

# Reef Conservation UK

## PROGRAMME & ABSTRACTS

Zoological Society of London

3<sup>rd</sup> December 2011

Presented by  
REEF CONSERVATION UK

*RCUK (Reef Conservation UK)  
Dedicated to the Conservation and Awareness of Coral reefs*

# Conference Committee

## RCUK Meeting Organising Committee

**Heather Koldeway** Zoological Society of London  
**David Curnick** Zoological Society of London  
**Simon Harding** Zoological Society of London  
**Kristian Teleki** SeaWeb  
**Elizabeth Wood** Marine Conservation Society  
**Terri Young** UNEP World Conservation Monitoring Centre  
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There are currently three ways to keep you up to date on RCUK news and events:

1. RCUK listserv – details of how to join can be found at [www.jiscmail.ac.uk/lists/iyor-uk.html](http://www.jiscmail.ac.uk/lists/iyor-uk.html)
2. RCUK website ([www.rcuk.org/uk](http://www.rcuk.org/uk))
3. Any specific enquiries can be directed to [rcuk@zsl.org](mailto:rcuk@zsl.org)

### **A big thank you to our sponsors!**

Firstly to Chris Poonian and C-3 Community Centred Conservation ([www.c-3.org.uk/](http://www.c-3.org.uk/)) for their generous support of this year's event. For more details on C-3, please see visit their website, or take a look at their brochure.

We would also like to thank Guylian Chocolates (Belgium) for their continued support of RCUK. Guylian have been a long term supporter of coral reef conservation through their partnership with Project Seahorse.

## **Welcome to the 14<sup>th</sup> Reef Conservation UK (RCUK) Meeting 2011**

Welcome to the **14<sup>th</sup> annual meeting of the RCUK** at the Zoological Society of London. Once again we are pleased to have been able to assemble what we think you will agree is a very interesting programme. The meeting continues to illustrate the impressive array of coral reef interests and activities here in the UK.

The RCUK Committee has managed to organise this meeting every year though the voluntary efforts of many people and organisations, most of which are listed on page 2. However, RCUK relies on your continued support and participation to ensure it maintains an active role in the UK in promoting coral reef conservation. There are many ways that you can contribute to RCUK throughout the year and we are happy to take your suggestions on board. Drop us a line at [rcuk@zsl.org](mailto:rcuk@zsl.org) if you are interested.

We hope you will find this day interesting and fruitful. If there is anything you think we can improve on, do let one of us know at [rcuk@zsl.org](mailto:rcuk@zsl.org).

We thank you all for making this meeting and RCUK a continued success.

***RCUK Committee***

***3<sup>rd</sup> December 2011***

# RCUK Agenda

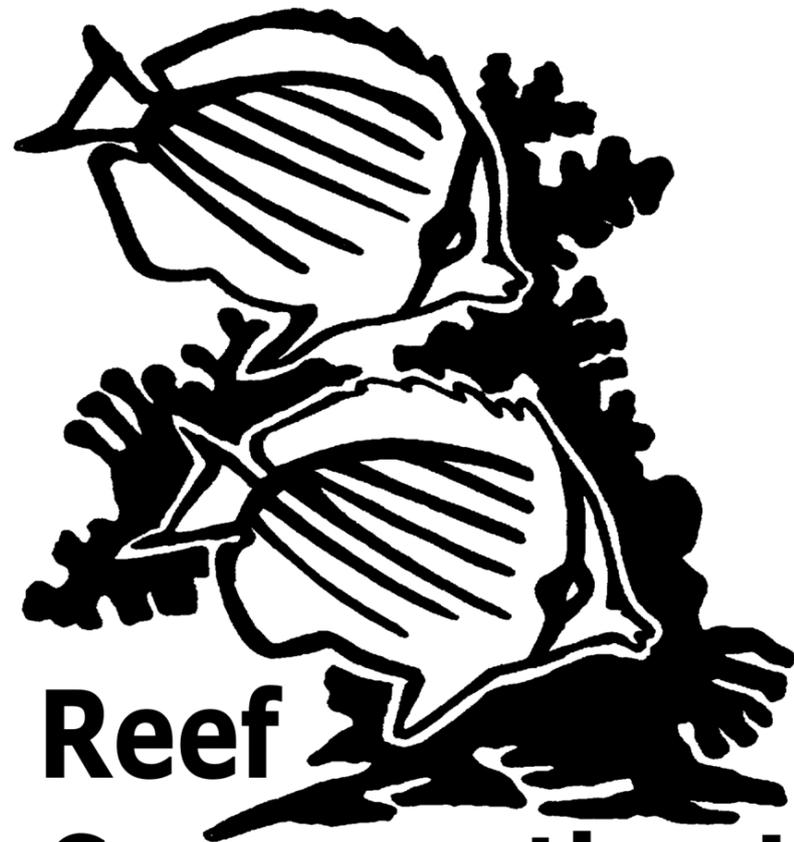
Saturday 3rd December 2011 - Huxley Theatre, ZSL

Time	Title	Speaker	Institution
08:30 - 09:00	<b>Registration and Coffee</b>		
09:00 - 09:05	Introduction to RCUK	Heather Koldewey	ZSL
<b>Session 1: Fisheries/Management</b>		<b>Chair: Heather Koldewey</b>	
09:05 - 09:25	It works to accept marine reserves wherever we can get them	Amanda Vincent	Project Seahorse / University of British Columbia
09:25 - 09:40	Modeling the economic benefits of temporary octopus fisheries closures	Frances Humber	Blue Ventures
09:40 - 09:55	Interactions between fishing and seaweed farming in the central Philippines: network analysis of occupational diversity and patterns of dependence in household livelihood portfolios.	Nick Hill	Imperial / Institute of Zoology
09:55 - 10:10	Can local stakeholders choose effective and suitable sites for designation as marine protected areas?	Debbie Winton	Earthwatch Institute
10:10 - 10:15	Moving towards sustainability in subsistence fisheries of the Wakatobi Marine National Park, Indonesia	Dan Exton	Operation Wallacea
10:15 - 10:20	Breaking or Following the Fishing Rules and Regulations: Motivations, Benefits and Incentives for Kia Islanders, Fiji	Lui Hepworth	University of Brighton
10:20 - 10:25	EDGE Corals and Canouan	Catherine Head	ZSL and Oxford University
10:25 - 10:40	Panel discussion session	<i>All session speakers</i>	
<b>Total Session Time 100 mins</b>			
10:40 - 11:10	<b>Tea and Coffee break</b>		
<b>Session 2: Climate Change</b>		<b>Chair: David Curnick</b>	
11:10 - 11:25	Can seagrass be used to offset coral reef acidification?	Richard Unsworth	Swansea University
11:25 - 11:40	Anthropogenic aerosol emissions drive variations in Caribbean coral growth	Lester Kwiatkowski	University of Exeter
11:40 - 11:55	Balancing the carbonate budget: maintenance of positive framework growth in the Caribbean requires local and global action	Emma Kennedy	University of Exeter
11:55 - 12:10	Tobago's coral reefs in the melting pot of climate change - a 4-year monitoring study	Jan-Willem van Bochove	Coral Cay
12:10 - 12:15	Acclimation of the cold water coral <i>Lophelia pertusa</i> to predicted rises in atmospheric CO2 and sea temperatures	Seb Hennige	Heriot-Watt University
12:15 - 12:20	The Importance of Thermal History and Light Environment on Regulating the Environmental Sensitivity of Scleractinian Corals	Sarah-Jane	University of Essex
12:20 - 12:35	Panel discussion session	<i>All session speakers</i>	
<b>Total Session Time 85mins</b>			
12:35 - 14:00	<b>Lunch and poster session</b>		
<b>Session 3: Coral Biology</b>		<b>Chair: Simon Harding</b>	
14:00 - 14:15	White Syndrome: an unmanageable threat to coral reefs?	John Bythell	Newcastle University
14:15 - 14:30	Modelling global dispersal and potential genetic connectivity of broadcast spawning corals: Implications for the biogeography and long term fate of coral reefs	Sally Wood	University of Bristol
14:45 - 15:00	Developed census based methods to assess reef carbonate production states: implications for ecological change monitoring	Chris Perry	University of Exeter
15:00 - 15:15	Ciliate and bacterial communities associated with White Syndrome and Brown Band Disease in reef building corals	Michael Sweet	University of Newcastle
15:15 - 15:20	Are coral chromoproteins photoprotective?	Ed Smith	University of Southampton
15:20 - 15:25	Interactions between a reef-building coral and its hydroid symbiont <i>Zanclaea margaritae</i>	Olga Pantos	University of Queensland
15:25 - 15:40	Panel discussion session	<i>All session speakers</i>	
<b>Total Session Time 85mins</b>			
15:40 - 16:10	<b>Tea and Coffee break</b>		
<b>Session 4: Ecology</b>		<b>Chair: Heather Koldewey</b>	
16:10 - 16:25	Punk reefs: the loud and spiky one make the best homes	Julius Piercy	University of Essex
16:25 - 16:40	The Mingulay reef complex: approaching a decade of research into the ecology of Scotland's only known inshore cold-water coral reef	Murray Roberts	Heriot-Watt University
16:40 - 16:55	The use of trait-based indices in coral reef ecology: an initial exploration	Elizabeth Widman	University of Warwick
16:55 - 17:10	Boat Noise and Ambient Noise Affects Directional Swimming Behaviour and Recruitment in Larval Reef Fish	Sophie Holles	University of Bristol
17:10 - 17:15	The use of Stereo-Video monitoring to compare reef fish communities between three marine biogeographical regions	Alison Curtis	Operation Wallacea
17:15 - 17:20	The parasitic flatworm <i>Amakusaplana acroporae</i> – A global threat to coral reefs?	Ben Hume	University of Southampton
17:20 - 17:35	Panel discussion session	<i>All session speakers</i>	
<b>Total Session Time 85mins</b>			
17:35 - 20:00	<b>Conclusions and drinks reception in the aquarium</b>		
<b>Poster Session</b>			
	Effects of <i>Diadema</i> antillarum abundance on algal community structure and coral disease prevalence in St. Lucia, West Indies	Abigail Leadbeater	Newcastle University
	Marine Protected Areas (MPAs): Where Biology meets Society	Angelie Nellas	Project Seahorse Foundation for Marine Conservation Inc.
	Arabian Gulf corals – Models for potential thermal adaptation	Ben Hume	University of Southampton
	Stereo-Video Systems to monitor reef fish communities	Dominic Andradi-Brown	Imperial College London

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**Poster Session continued**

Improving management effectiveness of the marine reserves of Rodrigues (western Indian Ocean)	Emily Hardman	Consultant (Marine Ecology)
Characteristics of macrofauna in a severely damaged temperate reef	Graham Epstein	
Feeding Plasticity of Reef	Jocelyn Curtis-Quick	University of Essex
Environmentally-regulated genes as basis for coral reef resilience	Joerg Wiedenmann	University of Southampton
Five years of CoralloSphere: E-taxonomy for extinct and extant scleractinian genera.	Kenneth Johnson	Natural History Museum
THROUGHFLOW project: Origins of the marine biodiversity hotspot in South East Asia – The reef-coral and bryozoan component	Nadiezhdha Santodomingo	Natural History Museum
Composition and analysis of the shark fishery in Peru.	Phil Doherty	University of Exeter
Interdit D'Interdire – Identification Of Pitfalls In Development Of Community Management For Shark Fisheries Of Northern Madagascar	Rebecca Short	Imperial College London
Studying the impacts of ocean acidification and warming on the cold water coral <i>Lophelia pertusa</i>	Seb Hennige	Heriot-Watt University



**Reef  
Conservation UK**

**ORAL PRESENTATIONS**

## White Syndrome: an unmanageable threat to coral reefs?

J. C. Bythell<sup>1</sup>, O. Pantos<sup>2</sup>, M. J. Sweet<sup>1</sup>

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White syndrome (WS) is a collective term used in the Indo-Pacific to describe a suite of several possible diseases and syndromes that result in a white lesion (clean, exposed skeleton) with a sharp, relatively straight boundary between it and the adjacent, apparently healthy tissues. Visibly and microscopically there is no obvious tissue necrosis and no microbial mass at the lesion interface. In the Caribbean, the collective term is rarely used, but the specific syndromes white plague and white band disease are common examples of white syndromes. These two diseases have already caused a massive and long-lasting mortality of the once-dominant *Acropora* spp., and now threaten *Montastrea*-dominated reef communities in the Caribbean. WS outbreaks have occurred throughout the Indo-Pacific in the last decade and WS is by far the most common coral disease on the GBR for example, having first broken out following the 2002 bleaching event. Here we document the occurrence of WS in the relatively pristine islands of New Georgia, Solomon Islands (2011) and show that it is also overwhelmingly the dominant coral disease in these islands, preferentially affecting *Acropora*, *Pocillopora* and *Stylophora* species. WS was host coral density dependent, showing the characteristics of a transmissible disease, but it occurs at higher prevalence rates in areas with better water quality (offshore and away from sources of land run-off). There was no significant difference in disease rates inside and outside of marine protected areas ( $n = 10$ ), with highest rates recorded in a pristine offshore MPA (Tetepare marine reserve), due to the greater population densities of the more susceptible species in these environments. Although disease prevalence rates were low overall (mean 0.8%), since the disease is typically fatal and shows high progression rates (ca.  $0.5\text{-}1\text{ cm.d}^{-1}$ ), this represents a considerable threat to these susceptible populations that are typical of offshore environments. The lack of any MPA effects indicates that we currently have no means to control the disease and it is highly likely that community shifts to more resistant genera will occur across the Indo-Pacific.

## **The use of Stereo-Video monitoring to compare reef fish communities between three marine biogeographical regions**

A.L Curtis, D. J. Smith, C. Delacy, D. A. Exton

Operation Wallacea, Wallacea House, Old Bolingbroke, Lincolnshire, PE23 4EX

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Traditionally, underwater visual census (UVC) programs have been proposed as a cost effective method to gather important data on reef fish communities. Recently, new developments in technology are resulting in an increase in the use of stereo-video techniques (SVS) as a potentially more robust method of performing underwater fish abundance surveys. However, few studies have directly compared SVS techniques with UVC in terms of their estimates of environmental variables, or reviewed the benefits, drawbacks, and suitability of each method in assessing those variables. Long-term reef monitoring programmes have been established at four research sites (Cuba, Honduras, Indonesia and Mozambique) for the past 5-10 years, assessing by UVC the changes amongst reef fish communities. Following a project trial in the Ponta do Ouro area of Mozambique, this was replaced by a twin video SVS system developed by the University of Western Australia, and this technique is now in use in three key coral regions (Indo-Pacific, Caribbean, Indian Ocean). Stereo-video surveys were subsequently conducted within the Ponta Frances National Park, Cayos Cochinos Marine Protected Area and the Wakatobi Marine National Park as part of an Operation Wallacea funded project. Specialised image-compilation software enabled species identification and fork lengths to be measured precisely. Teams of divers across the sites followed identical techniques to aid in data collection and spent considerable amounts of time contributing to the initial data analysis in the on-site laboratories. Given the scale of this project, data is still under analysis with aspirations to investigate further into the complexity of reef fish communities and the differences between them geographically. Based on the preliminary data collection using this novel method, further applications of the technique are discussed, as are advantages of including such a method within long term monitoring programs, with the aim to highlight the potential future importance of SVS.

## **Moving towards sustainability in subsistence fisheries of the Wakatobi Marine National Park, Indonesia**

D. A. Exton<sup>1</sup>, P. Simonin, J. Rice, T. Coles, D. J. Smith

<sup>1</sup>Operation Wallacea, Wallacea House, Old Bolingbroke, Lincolnshire, PE23 4EX

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Coral reef fisheries provide a protein source to millions of people throughout the tropics. However, overfishing is severely threatening the future of these productive fish communities, with implications for the survival of coral reef ecosystems in general. This has made the sustainable management of reef fisheries a priority for natural resource managers, yet the unique nature of subsistence fishing in the developing world has made success particularly difficult. This five year project took place in the well-studied Kaledupan district of the Wakatobi Marine National Park, Indonesia, and aimed to develop and implement a community-led, and ultimately self-sustaining, management programme. This was achieved through (1) the establishment of an island wide catch monitoring programme conducted by locally trained fisheries monitors, and run in conjunction with annual underwater visual census surveys of nearby reef communities; (2) the development of semi-closed access to replace the existing open access 'Olympic' system in the fishery through a boat registration scheme; (3) the creation of village level fisheries focus groups to raise awareness of the ecological impact of overfishing, and the democratic election of village representatives responsible for communication to and from stakeholders; (4) the formation of a Kaledupan Fisheries Forum comprising all village representatives as well as members of regional government and NGOs, tasked with developing the management strategy; (5) the identification and development of alternative income streams in the form of community-based ecotourism and a scheme for increasing prices for existing products. The long term legacy of this project remains to be seen, and monitoring and adaptation of the management programme will be required for the foreseeable future, but the success of this project to date, in terms of both management outcomes and the level of support from all stakeholder groups, could provide a model management 'package' to be implemented throughout Indonesia and beyond.

## Developing the next generation of coral conservationists: An EDGE approach

C. Head, D. Curnick, C. Waterman, R. Jones, H. Koldewey

Conservation Department, Zoological Society of London (ZSL), United Kingdom

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The EDGE of Existence conservation programme is based on a novel index that prioritises threatened species that represent high levels of evolutionary history within their taxa. Ten top priority Evolutionarily Distinct and Globally Endangered (EDGE) hard coral (order: Scleractinia) species were identified through an international workshop, based on the best available phylogenetic information and expert opinion. Three of these top priority species inhabit the coral triangle region; (*Heliofungia actiniformis*, *Physogyra lichtensteini*, and *Catalaphyllia jardinei*) where earlier this year the EDGE coral reef project ran an intensive 3-week training course for early-career Filipino, Indonesian, and Malaysian nationals. The course aimed to increase marine conservation capacity and build a network of young conservationists in the region by focusing on coral reef research and conservation management skills. ZSL are now continuing to support and mentor a selection of the course trainees, through the EDGE Fellowship programme, to carry out conservation research and implement conservation actions for the EDGE corals of the region.

In the Caribbean region the project has recently undertaken reef assessments in the Grenadine islands, at the invitation of the National Trust of St Vincent & Grenadine Islands, to provide baseline data and management recommendations for the islands' coastal waters. Small populations of three top priority EDGE coral species (*Dendrogyra cylindrus*, *Acropora palmata*, and *Dichocoenia stokesii*) were observed. ZSL are now working with the National Trust to improve management of these waters including protection measures for these EDGE coral colonies.

The novel EDGE species-based approach to coral reef conservation is fundamentally driven by the urgent need to mitigate the devastating impact of accelerated climate change on coral reefs by conserving long evolutionary lineages and genetic diversity.

## Acclimation of the cold water coral *Lophelia pertusa* to predicted rises in atmospheric CO<sub>2</sub> and sea temperatures

S. J. Hennige<sup>1</sup>, L. C. Wicks<sup>1</sup>, N. K. Kamenos<sup>2</sup>, J. M. Roberts<sup>1</sup>

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Cold-water corals are amongst the most three-dimensionally complex deep-sea habitats known and are associated with high local biodiversity. Despite their importance, little is known about how these organisms will fare in the face of predicted future climate change in terms of their eco-physiology and functionality. Projected rises in atmospheric  $p\text{CO}_2$  will reduce the oceanic pH and the availability of carbonate ions, and increased sea temperatures may perturb cold-water coral systems beyond their thermal limits. Currently, the long-term synergistic effects of projected increases in atmospheric  $p\text{CO}_2$  and sea temperatures upon the cold-water coral *Lophelia pertusa* are unknown. Here, we present data on the effects of increased sea temperatures (by 3°C) and increased  $p\text{CO}_2$ , (750 ppm) upon the metabolism and growth of the cold-water coral *Lophelia pertusa*, collected from the Mingulay Reef Complex, Scotland, UK. This data will help define the impact of ocean acidification and increased temperatures upon the growth, physiology and structural integrity of these reef framework-forming corals.

## **Breaking or Following the Fishing Rules and Regulations: Motivations, Benefits and Incentives for Kia Islanders, Fiji**

L. Hepworth

University of Brighton

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Although illegal fishing is prevalent, few studies have attempted to understand people's motives behind it. This study investigates motives for breaking the fishing conservation rules and regulations, as well as researching incentives for following them.

This study takes place on Kia Island, Fiji where the community is heavily dependent on its fishing grounds for their livelihood and hope to benefit from the establishment of a Marine Protected Area (MPA). Illegal fishing has become a major problem in this area, threatening these livelihoods.

Methods included, surveys with householders and semi-structured interviews with experienced fishers to empathise and understand people's needs to break the rules. A participatory approach was taken to ensure that those being studied also learnt from the experience.

Results found that people's motivations for breaking the rules fell under three main themes; 'Economic'; 'Monitoring and enforcement'; and 'Social and cultural aspects'.

The primary motive for illegal fishing was found to be economic, with a lack of education and awareness exacerbating the problem. It was found that some were desperate for money due to the high cost of living. This was found to be a national problem following coops and a flood, which have left the country in economic decline. To make up for this shortfall, some fishers break the rules and regulations as these methods bring in more money than legal ones. Inadequate enforcement of the fishing grounds and MPAs by authorities, NGOs and Fish Wardens allows these practices to continue. Low education levels and few workshops contribute to the lack of conservation knowledge.

This primary motive is consistent with previous studies, however disparities were found between the secondary and underlying motives. Underlying motives for illegal fishing should not be assumed, as they are based on many different factors and will therefore, be different in each case.

## **Interactions between fishing and seaweed farming in the central Philippines: network analysis of occupational diversity and patterns of dependence in household livelihood portfolios.**

N. Hill<sup>1,2</sup>, M. Rowcliffe<sup>1</sup>, H. Koldewey<sup>3</sup>, E. J. Milner-Gulland<sup>2</sup>

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Livelihood-based interventions such as the development of alternative occupations are increasingly promoted to help reduce fishing pressure on coral reefs. However, there is very little understanding of how alternative occupations interact within household livelihood portfolios. We used network analysis tools to examine the perceived importances of and interactions between all occupations engaged in by 300 households from 10 villages in Danajon Bank, central Philippines, with a specific focus on the interactions between fishing and seaweed farming. Networks were defined in terms of the aggregate number of households engaged in each occupation and the aggregate income from each occupation. These networks were used to examine the dependence of households on their perceived primary occupations in terms of the number of secondary occupations and the relative amount of income from secondary occupations. Households were aggregated by wealth quartile to examine patterns across wealth groups. Linear mixed effects models were then used to examine how household-level fishing income correlated with household socioeconomic variables and the structure of their livelihood portfolio. The wealthiest quartile had the greatest fishing income, but the lowest occupational and income dependence on fishing, and few primary seaweed farmers in the wealthiest quartile also engaged in fishing. For the remaining wealth quartiles, fishing remained a relatively important occupation, even for primary seaweed farmers. The mixed-effects models indicate that seaweed farming should be promoted so that households perceive it as their primary occupation if resource managers hope to use it to substitute for fishing. However, it is difficult to predict when households are most likely to perceive seaweed farming as their primary occupation. This study contributes to a broader understanding of the interaction between wealth and the availability of alternative occupations in determining the structure and diversity of livelihood portfolios, and hence household resilience in the face of resource scarcity.

## Boat noise and ambient noise affects directional swimming behaviour and recruitment in larval reef fish

S. Holles, A. Radford, L. Berten, D. Lecchini, S. Simpson

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Biotic and abiotic sounds alert animals to the presence of danger, food, conspecifics and suitable habitat, thus anthropogenic noise has the potential to disrupt vital life processes. Larval coral reef fish use reef sound as an orientation cue during recruitment from the open ocean, and anthropogenic noise could be threatening this crucial life-history stage. We investigated the effect of boat noise on directional swimming behaviour of settlement-stage coral reef fish by exposing 155 Cardinalfish (*Apogon sp.* and *Gymnapogon urospilotus*) to combinations of reef and boat noise in binary choice chambers, using ocean and white noise as control treatments. *Apogon sp.* showed a positive response towards reef noise, boat noise and reef combined with boat noise, but showed no preference for ocean or white noise. *G. urospilotus* showed no preference for reef, ocean, white or boat noise, but when reef and boat noise were combined they responded adversely. Our results suggest that *Apogon sp.* may continue to recruit to reefs that are noisy with boat traffic, but they may also be attracted to boats in the open ocean and never reach reef habitat. Conversely, *G. urospilotus* may be frightened away from coral reefs that are noisy with boat traffic. Boat noise can therefore affect directional swimming behaviour in coral reef fish at a life-history stage which is critical for the location of suitable habitat and future survival, though not all species respond in the same way. We suggest that anthropogenic noise has the potential to change community structure by affecting recruitment.

## Modeling the economic benefits of temporary octopus fisheries closures

K.L.L. Oleson<sup>1,2\*</sup>, T. A. Oliver<sup>1,3\*</sup>, H. Ratsimbazafy<sup>1</sup>, D. Raberinary<sup>1</sup>, S. Benbow<sup>1</sup>, A. Harris<sup>1</sup>, F. Humber<sup>1</sup>

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A local fisheries management model employing short-term, rotating fisheries closures is proliferating across coastal east Africa and Indian Ocean islands. Under the working hypothesis that it will increase landings and incomes, NGOs, international finance institutions, and government agencies are promoting the management technique, targeted at rapidly growing species such as octopus and crabs, as a potential conservation and poverty alleviation tool for artisanal fishing communities. In southwest Madagascar alone, over 100 such closures have been implemented in the octopus fishery, which targets a very rapidly growing species and generates a large portion of the total cash flow coming into local villages. To-date, no study has analysed the closures' effects on fisher incomes. This study sets up a rigorous economic impact assessment method, which can be used by managers to help design similar management efforts. Over 250,000 data points gathered over 8 years to investigate the economic effects of fisheries closures in a Locally Managed Marine Area in Madagascar. First, we examine village-scale octopus fishery-generated income before, during, and after closures. On average, the 12 villages who sponsored the 37 closure events did not see a significant decline in revenues during the closure periods relative to the two months before ( $p = \text{NS}$ ), and showed significantly higher revenues post-closure than either the before or during periods ( $p < 0.001$ ). We also assessed whether each particular closed site was a profitable investment, excluding revenue generated from other sites. Of the 37 closures, 28 were profitable and 9 were unprofitable under this stricter investment model. By proving, for the first time in the Indian Ocean region, the economic returns to fishers of sustainable fisheries management, this study forms the initial step to build an evidence base for negotiating sustainable finance mechanisms for the long-term continuation and expansion of marine conservation in the region.

\*co-primary authors

## The parasitic flatworm *Amakusaplana acroporae* – A global threat to coral reefs?

B. Hume, C. D'Angelo, E. Smith, J. Wiedenmann

National Oceanography Centre Southampton, University of Southampton, UK

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Introduction of exotic species can be a major cause of biodiversity loss. The corallivorous, ectoparasitic flatworm *Amakusaplana acroporae* can rapidly damage and destroy corals in the genus *Acropora* and is quickly becoming established globally within the cultured coral industry. As such, *A. acroporae* currently poses a large threat to unprotected reef environments through accidental or inconsiderate introductions. Until now, formal reports of *A. acroporae* have been confined to several cultured *Acropora* populations in the U.S.A., however, through sequencing of the 28S rDNA from specimens collected at the National Oceanography Centre, Southampton tropical aquarium we demonstrate the global distribution of *A. acroporae*. In addition, a collation of hobbyist literature pertaining to *A. acroporae* further demonstrates the global integration of *A. acroporae* in the hobbyist industry, most critically, in areas of close proximity to natural reef systems such as Florida, Hong Kong and Thailand. Commensalistic incorporation of the host endosymbiotic dinoflagellate algae (*Symbiodinium* spp.) by *A. acroporae*, as demonstrated by sequencing of the ITS1-5.8s-ITS2 region of host rDNA, endows the flatworm with cryptic camouflage specific to its host. Fluorometric analysis of the maximum quantum efficiency of Photosystem II (Fv/Fm) demonstrated that *Symbiodinium* maintained in the branched gut of *A. acroporae* were photosynthetically active, however, death of the flatworm within 5-7 days of isolation from host corals would suggest no major nutritional benefit is gained from the photosynthetic abilities of the incorporated *Symbiodinium*. In addition, quantitative phylogenetic analysis of the *Symbiodinium* C-subclades in host and parasite identified selective retention/survival of *Symbiodinium* within *A. acroporae*.

## Balancing the carbonate budget: maintenance of positive framework growth in the Caribbean requires local and global action

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Coral reef framework displays substantial architectural complexity, which is positively associated with high levels of biodiversity and other ecosystem services, such as sand production and coastal protection. Framework complexity is maintained by a balance between carbonate accretionary (e.g., calcifier production) and erosional forces acting at the reef surface (e.g., grazers, hurricane damage) and internally (e.g., micro- and macroborers). Ecosystem changes, both in the recent past (e.g., loss of *Diadema*, depleted coral cover) and future (e.g., ocean acidification, temperature change) may disrupt this balance. This can result in a negative carbonate budget, where erosion exceeds accretion and important reef structure is lost – something that is currently being seen across the Caribbean, with reefs becoming flatter. Due to their cryptic nature, bioeroders have been traditionally under-represented in the literature in comparison to primary CaCO<sub>3</sub> production, despite their importance in contributing to biodiversity, sediment production, cavity production, nutrient cycling, contribution to the food web and modification of framework growth. Here we model the carbonate budget of a Caribbean reef, taking into account both bioerosion and accretion, to assess the impacts of ecosystem change on the reef framework. We demonstrate that Caribbean reefs have been influenced by recent past events occurring on ecological timescales. We identify the factors important in driving reef budgets, and highlight how they have changed over the past fifty years, with bioerosion-associated factors now playing a more important role in determining budgetary state. We then use the latest climate forecasts to drive our model into the future, using ‘business as usual’ and ‘best case’ scenarios to explore the impact of mitigating global greenhouse gas emissions and taking local conservation action on future Caribbean reef budgets. We find that both local and global action is needed to achieve a positive carbonate budget which has important consequences for policy.

## **Anthropogenic aerosol emissions drive variations in Caribbean coral growth**

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Coral growth rates are highly dependent on environmental variables such as sea surface temperatures and solar irradiance. Multi-decadal variability in coral growth rates has been documented throughout the Caribbean for the last 150- 200 years. Recent global climate model evidence strongly suggests that multi-decadal variability in sea surface temperatures of the North Atlantic is a consequence of anthropogenic aerosol forcing. Given that we now believe we understand, and can recreate in the context of a model, multidecadal North Atlantic SST variability, we can both attribute past changes in coral growth to human activity, and explore model and observed data in parallel to identify the drivers of past changes in coral growth. With an understanding of past changes in coral growth, and historical validation of the climate model's behaviour, we can then make projections about how coral growth may change into the future. Our projections across a range of potential future climate pathways show that aerosols can decouple the relationship between a specific pathway's global radiative forcing and coral growth. Excluding the impact of extreme mass bleaching events, our findings indicate the key driver of observed multi-decadal coral growth rates in the Caribbean to date, is not ocean acidification or climate change due to greenhouse gases but regional climate change due to anthropogenic aerosol emissions.

## Marine Protected Areas (MPAs): Where Biology meets Society

A. C. Nellas

Project Seahorse Foundation for Marine Conservation Inc.

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A summary of the importance and key messages of three research studies conducted in the double barrier reef of Central Philippines. Each study, relates the importance of social and ecological information in locating, creating or establishing Marine Protected Areas (MPAs), and how these translate into conservation values .

***Hansen et.al. 2011. Hindsight in marine protected area selection: a comparison of ecological representation arising from opportunistic and systematic approaches.***

Systematic approaches to site selection for marine protected areas (MPAs) are often favoured over opportunistic approaches as a means to meet conservation objectives efficiently. In this study, we compared analytically the conservation value of these two approaches. We locate this study in Danajon Bank, central Philippines, where many MPAs were established opportunistically based on community preference, with few if any contributions from biophysical data. We began by identifying the biophysical data that would have been available when the first MPA was created in Danajon Bank (1995). We next used these data with the reserve selection software Marxan to identify MPAs that covered the same area as is protected under the current set of MPAs (0.32% of the total study area) and that would protect the greatest number of conservation targets at the lowest cost. We finally compared the conservation value of the current MPAs to the value of those selected by Marxan. Because of the dearth of biophysical data available in 1995 and the small area currently under protection, Marxan identified multiple configurations of MPAs that would protect the same percentage of conservation targets, with little differentiation among sites. Further, we discovered that the costs of obtaining and analyzing these data to be used for conservation planning would have been large relative to resources typically available to conservation planners in developing countries. Finally, we found that the current set of MPAs protected more ecological features than would be expected by chance, although not as many as could be protected using a systematic approach. Our results suggest that an opportunistic approach can be a valuable component of conservation planning, especially when biophysical data are sparse and community acceptance is a critical factor affecting the success of an MPA.

***Ban et.al. 2009, Systematic marine conservation planning in data-poor regions: socioeconomic data is essential.***

Systematic planning for conservation is highly regarded but relies on spatially explicit data that are lacking in many areas of conservation concern. The decision support tool Marxan is applied to a reef system in the central Philippines where 30 marine protected areas (MPAs) have been established in communities without much use of biophysical data. The intent was to explore how Marxan might assist with the legally required expansion to protect 15% of marine waters, and how existing MPAs might affect that process. Results show that biophysical information alone did not provide much guidance in identifying patterns of conservation importance in areas where the data are poor. Socioeconomic data were needed to distinguish among possible areas for protection; but here, as elsewhere in marine environments, the availability of such data was very limited. In the final analysis, local knowledge and integrated understanding of socioeconomic realities may offer the best spatially explicit information. The 30 existing MPAs, which encompassed a small proportion of the reef system, did not limit future options in developing a suite of MPAs on a broader scale. Rather, they appeared to generate the support for MPAs that is obligatory for any larger zoning effort. In summary,

establishing MPAs based on community-driven criteria has biological and social value, but efforts should be made to collect ecological and socioeconomic data to guide the continued creation of MPAs.

***Yasue et.al. 2009. Assessing ecological changes in and around marine reserves using community perceptions and biological surveys.***

1. Well-enforced partial or total no-fishing zones (collectively known as marine protected areas, or MPAs) can help restore degraded coral reefs and enhance fish populations.
2. A comparison was made of community perceptions of ecological changes in an MPA with concurrent scientific data on these changes in the same MPA. Such analyses are particularly important in community-based MPAs where local support is a key determinant of ecological success.
3. The no-take MPA in question was initially launched in partnership with the community in 1995 and formalized in 1998. The perceptions data come from interviews with community members in 1999 and 2004, the biological data come from underwater visual censuses of the MPA from 1998 to 2004.
4. Community members perceived more fish within the MPA and slight increases in catch outside the MPA. In contrast, fish censuses showed a high degree of stochastic variation and only minor increases in fish abundance, size and diversity in and around the MPA between 1998 and 2004.
5. Possible explanations for these discrepancies include different temporal, spatial or species frames of reference and/or limitations to the biological survey technique. Other options include wishful thinking, external influences, a desire to please, or confounding with other benefits.
6. This study demonstrates some of the strengths and weaknesses of community perceptions and biological data. In order to improve our understanding about the changes that occur over time in an MPA and engender community support for the long-term viability of MPAs, it is important to develop diverse and efficient monitoring schemes

## Interactions between a reef-building coral and its hydroid symbiont *Zanclaea margaritae*

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Hydroids form symbiotic relationships with a range of invertebrate hosts. Where they live with colonial invertebrates such as corals or bryozoans it has been hypothesized that the hydroids may benefit from physical support and protection from the host as well as nutritionally. However, relatively little is known about the interactions that occur between hydroids and their colonial hosts. This study investigates the physical interactions between the soft tissues of the two partners, how the coral skeleton is utilized by both, and how two fast-growing colonial cnidaria are able to coexist so intimately whilst avoiding being overgrown and smothered. Electron microscopy was used to investigate the physical interactions between the colonial hydroid *Zanclaea margaritae* and its reef-building coral host *Acropora muricata*. The hydroid tissues extend below the coral tissue surface sitting in direct contact with the host's skeleton. Desmocytes located within the epidermal layer of the hydroid's perisarc-free hydrorhizae fasten it to the coral skeleton. The large apical surface area of the desmocyte and high bifurcation of the distal end within the mesoglea, as well as the clustering of desmocytes suggests that a very strong attachment occurs between the hydroid and the coral skeleton. The close proximity of coral and hydroid tissues, suggest that metabolic exchange may occur. This is the first study to provide a detailed description of how symbiotic hydroids interact with their scleractinian coral hosts, and how they are able to attach to their host's skeleton, utilising it for physical support. Results suggest that the loss of perisarc, a characteristic commonly associated with symbiosis, allows the hydroid to utilise desmocytes for attachment to the host skeleton. The use of these anchoring structures provides a dynamic method of attachment, facilitating detachment from the coral skeleton during extension, thereby avoiding overgrowth and smothering enabling the hydroid to remain within the host colony for prolonged periods of time.

## Developed census based methods to assess reef carbonate production states: implications for ecological change monitoring

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Anthropogenic and environmental factors are driving major ecological transitions on coral reefs, with the impacts of these changes on the natural functioning and resilience of reefs receiving widespread attention. In contrast, our understanding of the implications for reefs as focal points for carbonate production and accumulation remains more limited, despite the critical role in creating and maintaining reef habitat type and reef architectural complexity. Here we describe a new, 'rapid' census-based methodology, termed *ReefBudget*, which has been developed to allow assessments of reef carbonate budget states. The methodology integrates detailed benthic and habitat surveys with published production and erosion rate data. Field testing of the methodology around Bonaire, southern Caribbean, investigated sites that differed in terms of coral cover, reef development and reef architectural complexity. Net rates of carbonate production ranged from +9.46 to -0.80 kg CaCO<sub>3</sub>.m<sup>-2</sup>.yr<sup>-1</sup>. Corals were the dominant carbonate producers and parrotfish the dominant substrate eroders at all sites, but most carbonate production and erosion was driven by just a few key species. Modelled scenarios of ecological change applied to our field-derived data, indicate that ecological changes comparable to those observed on many Caribbean reefs would move most of the reefs into states of net erosion or budgetary stasis. The *ReefBudget* methodology has great potential as a tool for assessing and monitoring reef carbonate production status at a range of time and spatial scales, and because of the rationale underpinning the methodology, to be integrated into reef management programmes to produce quantitative measures of reef condition and structural resilience.

## **Punk reefs: the loud and spiky one make the best homes**

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Fish and crustacean larvae use sounds of reefs to locate and navigate towards them after a development period spent in the pelagic environment. The importance of this behaviour in determining dispersal and settlement in larvae depends greatly on the distance from which they can detect reef noise, which, in turn, depends on the nature and intensity of the sound source, the propagation of sound in an underwater environment and the hearing abilities of the larvae.

Using recordings from seaward transects away from reefs in Oman and Indonesia we tested the robustness of current models, including our own, in explaining reef noise propagation. We then made predictions of sound propagation from reefs of different quality using recordings from five different sites in the Philippines. We also examined sound richness (spikiness) in an attempt to set the ground for studies on how fish distinguish between close but bad quality reefs and distant but good quality ones. Our findings suggest sounds from bad quality reefs are likely to be below the hearing threshold of many fish larvae even directly over the reef. Poor quality reefs also have lower sound richness which may allow the larvae that are able to hear the reefs to distinguish between different quality habitats through integration of the information with sound level, possibly resulting in active rejection of a poor quality site. This leads to fascinating new speculations over the way the larvae process acoustic information, including a) through what sensory/neurological processing do larvae distinguish between a close but bad quality reef and a distant but good quality one?, and b) which reefs are larvae more likely to choose: the closest or the healthiest?

Our findings may have important implications for fish and crustacean population dynamics through reduced likelihood of degraded reefs attracting new recruits. This effect is exacerbated in areas of high shipping activity where noise pollution could further mask these already quiet reefs, thus adding to the increasing list of adverse anthropogenic effects on coral reef ecosystems. We suggest that playbacks of healthy reef noise may serve as a potential management tool by increasing recruitment to degraded reefs through the addition of acoustic richness and intensity to the reef noise.

**The Mingulay reef complex: approaching a decade of research  
into the ecology of Scotland's only known inshore cold-water coral reef**

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Cold-water framework-forming corals can form appreciable deep-water biogenic reefs that persist for millennia and provide habitat for highly diverse animal communities. This talk will review interdisciplinary study of one such reef complex formed by *Lophelia pertusa* in the northeast Atlantic Ocean. The Mingulay reef complex was first mapped using multibeam echosounder in 2003 with further mapping in 2006 revealing previously unknown live reef areas. Habitat characterisation with seabed video confirmed distinctive mounded bathymetry was formed by reefs of *L. pertusa* with surficial coral debris dated to almost 4000 years BP. Benthic lander and mooring deployments revealed two dominant food supply mechanisms to the reefs, a regular rapid downwelling of surface water delivering pulses of warm fluorescent water and periodic advection of high turbidity bottom waters. Closed chamber respirometry studies suggest *L. pertusa* may respond to periodic seawater warming with rapid increases in metabolic rate. By integrating information from geophysical surveys of the seabed with the hydrographic surveys of the water column we have been able to examine the factors important in determining the occurrence of attached epifaunal species across the Mingulay reef complex and how these may be used to explain beta turnover (species turnover) in cold-water coral habitats. This analysis supports environmentally deterministic (niche) over random stochastic (neutral) processes as important in controlling beta diversity. Future studies to record Holocene reef development at Mingulay from vibro-cores collected through the reef mounds are now underway and the Mingulay coral reefs are currently being considered as a future Special Area of Conservation.

## **Are coral chromoproteins photoprotective?**

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Coral chromoproteins (CPs) are responsible for the vivid purple, pink and blue pigmentation in corals and other reef anthozoans. These pigment proteins are typically found in shallow water corals where the pigmentation is usually uniformly distributed or isolated to the tips and growth margins. While the biochemistry of these proteins is well understood, their function in corals is unclear. In common with their fluorescent counterparts, the fluorescent proteins (FPs), a photoprotective function has been proposed for coral CPs. These proteins are proposed to reduce the light stress on the coral's algal symbionts by absorbing light that would otherwise be potentially damaging to the photosynthetic machinery. Nevertheless, the photoprotective function remains hotly contested due to the lack of evidence for the direct alteration of the symbionts' photosynthetic efficiency by these proteins. To assess the proposed photoprotective function in chromoproteins, we conducted a study to address the effects of CP absorption on the coral's internal light field and its impacts on the symbionts' photosynthetic parameters using a combination of spectroscopic and physiological analyses. Our results clearly demonstrate photoprotective behaviour at wavelengths specific to the absorption characteristics of the proteins. We will discuss our results with reference to the spectral suitability of CPs, presence of different colour morphs and localisation in regions of low symbiont densities in some morphs/species. This study provides a new insight into the role of colour diversity in corals and the role of the host in maintaining a successful symbiosis.

## Ciliate and bacterial communities associated with White Syndrome and Brown Band Disease in reef building corals

M. J. Sweet, J. C. Bythell

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Coral pathogens are routinely detected in healthy corals and to understand disease causation we must be able to distinguish between pathogens that are *capable* of causing damage and which may proliferate under stressful conditions, those that are directly involved in a specific pathogenesis and heterotrophs that colonise dead and decaying tissues following disease. As a first step to understanding the common Indo-Pacific coral diseases White Syndrome (WS) and Brown Band Disease (BrB) we applied culture-independent molecular techniques to describe both ciliate (18S rRNA gene) and bacterial (16S rRNA gene) communities. The community profiles were highly similar between the two diseases. Four bacterial and nine ciliate ribotypes were observed in both diseases but absent in non-diseased specimens. Only one of the bacteria, *Arcobacter* sp. (JF831360) increased substantially in relative 16S rRNA gene abundance and was consistently represented in all disease lesion samples. Four of the eleven ciliate morphotypes detected contained coral algal symbionts, indicative of the ingestion of coral tissues. In both WS and BrB, there were two ciliate morphotypes consistently represented in all disease lesion samples. Morph1 (JN626268) was observed to burrow into and underneath the coral tissues at the lesion boundary. Morph2 (JN626269), previously identified in BrB, appears to play a secondary, less invasive role in pathogenesis, but has a higher population density in BrB, giving rise to the visible brown band. The strong similarity in bacterial and ciliate community composition of these diseases suggests that they are actually the same syndrome and we recommend that they are synonymised.

## Can seagrass be used to offset coral reef acidification?

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Anthropogenic CO<sub>2</sub> emissions are rapidly increasing the dissolved inorganic carbon (DIC) content of the world's oceans and consequently altering the pH. This makes them less saturated in aragonite reducing the capacity of many organisms to build skeletal or shell material. This reduces the potential viability of many marine ecosystems such as coral reefs. Highly productive tropical seagrasses often live adjacent to or among coral reefs and utilize large amounts of inorganic carbon, potentially reversing this alteration of seawater carbonate chemistry. In the proposed talk, the effect of this productivity on seawater carbonate chemistry and coral calcification is assessed. A collation of published data (11 studies, 64 records) revealed that seagrass meadows in the Indo-Pacific have a 83% chance of being net autotrophic, resulting in a net sink of 155 gC m<sup>-2</sup> yr<sup>-1</sup>. The effects of this seagrass productivity on seawater chemistry was then modelled. Increases in pH of up to 0.38 units, and  $\Omega_{\text{arag}}$  of 2.9 are possible in the presence of seagrass meadows (compared to without), and the precise value of these increases depended on dilution (tidal flushing) and depth. Scleractinian coral calcification in the presence of seagrass could be 18% greater than without seagrass. This study demonstrates the importance of seagrass conservation for coral reef resilience.

## **Tobago's coral reefs in the melting pot of climate change - a 4-year monitoring study**

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Following scientific surveys of Tobago's reefs during the mass coral bleaching event that hit much of the Caribbean region in 2005, Coral Cay Conservation (CCC) was re-invited to the island in 2007 to gather detailed scientific baseline and monitoring data in support of a management plan. Working in partnership with the Tobago House of Assembly and local NGOs under the *Tobago Coastal Ecosystem Mapping Project (TCEMP)*, teams of trained CCC volunteers conducted 927 50-metre surveys between April 2007 and June 2010.

Surveys conducted at the same reef sites in 2005 and 2010 showed a significant decrease in coral cover from 22% to 10% at 7 metres depth and 25% to 14% at 12 metres depth. These results highlight the impact of the 2005 mass-bleaching event and resulting coral disease outbreaks.

In 2010, unusually warm sea surface water temperatures resulted in a second mass-bleaching event of similar severity. Reefs around Speyside in particular, suffered from high bleaching levels with some sites nearing 100% bleaching across all coral species. Barrel and tube sponges at reef sites around Speyside also suffered from the unusually warm sea surface temperatures and many of them 'melted' away in the heat. Speyside offers some of Tobago's most popular dive sites and remained largely unaffected during the 2005 mass-bleaching event. The fact that Speyside now too, has been hard-hit, raises serious concerns about the ability of Tobago's reefs to recover from the multitude of local, anthropogenic and regional, climate-change related threats.

Data gathered under this project is now being used to guide the establishment of a conservation management plan that seeks to secure the most resilient reef sites in the hope that these sites will facilitate the recovery of Tobago's reefs.

## **It works to accept marine reserves wherever we can get them**

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Our results suggest that it can be just fine to implement marine reserves without a lot of biophysical data.

We compare the conservation value of marine reserves on coral reefs, when (i) sites were selected based largely on community interest and (ii) when sites were selected using a technical approach. Our Project Seahorse team was instrumental in catalyzing the creation of 34 community-managed reserves (no-take zones) on Danajon Bank, a double barrier reef in the central Philippines. Most reserves were established opportunistically based on community preference, with few if any contributions from biophysical data.

We were curious about what might have been gained had we used scientific approaches to place the same total area of reserves. We first identified the biophysical data that would have been available when the first reserve was created on Danajon Bank (1995). We next used these data with the reserve selection software Marxan, to identify the areas that would protect the greatest number of conservation targets at the lowest cost. We finally compared the conservation value of the current reserves to the value of those that were selected by Marxan.

It turns out that the existing set of reserves (selected by communities) protected many more ecological features than would be expected by chance, even if not as many as might have been using a systematic approach. Moreover, the costs of taking the technical approach would have been problematic for many conservation agencies. Finally, a more systematic approach might not have generated the enthusiasm that led to a rapid multiplication of marine reserves. All in all, expedient placement of reserves can work well.

## **The importance of thermal history and light environment on regulating the environmental sensitivity of scleractinian corals**

S-J. E. Walsh, D. J. Smith, D. J. Suggett, P. Brading.

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Coral bleaching is has been the subject of turbulent debates in recent years. Scientists agree that these habitats are at risk, however dispute surrounds the primary mechanisms of coral bleaching and the drivers of differences between locations and species. Many studies have observed variation amongst temporal onset and bleaching severity, particularly across coral growth forms and those species inhabiting 'marginal' environments. However, these studies have failed to identify the affect of the environment on life history traits and consequently the impact of these on susceptibility. Here we concentrate on identifying the effects of growth history on physiological coral traits and assess whether these have any influence on bleaching susceptibility and severity. Recognizing this is the first step toward establishing which habitats and species are keystones within reef systems, driving productivity and potentially preserving biodiversity in times of environmental stress. Growth environments have previously been shown to impact upon skeletal characteristics including bulk density. We suggest that certain physiological traits may serve as indicators of historic growth environment and furthermore provide indicators of sensitivity to future predicted climatic changes.

## The use of trait-based indices in coral reef ecology: an initial exploration

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Indices of reef health reduce aspects of environmental complexity into numbers, which scientists and reef managers then use to make conservation decisions. Most commonly biodiversity indices are calculated using species numbers and relative abundances. It has been suggested that by shifting the focus from species present in a community to what the species present are contributing to ecosystem functioning may produce more useful indices for management decisions. While a number of studies have related coral traits to environmental conditions no studies to our knowledge have explored the application of indices based on life-history traits to coral reefs.

Here we give an example of how an index calculated using life history traits of corals (average functional distinctness  $X^+$ ) compares with an index calculated using coral species data alone (average taxonomic distinctness  $\Delta^+$ ) for 66 reefs in southwest Madagascar. The practicalities of implementing trait-based indices in reef research and management are briefly discussed.

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## Can local stakeholders choose effective and suitable sites for designation as marine protected areas?

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With anthropogenic impacts on the oceans rapidly increasing, quick and efficient development of marine conservation strategies is vital. To achieve this in cases where local community members know their environment intimately, local knowledge may be enough to identify suitable areas for protection without the need for intensive and expensive scientific studies. It is widely shown that marine resources can be better managed when local stakeholders are involved, and incorporating fisher's knowledge in the early stages can be an effective way to do this.

In Rodrigues, Mauritius, a network of Marine Protected Areas (MPAs) was suggested as a solution to the problem of declining fish and octopus catches. Candidate areas were identified by local fishers during a series of community consultations, including healthy reefs with abundant fish and coral, passes thought to be important for dispersal of fish, likely nursery grounds, and reefs that were badly degraded which fishers hoped would recover. Following this, in 2007 four reserves were proclaimed by the local government, totalling 24.3km<sup>2</sup>.

MPA networks should be designed to conserve biodiversity, support fisheries and provide other ecological services of value to people. This study therefore assessed the MPAs against published criteria for effective marine reserve networks. The aim was to determine their suitability for protection and thus whether local stakeholders can create a successful network without extensive scientific study. Ten criteria were assessed through surveys of the MPAs to evaluate benthic cover, abundance of hard corals, macro-invertebrate populations, fish, and presence of juveniles and endemics. Results indicate that the majority of criteria were met by the MPA network, and all were met if other types of protected area within the lagoon were taken into consideration. The study suggests that if scientific data is lacking, local ecological knowledge can be used to identify functional MPA networks.

## **Modelling global dispersal and potential genetic connectivity of broadcast spawning corals: Implications for the biogeography and long term fate of coral reefs**

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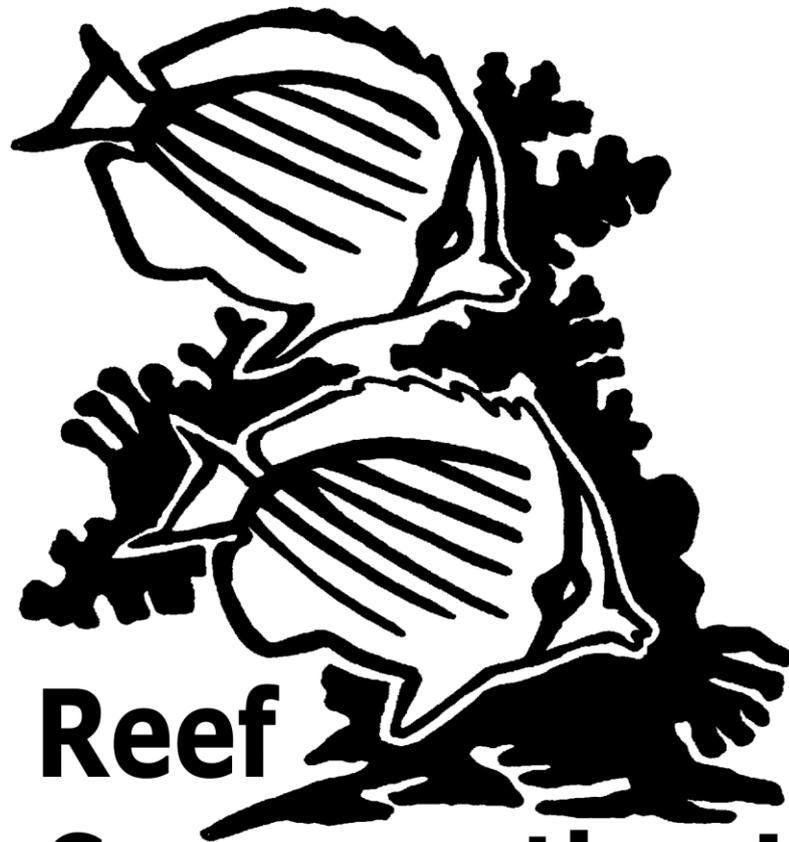
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Of the various factors controlling the distribution and ecology of coral reefs, dispersal of coral larvae by ocean currents may have particular significance to the future of reef ecosystems. Species range shifts, resilience to degradation via population replenishment and also adaptive potential via the flow of genetic material are all mediated by the dispersal and recruitment of individuals over various spatial and temporal scales. Over longer time periods, global genetic structure and species boundaries may be influenced by rare long-distance dispersal events. We aim to explore genetic connectivity between reef populations on scales appropriate to global environmental change, using a biophysical modelling approach.

Whilst previous models of global dispersal relating to coral biogeography have been idealised, we exploit recent advances in larval transport modelling, generally focusing on ecologically-relevant dispersal to regional scales, to develop a spatially explicit, global biophysical dispersal model for a generic broadcast spawning coral 'species'. Using the Connectivity Modelling System, a stochastic 'particle tracking' application coupled in this case to 1/12° resolution ocean current output from the global HYCOM model, and incorporating coral early life history traits and settlement habitat, we simulate the dispersal and potential connectivity of coral planulae over an 8 year spawning period (2003-2011). We explore whether this model is able to reproduce 'real world' patterns of connectivity as revealed by genetic analyses. We also discuss the potential applications of such a model in identifying vulnerable isolated locations as well as important source and stepping stone reefs for the maintenance of genetic diversity in corals over scales relevant to future rapid climate change.



**Reef  
Conservation UK**

**POSTER PRESENTATIONS**

## **Stereo-Video Systems to monitor reef fish communities**

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Diver operated stereo video systems (SVS) represent a major advance in baseline marine biodiversity assessments. Unlike traditional underwater visual census, they provide an easily standardised method for fish species identification and biomass monitoring, aiding reef fish community data comparisons from different survey teams across wide spatial and temporal scales. Stereo video systems in general provide increased accuracy and precision by; reducing risks of species misidentification, measuring fish length to within 5% error and imposing fixed boundaries on surveys.

Based on experiences from the Operation Wallacea Coral Reef Monitoring Programme; this methods poster provides an overview of some of the technical aspects and considerations of the twin SVS developed by the University of Western Australia as an assessment tool. The equipment requirements and physical system set up are considered, along with the process of in water camera calibration (utilising CAL software, calibration cubes and distance bars) and post dive video analysis using the EventMeasure software package.

## Are marine species more adaptable than we think?

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Marine ecosystems are complex networks of interactions between communities of species. By modelling the networks it is possible to predict how vulnerable communities are to changes, such as the loss of a key species. The degree to which a species can adapt its interactions within a community, termed *plasticity*, greatly increases its chance of survival, and the survival of the entire system, during periods of change. However our understanding of species interactions in the traditional literature is based on limited observations and a better estimation of plasticity could be achieved by processing more sources of information.

This research will use state-of-the-art text processing techniques to extract the data required to model these networks from existing sources of information about marine species, including traditional document collections and the Internet, and stored in a relational database as *tuples* e.g. eats(Nembrotha kubaryana, Sigillina signifera). Interactions will be evaluated by the confidence of correct classification and the credibility of the source, as well as providing full referencing. Once the data is in a structured form it can be queried to provide actionable knowledge.

We hypothesis that some species are more plastic than traditional literature would predict and that their presence in a changing ecosystem increases the resilience of the community as a whole. This can be answered, to some extent, by looking at the range of conditions a species can exist and the interactions it has within different communities. This, of course, would be an indicator that would require further robust research.

This research is not intended to undermine the conservation message but more to improve ecosystem modelling and focus on protecting systems vulnerable to collapse.

A demonstration of how the interactions of marine species can be visualised and explored is here: [http://www.jonchamberlain.com/marine\\_interaction.php](http://www.jonchamberlain.com/marine_interaction.php).

## Feeding Plasticity of Reef Fish

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Reef fish play important ecosystem functional roles, and the importance of one such role, herbivory, has been well documented. Assessments of reef health, vulnerability and resilience are mostly achieved by estimates of the total biomass held within specific functional guilds and the number of species that add to this biomass. The ability to assess functional biomass depends largely on our assignment of a species' fundamental niche. The species *Plectroglyphidodon lacrymatus* is conventionally classed as a territorial herbivore, and *Chaetodon baronessa* as an obligate *Acropora* corallivore. We hypothesised that the degree to which the species depend on herbivory and corallivory, respectively, varies across habitat quality gradients. Research was conducted on three reef sites of varying quality within the Wakatobi Marine Park, South East Sulawesi, Indonesia. *P. lacrymatus* switched to planktivorous feeding at two of the reefs. The expansion in the realised niche occurred on the same two reefs where higher frequencies and durations of inter/intra aggressive behaviours were recorded, territory volume was also significantly smaller and the abundance of competitors was higher. The results suggest that competition was the driver for niche expansion. Both behavioural and isotope data found *C. baronessa* fed on a broad range of coral genera on sites where *Acropora* was less abundant. Algal feeding also took place on sites with low coral cover. Therefore niche expansion for this species seemed to be driven by resource availability. Determining fish response to habitat change is the key to understanding reef resilience and the future management of reefs.

## Composition and analysis of the shark fishery in Peru

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Small scale fisheries are of vast importance and contribute one third of annual global catch, providing a vital protein source to approximately one billion people. With an increasing concern for the removal of sharks, driven by the vast demand for their meat and fins we aim to establish the impact of small scale fisheries on sharks in Peru. Onboard observers were used to document catch from 145 longline fishing trips originating from Ilo, a port in the south of Peru. Fishing effort is split between two seasons; one primarily targeting dolphinfish (Dec to Feb), the second primarily targeting sharks (Mar-Nov). Throughout this study 16 610 individual sharks were caught with a maximum catch per unit effort of 33.3 sharks per 1 000 hooks during the shark season from Ilo, higher than many other fisheries operating in the Pacific. These small scale fisheries operate along the entire coast and continue to expand resulting in increased pressure upon target species and upon limited resources. An average of 92.8% of sharks caught were considered sexually immature and under the legal minimum landing size. There were significant differences in mean fork lengths for blue sharks between the sexes at Ilo ( $F_{1,4113}=4.71$ ,  $p<0.05$ ), with results comparable to other studies within the south Pacific, and with studies globally showing a frequent occurrence of sex and size segregation within blue and mako sharks. We conclude continuation of expansion of the small scale fisheries in Peru, along with ineffective legislative approaches leading to removal of immature individuals could be detrimental to these shark populations, and highlight the need for new management strategies to attempt to alleviate the pressure on sharks and attempt to conserve these vulnerable species, whilst attempting to stabilise and maintain fisher livelihoods to try and ensure a sustainable future for these fisheries.

## Characteristics of macrofaunal assemblages on a heavily impacted temperate biogenic reef

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The branched, unattached nodules of coralline algae, known as maerl, can be found in many coastal regions from the tropics to northern Norway and are able to form large aggregated beds, making it the most ubiquitous of biogenic reefs. It is very slow growing ( $< 1 \text{ mm yr}^{-1}$ ) and highly susceptible to damage, with the major anthropogenic cause being demersal fishing, possibly impacting over the long term both the maerl and its associated flora and fauna. A grab and photographic method was used to sample a site (Tan Spit, Firth Of Clyde, Scotland) known to have historically contained a dense maerl bed, but has for over forty years, received varying levels of damage from scallop dredging. No live maerl was found at the site. Reasons for this near destruction of the maerl bed include dredging, and eutrophication due to the realignment of sewage works. Across the site, 63 macrofaunal species were found, with a mean density of 220.6 individual organisms  $\text{m}^{-2}$ , and a mean diversity ( $H_s$ ) of 3.82. Both species richness and macrofaunal abundance were positively correlated with the density of dead maerl fragments. Stations with high maerl densities contained assemblages characterised by long living and fragile species, whereas those stations with low maerl densities contained assemblages characterised by opportunistic species. This clearly indicates that dead maerl fragments are able to maintain a level of habitat heterogeneity and therefore macrofaunal diversity. Those stations with a dense surface layer of coarse shell and stone overlying a high subsurface maerl density had the highest macrofaunal abundance and richness, attributed to a level of similarity to an open layer of live maerl thalli. Overall, a higher level of diversity was seen than would be expected of an otherwise muddy habitat. However, this was still much lower than that of a healthy maerl bed.

## **Improving Management Effectiveness of the Marine Reserves of Rodrigues (western Indian Ocean)**

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Intensive fishing pressure in the Rodrigues lagoon has resulted in drastic declines of both fin-fish and invertebrate landings and the degradation of lagoon habitats. In recognition of the status of the marine resources, four marine reserves were identified by the local fishing community and proclaimed by the local government in 2007, but implementation had stalled, partly due to the lack of a management plan for the reserves. It is now well documented that management effectiveness can be improved when local marine resource users are more involved in management processes. While this is usually achieved through consultation, this project aimed to progress the implementation of the reserves by empowering local stakeholders to actually plan the management of the four reserves. A series of training workshops were held to build local capacity in management planning and to capture local knowledge using participatory mapping techniques. Through the workshops, participants devised and agreed the management vision, goals, objectives, strategies and actions. A core group of stakeholders (fishers, representatives of the local marine conservation NGO, tourism representatives and fisheries enforcement officers) used the workshop outputs, results of previous scientific studies and their local knowledge to draft the plan. Extensive consultations were held with the local communities and tour operators to ensure their interests were taken into consideration. The process used to complete the draft management plan developed a strong sense of ownership amongst the local community and it is expected that this participatory approach will improve compliance and management effectiveness of the marine reserves.

## Arabian Gulf corals – Models for potential thermal adaptation

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Limitations of thermal tolerance in scleractinian corals, coupled with current and predicted long-term rises in global sea surface temperatures, are causing a major decline in coral populations world-wide. Water temperatures only slightly above the average annual maximum can result in an often fatal loss of the coral's symbiotic algae (zooxanthellae), a process commonly known as "coral bleaching". In order to better understand the thermal adaptive capacity of corals we purpose the use of specimens of the globally distributed coral, *Porites lobata*, originating from two areas of contrasting thermal profile: the Fijian region and the Arabian Gulf (maximal monthly mean temperatures of approximately 28°C and 34°C respectively). The higher temperature maxima found in the Arabian Gulf is comparable to the sea surface temperatures corals may be expected to encounter due to global warming over the next century. As such, corals from the Arabian Gulf may serve as effective models for the adaptation potential of coral reefs. Laboratory experiments under tightly controlled conditions can facilitate studies of the molecular basis of the corals' resistance towards temperature stress and to establish the specific contributions of the coral host and algal symbionts. We have set up long-term aquarium cultures of *P. lobata* from both regions and have performed subcladal analysis of endosymbiotic *Symbiodinium* spp. with surprising results.

## Five years of *Corallosphere*: E-taxonomy for extinct and extant scleractinian genera.

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The Corallosphere (<http://corallosphere.org>) is a web-based tool that we are using to compile a genus-level taxonomic revision of the Scleractinia. The section on Scleractinia in the *Treatise of Invertebrate Paleontology* (Wells, 1956) and the *Traité de zoologie* (Chevalier and Beauvais 1987) are currently the main authoritative references on the morphology, taxonomy, ecology and systematics of extinct and extant scleractinians. However, progress continues in coral systematics and taxonomy, and continued revision of taxonomic treatises is required. A large obstacle to producing these revisions is the work involved to produce a synthesis of large volumes of information extracted from sources such as existing taxonomic publications, museum collections, web-based data sets, and particularly the cumulative expertise of the community of experienced taxonomists. Our approach has been to work as a team, with individual authors contributing information for subsets of taxa. *Corallosphere.org* has been developed to facilitate the assembly of disparate data required by authors and to publish working drafts of taxonomic summaries so that the information is accessible before the final publication of the *Treatise* volume. The main areas covered in the Corallosphere include text descriptions for diagnoses of valid genera, as well as tools for managing taxonomic synonymies, images, a bibliography, and an illustrated glossary of morphological terms. A flexible work-flow allows registered users with variable levels of access to compile, edit, review, and annotate generic diagnoses directly from the internet. Since *Corallosphere.org* was first deployed in 2006, our team of nine editors and 25 authors have contributed tens of thousands data points data into the system. As of December 2011, 1835 taxa are listed in *Corallosphere.org*, including 1655 genera and subgenera that are the main focus of the revision. Most genera are taxonomically available for use (93%), and two-thirds of genera are available and valid. Completeness of information within genera varies according to the information type. Overall, over 60% of genera and subgenera are currently associated with diagnosis, descriptions, and information about types. Our ultimate aim is to produce a system that will facilitate the rapid publication of the next version of the *Treatise* based on community-wide consensus, and help remove the taxonomic impediment that slows progress towards an increased understanding of the biology, ecology, and evolutionary history of the Scleractinia.

## Habitat refugia for corals in the Rodrigues lagoon

R. Klaus, E. R. Hardman

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The island of Rodrigues (Republic of Mauritius) is surrounded by 90 km of fringing reef, which creates a shallow lagoon of 240 km<sup>2</sup>. The reefs of Rodrigues were one of the few areas in the western Indian Ocean to escape the mass coral bleaching event of 1997–1998. Periodic bleaching events in recent years have however resulted in localised coral mortality, and reef flat sites now have a low live coral cover (<30%), with an abundance of either turf algae or xeniid soft corals. Comparisons with data collected in 2000, suggest a degradation of these reef flat sites in the past 10 years due to a combination of coral bleaching and human impacts. There are areas however where live coral cover remains high (between 40-60 %) in channels or deeper parts of the lagoon (3–5 m depth) and on offshore reef pinnacles. Typically these areas support simpler communities dominated by *Acropora* spp., *Montipora* spp. or *Lobophyton* sp. and are subject to lower light levels often as a result of high turbidity. Rodrigues is both geographically and oceanographically isolated and it is therefore likely that the reefs are largely self-seeding, making them more susceptible to climate-driven reef degradation. This highlights the importance of these refugia in acting as a larval source for the island's degraded reef flats. Due to its westerly location, Rodrigues may also act as a source of larvae for other reefs in the western Indian Ocean, which further underscores the importance of these reefs at a regional level.

**Effects of *Diadema antillarum* abundance on algal community structure and coral disease prevalence in St. Lucia, West Indies**

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Declines in coral cover have been attributed to several factors including mortality due to disease and increasing algal coverage. Algae may play a role in the facilitation of disease; providing positive feedback mechanisms required for phase shift to algal reef habitats. Algae may promote coral disease by acting as reservoirs or vectors for pathogens. Grazers have a significant impact on algal abundance and community structure and the loss of the grazing urchin, *Diadema antillarum*, from Caribbean reefs in 1983/4 led to an overall increase in algae. However, recovery of this grazer has been documented in some areas. Here we look at the effect of *D. antillarum* on algal cover and community structure and attempt to link this with coral disease prevalence. Algal prevalence and community structure varied between sites (One-way ANOVA,  $p < 0.0001$ . ANOSIM,  $p = 0.001$ ) and relationships between *D. antillarum* and algae were observed. Areas with greater numbers of *D. antillarum* had lower total cover of algae (ANCOVA,  $p = 0.024$ ) but increased very thin turf algae (< 2 mm thick) (ANCOVA,  $p = 0.037$ ). Sites with low or no *D. antillarum* present were dominated by algae but main algal type (turf vs. macroalgae) differed between sites. Overall disease prevalence was low (1% of colonies affected) and did not differ between sites or with algal abundance; suggesting that disease is not related to the presence of algae. However, disease prevalence was positively related to coral cover (i.e. host density) (Regression ANOVA,  $p = 0.018$ ). For the first time, a ciliate pathogen seen in corals with White Plague on the Great Barrier Reef, Australia was found to be associated with algal samples in the Caribbean. However, these ciliates were seen in low densities and there was no consistent relationship with algae. This suggests that algae are not a major reservoir for this particular coral pathogen.

**THROUGHFLOW project: Origins of the marine biodiversity hotspot in South East Asia**  
**The reef-coral and bryozoan component**

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South East (SE) Asia hosts the global centre of maximum diversity for shallow marine ecosystems, mainly associated with thriving coral reefs. As part of the Thoroughflow ITN project, we aim to answer 1. When did this biodiversity explosion occur in geological time?, and 2. Which environmental factors controlled it?. Some previous studies have suggested that the formation of the ancestral centre of diversity could be related to the constriction of the Indonesian Throughflow current (ITF) during the Cenozoic, resulting in increased speciation and/or immigration. Scleractinian corals and bryozoans provide good models to test this hypothesis because their carbonate skeletons can be tracked in the fossil record. Since the fossil coral and bryozoan biota of this region has been poorly studied, our methods include not only the revision of existing museum collections but also the acquisition of extensive new collections. Two expeditions have been carried out in East Kalimantan (Indonesia) during November-December 2010 and June-July 2011. A high diversity of shallow water ecosystems, including coral reefs and seagrasses, was found. Based on preliminary observations of large benthic foraminifera and nannofossils, our samples are of Burdigalian to Messinian age (Miocene). Stratigraphical logs were drawn for 25 sections, and specimens were systematically collected. Coral species were dominated by platy forms, and they were very abundant (269 samples) in almost all localities. Coral morphologies respond to the gradient of siliciclastic sediments and nutrients input created by the progradation of the Mahakam Delta since the Early Miocene. Although at first sight bryozoan specimens were scarce (74 samples), after processing the samples a high diversity has been revealed, mainly using coral surfaces as substrates for colonization. The resulting taxa and their occurrences will be analyzed at various geographical and temporal scales, and integrated with parallel studies of palaeoenvironments, chronostratigraphy and high-resolution environmental proxies.

## **Interdit D'Interdire – Identification of pitfalls in development of community management for shark fisheries of northern Madagascar**

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Globally shark fisheries receive little attention, with artisanal and traditional fisheries being particularly neglected despite their likely significant contributions to overexploitation and its consequent effects. This is largely due to the influence of shark fin's high value in today's economy. Madagascar is no exception, demonstrating growth in the trade of both shark fins and meat in recent decades. The northern regions may contribute significantly to this exploitation, however their fisheries are poorly studied. Questionnaire data was used to characterise these fisheries, gauge means of viable monitoring and assess potential for future integrated management initiatives. The fishery was found to have changed in methods, scale and dependencies since the last assessment and potential drivers of these changes are presented. Considerable scope exists for management initiatives on a de-centralised, community-managed basis, with fishermen exhibiting good underlying ecological knowledge. However, revisions to conventional classifications and definitions in terms of catch and effort are suggested as vital for success. The use of questionnaire data for fisheries assessments is reviewed, with demonstration of considerable success, and recommendations for improvements provided.

## Environmentally-regulated genes as basis for coral reef resilience

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The future of coral reefs is dependent on the adaptability of scleractinian corals to changes in environmental conditions. The capacity to respond quickly to changes depends strongly on the expression of environmentally regulated genes. We identified the coral *Acropora millepora* and their green fluorescent protein (GFP)-like host pigments as ideal model system to study the regulatory plasticity of environmentally controlled genes. The pigments are considered to fulfill a photoprotective function, optimizing growth in shallow waters. We found that the pigment-encoding genes are strongly regulated by light. However, we determined pronounced differences between colour morphs regarding the absolute amount of transcripts encoding GFP-like proteins: Transcript concentrations differed, for instance, by more than factor five both in the light exposed and shaded tissue of different colour morphs. These results imply that the tissue concentration of a protective coral protein depends not only on the environmental control of the encoding gene but also on the morphotype-specific maximal response of the gene to a stimulus. The variability in transcript levels among the colour morphs appears to be genetically fixed as colour differences within species are retained under identical environmental conditions. We present the results of an in-depth analysis of genes encoding GFP-like proteins, providing insights in gene regulation strategies in reef corals.

**The RCUK Organising Committee would like to thank everyone for  
participating in the RCUK 2011 Annual Meeting**

We hope you have found this a valuable experience in continuing to promote multidisciplinary conservation, public awareness and education about coral reefs through bringing together fellow UK reef workers and interested parties.

We hope to see you at RCUK 2012 for the 15<sup>th</sup> RCUK Annual Meeting!