided support to, and attended the 3rd International Tropical Marine Ecosystems Management Symposium (ITMEMS) in October 2006.

Of particular note is the 3rd ITMEMS conference of which a large contingent of CRTR Program members attended in Cozumel, Mexico. The CRTR was a prominent supporter and participator in a number of the conference sessions including a Local Mayors Panel, workshop sessions and the sponsoring of a special event promoting the work being undertaken by the Program. This event was critical in raising the profile of the Program and its participants, building linkages into the management community and exchanging information to ensure that the CRTR outputs are credible, in demand and viewed as valuable to the stakeholders the Program is targeting.

These above activities, combined with those of the individual Working Groups and Centres of Excellence, have ensured that the targeted research is relevant to the appropriate audiences, and in particular, has emphasized the value of the research outputs. The efforts to date have also built essential linkages with those stakeholders who will most benefit from the Program's findings and products.



Cozumel was host to the 3rd ITMEMS conference where the CRTR Program had a major session to highlight the importance of integration between scientists and managers



The CRTR Program was a strong supporter of the Local Mayors Panel held as a part of the 3rd ITMEMS conference in Mexico

3rd International Tropical Marine Ecosystems Management Symposium (ITMEMS)

The 3rd ITMEMS Conference was held from the 15 – 20 October in Cozumel, Mexico. The CRTR Program had a strong presence at the conference with all Synthesis Panel members attending along with a number of Working Group members. The Program sponsored a special cocktail reception event which highlighted the work of the Program including the importance of integration between managers and scientists as well as providing an effective feedback mechanism on priorities and the utility of the targeted research to management needs. Individuals participated in 14 different workshop sessions. Of note was the participation of the members of the Modelling & Decision Support Working Group under the Modelling and Decision Support Theme, whereby (amongst other things) they conducted sessions of modelling workshops where a new regional model for the Meso-American Barrier Reef System was presented.

Local Mayors Panel

The Program was also a major supporter and sponsor of the Local Mayors Panel which was held as part of ITMEMS.

The Mayors Panel consisted of:

- *Gustavo Ortega Joaquin* Mayor, Island of Cozumel, Mexico
- *Mahmoud Juma Issa* Mayor, Zanzibar Municipal Council, Tanzania
- *Ann Bunnell* Deputy Mayor, Townsville, Queensland, Australia
- *Lucilo Bayron* Vice Mayor, Puerto Princesa City, Philippines
- *Teariki Matenga* Mayor, Tukitumea, Rarotonga, Cook Islands
- *Hermani Braganza* Mayor, City of Alaminos, Pangasinan, Philippines
- *Jeremy Harris* Former Mayor, Honolulu, Hawaii, USA

The Program sponsored the three mayors from the Philippines (Mayor Braganza), Zanzibar (Mayor Issa) and the Cook Islands (Mayor Matenga).

The public Panel sessions were strongly supported by attendees at ITMEMS and culminated in the drafting and signing of a Local Government Leaders' Statement (see Appendix B) whereby the Panel identified six major issues that should be addressed to develop the partnership between the global coral reef management community and local government.

The Local Government Initiative is now being integrated into projects managed by CRTR Program Centres of Excellence

The Program is continuing the association with these mayors and others through the Local Government Initiative (see below).

Further information and findings on the ITMEMS conference can be found at the ITMEMS website www.itmems.org.

Local Government Initiative

The Local Government Initiative is a new initiative developed under the CRTR Program which aims to bring about change to assist in raising awareness of the issues facing local governments and communities who depend upon coral reefs for their livelihoods, and to work with chosen communities to exchange information and knowledge which may assist in addressing these issues. They include:

- ☐ Unsustainable fishing and coastal management practices.
- ☐ Lack of public awareness, limited acceptance of rules and low level of compliance.
- ☐ Lax or ineffective enforcement.
- ☐ Lack of plans/ordinance for coral reef management.
- ☐ Lack of alternative income generating activities to reduce human impacts on the reefs.
- ☐ Lack of funding.

The Local Government Initiative aims to address these issues through the following goals:

1. To 'green' policies and business practices of local government so that they align with those factors essential to maintaining coral reef health and productivity.
2. To improve the capacity of the Coral Reef Targeted Research and Capacity Building for Management (CRTR) Program's Centres of Excellence to partner with local governments throughout their target regions in the identification, dissemination and uptake of good practices.

All Centres of Excellence are currently preparing projects within their regions to bring about change in the practices of local governments and communities in combating some of the issues facing coastal and coral reef ecosystems from human impacts.

A compendium of good management practices has been developed and integrated into the CTR Program's Local Government Initiative projects

Compilation of reef-friendly practices

Through support from the Japanese Trust Fund, a compendium of good management practices for coral reefs, based on sound science and documented literature, has been compiled by the Research Institute for the Sub-tropics (RIS), a Japanese NGO. These practices range from integrated coastal management, erosion management and waste water treatment, to Marine Protected Areas, tourism guidelines and restrictions on fishing and equipment.

These practices including the rationale, methods, results and lessons learned, have been drawn from coral reef management contexts around the world.

Pre-testing of good practices

A representative sample of the coral reef friendly practices compiled above was vetted in stakeholder consultations with Filipino Mayors and other local government leaders in Alaminos City, Pangasinan, Philippines in early August 2006. Over 80 stakeholders attended the day long workshop, which included a briefing on the declining state of coastal and marine resources in the Philippines, estimates of economic loss from degraded coral reefs, and what some communities were doing in response.

Examples of field-tested best practice for coral reef management in the Philippines were presented to stakeholders for discussion, along with those examples from other parts of the world. Local government leaders were both disturbed by the accelerated rates of coral reef degradation and consequent loss of resource rents in the Philippines (e.g., in the fisheries and tourism sectors) and hopeful that this could be turned around with decisive and appropriate actions.

Presentation of pilot results at ITMEMS 3

The local government leaders representing coral reef communities from around the world (e.g., from Mexico, Philippines, Cook Islands, Tanzania, Fiji, PNG, Hawaii, Australia, Belize) discussed a compendium of coral reef friendly practices and the pre-test results in the Philippines.

The Commitment by mayors and other local government leaders to take on board several of these good practices in response to threats to coral reefs in their own communities is expected, along with a statement calling local government leaders to take action and develop a strategy outlining key steps that they can take to protect coral reefs in their communities.

Publication of Manual and Brochures in three languages for broad dissemination

Feedback from the Local Government Leaders' Forum and plenary discussions involving a broad group of stakeholders will be incorporated into a final report. This will also be reviewed by the coral reef research community to ensure that recommendations are robust and based on good science.

An illustrated brochure of these coral reef friendly practices will be published initially in English, Spanish and Tagalog for broad dissemination to local governments which depend on coral reef goods and services.

Synthesis Panel

The Synthesis Panel has continued to make decisions determining the direction of the Program's research agenda. During 2006, the Panel held its meeting at Puerto Morelos, Mexico, from the 11-14 October 2006. A copy of the minutes will be available in the 2007 six-monthly progress report.

Common Sampling for Working Groups & Centres of Excellence

In October, 2004, a joint meeting of selected working group members initiated a special program to establish common repeated measures of key process variables in and around each of the Centres of Excellence. The approach was roughly modeled after the 50 hectare terrestrial monitoring plots originally established by researchers of the Smithsonian Tropical Research Institute, which has since grown into a global network of comparable data sets. The CRTR team met with two consulting statisticians to help in reviewing program design.

Dr. Rob van Woesik of the BWG has been coordinating the effort and study sites have been established in three of the CoEs to date. Additional effort will be directed toward the Philippines in 2007, as well as engaging other Working Group members who can assist with standard operating procedures, methods and techniques in common data collection.

This will be so that all repeated measures sampling will be comparable across study sites and over the life of the program. Ultimately, the data generated should also benefit each of the Working Groups and CoEs, but also contribute toward data validation and parameterization needed by the Modelling and Decision Support Working Group.

Technical Baseline Compendium

The draft of the technical baseline summary, to serve as the state-of-knowledge at the commencement of the project, was presented during the October, 2006 Synthesis Panel meeting for review and comment by Synthesis Panel members.

The compendium will be made available for internal Program members in early 2007. A special edition for external release will also be completed in early 2007.

Synthesis Workshop

Based upon targeted research conducted and findings to date, a workshop will be held in early 2007 for Synthesis Panel members to commence the integration and synthesis of this research information and outputs. A key output from this meeting will be the development of summary statements on the research findings so far.

The intent of the workshop is to review summary material for producing several documents 1) a statement by the panel relating to early findings and areas of concern (and produced as a product by the CRTR program) 2) a policy forum discussion to be submitted to Science and other peer-reviewed articles.

These outcomes will be the first synthesised product from the Program utilising research outputs from across the six Working Groups and will be specifically for the Program's target audiences.

Component Four: Program Management

2006 has seen the finalisation of many of the procedures to be implemented by the Project Executing Agency (PEA) to ensure an effective and accountable operating structure. All sub-grant contracts are now in place and the terms and conditions of the contracts are being effectively met with the assistance of the institutions involved. CRTR members of the Management Team, Working Groups and Centres of Excellence, along with their respective institutions, have been instrumental in assisting the PEA through the implementation process and the ongoing operation of the Program, and their support is most appreciated.

Despite a slower than expected start to the funds disbursement, the past year has seen a steady progression towards meeting the estimated program expenditure as outlined in the project planning documents, due to all sub-grant Agreements now being in place and increased momentum with the Program activities under all three components.

Monitoring and evaluation of Program activities has been tracked throughout the year. Following direction from the World Bank, the performance indicators for the Program are currently undergoing revision. Due to this, a monitoring and evaluation report is unable to be supplied with this report, but will be undertaken against the new performance indicators and submitted to the World Bank Team Leader once these have been finalised.

Work has continued on the development of the Communication program for the CRTR Program with the communication strategy and visual identity being reviewed and revised by Currie Communications. Promotional and information products have also been produced including posters and research updates. These products were presented at the ITMEMS Conference in October to an audience of coral reef managers and decision-makers, with great effect. Efforts in this area will continue in 2007 with a greater emphasis on the production of synthesized information.

Activities & Implications

Disbursements

Disbursements have continued during 2006 with the Program on-target with its expenditure projections. By the end of the reporting period (30 September 2006), the Project is on-target to meet its expenditure objectives for Year Two. Activities funded include the research activities under Component One, the research and capacity building activities under Component Two and the activities to link scientific knowledge to management under Component Three.

Prolonged agreement negotiations with some institutions caused initial delays in the disbursement of funds. However, these negotiations have now all been finalised and the disbursement under the GEF funding source is now on-track. Research activity has also accelerated in the past year which has had an impact on the amounts disbursed as Working Groups increase activity to meet their objectives.

Procurement

The procurement for the Project for the year is below:

Consultancies

During the reporting period, the following consultancy has been granted:

- ☐ Mr Andy Hooten, Synthesis Panel Executive Secretary & US Coordinator.
- ☐ Dr Lauretta Burke, Provide technical guidance to the GIS unit located at the Institute of Marine Science, Zanzibar.
- ☐ Dr Roger Green and Dr Brian McArdle were contracted on a retainer basis, to participate in discussions and provide statistical guidance on common sampling and information sharing approaches.

Executive Committee Honoraria

As mentioned in previous reports, Drs Knowlton and Muthiga have been placed on the Honoria list for their work undertaken on behalf of the Project as Executive Committee members.

Sub-Grants

During the reporting period, the Project Executing Agency have finalised all sub-grant Agreements.

Monitoring & Evaluation

Monitoring of Program activities has continued during 2006 and there have been significant inroads in the first two years of the Program to ensure that the research outputs are of value to the target audiences. Due to the revision of the Program's performance indicators a report has not been prepared at this stage demonstrating targets and impacts against the revised indicators. A report will be prepared once the performance indicators have been finalised in the coming months.



A series of CRTR Program posters have proven popular at major events



CRTR Program Research Updates aim to provide a detailed insight into research progress

Communication

Following the resignation of Elaine Tilson in May 2006 as the Communication Officer, the Program appointed Currie Communications in the interim period to review the communication strategy and provide recommendations as to how the Program could move forward, and to revise the Program branding.

Kim Mitchell, a senior consultant from Currie Communications has been working effectively with the Management Team, and more recently, with the Synthesis Panel to revise and implement the communication strategy and Program branding. Specific details of the communication activity are detailed below by Mr Mitchell.

A detailed review of the CRTR Program communication program and visual identity was facilitated by Currie within the first few weeks of being appointed. This has since resulted in a complete revision of the program branding, establishment of more open and flexible design protocols for products and the development of a revised communication strategy.

Following consultation with members of the Executive Committee and PEA, the new visual identity has now been applied to a number of flagship communication materials, including conference/exhibition posters, program promotional materials such as the summary brochure, postcards and other corporate materials including business cards for all Synthesis Panel members, PowerPoint, letterhead and other templates.

Currie has also worked with Synthesis Panel members to initiate a series of 'Research Updates' which were published for the ITMEMS 2006 conference in Mexico. A series of highly visual scientific posters have also been developed for each of the Working Groups as well as for the Centres of Excellence and Local Government Initiative.

Both products have been very well received by Working Group and COE Chairs with strong demand for additional copies noted for targeted communication by CRTR Program members.



The revised CRTR Program website will offer higher levels of functionality and ease of use to access program information

The CRTR Program website is undergoing a major update, with a stronger focus on connecting on-line users with CRTR Program research outcomes, providing a news and feature article-style information service for first-time users while ensuring the site has the level of technical capacity and interactivity required by CRTR participants. The revised website also offers significantly easier navigation and functionality, aiming to allow users to go directly to their area of interest (by Working Group, COE, etc) or stepping through an intuitive pathway via the graphic-rich strapline and banner sections.

Kim Mitchell participated in a one-week Communication Workshop at the SCRIPPS Institute, University of California, in late August 2006 to interact with the SeaWeb communication group and senior staff members at SCRIPPS. During this workshop Kim met with CRTR Program Synthesis Panel Chair Nancy Knowlton to facilitate feedback on the CRTR's Communication and Capacity-Building Strategies. Kim also coordinated a component to the workshop's media training session by stepping participants through a media conference exercise to improve the level of skills in anticipating, and successfully answering, questions from the media.

Kim also attended the October 2006 Synthesis Panel meeting in Puerto Morelos, Mexico. During this time a number of one-to-one briefings were undertaken with the various Chairs to determine the level of progress, and assistance required, in implementing communication workplans. A major communication focus emerging for many of the Working Groups lies in the development of Products derived from CRTR and other research for key program stakeholders. Working with Chairs and project teams in successfully developing and disseminating such materials will be a priority focus for the CRTR Program in the coming year.

Following approval of the final draft CRTR Program Communication Strategy Currie will work with the PEA to assist Working Groups and COEs to develop communication working plans and also to refine communication guidelines and protocols for the broader program.

Appendix A – Students affiliated with the CRTR

Working Group or Centre of Excellence	Surname	First Name	Scholarship	Country	Scholarship Institution	Scholarship Title	Start Date	End Date
Bleaching	Kongjandtre	Narinratana	PhD	Thailand	University of Queensland, Australia.	Taxonomy and connectivity of corals from the genus <i>Favia</i> in Thailand and on the southern Great Barrier Reef.	01/07/2006	30/03/2010
Bleaching	Padillo-Gamino	Jackie	PhD	TBC	University of Hawaii	Assessing the impacts of disturbance on reproduction of corals	01/01/2005	31/12/2010
Bleaching	Furaha	Juliet	Masters	TBC	Moj University	The influence of area protection and site characteristics on recruitment, survival, and growth of coral species on the Kenyan Coast	01/01/2005	01/01/2008
Bleaching	Visram	Shakil	PhD	TBC	TBC	TBC	TBC	TBC
Connectivity	Alvarado	Nathaniel	B.Sc.	Belize	University of Maine, USA	Coral ecology	01/01/2006	31/12/2007
Connectivity	Mojica	Angela	M.Sc.	Guatemala	Old Dominion University, USA	(1) Impact of grazing crabs on coral reefs (2) Postlarval lobster responses to settlement cues	01/07/2006	30/06/2008
Connectivity	León Zubillaga	Ainhua	M.Sc.,	Venezuelan	Universidad Simón Bolívar, Caracas with secondments to Georgia Tech, Waterloo University (Canada)	Genetics and connectivity of <i>Acropora palmata</i>	01/04/2006	31/03/2009
Connectivity	Porto Morales	Isabel	M.Sc.	Colombia	Universidad de los Andes, Colombia, with secondment to Georgia Tech.	Coral genetics and connectivity	01/06/2006	31/05/2008
Connectivity	María Salas De La Fuente	Eva	MSc	Costa Rica		Population genetics of the Bicolor damselfish, <i>Stegastes partitus</i>	01/06/2005	30/05/2007
Disease	Croquer	Aldo	Post-doc		University of Puerto Rico	Geographic assessment and monitoring of diseases in the wider Caribbean.	TBC	TBC
Disease	Jordán Garza	Guillermo	Masters	Mexico	Instituto de Ciencias del Mar y Limnología, Mexico	Geographic assessment and monitoring of diseases on Mexico reefs	TBC	TBC

Disease	Ridep-Morris	Alma		Australia	James Cook University, Australia	The dynamics and epidemiology of a coral disease outbreak in Nikko Bay	TBC	TBC
Disease	Rosell	Kathryn B.		Philippines	Philippines	The effects of the riverine discharges on coral disease prevalence	TBC	TBC
Modelling & Decision Support	Ching Fung	Tak	PhD	UK	University College, UK	Modelling coral reef ecosystems and their interaction with human societies	01/10/2004	30/09/2008
Modelling & Decision Support	Geronimo	Rollan C.	MSc	Philippines	University of the Philippines	Modeling marine protected area networks along the South China Sea	01/01/2006	30/03/2007
Modelling & Decision Support	Trebilco	Jessica	PhD	Australia	University of Tasmania, Australia	Decision support systems for managing coral reefs at a regional scale	01/10/2006	31/10/2009
Modelling & Decision Support	Cleland	Deborah	Other	Australia	ANU, Australia	Summer Research Scholarship	01/09/2006	31/03/2007
Remote Sensing	Idip	David	MSc	Palau	Canada (2/3) and Exeter (1/3)	Dedicated training in remote sensing: mapping reefs, bathymetry, wave exposure and beta diversity of Palau	15/09/2006	31/08/2007
Remote Sensing	Bejarano	Sonia	PhD	UK	University of Exeter	Use of acoustic remote sensing to predict relative fish density and grazing intensity	01/10/2005	30/10/2008
Remote Sensing	Lim	Alan	PhD	Canada	University of Waterloo	Use of remote sensing to detect ecological changes in coral reef environments using textural measures	TBC	TBC
Remote Sensing	Ticzon	Victor		Philippines	University of the Philippines	Use of remote sensing to predict the density of keystone taxa	01/04/2005	TBC
Remote Sensing	Penafior	Eileen	PhD	Philippines	University of the Philippines	Remote sensing of coral bleaching. Began October 2005	TBC	TBC
Restoration and Remediation	Vicentuan	Kareen	Masters	Philippines	UPMSI, Philippines	The reproductive biology of scleractinian corals and in addition, the effects of fragmentation on their reproductive status	01/01/2006	30/03/2008
Restoration and Remediation	Baria	Maria	Masters	Philippines	UPMSI, Philippines	Spatial and temporal patterns of coral recruitment in Bolinao, Pangasinan	01/03/2006	TBC
Restoration and Remediation	Cabaitan	Patrick	Masters	Philippines	University of the Philippines	TBC	TBC	TBC

Restoration and Remediation	De La Cruz	Dexter	Masters	Philippines	University of the Philippines	TBC	TBC	TBC
Restoration and Remediation	Baria	Vanessa	Masters	Philippines	University of the Philippines	TBC	TBC	TBC
Australasian	Schuttenberg	Heidi	PhD	USA	James Cook University, Australia	Understanding Effective Coral Reef Governance	01/12/2006	30/03/2010
Australasian	Kongjandtre	Narinratana (Nong)	PhD	Thailand	University of Queensland, Australia	Taxonomy and connectivity of corals from the genus Favia in Thailand and on the southern Great Barrier Reef.	01/07/2006	30/03/2010
Australasian	Albert	Simon	PhD	Australia	The University of Queensland	New tools to identify coral reef ecosystems at risk	TBC	TBC
East African	Mbije	Nsajigwa	PhD	Africa	Tanzania	TBC	TBC	TBC
East African	Suleiman	Mohammed	PhD	TBC	State University of Zanzibar	TBC	TBC	TBC
East African	Jones	Leonard	PhD	TBC	Institute of Marine Sciences	TBC	TBC	TBC
Meso American	Coronado	Cesar	PhD	Mexico	Centro de Investigación Científica y de Educación Superior de Ensenada, Mexico	Water Circulation in the Puerto Morelos Reef Lagoon	01/01/2006	01/01/2010
Meso American	Colombo	Florencia	PhD student	Mexico	Centro de Investigación Científica y de Educación Superior de Ensenada, Mexico	Support for attending the course on Light and Photosynthesis on Coral Reefs	10/01/2006	10/02/2006
Meso American	Perera	Susana	Manager	Cuba	Centro Nacional de Áreas Protegidas de Cuba, Cuba	Support for Attending the course of Marine Protected Areas	17/06/2006	25/06/2006
Meso American	Valderrama Hernández	Aylem	Manager	Cuba	Centro Nacional de Áreas Protegidas de Cuba, Cuba	Support for attending the Marine Protected Areas course	16/06/2006	25/06/2006
Meso American	Bohorquez	Carlos	Manager	Colombia	Colombia	Support for attending the Marine Protected Areas course	17/06/2006	25/06/2006
Meso American	Yepsi	Alejandra	Manager	Venezuela	Venezuela	Support for attending the Marine Protected Areas Course	17/06/2006	25/06/2006
Meso American	García Nieto	Natalia	Masters	Mexico	Facultad de Ciencias, UNAM, México	Support for attending the Marine Protected Areas course	17/06/2006	25/06/2006
South East Asian	Arboleda	Mark Dondi	PhD	Philippines	Marine Science Institute, Philippines	TBC	16/06/2005	15/06/2007
South East Asian	Ravago-Gotangco	Rachel	PhD	Philippines	The Marine Science Institute, Philippines	TBC	01/11/2005	31/10/2006
South East Asian	Vergara	Mark	MSc	Philippines	The Marine Science Institute, Philippines	TBC	01/02/2005	31/01/2007



South East Asian	Lumibao	Candice	MSc	Philippines	The Marine Science Institute, Philippines	TBC	01/02/2006	31/08/2006
South East Asian	Pueblos	Miahnie Joy	MSc	Philippines	The Marine Science Institute, Philippines	TBC	15/07/2006	15/10/2006



Appendix B – Local Mayors Statement

ITEMS 3 COZUMEL DECLARATION LOCAL GOVERNMENT LEADERS' STATEMENT

Local Governments hold the key to the future of coral reefs and other tropical marine ecosystems.

Greenhouse gas emissions, land based sources of marine pollution, unsustainable coastal development, overfishing and destructive fishing are local problems that impact at the global level. Healthy coral reefs are a beautiful indicator of healthy coastal and marine ecosystems and an increasingly valuable natural resource. The economic, social and cultural futures of people of tropical coasts and islands are linked to the health of coral reefs.

Local Government is on the front line of the issues that directly affect the future of coral reefs and associated ecosystems. Many local governments face huge and constantly changing challenges in providing for sustainability – meeting the needs of the present without compromising the needs of the future.

We are grateful for the opportunity provided for us to engage with the expertise of the coral reef management and scientific community through participation in the program of the Third International Tropical Marine Ecosystems Management Symposium.

We have identified 6 major issues that should be addressed to develop the partnership between the global coral reef management community and local government

EMPOWERMENT

We call upon the management and scientific community to support the empowerment and resourcing of local governments to manage tropical marine ecosystems.

NETWORKS

We call upon the management community to work with local government and community networks to develop informed partnerships to address the management of tropical marine ecosystems.

CAPACITY BUILDING

We call upon the management community to work with local government to develop practical technical capacity at the local level to address marine ecosystem issues.

KNOWLEDGE AND COMMUNICATION

We call upon researchers to communicate current research information in a manner that addresses the needs of local government.

POLITICAL WILL

We call upon the management community to work with local government to build the political will to meet the challenges of managing tropical marine ecosystems.

RECOGNITION OF ACHIEVEMENT



We encourage the management community to publicly recognize the achievements of local government in sustainable management of marine resources.

Gustavo Ortega Joaquin Mayor, Island of Cozumel, Mexico

Mahmoud Juma Issa Mayor, Zanzibar Municipal Council, Tanzania

Ann Bunnell Deputy Mayor, Townsville, Queensland, Australia

Lucilo Bayron Vice Mayor, Puerto Princesa City, Philippines

Teariki Matenga Mayor, Tukitumea, Rarotonga, Cook Islands

Hermani Braganza Mayor, City of Alaminos, Pangasinan, Philippines

Jeremy Harris Former Mayor, Honolulu, Hawaii, USA