BIANNUAL REPORT 2007-2008

AIMS @ JCU

Contents

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Portrait photographs provided by students/staff themselves
Photograph above courtesy of AIMS@JCU student Gergely Torda

Foreword

The partnership between two of the world's top marine science research institutes was always going to be formidable. And so it has proven to be, with a wealth of young marine science talent rising to the surface through their training at AIMS@JCU.

Fostering this talent is increasingly taking on urgency as Australia moves towards greater reliance on marine based industries for its wealth, well-being, identity and security.

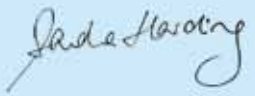
In May this year we signed an agreement extending AIMS@JCU by a year, until June 2010. Between now and the end of the extended agreement we are reviewing all aspects of the joint venture with a view to refreshing and restructuring the collaboration and fine-tuning it for the future.

In 2004, AIMS affiliated with JCU to form AIMS@JCU. This formalised the long-standing collaborative research relationship between the two organisations, through investment in infrastructure and research staff. AIMS and JCU received additional funding of $3.9m in the 2003-04 Federal Budget to support this collaboration, providing critical infrastructure and greatly boosting regional capabilities.

The joint venture is in tune with new directions being set for Australian marine science. The Federal Government's Ocean Policy Science Advisory Group blueprint, "A Marine Nation: national framework for marine research and innovation" launched in March 2009 by the Minister for Innovation, Industry, Science and Research Senator Kim Carr, called strongly for increased effort to counter the projected shortfall in new recruits to marine research. Marine science education is an essential element in ensuring sufficient intellectual capacity into the future.

In an environment of current and projected growth of marine science activities in Australia, we need to ensure that initiatives such as AIMS@JCU are nurtured and supported in order to provide marine science talent for this country's future.

Dr. Ian Poiner
Chief Executive Officer of AIMS



Prof. Sandra Harding
Vice-Chancellor of JCU

Our Vision

AIMS@JCU, a joint venture between the Australian Institute of Marine Science and James Cook University, facilitates and fosters high quality research by integrating the strengths and areas of synergy between the two parent institutions. The broad objective of this joint venture is to produce leading edge science that harnesses the latent potential in both institutions by merging infrastructure and expertise.

To realise this objective the joint venture will continue to build research training opportunities and strength in theme-based research areas. In addition AIMS@JCU will help address areas of state and national skills shortages that can be explored and satisfied through activities of the joint venture. Research will continue to focus on meeting institutional, national and state priorities while breaking new ground in various areas of research.

What is AIMS@JCU?

AIMS@JCU is a joint venture between the Australian Institute of Marine Science and James Cook University. The intent of AIMS@JCU is to increase research activities within tropical, marine-based research areas; improve research capabilities and outputs of the partner institutions; and improve research training opportunities for students.

Specifically, AIMS@JCU enables the two partner institutions to undertake activities collectively which they could not have undertaken individually, and create new areas of research expertise, both individually and together.

Research Director's Report

Dr. Michelle Heupel

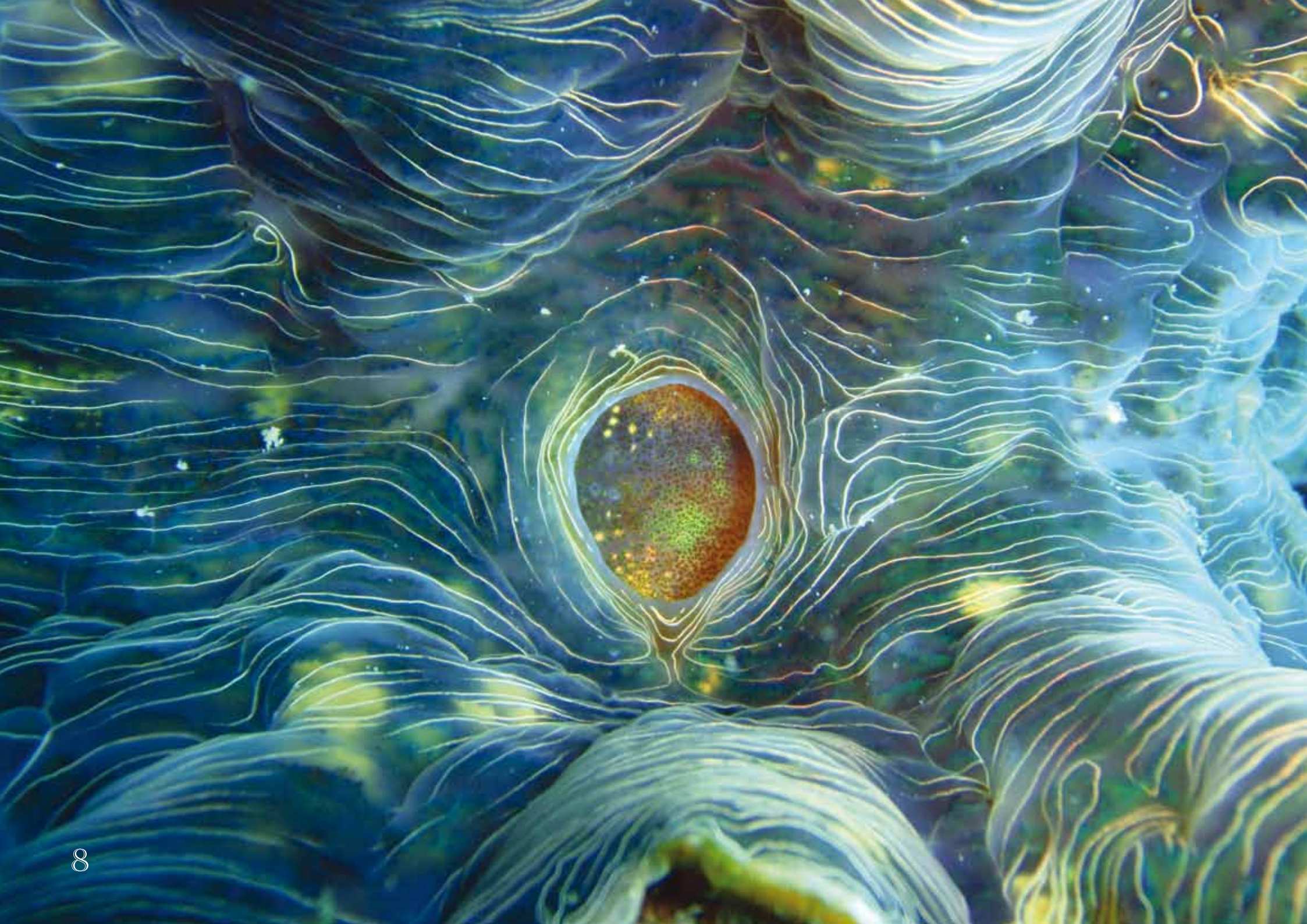
It is my pleasure to introduce you to the AIMS@JCU 2007-2008 Biannual Report. Over the last two years AIMS@JCU has grown and changed in several ways while continuing to support and encourage high quality research between the two parent institutions. The combination of these two premiere research and education institutions provides an unparalleled opportunity for scientific advancement. As you will see throughout this report, AIMS@JCU is currently focused on three main research themes with established experts in these fields from each parent institution acting as Program Leaders. The theme areas foster the research of varying numbers of students ranging from Honours to PhD level studies. Many of the student members in these programs are supported by AIMS@JCU funding for their research and are active at both institutions.

Since the last report several changes have occurred. Brett Dinsdale, the Executive Officer and Trisha Fielding, the Communications Officer both left to take up new opportunities. Rhondda Jones, the Independent Chairperson on the AIMS@JCU Board, finished her tenure and two Board members, Peter Willers and Ned Pankhurst left and were replaced by David Mead and Chris Cocklin respectively. These changes have led to a new structure for the AIMS@JCU Board which now functions as a Management Committee for the Joint Venture. The Management Committee also took this transition period as an opportunity to recruit a Research Director to help guide the Joint Venture into a new path via a Strategic Plan and new research initiatives.

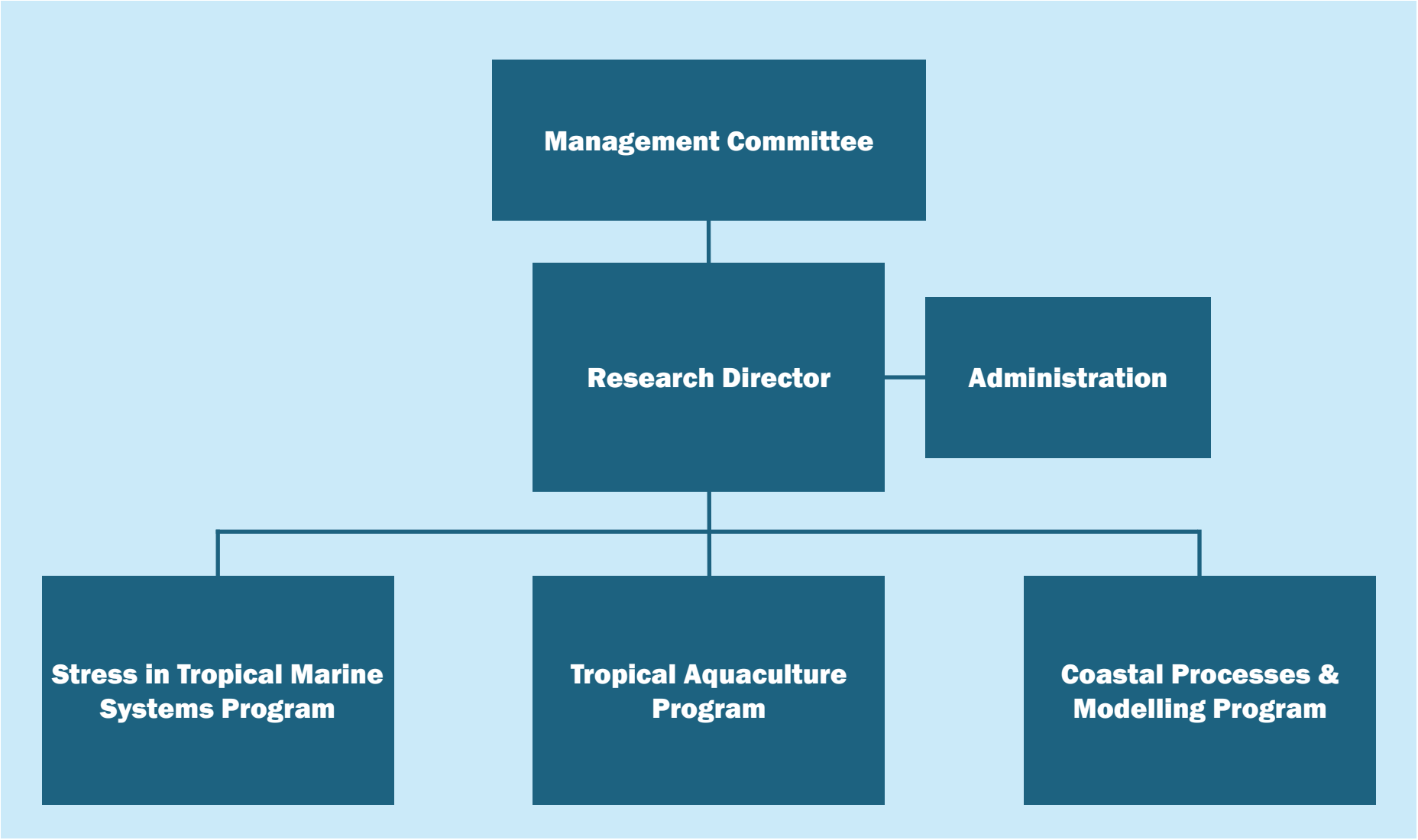
AIMS@JCU is still in a period of flux with transitions also occurring within the staff and students involved in the Joint Venture. One Postdoctoral Scientist, Thomas Stieglitz, completed his tenure in 2008 and a second, Greg Smith, is due to complete in late 2009. Several AIMS@JCU PhD students are also scheduled to complete their degrees in 2009. The movement of these individuals from the group signifies the growth and achievements accomplished within the last few years and the realisation of research projects that helped establish the Joint Venture. In 2009 an additional five PhD and three Honours students were recruited to AIMS@JCU to conduct new and different research projects and continue to expand and develop the Joint Venture. 2009 will also see AIMS@JCU release a Strategic Plan for the future and begin examination of a new structure for the group and additional research themes of interest to the two parent institutions.

The facilities and staffing available to AIMS@JCU members make this a strong and unique organisation with much to offer its participants now and into the future. The coming years will see changes to this organisation to strengthen, expand and improve the Joint Venture for everyone involved. I thank all of our members for their continued support and enthusiasm for this venture. Special thanks go to the AIMS@JCU Management Committee for their support, guidance and strategic thinking about where AIMS@JCU can and will go into the future. I sincerely thank the Program Leaders and Postdoctoral Scientists for their time and commitment to the Joint Venture and all of the students involved. Thanks also need to be extended to Lauren Gregory and Vanessa Adams for their dedication to the tasks at hand in running the AIMS@JCU office. Without the commitment and dedication of each of these individuals AIMS@JCU would not be where it is today. I look forward to working together with all of our members to take AIMS@JCU into the future with a renewed strategy building upon the hard work and dedication that has carried the group this far. The future of AIMS@JCU continues to be bright as we move into the next phase of the Joint Venture.

Photograph opposite courtesy of AIMS@JCU student Darren Coker



Management Structure



Photograph opposite courtesy of AIMS@JCU student Darren Coker

Management Committee Members

AIMS@JCU is governed by a Management Committee consisting of four members: two from each partner institution (plus a nominated alternate representative from each institution).

The Management Committee is responsible for making research and operational decisions for the Joint Venture in consultation with the Research Director. The Management Committee meets quarterly with the Research Director.

Doctor Julian Caley

Principle Research Scientist

Conservation and Biodiversity

Australian Institute of Marine Science

David Mead

General Manager

Australian Institute of Marine Science

Doctor Chris Battershill

(alternate representative)

Research Team Leader

Supporting Sustainable Use of Marine Biodiversity

Australian Institute of Marine Science

Professor Chris Cocklin

Deputy-Vice-Chancellor Research and Innovation

James Cook University

Professor Helene Marsh

Dean of Postgraduate Studies

Graduate Research School

James Cook University

Professor Michael Kingsford

(alternate representative)

Head of School of Marine and Tropical Biology

James Cook University

Doctor Michelle Heupel

Research Director

Photograph opposite courtesy of AIMS@JCU student Darren Coker

Dr. Julian Caley

Julian Caley is a Principal Research Scientist with AIMS. His marine research has ranged through population and community ecology, macroecology and evolutionary biology. This research has used many different model organisms depending on the question of interest, but most of his recent work has concentrated on the evolution and evolutionary ecology of reef fishes with an emerging interest in the evolution of coral symbiosis. In particular, his current research explores ecological and contemporary evolutionary processes that generate and maintain biodiversity.

Julian received his Ph.D. from the University of Sydney in 1992 and has since held four prestigious research fellowships at the University of British Columbia and James Cook University. He has supervised many research students and has published numerous scientific papers. In addition to his responsibilities as a research leader at AIMS, he has been involved from the beginning in the establishment of the AIMS@JCU joint venture as a member of the Institutional Steering Committee and now as a Member of its Management Committee. Julian is also a graduate of the Australian Institute of Company Directors.

Mr. David Mead

David Mead is the General Manager of AIMS and is responsible for day to day operations of the Institute. In this role he manages a broad spectrum of areas including; health and safety, field and ship operations, engineering and technical and corporate services. Additionally he oversees the business and commercial aspects of the institute and is involved in developing external revenue opportunities and in the strategic planning of research.

David has an Honours degree in mechanical engineering and tertiary qualifications in business (Master of Business Technology). Prior to taking up this position, David worked as a senior manager at Snowy Hydro Limited for 14 years, a renewable energy generation and electricity retail company. During this period he had a diverse range of roles, from strategic planning and business development through to leading teams responsible for improving maintenance and asset management systems and processes. This work culminated in David being awarded the inaugural Steve Maxwell National Maintenance Leadership Award.

Prior to Snowy Hydro Limited, David worked for several years at BHP Research as a research engineer undertaking mathematical and numerical modelling of rock fracturing under explosive loadings.

Dr. Chris Battershill

Chris Battershill is the Leader for the "Supporting Sustainable Use of Marine Biodiversity" Research Team at AIMS, having lead teams in Marine Biotechnology and Microbiology at AIMS and in New Zealand. Chris is personally active in research associated with Biodiversity Assessments, Conservation Ecology, New Species Aquaculture (particularly for production of biomedicinal compounds), Biodiscovery and Chemical Ecology.

Chris completed postdoctoral fellowships at the University of Canterbury in conjunction with the National Cancer Institute (US), SeaPharm/Harbour Branch Oceanographic Institute (US), and at AIMS. Highlights of his research career include enhancing discovery and production of marine biomedicinal leads and research examining the chemical ecology and dynamics of biodiverse seafloor habitats.

Research projects have been carried out from the high tropics to the Antarctic. Publications include co-authorship of three books on marine taxonomy and experimental design, as well as over 90 international peer reviewed publications. Chris is an adjunct Professor at the University of Western Australia and James Cook University; and Inaugural Leader of the Biotechnology and Aquaculture Node of the Western Australian Marine Science Institution.

Prof. Chris Cocklin

Professor Cocklin was appointed to the position of Deputy Vice-Chancellor, Research and Innovation in August 2008. He was previously Pro-Vice-Chancellor of the Faculty of Science, Engineering and IT at JCU (from February 2007). Prior to that he was employed for 10 years at Monash University, where he served as Head of the School of Geography and Environmental Science and as the inaugural Director of the Monash Environment Institute.

Chris' interests are in resources and environmental policy, agriculture and rural communities, global environmental change, sustainable development, and corporate environmental management. He is a member of the Queensland Premier's Advisory Council on Climate Change, a Board Member of the Australian Tropical Herbarium, the Tropical Landscapes Joint Venture, the Reef and Rainforest Research Centre, and the AIMS@JCU Joint Venture.

Over the course of his career, Professor Cocklin has published approximately 190 articles, books, research monographs, technical reports and reviews. He has delivered approximately 120 papers to professional conferences and meetings, including more than 30 invited/keynote addresses.

In 2004 he was appointed by the Intergovernmental Panel on Climate Change (IPCC) as a Lead Author of the Fourth Assessment Report. He was also an invited participant in the Prime Minister's Australia 2020 summit, held in 2008. In addition to his position at JCU, he holds the position of Honorary Professor in Geography and Environmental Science at Monash University.

Prof. Helene Marsh

Helene Marsh is Dean of Postgraduate Studies and Professor of Environmental Science at JCU. The focus of her research has been dugong population ecology with an emphasis on life history, reproductive ecology, population dynamics, diet, distribution, abundance and movements. Helene is committed to informing interdisciplinary solutions to conservation problems and has collaborated widely with colleagues in other disciplines including Anatomy, Anthropology, Botany, Biochemistry, Genetics, Geography, GIS, Law, Psychology, Sociology and Statistics.

The policy outcomes of Helene's research include significant contributions to the science base for the Dugong Sanctuary established in Torres Strait; dugong management in the Great Barrier Reef Marine Park, especially the Dugong Protected Areas and no-take areas to protect dugongs in various zoning plans; and the establishment of a Commonwealth Ministerial Taskforce to Investigate the Sustainability of Indigenous Hunting of Dugongs and Turtles.

Helene's research has also provided the conceptual basis for the 'Back on Track' Program currently being conducted by the Queensland EPA. Helene was awarded a Pew Charitable Trust Fellowship in Marine Conservation in 1998 and a Distinguished Service Award by the Society of Conservation Biology in 2008. Both awards were for her contributions to dugong research and conservation. She has authored more than 200 scientific publications.

Prof. Michael Kingsford

Michael Kingsford is currently Head of the School of Marine Biology and Aquaculture at James Cook University. The School is a recognised world leader in tropical marine studies. He is also coordinator of the Area of Research Strength, Marine Science at JCU, member of the International Advisory Committee of the Great Barrier Reef Research Foundation, Immediate Past President of the Australian Coral Reef Society and the former Director of One Tree Island Research Station in the southern Great Barrier Reef.

Mike has published extensively on the ecology of reef fishes, jellyfishes and biological oceanography. His projects have encompassed a range of latitudes and include a well respected book on temperate marine environments. A major focus of his research has been on connectivity of reef fish populations and how the findings can assist managers of marine parks. In addition to research and leadership, he teaches undergraduate and postgraduate students and supervises many postgraduate students.

Research Director

Dr. Michelle Heupel

As Research Director for AIMS@JCU Michelle Heupel works part-time for the Joint Venture while continuing to conduct scientific research and supervise postgraduate students at JCU and overseas. Michelle's research focus is marine ecology, primarily examining the movement and behaviour of elasmobranch fishes (shark and rays). She has focused largely on acoustic monitoring of fish to define long-term movement and presence patterns in specific habitats. This research helps define long-term dependence on key habitats such as inshore nursery areas and coral reefs.

Michelle conducted her PhD studies at the University of Queensland. Following her PhD she took a position as a Postdoctoral Scientist in the Center for Shark Research at Mote Marine Laboratory in Sarasota, Florida, USA. During her tenure at Mote Michelle was awarded several major grants from the National Science Foundation and the National Marine Fisheries Service.

Since moving to Townsville in 2007 Michelle has established a research program examining long-term residence and movement patterns of inshore predators including sharks, rays and large teleost fishes. Michelle's research interests include defining how individuals use space in relation to human activities (i.e., fishing, marine park zoning, boating) and environmental change (i.e., response to salinity, temperature change or extreme weather events). Current and future research will continue to explore these areas.

Photograph opposite courtesy of AIMS@JCU Research Director Michelle Heupel

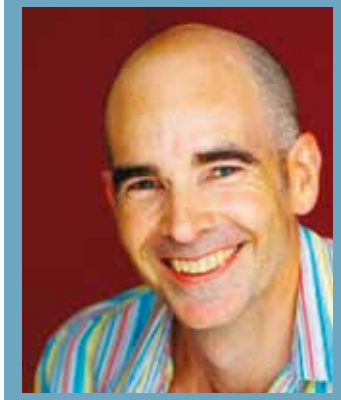
Changes to AIMS@JCU during 2007-2008

In April 2008 **Professor Rhondda Jones**, the AIMS@JCU Independent Chair, stepped down and **Doctor Michelle Heupel** was appointed as the AIMS@JCU Research Director.

Rhondda Jones was the first Professor of Zoology at James Cook University and was, until her retirement, Deputy Vice Chancellor. Her main research interests revolve around insect biology, insect ecology; and population and behavioural modelling. She has served on numerous national scientific bodies covering many aspects of science and public policy. Rhondda was instrumental in development and guidance of the AIMS@JCU Joint Venture from its inception. Her contributions to AIMS@JCU will be greatly missed.

Brett Dinsdale the Executive Officer and **Trisha Fielding**, Administrative Officer both left AIMS@JCU for other opportunities in 2007 and have been replaced by **Vanessa Adams** and **Lauren Gregory.**

Associate Professor Mark McCormick has stepped down as the JCU Stress in Tropical Marine Systems Program Leader and was replaced by Professor Bette Willis. Mark is still an active member and supervisor for AIMS@JCU.



Mark McCormick is an Associate Professor in Marine Ecology at JCU. He has a very broad range of interests within the field of reef fish population dynamics. Mark's major research field explores the links between life history stages of coral reef fishes, and how events in earlier phases influence subsequent population dynamics. To this end, he has active research programs in the field of maternal effects, larval development and growth, and how individual performance measures of larvae and juveniles influence survival within the confines of their social and physical environment. Mark has an active research program exploring predator-prey interactions, and how these influence which prey survive. He and his team have shown that chemical alarm signals are an important mechanism whereby newly settled fish can learn the identity of predators. Recent advances are that some reef fishes have been shown to have an innate ability to detect predators.

Photograph opposite courtesy of AIMS@JCU Program Leader Mike Hall

Stress In Tropical Marine Systems Program

General Information:

Global warming, fishing, pollution, habitat loss or degradation, competition and social aggression are all examples of different types of stress which are common in marine systems. Although the action of stress is on the individual, stress influences the dynamics of populations through to ecosystems.

Understanding how stress acts is important to predict the response of an individual, population, community or ecosystem to change in its environment. Furthermore, as a variety of stressors can cause similar stress responses, understanding the physiological and molecular basis of stress responses may enable us to identify the particular stressors responsible for degradation of marine organisms in the field and in aquaculture.

This program incorporates: technological development; the biology of stress including ecology, genomics and evolution; and the application of research to practical problems.

The major themes within this research area are:

- Cellular processes involved in stress responses
- Ecological and population responses to stress
- Evolution of stress tolerance

Program Leaders Contacts:

Bette Willis -
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Madeleine van Oppen -
m.vanoppen@aims.gov.au

Photograph opposite courtesy of AIMS@JCU student Heidi Luter

Stress In Tropical Marine Systems Program

Achievements:

The Stress in Tropical Marine Systems Program has grown tremendously in the last 2 years, with 5 scholarship students joining the program in 2007-2008 and an additional 5 scholarship students joining in 2009. The program has also benefited from a highly productive postdoctoral fellow, Monica Gagliano. Her work has been featured in many media outlets including two media releases in 2008 and a feature on ABC's show "Two in the Top End" with Tim Flannery.

The Stress in Tropical Marine Systems students have taken advantage of many collaborative and training opportunities.

Domestic activities:

- Training courses and professional development at the University of Queensland
- Training courses and professional development at the University of New South Wales
- Collaboration and supervision through the University of Western Australia

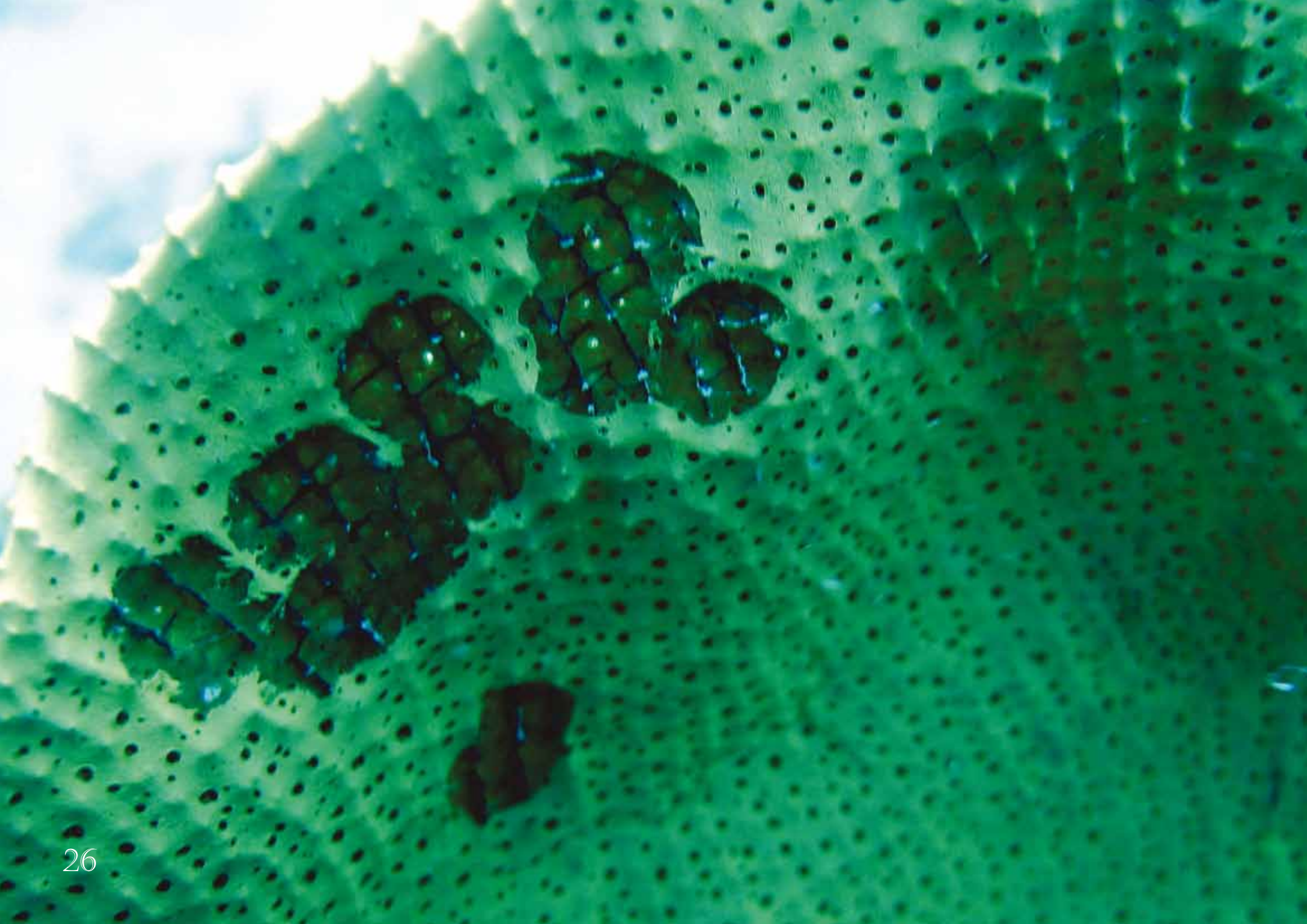
International activities:

- Collaborations and training with Academia Sinica, Taiwan
- Collaborations with the University of Hawaii
- Collaborations with US Geological Services
- Professional training at Universidad Nacional Autonoma de Mexico

Notable student paper:

Abrego, D, Ulstrup, KE, Willis, BL and van Oppen, MJH (2008). Species-specific interactions between algal endosymbionts and coral hosts define their bleaching response to heat and light stress. Proceedings of the Royal Society B-Biological Sciences 275(1648): 2273-2282

Photograph above courtesy of AIMS@JCU student Gergely Torda



Program Leaders

Prof. Bette Willis

Bette is a Professor in the School of Marine and Tropical Biology at JCU, where she has led an active research group addressing questions relating to the impacts of stress on the biology and ecology of scleractinian corals for the past 20 years. Currently, she is a Chief Investigator in the ARC Centre of Excellence for Coral Reef Studies and co-chairs the GEF/World Bank Working Group on Coral Disease in the Coral Reef Targeted Research program.

Bette's early research was directed towards understanding the evolutionary implications of mass spawning and hybridization in corals. Most recently, a major research focus has been to determine the ecological significance of coral disease on the Great Barrier Reef and potential environmental drivers. A second focus has been to evaluate the potential for algal endosymbioses to enhance the capacity of corals to cope with climate change. Overall, her research strives to understand factors that underpin the health of reef corals and the replenishment of reefs, from mechanisms of innate immunity to those enabling acclimatization or adaptation to thermal stress.

Dr. Madeleine van Oppen

Madeleine is a Principal Research Scientist and Director of the Centre for Marine Microbiology and Genetics Research at AIMS, where she has worked since 2001. She obtained her PhD in the Netherlands in 1995 on the molecular biogeography and evolution of benthic cold-water seaweeds. Following her PhD, she took up a postdoctoral position at the University of East Anglia in the UK to work on sexual selection and speciation in Lake Malawi cichlid fishes. In 1997 she moved to JCU, first as a JCU Postdoctoral Fellow and later as an ARC Australian Research Fellow to work on the evolutionary genetics of reef corals and their algal endosymbionts.

Madeleine's research focuses on acclimatisation and adaptation of corals to increased sea water temperatures (e.g., the role of zooxanthellae in coral physiology, heritable genetic variation for heat tolerance, the molecular basis of the coral bleaching response, identification of genes for thermal tolerance); genetic connectivity of coral reefs; and molecular systematics and evolutionary genetics of marine organisms.

Photograph opposite courtesy of AIMS@JCU student Heidi Luter

Dr. Monica Gagliano

Stress in Tropical Marine Systems Post-Doctoral Scientist Monica Gagliano has been busy completing the first of a series of field experiments on the sublethal effects of ocean acidification on the early life history of coral reef fishes. Her preliminary findings suggest that a drop in seawater pH will affect the development of larval ear bones (otoliths) and cause a higher incidence of otolith asymmetry in her model species (*P. amboinensis*). In her previous work, Monica showed that otolith asymmetry in the early life stages of reef fish interferes with their capacity to find and settle on coral reefs (published last year in the Proceedings of the Royal Society of London B 275:527-534). While it is now clear that the occurrence of such developmental 'errors' is partly of maternal origin, the new findings suggest that the incidence of developmental problems of this kind may be exacerbated by ocean acidification with serious consequences for recruitment processes and population replenishment.

The outstanding quality of her cutting-edge work using otoliths as well as other physiological measures and combining the two techniques to address issues on life history and recruitment processes has now been acknowledged internationally and as a result, Monica will be carrying the AIMS@JCU flag to the US where she has been invited to deliver a thematic keynote speech on Life history and management of coral reef fishes at the 4th International Symposium on Fish Otolith Research and Application in 2009. The meeting held in Monterey and organized by the NOAA US National Marine Fisheries Service laboratory in Santa Cruz, Moss Landing Marine Laboratories and the University of California at Santa Cruz, will bring together leading scientists from around the world to present state-of-the-art research and future directions for this increasingly important area of science and its application to contemporary fisheries research and management problems.

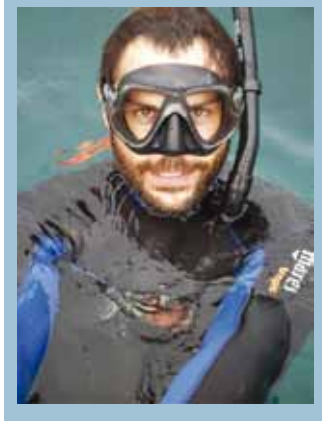
Closer to home, Monica was the convener and chair of the Fish larval behaviour & recruitment processes at international Indo-Pacific Fish Conference in June 2009 in Fremantle, WA. At the meeting, Monica also presented her own latest work on Coenzyme Q thermal adaptation in coral reef fishes conducted in collaboration with Walt Dunlap (AIMS Townsville), Rocky deNys (JCU) and Martial Depczynski (AIMS Perth). The study was recently published in the international journal Biology Letters.

Photograph opposite courtesy of AIMS@JCU student Gergely Torda

Francois Seneca, PhD candidate

Molecular Stress Response in the Scleractinian Coral, *Acropora millepora*

Francois Seneca grew up diving off the Mediterranean coast of Monaco. He pursued his interests in marine ecology and coral reef ecosystems at the University of Hawaii (Oahu), where he worked at both the Kewalo Marine Laboratory with Drs. Michael Hadfield and Cindy Hunter and the Waikiki Aquarium with Dr. Jerry Crow. After completing his Bachelors degree, Francois returned to Monaco for an internship at the Scientific Centre of Monaco where he developed an interest in applying molecular techniques to answer ecological questions.



Francois started his doctoral research in 2005. His project investigates molecular stress responses to environmental and anthropogenic stressors in the reef-building coral, *Acropora millepora*. He has applied progressive techniques, such as quantitative real-time PCR and microarrays, to improve our understanding of the cellular processes leading to coral mortality due to bleaching and pollutants. The results have yielded essential house-keeping genes, and identified potential key genes involved in the coral bleaching response. His findings expand our understanding of the biological processes currently changing our reefs with the hope that this information contributes to coral reef conservation.

Photograph above, right courtesy of AIMS@JCU student Eneour Puill-Stephan

Eneour Puill-Stephan, PhD candidate

Self-Nonself Recognition and Chimerism in *Acropora millepora*, and the Acquisition of Immunity

After completing a Master by Research in France looking at osmoregulation in fishes, Eneour decided four years ago to come in Townsville and try to investigate some aspects of corals' biology at JCU. He was awarded an AIMS@JCU scholarship, and has now almost completed his PhD after three and half years of very interesting field and laboratory work. He is now finishing the writing of his thesis on Chimerism and Allorecognition in *Acropora millepora*.

A few studies have revealed that the self-recognition response is suppressed in juvenile corals and consequently, at this stage, genetically distinct individuals are able to fuse. These chimeras represent an 'intimate arena in which different genotypes may cooperate or compete' and constitute a very interesting test case for understanding the onset of innate immunity in corals.

It is unknown to what extent coral chimeras are formed in nature, whether experimentally formed chimeras can persist and if so, what the consequences are in terms of competition with genetically 'pure' individuals. Furthermore, the role chimeras may play in disease resistance is completely unexplored.

The most obvious potential benefit of chimera formation arises from the immediate increase in size of all members of the chimera. Size is positively correlated with an increase in survivorship, competitive ability, fecundity and a decrease in age at first reproduction. Chimeras represent greater genetic diversity within a coral colony than non-chimeras, which could give them a selective advantage in a heterogeneous environment.

Perhaps the most significant implication of increased genetic diversity may be the potential to resist invading pathogens. By using highly polymorphic microsatellites developed at AIMS, this project will explore the potential of corals to form genetic chimeras and the extent of chimerism in natural coral populations (e.g., *Acropora millepora*) on the Great Barrier Reef. The role these genetically diverse chimeras might play in the resistance to different stress such as invading pathogens will be investigated.

Patricia Warner, PhD candidate

Reproductive ecology and population genetic approaches to assessing connectivity in the brooding coral, *Seriatopora hystrix*

Patricia started her research in September 2007 to investigate the reproductive characteristics of *Seriatopora hystrix* populations in the Palm Islands. In 2008, she was awarded a James Cook University Postgraduate Research Scholarship, as well as an AIMS@JCU Scholarship for three years of doctoral study. Her project aims to determine the timing and periodicity of sperm release, fertilisation, and larval release through regular histological monitoring of gonadal tissue in tagged *S. hystrix* colonies.

In addition, Patricia is employing a molecular parentage analysis on mapped quadrats of *S. hystrix* colonies and their collected brooded planula to assess the distance and patterns of sperm dispersal for this species. Finally, she will be investigating small-scale (10's of meters) and regional-scale (Palm Islands and Lizard Island) population structures and how those patterns can explain the processes working on populations across the whole GBR.

Photograph above, right courtesy of AIMS@JCU student Patricia Warner

Heidi Luter, PhD candidate

Causes and Impacts of Sponge Disease on the Great Barrier Reef

Heidi, originally from Colorado, completed her Masters of Applied Science at JCU in 2006 where she studied the effects of size and spatial competition on the bioactivity of a thin encrusting sponge. This project sparked an ongoing interest in sponges, which led her to apply for a PhD investigating the causes and impacts of sponge disease on the GBR and Torres Strait.

Sponges form a highly diverse and significant component of benthic communities, with an estimated 15,000 species found worldwide. Sponges can provide food and shelter to commercially important species, they dominate the substrate excluding other sessile organisms and they are a significant energy coupling between benthic and pelagic ecosystems. Therefore, degradation of sponge communities can have catastrophic impacts on the surrounding environment. An epidemic in 1938 caused widespread sponge mortality throughout the Caribbean. Massive sponge mortalities have also occurred in the Mediterranean, drastically reducing outputs of economically important sponge fisheries. More recently, there have been reported disease outbreaks affecting the giant barrel sponge, *Xestospongia muta*, in Belize and the Caribbean and *Ianthella basta* in Papua New Guinea. Despite some of the devastating effects of sponge disease epidemics in the past, many studies fail to properly identify the etiological agent responsible for the disease. To date, the GBR has not experienced the catastrophic sponge mortalities observed in other places around the world; however, anecdotal reports suggest an increasing prevalence of sponge disease on the GBR. With the proposed addition of a commercial sponge farm in the GBR World Heritage Area, the frequency and severity of sponge disease outbreaks may increase.

Links between environmental change and disease have been observed in both terrestrial and marine systems. Elevated sea water temperature and eutrophication have already been shown to affect pathogen virulence, transmission and host susceptibility in corals and it is possible that sponges are being impacted in similar ways. This project will examine the prevalence of sponge disease on the GBR, focusing particularly on pathogen identification and disease transmission. The role of environmental stress in disease processes will also be examined. Specific project aims include:

1. Determine the prevalence and etiological agents of disease in GBR *Ianthella basta* populations and perform re-infection trials to confirm the role of putative pathogens in disease establishment.
2. Examine how environmental factors, such as temperature and nutrient enrichment, impact on disease processes (infection, transmission and virulence).

Emily Howells, PhD candidate

Genetic Resilience of Zooxanthellae Populations: The Role of Coral Endosymbionts in Reef Adaptation to Climate Change

After working and travelling her way around Australia and New Zealand, Emily moved to Townsville to obtain a degree in Marine Biology at James Cook University. She completed

an honours project with AIMS@JCU in 2006 on the population genetics of zooxanthellae (*Symbiodinium* spp.) and is continuing research on common types of zooxanthellae symbiotic with reef building corals on the Great Barrier Reef. Emily commenced her PhD in April 2008 and has been awarded AIMS@JCU funding to support her project research over the next 3 years.

Zooxanthellae are essential primary producers on tropical reefs and are necessary for coral health and survival. Breakdown of the coral-zooxanthellae symbiosis manifested as coral bleaching (= loss of zooxanthellae and/or their photosynthetic pigments) has lead to mass mortality and reduced reproductive output of corals on reefs around the world, including the Great Barrier Reef. The frequency of bleaching episodes is expected to increase with rises in sea surface temperature linked to global warming. While corals hosting different types of zooxanthellae have shown different susceptibility to bleaching, we are yet to understand the underlying mechanisms in zooxanthellae that contribute to bleaching resistance and increased thermal tolerance in corals.

Novel genetic approaches will be applied to understand how populations of different types of zooxanthellae on the Great Barrier Reef respond to thermal stress. Genetic diversity within reefs and genetic exchange among reefs will be investigated using microsatellite markers. This will determine the capacity of damaged reefs to be reseeded from surrounding reefs and for DNA linked to thermal tolerance to be spread among reefs. Genes involved in the heat stress response will be identified using gene expression techniques. DNA variation at these genes across different thermal environments will be analysed to confirm their role in thermal tolerance. Project results will be combined with complimentary research being undertaken on the model coral host *Acropora millepora* (Dr. Line Bay) to provide a holistic representation of genetic resilience in the coral-zooxanthellae partnership.

Vivian Cumbo, PhD candidate

Understanding the initial establishment of symbiosis in corals

Vivian grew up in Sydney, Australia and completed her BSc Hons in Microbiology and Marine Biology at the University of NSW. Her honours thesis was on the Antimicrobial compounds in the Scleractinian Corals *Montipora digitata* and *Montipora tortuosa*. She is currently enrolled in the School of Marine and Tropical Biology at James Cook University, and is writing up her PhD thesis.

Corals from the order Scleractinian form obligate symbiotic relationships with dinoflagellates known as *Symbiodinium*. These symbionts play a crucial role in determining the fate of the host throughout its lifetime and host adaptability under variable environmental conditions over generations. Stressful environmental conditions (conditions outside the normal local range) can result in the loss of *Symbiodinium* from the coral. This process is known as coral bleaching, and can lead to the death of the coral host. Many bleaching events are caused by an increase in seawater temperature, therefore, unless the symbiotic relationship can adapt to withstand increases in seawater temperature, global warming threatens coral reefs worldwide. The coral hosts' fitness may be enhanced by associating with diverse *Symbiodinium* types and/or those best adapted to the local environment. The initial establishment of symbiosis is therefore critical for coral because it gives them an opportunity to associate with different strains of *Symbiodinium*.

This project aims to develop a greater understand about the initial establishment of symbiosis in corals by examining:

- Whether environmental conditions affect the establishment and development of symbionts with contrasting stress tolerance
- When given a choice of the homologous or more heat tolerant *Symbiodinium*, which out competes the other in establishing symbiosis within the host under increases in temperature
- What *Symbiodinium* is readily available for the onset of symbiosis at different biogeographical locations and with different species of host coral
- Whether corals form endosymbiotic relationships with other algae; for example the recently discovered *Chromera velia*

Jessica Haapkyla, PhD candidate

Impacts and Drivers of Coral Disease on Indo-Pacific Reefs

Originally from Finland, Jessica did her Master's degree on phytoplankton diversity and resting stages in the Baltic Sea in winter. She then decided to convert to tropical marine biology and pursued an internship on coral monitoring around the Hawaiian Islands with the Hawaii Institute of Marine Biology. Ever since, she has worked on reefs in different parts of the world and became interested in coral diseases while working in Indonesia.

Jessica's PhD study aims to assess the impact of coral disease on coral populations as well as elucidate environmental drivers of coral disease. Not much is known about coral diseases in the Indo-Pacific. Determining the impact of disease on rates of coral mortality, reproductive success and growth is essential for advancing understanding of the role of coral disease in coral reef ecosystems. Understanding drivers of coral disease will help to better manage coral reefs.

Fieldwork will be conducted in the Wakatobi Marine National Park (WMNP), South-East Sulawesi, Indonesia, on Magnetic Island, an inshore reef of the GBR and on Heron Island, the Global Environment Facility (GEF) Centre of Excellence. In the WMNP, spatio-temporal disease dynamics will be investigated. On Heron Island, prevalence of coral disease will be compared between summer and winter over 2 years. Dynamics and environmental drivers of the coral disease atramentous necrosis impacting populations of *Montipora* will be investigated on Magnetic Island. Based on the results of the field study, an aquarium-based experiment will be conducted at AIMS to investigate drivers of atramentous necrosis more in depth. Histological and microbiological investigations will further advance the understanding of this inshore coral disease.

Adrian Lutz, PhD candidate

Coenzyme Q and Plastoquinone Redox Balance as a Physiological Determinant of Oxidative Stress in Coral-Algal Symbiosis

Adrian grew up in Switzerland and completed his MSc in biology at the University of Basel. He first came to Townsville in 2005 to work with Madeleine van Oppen for his thesis on the genetic connectivity of *Seriatopora hystrix*. Thanks to an AIMS@JCU scholarship, he returned to Townsville to work with Walt Dunlap, David Miller and Madeleine van Oppen. His PhD investigates the potential antioxidant role of Coenzyme Q and Plastoquinone in coral symbiosis.

The majority of tropical marine anthozoans harbour in their gastrodermal cells symbiotic dinoflagellates of the genus *Symbiodinium* (zooxanthellae). Although the gross metabolic benefits of this symbiosis are well recognised, it is poorly understood how symbiotic interactions are established and regulated at physiological and molecular levels. In particular, the disruption of coral-algal symbiosis known as “coral bleaching” is a subject of contemporary significance in global climate change research.

It is widely accepted that prolonged exposure to elevated seawater temperatures and solar radiation is the primary cause for widespread coral bleaching in nature, however, the aetiology causing the breakdown of the symbiosis is not fully understood. Oxidative stress has been proposed as a unifying mechanism behind several environmental stressors that cause bleaching.

In order to gain insight in the response of the coral-algal symbiosis to oxidative stress, we have developed and tested a technique for the simultaneous determination of the redox state of the plastoquinone and coenzyme Q pools by high pressure liquid chromatography-mass spectrometry (HPLC-MS). The technique allows for simultaneous quantification of the redox state of plastoquinone in the algae and of coenzyme Q in the coral within the same sample. The regulation of the coenzyme Q and plastoquinone redox states are crucial to a healthy metabolism because they are an essential component of respiration and photosynthesis. However, the reduced forms of coenzyme Q and plastoquinone also act as powerful antioxidants and thus maintaining a highly reduced redox balance is considered to be of major importance under conditions of oxidative stress. Using a biochemistry and genomical approach, this project investigates how the coral-algal symbiosis regulates these redox states under different environmental conditions, specifically under oxidative stress caused by elevated temperatures.

Neal Cantin, PhD

Chronic effects of herbicide exposure on photosynthesis, symbiosis and reproduction of reef building corals

Neal Cantin completed his PhD with AIMS@JCU in July 2008. This was the first study to investigate the chronic sub-lethal effects of long-term herbicide (diuron) exposures on symbiotic corals prior to coral spawning. Two of the three species studied, *Acropora valida* and *Pocillopora damicornis*, exhibited reduced egg production and failed to reproduce successfully. However, all of the gametes that were released, in reduced numbers following diuron exposure, remained viable and fully developed into competent coral larvae.

Neal's thesis also showed that there are important physiological functional differences between different algal symbionts, zooxanthellae, which live symbiotically within coral tissues. Certain zooxanthellae types (*Symbiodinium* C1) can provide the coral host animal with up to two times more energy from photosynthesis, which can provide competitive growth advantages for juvenile corals.

He has since published two papers related to the funding provided by AIMS@JCU:

Cantin, NE; Negri, AP and Willis, BL. (2007) Photoinhibition from chronic herbicide exposure reduces reproductive output of reef-building corals. Marine Ecology Progress Series 344: 81-93.

Cantin, NE; van Oppen, MJH; Willis, BL; Mieog, JM and Negri, AP. (2009) Juvenile corals can acquire more carbon from high-performance symbionts. Coral Reefs 28: 405-414.

Neal is currently working as a Postdoctoral Investigator at the Woods Hole Oceanographic Institution (WHOI), in Woods Hole Massachusetts, USA. His research is investigating the physical and biological factors influencing seasonal and historical calcification rates of massive reef building corals in the Saudi Arabian Red Sea. Neal is developing the use of computed tomography (CT) scans of coral cores to quantify calcification rates and using biochemical tools learned during his PhD. to investigate the link between colony energetic reserves and coral calcification.

Photograph opposite courtesy of AIMS@JCU student Gergely Torda

Tropical Aquaculture Program

General Information:

Tropical Aquaculture is a core research program within AIMS@JCU. It is built on a synergistic partnership between Tropical Aquaculture at AIMS, and across two faculties via the School of Marine and Tropical Biology and the School of Veterinary and Biomedical Sciences at James Cook University. The program has excellent resources, with staff and students working on aquaculture projects having direct access to pristine coastal seawater, state-of-the art land- and sea-based aquaculture facilities, and biotechnology and veterinary science laboratories, including molecular microbiology.

Aquaculture is the fastest growing primary industry in Australia for the production of seafood and bio-products. The AIMS@JCU Tropical Aquaculture team has expertise in the established industry sectors (penaeid prawns, pearl oyster, finfish) and in emerging, developing aquaculture sectors (tropical rock lobsters, sponges, crabs, freshwater prawns and marine ornamentals). It also has strong research capabilities in the mitigation of environmental effects of high density culture systems (ponds, fish cage and re-circulating systems) and in developing aquaculture for remote communities.

The major themes within the program are:

- Hatchery technology
- Environmental impacts
- Emerging species

Program Leaders Contacts:

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Tropical Aquaculture Program

Achievements:

The Tropical Aquaculture Program has continued to thrive within AIMS@JCU since its initiation. This program has supported Honours, Masters and PhD students with a wide array of research topics including biological processes, biodiversity, ecology, microbiology, virology and life history of cultured species.

The program has benefited from this diverse array of research, access to the AIMS@JCU Controlled Environment Facility (CEF) and Aquashed located in the Marine and Aquaculture Research Facilities Unit (MARFU) at JCU. The achievements of Postdoctoral Fellow Greg Smith have also been highly beneficial to the program. Greg has mentored several students while advancing captive animal facilities at AIMS and maintaining his own line of research.

Students in the Tropical Aquaculture Program have taken advantage of opportunities to collaborate with others and attend conferences, workshops and training opportunities wherever possible, including:

Collaborations:

University Pierre & Marie Curie, France

Universite de Caen, France

Notable student paper:

7th most downloaded paper from the journal Aquaculture:

Cano-Gomez, A, Bourne, D.G., Hall, M.R., Owens, L. and Høj, L. (2008) Molecular identification, typing and tracking of *Vibrio harveyi* in aquaculture systems: Current methods and future prospects. Aquaculture 287:1-10.

Photograph above courtesy of AIMS@JCU Program Leader Mike Hall

Prof. Paul Southgate

Paul has two major research interests: culture of tropical molluscs and hatchery foods for aquaculture. His research with molluscs focuses primarily on pearl oysters and he leads the Pearl Oyster Research Group at JCU. Research focuses on pearl oyster resources and industry development in Pacific island countries, factors influencing pearl quality and pearl oyster genetics.

Paul's research with hatchery foods focuses on development of novel live-foods and micro-particulate diets for bivalve, finfish and crab larvae, and the use of micro-particulate diets to investigate nutritional requirements of larval stages.

Dr. Mike Hall

Mike is a Principal Research Scientist at AIMS in the Sustainable Use of Marine Biodiversity Program and leads Tropical Aquaculture research in economically important crustacea. His university years were spent in the USA and overseas, obtaining his PhD from the University of Wales (UK). He has previously held research positions at the Max-Planck Institute (Germany) and University of Bristol (UK), specifically in understanding physiological and endocrinological processes that occur on a circadian and seasonal basis.

Current research includes established seafood aquaculture species (penaeid prawns), emerging candidates (tropical rock lobsters) and ornamental marine species. Specific focus is placed on understanding the relationship between stress and health, the role of microbes in larval rearing systems, and the development of generic hatchery production systems, the development of larval feeds for the production of high quality and healthy larvae.

Photograph opposite courtesy of AIMS@JCU member Chaoshu Zeng

Dr. Greg Smith

Greg has been an AIMS@JCU Postdoctoral Scientist since September 2006, working on the development of generic hatchery technologies for the tropical lobster *Panulirus ornatus*. Shortly after commencing duties with AIMS@JCU he was tasked with fitting-out and commissioning the controlled environment facility at AIMS and addressing water quality concerns. Greg instigated upgrades to the primary seawater treatment that benefited both AIMS@JCU CEF and the water supplied to MARFU at JCU.

As part of a key component of the AIMS@JCU Joint Venture, Greg supervises AIMS@JCU students and provides advice on water quality, lipid nutrition and crustacean larval behaviour. He has co-supervised three PhD projects within the Tropical Aquaculture Program. These included projects on marine ornamentals, such as Cleaner Shrimp propagation (Vasiliki Tziouveli), enzyme and lipid profiling (Jerome Genodepa and Xugan Wu, respectively) of both *P. ornatus* and crab larvae.

One of the most satisfying results has been elucidating some of the requirements for captive rearing of *P. ornatus* larvae, resulting in the production of 5 separate cohorts of puerulus (metamorphosis stage of lobster larvae). The ability to produce larvae on demand has facilitated work on feeding behaviour and food particle size (Smith, G.G., Hall, M.R., Salmon, M., 2009. Use of microspheres, fresh and microbound diets to ascertain dietary path, component size and digestive gland functioning in phyllosoma of the spiny lobster *Panulirus ornatus.* New Zealand Journal of Marine and Freshwater Research 43, 205-215) and larval morphology (Smith, G.G., Salmon, M., Kenway, M., Hall, M. Description of the larval morphology of captive reared *Panulirus ornatus* spiny lobsters, bench-marked against wild-caught specimens. Aquaculture, in press). These results have also been presented at international and national forums; 8th International Conference and Workshop on Lobster Biology, Sept 23 - 28, 2007 Charlottetown, Canada and Australasian Aquaculture, 03-06 August 2008, Brisbane, Australia.

Greg has participated in a plankton collection cruise in the Coral Sea that identified putative prey items for *P. ornatus* larvae, this enabled prey shape, texture and biochemistry to be elucidated; information crucial to larval diet design. Future plans include continued supervision of AIMS@JCU PhD candidates and research into enhancement of feed response through form, texture and biochemical stimuli.

Photograph opposite courtesy of AIMS@JCU Program Leader Mike Hall

Sarah Castine, PhD candidate

Nitrogen transformation and removal from settlement ponds of tropical aquaculture systems

After completing her undergraduate degree at Flinders University in South Australia, Sarah transferred to Townsville to carry out her honours project. She subsequently worked at AIMS for nine months on the "Environmental Impacts of Sea Cage Aquaculture in Hinchinbrook Channel". Through this project she developed a passion to see the Australian aquaculture industry develop in an environmentally sustainable manner, this in turn, lead to the evolution of her PhD project.

The aquaculture industry is developing in response to growing demand for seafood. However, heavy nutrient discharges (i.e., 35 kg N and 7 kg P t^{-1} for cultured fish) from these operations result in high clean up costs for farm proprietors or, in some cases, environmental degradation. The latter has caused some negative perceptions regarding the aquaculture industry which must be resolved if the industry is to develop in the future. Nitrogen is the nutrient of primary ecological importance and is added to the farm in the form of pelleted food, the majority of which is not retained by the target species. Instead, a large proportion of nitrogen is lost to the environment, either as faeces or excreted across the gills as ammonia contributing to nutrient loading in receiving water. Stringent regulations regarding the quality of discharge waters are enforced at various government levels, so efficient effluent clean up practises are required by all farm operators in Australia.

Settlement ponds are broadly utilised around the world for the treatment of effluent water from land based aquaculture farms. Discharge water is flushed into large, shallow ponds where particulates settle out and, ideally dissolved nutrients are assimilated or transformed. Settlement ponds have been adopted by the Australian aquaculture industry, as farms are required to dedicate 30% of their lease area for the bioremediation of effluent waters. However, there is some debate about the efficiency of such ponds for removing dissolved nutrients. Previous research has found that only 23% of nitrogen was removed from settlement ponds associated with prawn farms in southern Queensland. Despite the prevalence of settlement ponds, the processes of nitrogen removal and transformation acting within these ponds are poorly understood. Furthermore, traits relating to successful ponds have not been identified because comparisons of nitrogen removal efficiency between pond systems have not been made. The knowledge gap regarding the natural processes which transform nutrients in effluent water is responsible, in part, to a lack of management strategies applicable to settlement ponds.

Vasiliki Tziouveli, PhD candidate

Steps towards mass production of the white-striped cleaner shrimp, *Lysmata amboinensis*

Vasiliki Tziouveli, originally from Greece, completed her undergraduate studies at the University of Liverpool, UK. When she finished her honours project at Port Erin Marine Biological Station, Isle of Man, she came to Australia to commence the PhD with the School of Marine & Tropical Biology, James Cook University. Her project is with the Discipline of Aquaculture and looks at the potential for captive culture of a high-value aquarium species, the white-striped cleaner shrimp, *Lysmata amboinensis*.

The popularity of this marine ornamental species has grown in the last decades. Demand cannot always meet supply and the ecological impact of removing these fish cleaner shrimp from the reefs has not been documented. Aquaculture is seen as the potential answer to sustainable year-round supply. However, due to the long larval phase of the cleaner shrimp, punctuated by low survival, closing the life cycle in captivity and producing new broodstock consistently and reliably has been a challenge for aquarists and aquaculturists around the world.

The project aims to gather valuable information on the culture requirements of the cleaner shrimp. In order to establish hatchery-based pairs, the time males become sexually mature and the time they change to hermaphrodites had to be identified. Next, different maturation diets were tested for suitability, with the ultimate goal of increasing fecundity and larval quality. Also larval diets were examined to improve early larval survival and promote faster development. To assist in successful larviculture the fatty acid profiles of adults and larvae and histological description of mouthparts and digestive system of the larvae were generated for future reference in diet preparation.

Small-scale captive production of juveniles has been achieved within the duration of the PhD.

Jerome Genodepa, PhD candidate

Ontogeny of the digestive capacity of larvae of two commercially important tropical crustaceans, the mud crab (*Scylla serrata*) and the spiny lobster (*Panulirus ornatus*).

Jerome has been working on hatchery production of mud crabs and has conducted studies on replacement of live feeds with formulated diets. Recognising the difficulty of certain larval stages to digest formulated diets, he is now looking into the development of larval digestive enzymes, because enzymes are known to reflect capacity to digest different types of food. Jerome is analysing the digestive enzymes in early developmental stages of the mud crab (*Scylla serrata*) and the spiny lobster (*Panulirus ornatus*) to better understand nutrition of these two commercially important species. A better understanding of the digestive abilities of larval stages of these species can lead to the development of more optimal diet and feeding regime and thus improve hatchery production.

Photograph above, right courtesy of AIMS@JCU Program Leader Paul Southgate

Ana Cano-Gomez, PhD candidate

Diagnosis of *Vibrio harveyi* related infections in the larval rearing system of the tropical rock lobster *Panulirus ornatus*

After completing a Bachelor in Marine Sciences with focus in Biochemistry and Molecular Biology in Spain in 2005, Ana came to Townsville for postgraduate studies. She coursed a Graduate Diploma and a Graduate Certificate in Research Methods in Biotechnology. Ana started to volunteer at AIMS in 2007 getting involved in the rock lobster project. Her interest is the diagnosis of bacterial infection of the larvae in aquaculture rearing systems. With this aim, Ana is doing a PhD at the Faculty of Veterinary and Biomedical Sciences at JCU. In addition she will focus on the mechanism of infection of *Vibrio* spp. in the tropical rock lobster *Palunirus ornatus*.

The ornate rock lobster *Panulirus ornatus*, is a potential aquaculture candidate in Australia but bacterial infections, mainly by *Vibrio* species have prevented larval rearing at a commercial scale. The development and sustainability of *P. ornatus* aquaculture requires a fast and reliable technique for the identification, detection and monitoring of pathogenic vibrios in order to manage potential infections. The lack of discriminatory power of biochemical tests suggests that molecular techniques are required for a precise identification

of *Vibrio* species. The complex phylogeny of this group of vibrios and the diversity of pathogenicity mechanisms among strains make the identification of pathogenic strains the main challenge for the control of infection in aquaculture systems.

The first step for the diagnostic of *Vibrio* infections is the development of a robust identification tool in order to differentiate closely related species and strains. Previously, analysis by Polymerase Chain Reaction (PCR) amplification of several genes of *V. harveyi*-like colonies isolated from a larval rearing system of *P. ornatus* during mass mortality events was proved to be discriminative and the isolates were identified as *V. harveyi, V. campbellii* and *V. rotiferianus*. We propose a robust analysis of multiple genes from *Vibrio* sp. present in Australia to design a standard identification tool for farmers, microbiologists and veterinarians and the first step for the development of diagnostic tools for *Vibrio* infections in the larval rearing system of *P. ornatus.* Ideally, the proposed detection tool would offer a comparative analysis between the presence of total *V. harveyi* and pathogenic strains. The techniques would be useful as a management tool to avoid high-cost intervention when not essential and as research tools, to study the dynamics of the pathogens in experimentally infected larvae or the effect of different treatments for the control of infection.

Xugan Wu, PhD candidate

A comparative study of lipid nutrition of two tropical commercial crustaceans (*Portunus pelagicus* and *Panulirus ornatus*)

Xugan has now finished his confirmation seminar along with completing two experiments to date on the blue swimmer crab at MARFU of JCU. He is writing two manuscripts: "The effect of different ARA level on the survival, growth and development period of megalopa *Portunus pelagicus*" and "Ontogenetic changes of lipid composition of HUFA, PUFA, phospholipid and cholesterol during the larval development period of *P. pelagicus*".

At the same time, Xugan is running an experiment at AIMS, Ontogenetic changes of lipid composition of dry weight, wet weight, elemental composition, HUFA, PUFA, phospholipid and cholesterol during the larval development period of ornate rock lobster *Panulirus ornatus*. Another starvation experiment is in preparation. Those will give important clues for the improvement of up-coming experimental designs. The separation and determination of different prostaglandin seems extremely difficult due to similar molecular weights and the complicated required operation. The next step will be to do some pilot studies on this important process.

Photograph above, right courtesy of AIMS@JCU student Patricia Warner

Scott Seymour, PhD candidate

Utilising biodiversity of the tropical Australian macroalgae for integrated aquaculture

In Australia, much of the aquaculture industry focuses on monoculture farming practices. Within this style of farming, high nutrient loads in effluent water can lead to lost farming efficiency and changes in the surrounding environment. Some countries, particularly in Europe, are developing integrated aquaculture practices which incorporate macroalgae culture with finfish culture to increase nutrient utilisation, decreasing environmental impacts whilst increasing farm productivity. Over the next three years, Scott aims to identify candidate seaweed species from tropical Australian waters (particularly around the Townsville region) for integration with prawn and finfish farming in Australia. This research will also work beyond the prawn/finfish – seaweed system, aiming to develop a prawn/finfish – seaweed – sea urchin (*Tripneustes gratilla*) integrated system.

Scott's research has begun by conducting feeding assays to determine seaweed preferences by *Tripneustes gratilla*. This will then be expanded upon by determination of urchin growth fed various seaweed diets; propagation and growth

rates of favoured seaweeds; and development of artificial seaweed diets for the sea urchins. This work is an extension of Scott's Honours research (conducted in 2007) which focussed on the potential of *Caulerpa* seaweeds for nutrient removal from aquaculture effluent. His interest in developing sustainable aquaculture systems is led by a desire to improve the industry's environmental sustainability, whilst increasing the efficiency and productivity of aquaculture ventures. Farms utilising integrated aquaculture systems have the potential of increasing productivity and profitability through diversification.

Scott is departing for South Africa in 2009 to meet with researchers at the University of Cape Town. John Bolton, head of the Botany Department at the University of Cape Town, has conducted much research on abalone (*Haliotis* sp.) and seaweed (*Ulva* sp.) integrated aquaculture and is planning to explore the potential of *Tripneustes gratilla*. This trip will enable him to share knowledge gained during the first year of his PhD and potentially establish collaboration between the two universities in the future.

May-Helen Holme, PhD

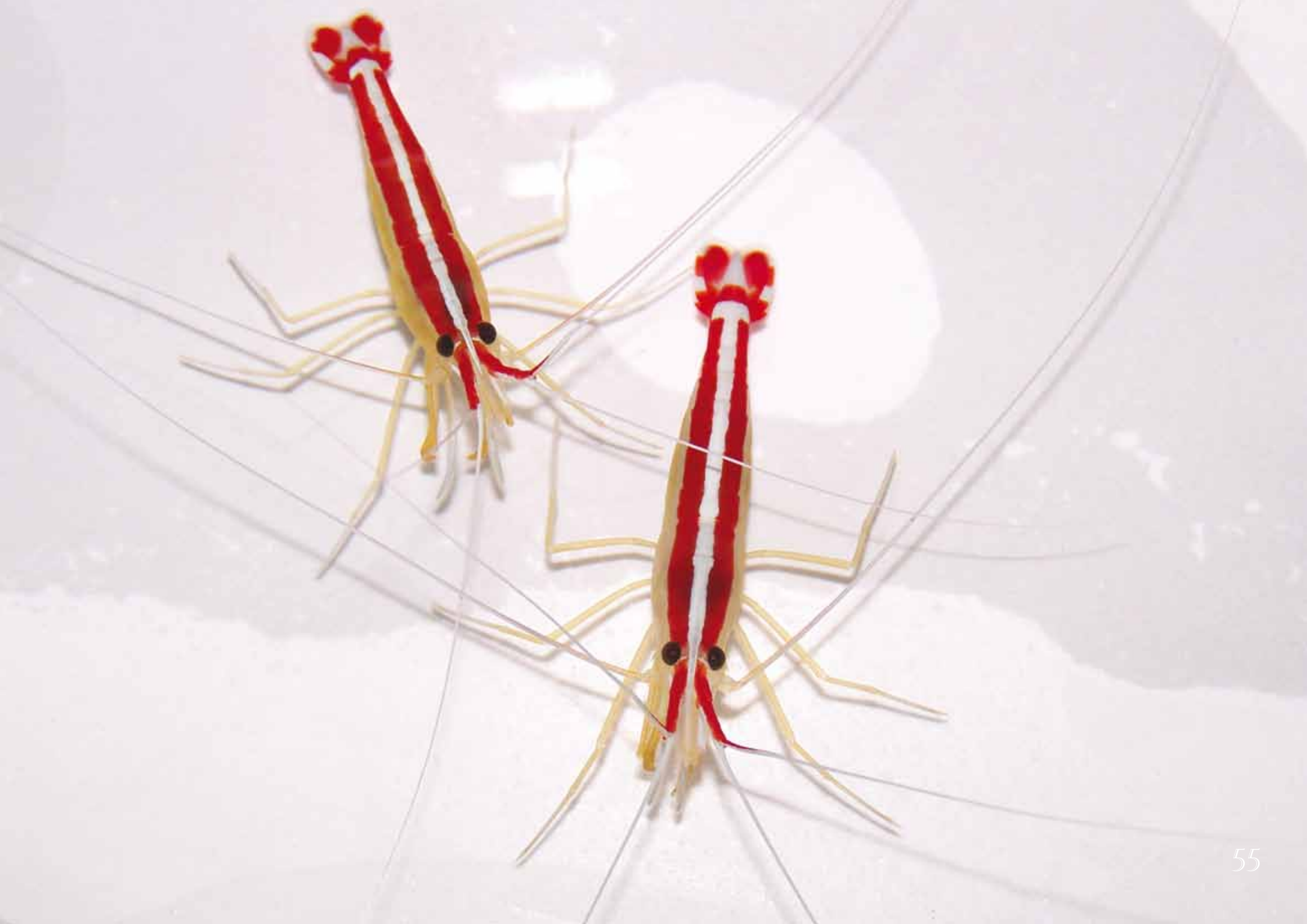
The development of larval feeds for mud crab (*Scylla serrata*)

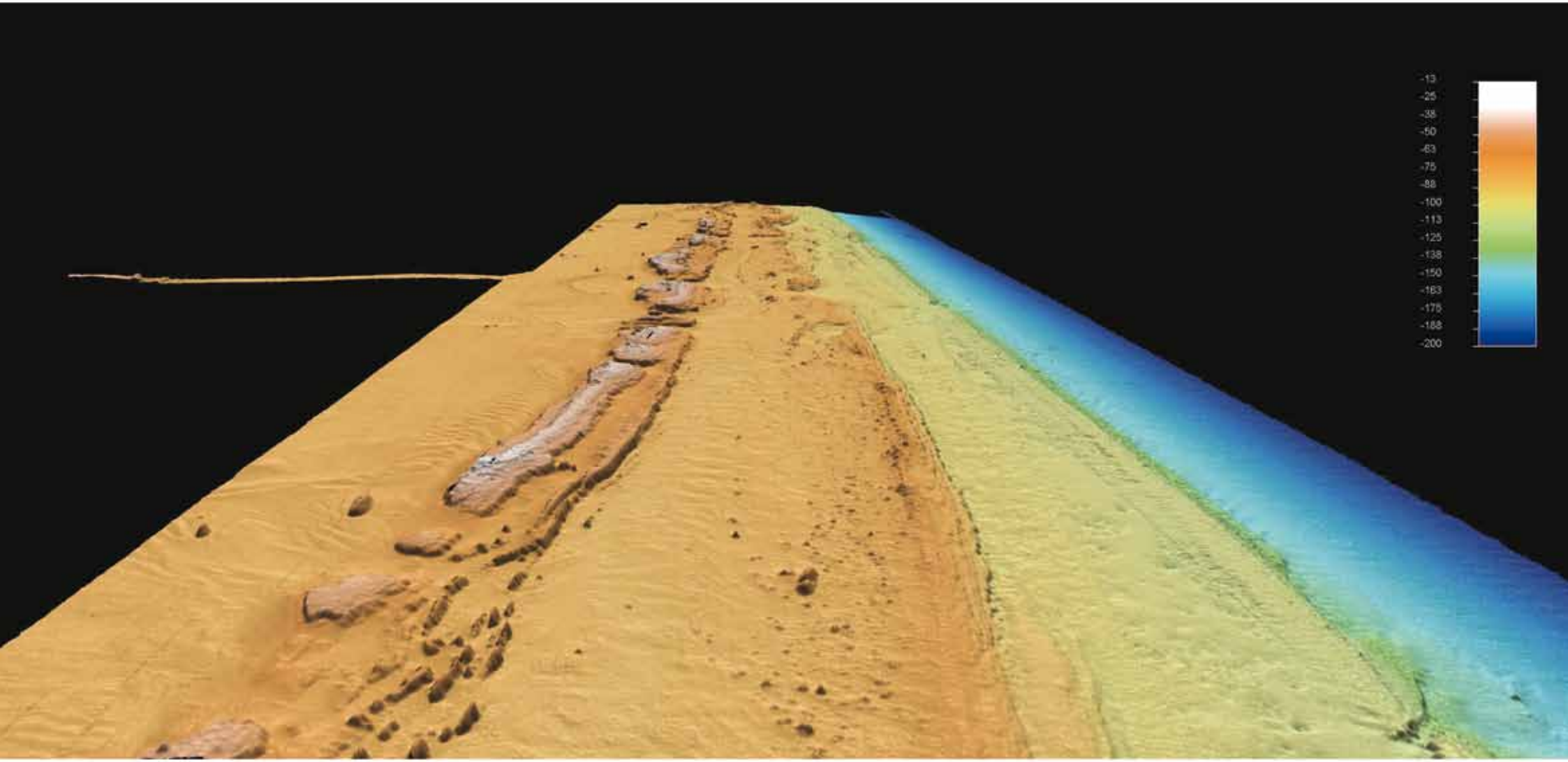
Traditionally mud crab (*Serrata* spp.) farming in South-East Asia and Australia has been based on capturing and fattening of juveniles from the wild. As farming has exceeded the capacity of the crab fishery, wild stock is rapidly declining. To meet the growing demand and to prevent further over-exploitation, development of stock enhancement and aquaculture programs is essential. However, expansion of the industry is currently restrained by lack of large-scale adoption of hatchery technology and by availability of suitable, cost-effective foods. Despite considerable potential for mud crab (*Scylla* spp.) farming in the Indo-Pacific, further development of the mud crab aquaculture industry has been hindered by low and inconsistent larval survival. This problem has been linked to inappropriate nutrition at the larval stages, and the lack of appropriate larval diets is therefore considered a major bottle neck to the expansion of the industry. The research conducted at JCU has brought us closer to understanding the nutritional requirements of this species and we have developed effective methods for further experimentation. The PhD work resulted in several first-authored publications in international peer–reviewed journals:

Holme, M.H., Zeng, C., Southgate, P.C., 2006, Use of microbound diets for larval culture of mud crab, Scylla serrata. Aquaculture 257, 482-490; Holme, M.H., Zeng, C., Southgate, P.C., 2006, The effect of supplemental dietary cholesterol on growth, development and survival of mud crab Scylla serrata, megalopa fed semi-purified diets. Aquaculture 261, 1328-1334; Holme, M.H., Zeng, C., Southgate, P.C., 2006. Towards development of formulated diets for mud crab larvae and a better understanding of their nutritional requirements. Aqua Feeds: Formulations and Beyond, 3: 3-6; Holme, M.H., Southgate, P.C., Zeng, C., 2007, An assessment of optimal levels of dietary lecithin and cholesterol for mud crab, Scylla serrata, megalopa using semi-purified microbound diets. Aquaculture Nutrition 13, 413-423; Holme, M.H., Southgate, P.C., Zeng, C., 2007, Survival, development and growth response of mud crab, Scylla serrata megalopa, fed semi-purified diets containing various ratios fish oil:corn oil ratios. Aquaculture 69, 427-435; Holme, M.H., Zeng, C., Southgate, P.C., 2009. A review of recent progress toward development of a formulated microbound diet for mud crab, Scylla serrata, larvae and their nutritional requirements. Aquaculture 286, 164-175; Holme, M.H., Southgate, P.C., Zeng, C., 2009. Effects of starvation and feeding on lipid class and fatty acid profile of late stage mud crab, Scylla serrata, larvae

After completing her thesis at JCU in December 2008, May-Helen moved to Norway where she now works as a research scientist for Ewos Innovation, the world's largest producer of salmon feed. "It's an exciting job in private industry research, and so there is no doubt that my degree from JCU has qualified me for an exciting career in world class research".

Photograph opposite courtesy of AIMS@JCU student Vasiliki Tziouveli

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Coastal Processes and Modelling Program

General Information:

The Coastal Processes and Modelling research program within AIMS@JCU brings together the two organisations' staff and complementary capabilities to focus on coastal processes of special interest in tropical environments.

Improving our understanding of biological, physical and chemical processes in the coastal zone is essential to the effective management of this culturally and economically important region.

The major themes within the program are:

- Hydrodynamic modelling and hydrological processes, including sediment dynamics;
- Water quality, catchment/coastal interactions, and near-shore processes;
- Biogeosciences and environmental change;
- Biological and chemical oceanography;
- New observing technologies.

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Image opposite courtesy of AIMS@JCU Student Thomas Bridge

Coastal Processes and Modelling Program

Achievements:

The Coastal Processes and Modelling program has continued to contribute greatly to the AIMS@JCU membership and output. Thomas Stieglitz has had a productive postdoctoral fellowship including being a mentor for students and conducting high profile research. Thomas's work on the Yongala's Halo of Holes was extended through 2008 by provision of acoustic receivers through Australian Acoustic Tracking and Monitoring System (AATAMS) Integrated Marine Observing System (IMOS) to continue the tracking of black-blotched Fantail Rays.

Coastal Processes and Modelling scholarship students have attracted funding from high profile funding bodies and taken advantage of domestic and international collaborations.

Domestic activities:

- Collaborations and training courses at the University of Queensland
- Collaborations and training courses at CSIRO, Hobart
- Collaboration with Queensland Parks and Wildlife Service

International activities:

- Collaborations with IRD Nouméa
- Collaborations with US Geological Services
- Collaborations and training with National Oceanic and Atmospheric Administration (NOAA)

Funding support:

- Great Barrier Reef Marine Park Authority
- Birds Australia
- Birds Queensland
- Queensland Parks and Wildlife Service
- National Oceanic and Atmospheric Administration
- Australia Research Council Research Network for Earth System Science
- Ecological Society of Australia

Notable student paper:

Erwin, C. & Congdon, B. (2007) Day-to-day variation in sea-surface temperature reduces sooty tern Sterna fuscata foraging success on the Great Barrier Reef, Australia. Marine Ecology Progress Series 331: 255-266.

Image opposite courtesy of AIMS@JCU student Lachlan McKinna

Photographs courtesy of Rob Beaman (above left) and the Australian Centre for Field Robotics (ACFR), University of Sydney (above right) via AIMS@JCU student Thomas Bridge

Program Leaders

Assoc. Prof. Michael Ridd

Michael is Associate Professor (Analytical Chemistry) and Head of Discipline in the School of Pharmacy and Molecular Sciences at James Cook University. Previous positions include Senior Environmental Geochemist for Ok Tedi Mining Limited; Lecturer in Analytical Chemistry/Director Advanced Analytical Centre, JCU; and Resources and Energy Advisor, Parliamentary Research Service.

Michael's research interests include biogeochemistry of intertidal sediments; development of passive sampling devices for metals and nutrients; and metal cycling through sediment, waters and biota.

Mr. Craig Steinberg

Craig has over 20 years experience as a physical oceanographer undertaking research in multidisciplinary studies at AIMS through the Responding to Climate Change Research Team. This involves observation, analysis and numerical modelling on scales that range from individual reefs to the Coral Sea basin, of phenomena ranging from waves to ocean circulation. He is currently investigating impacts of circulation, upwelling and tidal mixing on productivity hot spots and coral bleaching.

In recent years Craig has been extensively involved in the implementation of the Great Barrier Reef Ocean Observing System, a regional node of Australia's Integrated Marine Observing System. It aims to provide high quality long term data streams and products for research, management and the general community.

Dr. Thomas Steiglitz

The wreck of the Yongala is one of the world's most famous wreck-diving sites. Rarely seen by the divers are hundreds of depressions surrounding the wreck, which were previously discovered by Thomas when mapping the wreck with a multibeam echosounder. There is little doubt that this 'Halo of Holes' is of biogenic origin, however the animal(s) responsible for these earthworks remain(s) unknown. His team has since surveyed other shipwrecks, shoalgrounds and interreefal areas, and found that such halos are a rather common feature of the GBR's seafloor.

Repeat surveys of the Yongala's halo suggest that the holes are generated on yearly to decadal time scales.

Subsequently, Thomas and his team have been acoustically tracking the movements of black-blotched fantail rays (*Taeniura meyeni*; also called bullrays) in order to establish their usage of the seafloor, and to determine if these large stingrays have anything to do with these holes. An array of acoustic receivers deployed around the wreck detected tagged animals for a period of more than 12 months. However, the detection efficiency was lower than expected, most likely due to the reflection of the acoustic signals off the wreck (self-collision of the signal). Regardless of the compromised detection capabilities, they have learnt a great deal about the animals and their usage of the Yongala.

About half of the tagged animals left the Yongala within 24 hours of tagging and were not recorded again. Of the others, only one male animal was by and large continuously present around the wreck. The females were sporadically present, for a few days at a time. This indicates that not all rays may be permanent residents to the Yongala as previously assumed. The rays move in a predictable diurnal pattern. At night, they are in mid water depth close to the wreck, and during the day they remain on the seafloor surrounding the wreck. From dive observations, it was observed that the rays visit the Yongala to be cleaned by cleaner wrasses. The rays spent most of the time close to the wreck, but also roam around on the seafloor where fresh holes have recently been added to the halo. So far it cannot be concluded from the tracking study that the rays are responsible for the holes...

In addition to the work on the Yongala's Halo of Holes, Thomas has continued his research on numerous seabed mapping and land-ocean interaction projects.

Photograph opposite courtesy of Giles Winstanley via AIMS@JCU Post Doctoral Scientist Dr. Thomas Steiglitz

Carol Devney, PhD candidate

Flexibility of response to climate change in pelagic foraging terns

Carol has a BSc. in Environmental Chemistry from the Colorado School of Mines in the USA. In 2004, she completed a Grad. Dipl. of Research Methods at JCU and enrolled in an MSc. in 2005. An AIMS@JCU Scholarship allowed her to upgrade her current research project to a PhD.

Carol's PhD research focuses on the total impacts of climate variation on tropical seabird populations across the GBR and the potential capacity of these species to resist predicted climate change-associated reductions in prey availability. The most interesting of her findings to date has come from assessments of 18-years of Queensland Parks & Wildlife Service data on three seabird species at Michaelmas Cay on the northern GBR. Here population dynamics of Sooty terns *Sterna fuscata* and Common noddies *Anous stolidus* were found to be directly related to changes in chlorophyll concentrations and thermocline depth that long preceded shifts in the El Niño Southern Oscillation. In essence, these seabird species could detect changes in oceanography associated with the El Niño up to a year before those changes were officially registered, relationships which are presumably linked to an association with underwater predators, such as pelagic tuna and mackerel, to capture prey. This finding is important because intense El Niño events severely impact a gamut of marine populations globally. It also suggests that seabird population declines observed across the GBR over the study period may be related the El Niño, and this knowledge is crucial for management towards conservation of these species.

Carol has also found that species of seabirds which breed together at the same location are not impacted in the same way by climate variation, and this appears to be a result of differences in the way species forage and raise their young. We care about these differences because it means that only some species may be able to respond to future climate change by adjusting their behaviour and/or development. Fieldwork at Heron Island, southern GBR, confirms that at least one species of long-lived seabird which shares foraging and breeding characteristics with many other seabird species in the region, will not be likely able to resist predicted global warming through behavioural or physiological flexibility.

Jasmine Jaffrés, PhD candidate

The Oceanographic and Geochemical Effects of Increasing Anthropogenic CO_2 on Planktonic and Benthic Calcification in the Coral Sea and Outer Great Barrier Reef

Jasmine is originally from Switzerland and moved to Australia in 2002. She completed her BSc(Hons) in Marine Science in 2005.

This multidisciplinary study will address the question of how

corals and calcareous plankton will fare in a warmer, higher CO_2 world from the perspective of physical oceanography and carbonate thermodynamics.

The anthropogenic CO_2 rise in the atmosphere is predicted to have two undesirable side-effects: increased global temperatures due to the insulating properties of atmospheric CO_2; and increased oceanic uptake of atmospheric CO_2, leading to acidification of surface seawater. This acidification process is already lowering surface seawater pH. Acidification may also affect the sea surface mixed layer and reduce the capacity of surface waters of the ocean to store anthropogenic CO_2, resulting in increased CO_2 in the atmosphere, and thus accelerated greenhouse gas warming of the surface of the earth.

This study will investigate the functional interactions between oceanographic, thermal stratification parameters, pCO_2, temperature and calcification via modelling of the sea surface layer over a range relevant to climate-change predictions. The study will also explore the effects of regional warming on the sea surface mixed layer: its possible thinning; an expected in upwelling/mixing with cold, deep Coral Sea water; and changes to seawater pH; carbonate equilibria; and $CaCO_3$ and organic matter sinking rates. Furthermore, the consequences of enhanced acidification and nutrient depletion caused by mixed layer thinning will be examined. The model could be used to predict the possible effects of anthropogenic CO_2 disposal into deep Coral Sea waters.

Marie Magnusson, PhD candidate

Effects of priority herbicides and their breakdown products on estuarine microphytobenthic communities in the Great Barrier Reef Lagoon

After completing her MSc in marine ecotoxicology in Sweden, Marie spent six months at JCU volunteering for Assoc. Prof. Kirsten Heimann and Dr. Raphael Wűst in a research project focussing on using fossil diatom assemblages as predictors of paleoclimate. This collaboration made Marie interested in working with microalgae, and in 2005 she was fortunate enough to be able to combine this with her interest in ecotoxicology when she started the research for her PhD under the supervision of Assoc. Prof. Kirsten Heimann (JCU), Dr. Andrew Negri (AIMS) and Assoc. Prof. Michael Ridd (JCU).

Benthic microalgae form an integral part of shallow-water systems around the world and are major contributors to primary productivity and biomass in estuarine environments. They are also central in sediment chemistry, nutrient fluxes and benthic/pelagic coupling, and detrimental effects on benthic microalgal communities therefore hold the potential to carry severe consequences to ecosystem levels.

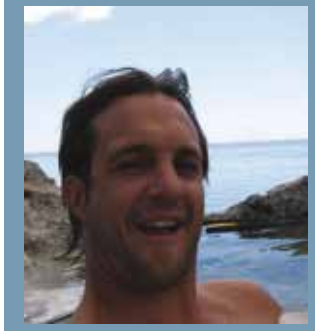
Herbicides have repeatedly been detected in the water and sediments along the Queensland coast in Australia. The effects of photosystem II (PSII) inhibiting herbicides on local microphytobenthos at increasing levels of biological organisation and complexity was therefore researched. Important results are for example:

- Inhibition of photosynthetic yield (Y(II), a measure of the efficiency of photosynthesis) measured with PAM-fluorometry has been validated as a suitable toxicological endpoint, clearly related to algal growth.
- Local, tropical species of microalgae are more or equally sensitive to herbicides compared to standard ecotoxicology test-species
- PSII inhibitors act additively in mixtures
- Despite derivation of similar IC50s, neither acute nor standard 72-h growth-inhibition toxicity tests with single species algal cultures can accurately predict the response of an intact, multispecies community under long-term herbicide-exposure stress, due to the possibility of community composition changes and Pollution Induced Community Tolerance, and possible shifts in energy-acquisition path-ways.
- High concentrations of herbicides, particularly diuron, were detected in sediments and porewaters from the Tully, Herbert and Johnstone Rivers. Diuron was also detected in the Daintree River.
- Environmental contamination of the highly potent insecticide imidacloprid was also confirmed in the Tully River during this study, along with higher than expected concentrations of the organochlorine dieldrin.

Ronald Hoeke, PhD candidate

Investigation of bed shear, water mixing and circulation in oceanic coral reefs

Ron Karl Hoeke has worked for the NOAA's Coral Reef Conservation Program for the last eight years. This work included frequent participation on multi-disciplinary research cruises throughout the tropical Pacific, and allowed him to observe both heavily impacted and relatively pristine coral reef ecosystems. This experience has lead to a passion to under better understand these complex systems.



Human related impacts to coral reefs have increased to the point that coral reefs are threatened on a global scale. If these impacts are to be mitigated, greater understanding of coral reef hydrodynamics is required. Terrestrial inputs and hydrological forcing of reef systems control or strongly influence many ecological aspects of the reef, such as the fate of pollutants, the distribution of organisms, nutrient uptake, overall productivity, dispersal and recruitment of larvae, patterns of coral bleaching, and degree of disturbance due to episodic storms. Most investigations into reef circulation and mixing have been primarily limited to winds and tides; relatively few have investigated the role of surface gravity waves, which is surprising since the dominance of surface gravity waves on circulation patterns and flushing of many coral reefs has been well demonstrated. Additionally, distribution of wave-generated bed shear stresses have often been shown to be the pivotal factor in determining benthic community composition in the forereef zone.

In order to bring these aspects of coral reef hydrodynamics together, a detailed assessment of circulation and hydrodynamic forcing of two distinct reef morphologies are being undertaken: a fringing reef/embayment system and an atoll. This research is centred on modelling the contribution of wave driven flow to the hydrodynamics of coral reefs. The two study sites, Hanalei Bay on the island of Kauai and Midway Atoll, both in the Hawaiian Archipelago. Modelling techniques are being investigated, as well as corroboration of modelling results with biological and geological data.

Lachlan McKinna, PhD candidate

Optical Detection and Measurement of Nitrogen Fixing Cyanobacteria *Trichodesmium* within the Great Barrier Reef

Lachlan is originally from Cooktown, North Queensland and completed his BSc(Hons) with a Maths/Physics double major at JCU in 2006. His research project is multidisciplinary and examines the abundance of the Nitrogen fixing cyanobacterium *Trichodesmium* spp. within the Great Barrier Reef (GBR) using ocean colour remote sensing. Remote sensing satellite products from the CZCS, SeaWiFS, MODIS have been key to observing *Trichodesmium* in past research. However, coastal waters of the GBR are complex in optical composition often containing fluctuating amounts of non-algal particles, coloured dissolved organic matter and variable phytoplankton communities. In optically complex waters such as the GBR, standard bio-optical satellite retrieval algorithms can be confounded and give poor results.

This project applies the theory of radiative transfer which describes how the colour of seawater is dependent upon the optical properties of constituent matter. The "ocean colour" is dependent upon the inherent optical properties (IOPs) of scattering, absorption and fluorescence. Therefore by taking direct measurements of IOPs alongside hyperspectral radiometric measurements of the water-leaving radiance (ocean colour), it is possible to develop *Trichodesmium* specific retrieval algorithm. During field components of this project shipboard IOP and radiometric measurements have been made. Following from the work of Matthew Slivkoff, an array of optical instruments is being used to gather data over *Trichodesmium* rich waters aboard AIMS research vessels. This data is being analysed using appropriate physics based algorithms.

This project has three main components:

1. Collection of optical and radiometric data from the GBR,
2. Develop physics based techniques suitable for identifying *Trichodesmium* optically and,
3. Draw conclusions about the spatial and temporal distribution of biological constituents.

Severine Choukroun, PhD candidate

Sea surface circulation in the GBR and adjacent Coral Sea

Severine is originally from France and first came to Australia to undertake internships at the CSIRO in Melbourne (in 2002) and at AIMS in 2003 as part of her master degree in Physical oceanography and ocean engineering. She then worked as a Research Assistant in physical oceanography for AIMS and NOAA in Hawaii before starting her PhD at JCU in 2005.

This project investigates the surface circulation patterns and eddy variability of the Coral Sea and the Great Barrier Reef (GBR). Analytical techniques on data derived from satellite tracked surface drifters, current meters moorings deployed in the GBR and satellite imagery were utilised to obtain a representative of the Coral Sea circulation and its affect on the GBR. Coral Sea inflow and the circulation in the GBR are key parameters to understand the connectivity of coral reef fauna. Knowledge of connectivity patterns is important to enable the formulation of realistic management strategies to ensure successful conservation of reef biodiversity, especially under the looming spectre of climate change.

Another aspect of the research has focused on resolving the flushing time of waters in the GBR which has important implications for research into the influence of pollutants from terrestrial origin. These results, including diffusion and kinetic energy quantification, are also invaluable for hydrodynamic model calibrations and validations, providing for the first time, an evaluation of the parameters from in situ measurements at large scale.

Photograph above courtesy of AIMS@JCU student Carol Devney

2007 Honours Awards

Cameron Crothers-Stomps - Selection of bacteriophage as a biocontrol agent to combat *Vibrio harveyi*, a pathogen of Tropical Rock Lobster (*Panulirus ornatus*) phyllosoma.

Grethe Hillersoy - A genetic approach to exploring the capacity of coral trout (*Plectropomus leopardus*) to respond to a changing thermal environment.

Jessica Stella - Climate change and coral reefs: Habitat loss and declining biodiversity.

James Moore - Early life history impacts of coral bleaching on reef fishes (Pisces: Pomacentridae).

Elizabeth Downs - The stress defence systems of marine macro-organisms - a potential anti-inflammatory and neuroprotective compounds?

Bonnie Eklom - Molecular identification of anti-inflammatory and neuroprotective compounds isolated from marine organisms.

Elizabeth Abbey - Response of coral reefs to abrupt climate changes.

Deane Ludman - Source, timing and frequency of turbidite deposits along the Great Barrier Reef margin.

Erol Erikkson - Feeding behaviour of large rays at the wreck of the Yongala and their role as ecosystem engineers.

2007 Travel Awards

May-Helen Holme - Asian Pacific Aquaculture 2007 Conference in Hanoi, Vietnam.

Jana Guenther - Australian Marine Sciences Association (AMSA) 2007 Conference in Melbourne.

Luiz Felipe Mendes de Gusmao, Eneour Puill-Stephan & David Abrego - Australian Coral Reef Society (ACRS) 2007 Conference in Perth.

Carol Devney - Ecological Society of Australia - Adapting to Change 2007 Conference in Perth.

2008 Honours Awards

David Jones - Effective population size in a coral reef fish, *Pomacentrus amboinensis*.

2008 Travel Awards

Patricia Warner -
Vivian Cumbo -
Paulina Cetina Heredia -
David Abrego -
Francois Seneca -
Eneour Puill-Stephan -
Yui Sato -
Jessica Haapkyla -
Emmanuelle Botte -
Allison Paley -

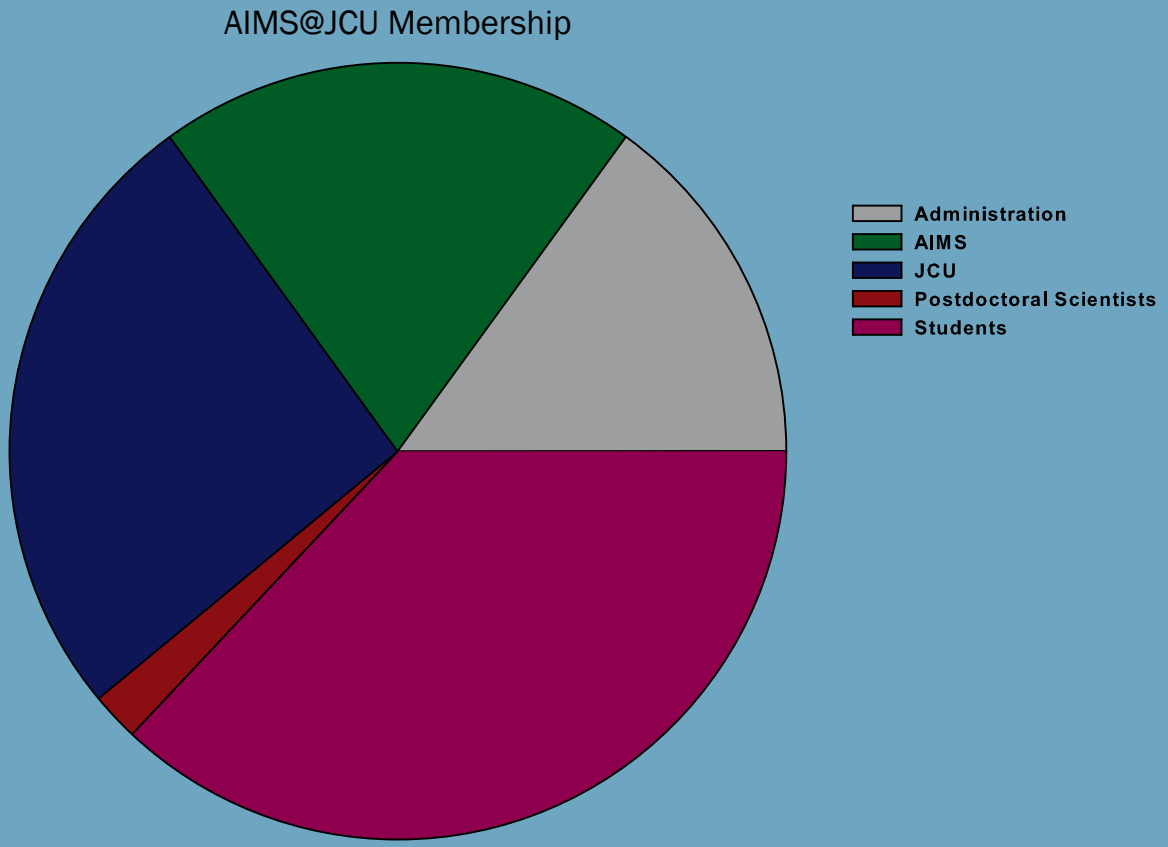
} 11th International Coral Reef Symposium 2008 Conference in Florida, USA.

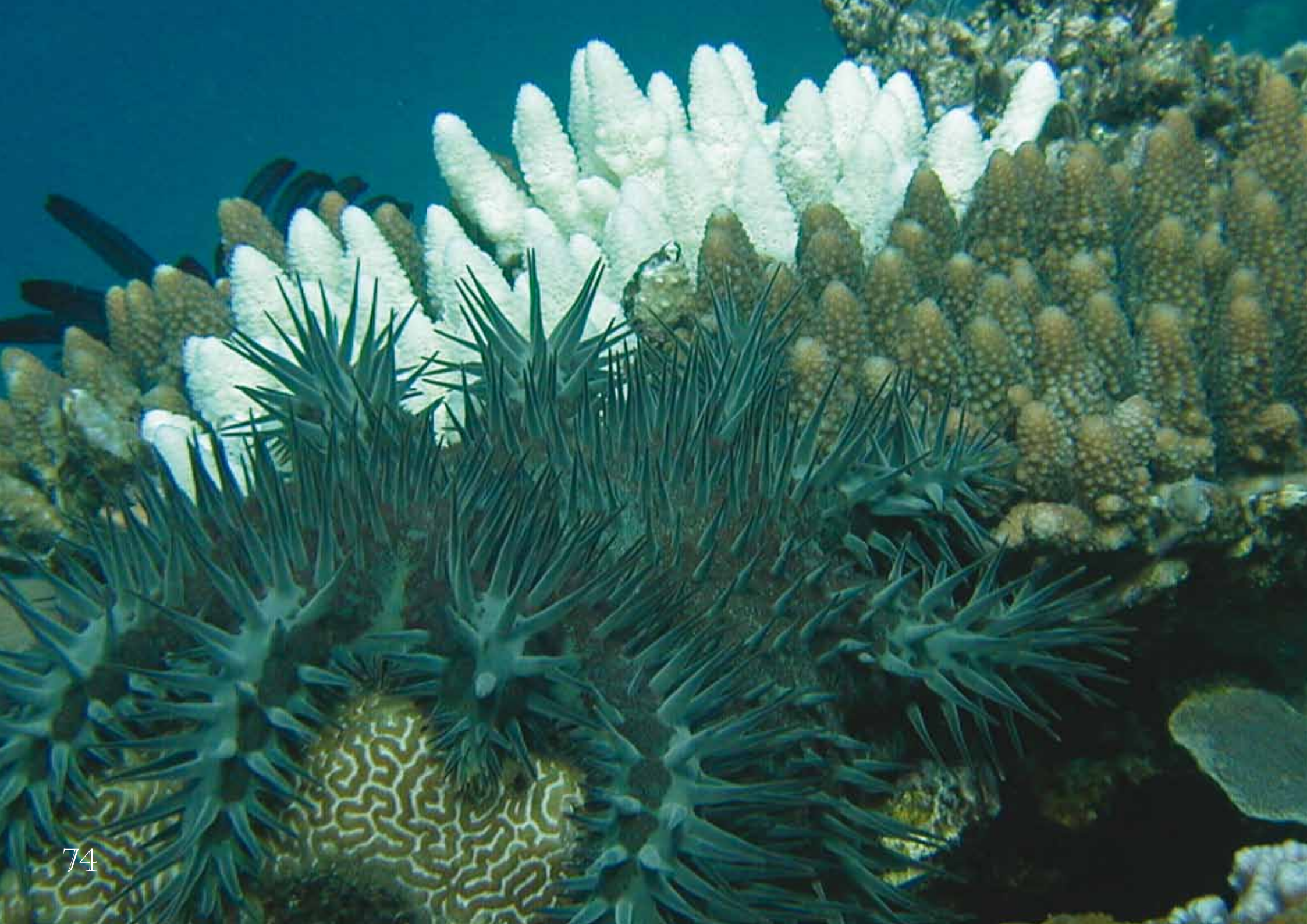
Monica Gagliano - 12th International Behavioural Ecology Congress in Ithaca (New York), USA

Photograph above courtesy of AIMS@JCU member Chaoshu Zeng

Membership Structure

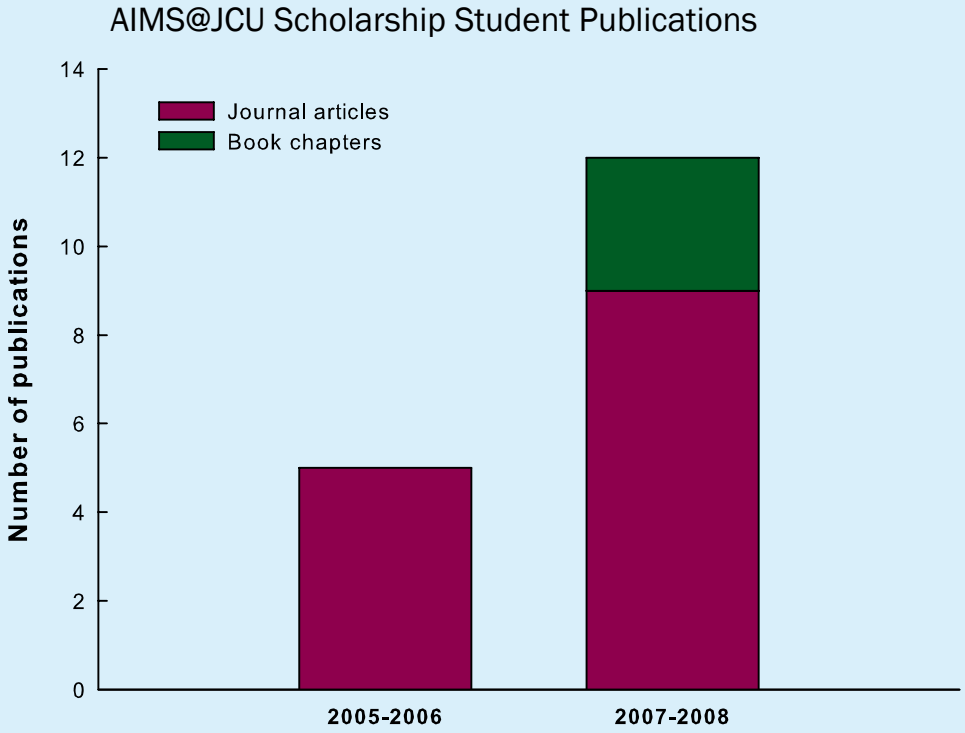
AIMS@JCU strives to maintain a balanced membership. The group has a strong student membership and balanced support from both institutions. The current membership breakdown is shown below. AIMS@JCU supports postdoctoral fellowships in each program and encourages membership from both AIMS and JCU. Administration includes the Management Committee, Program Leaders, Research Director and administrative staff.





Publications Summary

During 2004-2006 the total output of all AIMS@JCU members was 251 papers in refereed journals, 13 book chapters and 3 books. In 2007 -2008 the group has been equally productive with 256 papers in refereed journals, 18 book chapters and 4 books. AIMS@JCU places a large emphasis on the support, growth and development of students. Therefore, the research output of the AIMS@JCU scholarship students is highlighted below:



Increasing numbers of students and progression through their degrees has resulted in increased output over time. Based on currently submitted publications, student productivity and publications will continue to grow in 2009.

A selection of the 256 publications from AIMS@JCU members is provided in the following pages.

Key:
AIMS@JCU Student Member
AIMS@JCU Postdoctoral Scientist

Edited Volumes

Southgate PC & Lucas JS (2008) The pearl oyster. Elsevier, Oxford, UK

Book Chapters

Munday PL, Jones GP, Sheaves MJ, Williams AJ & Goby G (2007) Vulnerability of Fishes of the Great Barrier Reef to Climate Change. In: JE Johnson & PA Marshall (eds) Climate change and the Great Barrier Reef: A Vulnerability Assessment. Great Barrier Reef Marine Park Authority and the Australian Greenhouse Office. 357 – 392

Smithers SG, Harvey N, Hopley D & Woodroffe CD (2007) Vulnerability of Geomorphological features in the Great Barrier Reef to Climate Change. In: JE Johnson & PA Marshall (eds) Climate change and the Great Barrier Reef: A Vulnerability Assessment. Great Barrier Reef Marine Park Authority and the Australian Greenhouse Office. 667 – 716

Anthony SL & Thomas S (2008) Coral husbandry and long-term coral survival in the Coral Reef Exhibit at Reef HQ Aquarium, Townsville, Australia. In: RJ Leewis & M Janse (eds) Advances in Coral Husbandry in Public Aquariums - Public Aquarium Husbandry Series. Burgers Zoo. 1 – 10

Congdon B (2008) Seabirds. In: P Huchings, N Kingsford & O Hoegh-Guldberg (eds)The Great Barrier Reef: Biology, Environment and Management. Springer / CSIRO Publishing. 359 – 368

Congdon B & Harrison DA (2008) Vertebrate Pests of the Wet Tropics Bioregion: Current Status and Future Trends. In: NE Stork & SM Turton (eds) Living in a Dynamic Tropical Forest Landscape. Blackwell Publishing Ltd. 322 – 333

de Nys R & Ison O (2008) Biofouling. In: PC Southgate & JS Lucas (eds) The Pearl Oyster. Elsevier. 527 – 553

Kingsford MJ, Heimann KRM, Alexander CG & McKinnon AD (2008) Plankton. In: P Huchings, N Kingsford & O Hoegh-Guldberg (eds)The Great Barrier Reef: Biology, Environment and Management. Springer / CSIRO Publishing. 129 – 144

Book Chapters cont.

Southgate PC (2008) Pearl oyster culture. In: PC Southgate & JS Lucas (eds) The Pearl Oyster. Elsevier. 231 – 272

Southgate PC, Hart A, Wada. KT, Monteforte M, Carino M, Landy S, Lo C, Acosta-Salmon H & Wang A (2008) Exploitation and culture of major commercial species. In: PC Southgate & JS Lucas (eds) The Pearl Oyster. Elsevier. 303 – 355

Southgate PC, Lucas JS & Torrey RD (2008) Future developments. In: PC Southgate & JS Lucas (eds) The Pearl Oyster. Elsevier. 555 - 565

Journal Articles – 2007

Atkinson IM, du Boulay D, Chee C, Chiu K, Coddington P, Gerson A, King TL, McMullen DF, Quilici R, Turner P, Wendleborn A, Wyatt MJ & Zhang D (2007) Developing CIMA Based Cyberinfrastructure for Remote access to scientific instruments and collaborative e-research. In: Proceedings of the fifth Australasian Symposium on ACSW frontiers 3 - 10 (eds Lj Brankovic et al). Australian Computer Society Inc, Ballarat

Atkinson L, Adams E & Crozier RH (2007) Microsatellite markers for the polygamous termite Nasutitermes corniger (Isoptera: Termitidae). Molecular Ecology Notes, 7, 299 – 301

Bannister RJ, Brinkman R, Wolff CWW, Battershill C & de Nys R (2007) The distribution and abundance of dictyoceratid sponges in relation to hydrodynamic features: identifying candidates and environmental conditions for sponge aquaculture. Marine and Freshwater Research, 58, 624 – 633

Cantin NE, Negri AP & Willis BL (2007) Photoinhibition from chronic herbicide exposure reduces reproductive output of reef-building corals. Marine Ecology-Progress Series, 344, 81 – 93

Crozier RH (2007) Research Evaluation Skews from Excellence. Australasian Science Magazine, 28 (8), 41 – 41

Crozier YC, Jia X, Yao JY, Field AR, Cook JM & Crozier RH (2007) Microsatellite primers for Ficus racemosa and Ficus rubiginosa. Molecular Ecology Notes, 7, 57 – 59

Devney CA & Congdon B (2007) Day-to-Day variation in sea-surface temperature reduces sooty tern Sterna fuscata foraging success on the Great Barrier Reef, Australia. Marine Ecology-Progress Series, 331, 255 – 266

2007 Journal Articles cont.

Ettinger-Epstein P, Motti C, de Nys R, Wright A, Battershill C & Tapiolas D (2007) Acetylated Sesterterpenes from the Great Barrier Reef Sponge Luffariella variabilis. Journal of Natural Products, 70, 648 – 651

Ettinger-Epstein P, Whalan SW, Battershill C & de Nys R (2007) Temperature cues gametogenesis and larval release in a tropical sponge. Marine Biology, 153, 171 – 178

Gagliano M & McCormick MI (2007) Maternal condition influences phenotypic selection on offspring. Journal of Animal Ecology, 76, 174 – 182

Gagliano M & McCormick MI (2007) Compensating in the wild: is flexible growth the key to early juvenile survival? Oikos, 116, 111 – 120

Gagliano M, McCormick MI & Meekan MG (2007) Temperature-induced shifts in selective pressure at a critical developmental transition. Oecologia, 152, 219 – 225

Gagliano M, McCormick MI & Meekan MG (2007) Survival against the odds: ontogenetic changes in selective pressure mediate growth-mortality trade-offs in a marine fish. Proceedings of the Royal Society of London Series B-Containing Papers of a Biological Character, 274, 1575 – 1582

Genodepa J, Zeng C & Southgate PC (2007) Influence of binder type on leaching rate and ingestion of microbound diets by mud crab, Scylla serrata (Forsskal), larvae. Aquaculture Research, 38, 1486 – 1494

Heron ML (2007) Tsunami Monitoring by HF Ocean Radar: Time and Space Scales. In: Oceans 2007 - Europe 1 - 5 (eds T Thevar & D Green). IEEE

Heron ML, Ridd PV, Greenslade DJ, Skirving W & Heron SF (2007) HF Coastal Ocean Radar in an Observing System. In: Coasts and Ports 2007 on CD. Engineers Australia

Jaffres JBD, Shields - Zhou GA & Wallmann K (2007) The oxygen isotope evolution of seawater: A critical review of a long-standing controversy and an improved geological water cycle model for the past 3.4 billion years. Earth-Science Reviews, 83, 83 – 122

2007 Journal Articles cont.

Kassahn KS, Caley MJ, Ward AC, Connolly A, Glenn S & Crozier RH (2007) Heterologous microarray experiments used to identify the early gene response to heat stress in a coral reef fish. Molecular Ecology, 16, 1749 – 1763

Kassahn KS, Crozier RH, Ward AC, Stone G & Caley MJ (2007) From transcriptome to biological function: environmental stress in an ectothermic vertebrate, the coral reef fish Pomacentrus moluccensis. BMC Genomics, 8, 1 – 16

Luter HM, Duckworth A & Syms C (2007) Cytotoxic and anti-microbial activity of the sponge Iotrochota sp. as a function of size and spatial competitors. Marine Biology Research, 3, 312 – 318

Magnusson K, Magnusson ME, Ostberg P, Granberg M & Tiselius P (2007) Bioaccumulation of 14C-PCB 101 and 14C-PBDE 99 in the marine planktonic copepod Calanus finmarchicus under different food regimes. Marine Environmental Research, 63, 67 – 81

McCormick MI & Larson KJO (2007) Field verification of the use of chemical alarm cues in a coral reef fish. Coral Reefs, 26, 571 – 576

McCormick MI & Meekan MG (2007) Social Facilitation of Selective Mortality. Ecology, 88 (6), 1562 – 1570

Miller DJ, Hemmrich G, Ball EB, Hayward DC, Khalturin K, Funayama N, Agata K & Bosch T (2007) The innate immune repertoire in Cnidaria - ancestral complexity and stochastic gene loss. Genome Biology, 8 (4)

Moore P, Johnson PM, Smith G, Ritchie SA & van den Hurk AF (2007) Infection and Dissemination of Dengue Virus Type 2 in Aedes Aegypti, Aedes Albopictus, and Aedes Scutellaris from the Torres Strait, Australia. Journal of the American Mosquito Control Association, 23, 383 – 388

Pratchett MS (2007) Dietary selection by coral-feeding butterflyfishes (Chaetodontidae) on the Great Barrier Reef, Australia. Raffles Bulletin of Zoology, 14, 171 – 176

2007 Journal Articles cont.

Pratchett MS (2007) Feeding preferences of Acanthaster planci (Echinodermata: Asteroidea) under controlled conditions of food availability. Pacific Science: a quarterly devoted to the biological and physical sciences of the Pacific Region, 61 (1), 113 – 120

Stieglitz TC, Rapaglia J & Krupa SC (2007) An Effect of Pier Pilings on Nearshore Submarine Groundwater Discharge from a (Partially) Confined Acquifer. Estuaries and coasts, 30 (3), 543 – 550

Webster JM, Clague D & Braga JC (2007) Support for the Giant Wave Hypothesis: evidence from submerged terraces off Lanai, Hawaii. International Journal of Earth Sciences, 96, 517 – 524

Webster JM, Wallace L, Clague C & Braga JC (2007) Numerical modeling of the growth and drowning of Hawaiian coral reefs during the last two glacial cycles (0-250 kyr). G3: Geochemistry, Geophysics, Geosystems: an electronic journal of the earth sciences, 8 (3), 1 – 23

Whalan SW, Battershill CN & de Nys R (2007) Variability in reproductive output across a water quality gradient for a tropical marine sponge. Marine Biology, 153, 163 – 169

Whalan SW, Battershill CN & de Nys R (2007) Sexual reproduction of the brooding sponge Rhopaloeides odorabile. Coral Reefs, 26, 655 – 663

Wu X, Cheng Y, Sui L, Zeng C, Southgate PC & Yang X (2007) Effect of dietary supplementation of phospholipids and highly unsaturated fatty acids on reproductive performance and offspring quality of Chinese mitten crab, Eriocheir sinensis (H Milne-Edwards), female broodstock. Aquaculture, 273, 602 – 613

Zeng C (2007) Induced out-of-season spawning of the mud crab, Scylla paramamosain (Estampador) and effects of temperature on embryo development. Aquaculture Research, 38, 1478 - 1485

Journal Articles – 2008

Abrego D, Ulstrup KE, Willis BL & van Oppen MJH (2008) Species-specific interactions between algal endosymbionts and coral hosts define their bleaching response to heat and light stress. Proceedings of The Royal Society B, 275, 2273 – 2282

Journal Articles – 2008 cont.

Anthony SL, Page CA, Bourne DJ & Willis BL (2008) Newly characterized distinct phases of the coral disease 'atramentous necrosis' on the Great Barrier Reef. Diseases of Aquatic Organisms, 81 (3), 255 – 259

Bourne DJ, Boyett H, Henderson M, Muirhead A & Willis BL (2008) Identification of a Ciliate (Oligohymenophorea: Scuticociliatia) Associated with Brown Band Disease on Corals of the Great Barrier Reef. Applied and Environmental Microbiology, 74 (3), 883 – 888

Castine SA, Southgate PC & Zeng C (2008) Evaluation of four dietary protein sources for use in microbound diets fed to megalopae of the blue swimmer crab, Portunus pelagicus. Aquaculture, 281 (1-4), 95 – 99

Crozier RH (2008) Advanced eusociality, kin selection and male haploidy. Australian Journal of Entomology, 47, 2 – 8

Crozier RH & Schluns H (2008) Genetic caste determination in termites: out of the shade but not from Mars. Bioessays, 30 (4), 299 – 302

Ettinger-Epstein P, Tapiolas DM, Motti C, Wright A, & de Nys R (2008) Production of manoalide and its analogues by the sponge Luffariella variabilis is hardwired. Marine Biotechnology, 10 (1), 64 – 74

Ettinger-Epstein P, Whalan SW, & de Nys R (2008) A hierarchy of settlement cues influences larval behaviour in a coral reef sponge. Marine Ecology-Progress Series, 365, 103 – 113

Gagliano M (2008) On the spot: the absence of predators reveals eyespot plasticity in a marine fish. Behavioral Ecology, 19 (4), 733 – 739

Gagliano M, Depczynski MR, Simpson S & Moore JAY (2008) Dispersal without errors: symmetrical ears tune into the right frequency for survival. Proceedings of The Royal Society B, 275, 527 – 534

Heron ML, Prytz A, Heron SF, Helzel T, Schlick T, Greenslade DJ, Schulz E & Skirving W (2008) Tsunami observations by coastal ocean radar. International Journal of Remote Sensing, 29 (21), 6347 – 6359

Heron SF & Ridd PV (2008) The tidal flushing of multiple-loop animal burrows. Estuarine, Coastal and Shelf Science, 78 (1), 135 – 144

Journal Articles – 2008 cont.

Hill L, Davis J, Hapgood G, Whelan PI, Smith G, Ritchie SA, Cooper RD & Van der Hurk A (2008) Rapid identification of all Aedes albopictus, Aedes scutellaris and Aedes Aegypti Life Stages Using Real-Time Polymerase Chain Reaction Assays. American Journal of Tropical Medicine and Hygiene, 79 (6), 866 – 875

Horne J, van Herwerden L, Choat JH & Robertson DR (2008) High population connectivity across the Indo-Pacific: Congruent lack of phylogeographic structure in three reef fish congeners. Molecular Phylogenetics and Evolution, 49 (2), 629 – 638

Jerry DR (2008) Phylogeography of the freshwater catfish Tandanus tandanus (Plotosidae): a model species to understand evolution of the eastern Australian freshwater fish fauna. Marine and Freshwater Research, 59 (4), 351 – 360

Jones A, Cantin NE, Berkelmans R, Sinclair B & Negri A (2008) A 3D modeling method to calculate the surface areas of coral branches. Coral Reefs, 27 (3), 521 – 526

Jones D, Jerry DR, McCormick MI & Bay LK (2008) Development of nine microsatellite markers for Pomacentrus amboinensis. Molecular Ecology Resources, 8, 1332 – 1334

Littman RA, van Oppen MJH & Willis BL (2008) Methods for sampling free-living Symbiodinium (zooxanthellae) and their distribution and abundance at Lizard Island (Great Barrier Reef). Journal of Experimental Marine Biology and Ecology, 364, 48 – 53

Magnusson ME, Heimann KRM & Negri A (2008) Comparative effects of herbicides on photosynthesis and growth of tropical estuarine microalgae. Marine Pollution Bulletin, 56 (9), 1545 – 1552

McCormick MI & Larson KJO (2008) Effect of hunger on the response to, and the production of, chemical alarm cues in a coral reef fish. Animal Behaviour, 75 (6), 1973 – 1980

McCormick MI & Manassa RP (2008) Predation risk assessment by olfactory and visual cues in a coral reef fish. Coral Reefs, 27 (1), 105 – 113

Miller DJ & Ball EB (2008) Cryptic complexity captured: the Nematostellar genome reveals its secrets. Trends in Genetics, 24 (1), 1 – 4

Journal Articles – 2008 cont.

Miller DJ & Ball EB (2008) Animal evolution: Trichoplax, trees, and taxonomic turmoil. Current Biology, 18 (21), R1003-R1005

Moore R, Obornik M, Janouskovec J, Chrudimsky T, Vancova M, Green D, Wright S, Davies N, Bolch C, Heimann KRM, Slapeta J, Hoegh-Guldberg O, Logsdon J & Carter D (2008) A photosynthetic alveolate closely related to apicomplexan parasites. Nature, 451 (7181), 959 – 963

Munday PL, Jones GP, Pratchett MS & Williams AJ (2008) Climate change and the future for coral reef fishes. Fish and Fisheries, 9 (3), 261 – 285

Munday PL, Kingsford MJ, O'callaghan MD & Donelson JM (2008) Elevated temperature restricts growth potential of the coral reef fish Acanthochromis polyacanthus. Coral Reefs, 27 (4), 927 – 931

Pratchett MS & Berumen M (2008) Interspecific variation in distributions and diets of coral reef butterflyfishes (Teleostei: Chaetodontidae). Journal of Fish Biology, 73 (7), 1730 – 1747

Pratchett MS, Berumen ML, Marnane MJ, Eagle JV & Pratchett DJ (2008) Habitat associations of juvenile versus adult butterflyfishes. Coral Reefs, 27 (3), 541 – 551

Pratchett MS, Munday PL, Wilson SK, Graham NAJ, Cinner JE, Bellwood DR, Jones GP, Polunin NVC & McClanahan TR (2008) Effects of climate-induced coral bleaching on coral-reef fishes - ecological and economic consequences. Oceanography and Marine Biology: an annual review, 46, 251 – 296

Richards ZT (2008) Afterblast. Australasian Science Magazine, June, 16 – 18

Richards ZT, Beger M, Pinca S & Wallace CC (2008) Bikini Atoll coral biodiversity resilience five decades after nuclear testing. Marine Pollution Bulletin, 56 (3), 503 – 515

Richards ZT, van Oppen MJH, Wallace CC, Willis BL & Miller DJ (2008) Some rare Indo-Pacific coral species are probable hybrids. Public Library of Science ONE (PLOS ONE), 3 (9 e3240), 1 – 8

Stieglitz TC, Rapaglia J & Bokuniewicz H (2008) Estimation of submarine groundwater discharge from bulk ground electrical conductivity measurements. Journal of Geophysical Research-Oceans, 113 (C08007)

Journal Articles – 2008 cont.

Sussman M, Willis BL, Victor S & Bourne DJ (2008) Coral pathogens identified for white syndrome (WS) epizootics in the Indo-Pacific. Public Library of Science ONE (PLOS ONE), 3 (6), e2393

Webster JM, Beaman R, Bridge TC, Davies PJD, Byrne MB, Williams S, Manning P, Pizarro O, Thornborough K, Woolsey E, Thomas A & Tudhope S (2008) From corals to canyons: The Great Barrier Reef margin. EOS: Transactions, American Geophysical Union, 89, 217 – 218

Whalan SW, de Nys R, Smith-Keune CR, Evans BS, & Jerry DR (2008) Low genetic variability within and among populations of the brooding sponge Rhopaloeides odorabile on the central Great Barrier Reef. Aquatic Biology, 3 (2), 111 – 119

Whalan SW, Ettinger-Epstein P & de Nys R (2008) The effect of temperature on larval pre-settlement duration and metamorphosis for the sponge, Rhopaloeides odorabile. Coral Reefs, 27 (4), 783 – 786

Whalan SW, Ettinger-Epstein P, & de Nys R (2008) Larval vertical migration and hierarchical selectivity of settlement in a brooding marine sponge. Marine Ecology-Progress Series, 368, 145 - 154

Financial Statement

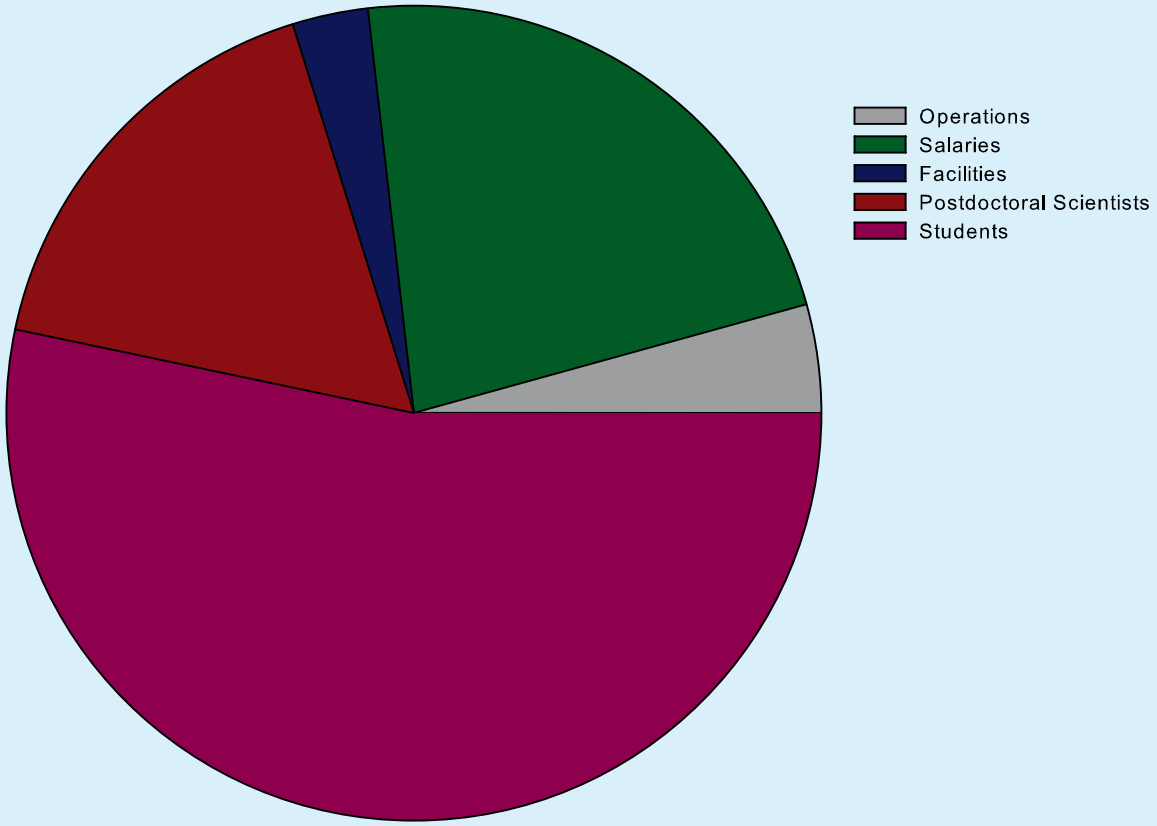
Financial Accounting of Operating Income and Expenditure for the years ending 31/12/2007 – 31/12/2008:

		2007 $	2008 $
Opening Balance		1,709,644	1,323,658
Income			
	Interest	80,335	71,232
	Other Revenue	0	0
	Total Income	80,335	71,232
Expenditures			
	Salaries	130,765	79,771
	Post-Doctoral Positions	62,949	94,682
	Program Coordination and Administration	26,139	14,161
	Commuter Vehicle	13,728	14,476
	Scholarships	219,740	253,007
	Other Awards	13,000	13,070
	Total Expenditure	466,321	469,167
Ending Balance		1,323,658	925,723

Financial Statement

One of the primary objectives of AIMS@JCU is to support student research both financially and through facilities and supervision. The average allocation of the AIMS@JCU budget strongly reflects this goal.

Budget Allocation 2007-2008



Future Directions for AIMS@JCU

Both Michael Ridd and Craig Steinberg left the Coastal Processes and Modelling program in 2009, but are still active AIMS@JCU members. They have been replaced by Scott Smithers and Richard Brinkman:

Assoc. Prof. Scott Smithers is a coastal geomorphologist in the School of Environmental and Earth Sciences at James Cook University. Scott has particular research interests in the geomorphology of coral reefs and reef islands, both on the Great Barrier Reef and in mid-ocean atoll settings.

Scott's current research focuses on: reef island formation, sediment budgets and morphodynamics; sediment dynamics and the Holocene growth of inshore turbid-zone reefs; interannual and Holocene sea-level change records from coral microatolls; records of environmental conditions and change from coral skeletons.

Dr. Richard Brinkman is a Senior Research Scientist at AIMS, where he leads and implements research projects within the broad topics of coastal oceanography and physical-biological interactions on continental shelves. Richard currently undertakes research on shelf dynamics, coupling of shelf and ocean circulation, sediment dynamics on tropical coasts, wave propagation over coral reefs and physical-biological interactions at regional and local scales, using a mix of field observations and numerical modelling.

Future Directions for AIMS@JCU

At the end of 2008, students were recruited to begin their studies in 2009:

2009 AIMS@JCU PhD Scholarship Winners:

Gergely Torda - Assessment of ecological connectivity in corals: implications for their recovery from major perturbations and their potential to adapt to climate change.

Jean-Baptiste Raina - Coral-associated bacteria and their role in the biogeochemical cycling of sulfur.

Darren Coker - Effects of host coral-bleaching on coral-dwelling fishes.

Raechel Littman - The dynamics of bacterial populations associated with corals and the role of bacterial pathogens in coral bleaching.

Charlotte Johannson - Managing Coral Reefs: the importance of working with functional groups to maintain ecosystem resilience.

2009 AIMS@JCU Honours Support Winners:

Karen Chong-Seng - Are corallivorous fishes vectors for coral disease?

Alexander Vail - Non-lethal predator effects on settlement of reef fish.

Heather Welladsen - The effects of ocean acidification and temperature on the physiology of giant clams and their symbionts.

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