

# **Reef Conservation UK**

## **Programme and Abstract Booklet**

**Zoological Society of London**

**7<sup>th</sup> December 2013**

**Presented by  
REEF CONSERVATION UK**

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

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# Reef Conservation UK 16<sup>TH</sup> Annual Meeting 2013

At the Zoological Society of London



**7<sup>th</sup> December 2013**

Welcome to the 16th annual meeting of the RCUK (Reef Conservation UK) at the Zoological Society of London. RCUK was formed to promote multidisciplinary conservation, public awareness and education about coral reefs, as well as to ensure that all reef related activities are conducted in a responsible manner.

This meeting will continue to highlight the need for multidisciplinary studies of coral reefs and adjacent environments, as linked to the RCUK themes of conservation, management and education. Therefore, students, researchers and professionals, from a wide range of backgrounds and disciplines who are involved with coral reef activities, are encouraged to participate.

## Conference Committee

RCUK Meeting Organising Committee

David Curnick	University College London / Zoological Society of London
Alastair Harborne	University of Queensland
Simon Harding	Independent
Emma Kennedy	Griffith University
Heather Koldewey	Zoological Society of London
Rebecca Short	Zoological Society of London
Kristian Teleki	Global Ocean Commission
Caroline Walsh	University of Kent
Elizabeth Wood	Marine Conservation Society

There are currently three ways to keep you up to date on RCUK news and events:

1. RCUK Google group – details of how to join can be found at <https://groups.google.com/forum/#!forum/rcuk>
2. RCUK website ([www.zsl.org/rcuk](http://www.zsl.org/rcuk))
3. Any specific enquiries can be directed to [rcuk@zsl.org](mailto:rcuk@zsl.org)

Many thanks to Guylian and C-3 Community Centred Conservation ([www.c-3.org.uk](http://www.c-3.org.uk)) for their continued support of this event

## RCUK 2013: Conference Agenda

08:15 Registration Opens (Tea/Coffee)

09:00 Welcome address

### SESSION I: Current status and distribution

09:00 What does the recent IPCC report tell us about coral reefs?  
*Charles Sheppard (University of Warwick)*

Reconstructing coral communities through time to determine the effect of human influence on the inshore Great Barrier  
*Hannah Markham (University of Queensland)*

Assessing change in the reefs of the Chagos Archipelago - updates since 2006  
*John Turner (Bangor University and Chagos Conservation Trust)*

Can heavily impacted coral reefs be ecologically resilient?  
*James Guest (University of New South Wales)*

Fusion in adult cold-water corals: building the framework for success  
*Sebastian Hennige (Herriot Watt University)*

10:30 COFFEE BREAK

### SESSION II: Speed Session

11:00 The effects of different nutrient levels and heterotrophic feeding on the ultrastructure of zooxanthellae in *Euphyllia paradivisia*  
*Sabrina Rosset (National Oceanography Centre)*

Coral lipidomics: An emerging research field  
*Cecilia D'Angelo (National Oceanography Centre)*

Eusociality in corals  
*Elizabeth Widman (University of Warwick)*

Restoration of the Caribbean elkhorn coral (*Acropora palmata*) using sexual reproduction  
*Dirk Petersen (SECORE)*

Reef cryptofauna of the Chagos Archipelago

*Catherine Head (Oxford University)*

Defended territories of an aggressive damselfish contain lower juvenile coral density than adjacent non-defended areas in Kenyan lagoon patch reefs

*Tim Gordon (Cambridge University)*

Dairy Bull reef: a resilient fringing reef on the north coast of Jamaica

*James Crabbe (University of Bedfordshire)*

Using a conceptual Bayesian network to investigate rate of changes and uncertainty in coral reef ecosystem

*Chiara Franco (University of Essex)*

Assessing the impacts of dive conservation initiatives on diver behaviour and coral reefs in South-East Asia

*Ronan Roche (Bangor University)*

Impact hypothesis for offshore wind farms: explanatory models for species distribution at extremely exposed rocky reefs

*Marie-Lise Schlappy (Uni Research, Thormøhlensgt)*

Protecting temperate reefs using MPAs: the UK approach

*Dan Bayley (Joint Nature Conservation Committee)*

Is aquaculture the future of the marine ornamental trade?

*Gordon Watson (University of Portsmouth)*

**12:30 POSTER SESSION AND LUNCH**

**SESSION III: Reef Ecology: Micro to Macro**

**13:30** White Band Disease in the endangered Caribbean coral *Acropora cervicornis*, a multi-pathogen bacterial infection and ciliate histophagy  
*Michael Sweet (University of Derby)*

Unravelling the virulence of the coral pathogen *Vibrio coralliilyticus* and its role in *Acropora* White Syndrome

*Bry Wilson (Australian Institute of Marine Science)*

The discovery of a new asynchronous broadcast spawning location in South East London

*Jamie Craggs & Gary Fletcher (Horniman Museum)*

Triggerfish as important agents of coral reef bioerosion and coral rubble generation

*Chris Perry (University of Exeter)*

Thresher sharks use tail-slaps as a hunting strategy  
*Simon Oliver (The Thresher Shark Research and Conservation Project)*

**15:00**      **COFFEE BREAK**

## **SESSION IV: How do we manage reefs in the future?**

**15:30**      Modelling dispersal as a control on coral biogeography under a changing climate  
*Sally Wood (University of Bristol)*

Nutrient impacts on coral reefs: new perspectives and implications for coastal management and reef survival  
*Joerg Wiedenmann (National Oceanography Centre)*

Status, distribution and temporal change in traditional fisheries landings, western Madagascar: two decades of change  
*Charlotte Gough (Blue Ventures)*

Spatial planning for MPA design- experiences from Cambodia  
*Sophie Benbow (Fauna & Flora International) & Tristan Brown (Coral Cay Conservation)*

Net-Works - working with industry to create an inclusive business model around a conservation issue  
*Nick Hill (Zoological Society of London)*

**17:00 - 20:00**      **Free drinks reception in ZSL London Zoo Aquarium**

For more information and details of future events, please see [www.zsl.org/rcuk](http://www.zsl.org/rcuk)

# Presentation Abstracts

*Abstracts have not been edited by the committee in any way other than to standardise the formatting throughout the document. If you have questions about any of the abstracts, please send these to the email address provided.*

## The recent IPCC report: what implications does this have for coral reefs?

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The Intergovernmental Panel on Climate Change reported in October with summaries for policymakers along with some scientific forecasts and projections; this being the first new appraisal for many years. More work is to follow over the next weeks, but this tells us a considerable amount on possible consequences to reefs of the newest scientific findings. In short, several previous projections have been 'hardened up', some with greater certainties attached to them, and some climatic forecasts present deepening problems. This short presentation covers several aspects of critical importance, starting with warming trends, CO<sub>2</sub> and sea level rise, all factors of pressing importance to reefs today. The IPCC does not do the original research itself, but collates and interprets that of others, and consensus must be reached, so one or two relevant aspects in earlier drafts might have been watered down as being too premature at the moment to be included in the final.

## **Reconstructing coral communities through time to determine the effect of human influence on the inshore Great Barrier Reef**

Hannah Markham<sup>1</sup>, George Roff, Jian-xin Zhao & John M. Pandolfi

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It is now widely accepted that reefs are undergoing rapid ecological change at a global scale, characterised by a shift towards domination by macroalgae instead of corals. With human pressure in coastal regions increasing disproportionately, chronic anthropogenic stressors are regarded as the catalyst in their global demise, with near-shore reefs suffering diversity loss, changes in habitat complexity and a reduction in the abundance of reef dwelling biota.

Following European settlement (1780-1870) the water quality within the Wet Tropics region of the Great Barrier Reef (GBR) lagoon has declined. Heavily modified river catchments and large areas of land cleared for agricultural purposes have resulted in high sediment and nutrient-loaded runoff into the GBR lagoon. However, establishing cause-and-effect for individual stressors within the reef environment is challenging due to the synergistic or antagonistic effects of multiple and cumulative pressures across multiple scales. Perceived shifts in the ecology of modern reef systems may be significant, yet may also be taken out of context, subject to shifting baselines as a result of a lack of historical data.

Through a palaeoecological approach of using reef matrix cores to extract fossil coral assemblages from the reef slope environment, the coral community structure at Russell Island is determined for the past millennium. Changes in the relative abundance of coral taxa within an accurately constrained temporal framework using high precision U-series dating allows a comparative analysis between contemporary reef monitoring data and the pre-European baseline.

The importance and application of palaeoecological studies in the reconstruction of ecological baselines is presented within the context of the structure and function of inshore reef systems at a centennial scale.

## Long term monitoring of coral reefs in Chagos

John R. Turner<sup>1</sup>

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Coral cover on Chagos reefs has been assessed for greater than 20 years, providing a valuable long term record of change over time in response to major environmental variables, such as warming events and bleaching induced mortality. Although photographs of many reef communities exist, what has been lacking is a video archive of the structure of communities which would allow documentation of change and the identification of features that may not previously have been recorded in counts because their significance was not evident at that time. A video archive enables new generations of scientists to revisit reefs visually, and the video can be reanalysed to identify changes and to address questions of resilience and response. 10 minute sequences of video were recorded over 5 m depth ranges (5-10, 10-15, 15-20, 20-25m depth) at seaward and lagoon sites on all atolls in 2006, and these are being repeated during the 2013 and 2014 Darwin Initiative expeditions. Initial analyses indicate that primary framework species that grew rapidly at shallow depths following the 1997 mortalities, are now being replaced by more diverse secondary framework species, which can be expected to increase in biomass in subsequent years unless affected by further impacts. There are already indications of new events occurring, such as mortality of lagoon corals below 15 m depth in Salomon lagoon; and loss of branching *Acropora* on lagoon reefs of Eagle Island and Danger Island due to Crown of Thorns starfish outbreaks.

## Can heavily impacted coral reefs be ecologically resilient?

James Guest<sup>1</sup>, Andrew Bauman, Alex Campbell, Chou Loke Ming, David Feary, Jeffrey Low, Peter Steinberg, Karenne Tun & Adriana Verges

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Coral reef ecosystems are very dynamic and have evolved to be resilient to a natural regime of disturbances that include sea level change, major storms and outbreaks of predators. It is now widely recognized however, that humans are altering this natural disturbance regime and that this is eroding the natural resilience of reefs and promoting shifts from coral to seaweed dominance on reefs. Some reefs are still very resilient, but typically these are less impacted, well-managed reefs with abundant herbivore populations. Singapore is a densely populated, highly urbanized island nation located just north of the equator. Human alteration of Singapore's coastline began almost two centuries ago. It continues unabated today and has led to elevated rates of sedimentation and levels of coastal eutrophication. Despite these adverse conditions, diverse coral assemblages exist around the majority of Singapore's southern islands. Here we present results from surveys that began in 1986 to study changes in benthic composition on reefs south of mainland Singapore. Our results show that there has been no change in benthic cover or coral community structure over the last 27 years at shallow survey sites (approx. 3 metres), however at deeper sites (approx. 6 metres depth) coral cover has declined significantly. At one site, recovery of coral cover to a pre-disturbance level following major coral bleaching occurred within 10 years. At both shallow and deep sites, there was no evidence of a shift from a coral to an algal dominated system despite demonstrably low rates of herbivory. Our results suggest that impacted reefs can indeed be resilient and that algal and coral distributions in this system are more likely to be structured by physical factors (e.g. light) than by herbivory.

## Fusion in adult cold-water corals: building the framework for success

Sebastian J. Hennige<sup>1</sup>, Cheryl L. Morrison, Armin U. Form, Janina Büscher,  
Nicholas A. Kamenos & Murray Roberts

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Key to the success of coral reefs and the rich biodiversity they support is their ability to form complex three-dimensional habitats through their calcium carbonate skeletal framework. In tropical reefs, encrusting coralline algae bind together substrates and dead coral framework to make reefs solid and continuous structures. However, below the photic zone where there are no calcifying algae, cold-water coral reefs also form large, stabilised, reef structures. Here we show that the adult cold-water coral *Lophelia pertusa* has the ability to skeletally fuse with other *Lophelia* colonies even though they are mature and genetically distinct. This is the first evidence of adult biomineralisers demonstrating skeletal fusion with non-related adult conspecifics, driven either by evolution of their historecognition complex, or its suppression, with possible reductions in aggression-related energetic expenditure. Understanding the mechanisms behind this evolution / suppression would be of benefit to vertebrate immunity research, as the cnidarian defence system offers a key insight into the basal functions of more complex immune pathways in vertebrates, and coral histocompatibility elements may be possible precursors to vertebrate T-cell allotransplantation responses.

## The effects of different nutrient levels and heterotrophic feeding on the ultrastructure of zooxanthellae in *Euphyllia paradivisia*

Sabrina Rosset<sup>1</sup>, Cecilia D'Angelo<sup>1</sup> & Jörg Wiedenmann<sup>1</sup>

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The success of scleractinian corals in oligotrophic waters is attributed to efficient nutrient recycling between the coral host and their symbiotic algae. The limited nutrients found in oligotrophic waters restrict symbiont proliferation, allowing for excess photosynthetic product to be translocated to the host rather than being used for symbiont growth. However, high levels of anthropogenically sourced dissolved inorganic nitrogen induce an elevated level of zooxanthellae proliferation, resulting in starvation from other macronutrients, particularly phosphate. Such imbalanced growth causes reduced photosynthetic efficiency and increased susceptibility of corals to thermal- and irradiance-driven bleaching. Here we investigated how zooxanthellae adapt to replete, extremely limited, and imbalanced (high nitrate/ ambient phosphate) nutrient conditions in hospite, by observing the ultrastructure of zooxanthellae in *Euphyllia paradivisia* using transmission electron microscopy. Furthermore, it was tested how heterotrophy by the host affects zooxanthellae growth and morphology during low nutrient conditions. Ultrastructural differences were examined by measuring cell size as well as the assimilation of lipid bodies, starch granules, starch surrounding the pyrenoid, accumulation body, and uric acid crystals. Our findings provide an indication of which biochemical pathways photosynthetic carbon is directed into under different nutrient conditions. Additionally, the apparent morphological differences between zooxanthellae of balanced and imbalanced growth, such as cell size and the ability to cumulate storage bodies, along with the enhanced susceptibility to bleaching under imbalanced nutrient conditions, highlight the great importance of water quality management, considering that reduced anthropogenic nutrification of coastal waters would enhance coral resilience to the effects of climate change.

## **Coral lipidomics: An emerging research field**

Cecilia D'Angelo<sup>1</sup>, Anthony Postle<sup>1</sup> & Jörg Wiedenmann<sup>1</sup>

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Reef corals have to cope with a broad range of natural and anthropogenic stressors. Our understanding of the influence of these factors on the survival and resilience of corals is strongly dependent on the availability of specific stress response markers. Recently, the role of lipids as major functional players in adaptation strategies of many organisms to a range of environmental conditions has been recognised. The comprehensive, large scale profiling of molecular lipid species of an organism (lipidomics) is now possible due to the advances in mass spectrometry technology. We will present the results of our mass spectrometric analyses of symbiotic algae (zooxanthellae) from different coral species maintained in a controlled laboratory setting. We have utilised electrospray ionization followed by tandem mass spectrometry (ESI-MS/MS) after direct infusion of total lipids extracted from freshly isolated zooxanthellae to analyse changes in their detailed lipid profile after exposure of corals to altered water parameters. Our experiments show that the particular lipid composition of zooxanthellae is strongly influenced by the environment of the corals. We will discuss the significance of these findings to develop new analytical strategies of coral's stress condition and further the general understanding of coral physiology.

## A novel trait-based approach to assessing reef similarity in Southwest Madagascar

E.Widman<sup>1</sup>, M. Keeling<sup>1</sup> & C. Sheppard<sup>1</sup>

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Dissimilarity coefficients (i.e. Bray-Curtis) are commonly used to assess the degree of coral species overlap between reef communities. A key shortcoming of such approaches is that they disregard the fact that some species are highly similar in terms of traits (and therefore have similar ecological roles) while others are not. Here we present a novel dissimilarity measure (*Tdis*) that compares *Scleractinian* reef communities in terms of their overlap in trait-combinations (by trait we mean important morphological, physiological, and behavioural attributes).

The utility of *Tdis* is demonstrated using community composition data from 68 reefs located along sedimentation, fishing intensity, and fetch gradients in southwest Madagascar. The similarity of the reefs was compared in terms of 26 key life-history traits of 231 species. A set of reefs in Southwest Madagascar is used.

We demonstrate how our trait-based dissimilarity coefficient could identify reefs that are functionally highly similar (i.e. they contain species with highly similar trait sets) despite being dissimilar in that they contain few overlapping species. Since traditional dissimilarity coefficients such as Bray-Curtis are unable to detect such functionally similar but mechanically different reefs we suggest that *Tdis* be added to the reef managers toolkit for monitoring and assessing reefs.

Our R-based package for translating coral species composition into coral trait composition and calculating *Tdis* is also briefly introduced.

## Restoration of the Caribbean elkhorn coral (*Acropora palmata*) using sexual reproduction

Dirk Petersen<sup>1</sup>, Valérie F. Chamberland<sup>2</sup>, Mike Brittsan<sup>3</sup> & Mark Vermeij<sup>2</sup>

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In 2010, the SCORE Foundation, in collaboration with the CARMABI Foundation and the Curacao Sea-Aquarium, has started a project in Curacao to study the potential of using sexual recruits for the restoration of the critically endangered elkhorn coral *Acropora palmata*.

Elkhorn coral larvae obtained from field collected gametes were cultured in land-based aquarium facilities. Larvae were settled on specific settlement tiles. They were either directly outplanted on the reef or kept in the aquarium system for up to one year before outplanting occurred. Although high absolute mortality (>85%) occurred in the initial 6 months under all conditions, high recruitment success was obtained for tiles with initial larvae settlement densities of  $12.3 \pm 4.4$  settlers tile<sup>-1</sup> (mean  $\pm$  SD). 80% of these tiles carried at least one recruit after the initial most crucial 12 months (= recruitment rate) compared to 26% in the aquarium system. Cost-benefit analyses further support our conclusion that extended culture in land-based facilities over months is not an advisable strategy.

We suggest outplanting of initial settlers on the reef directly after settlement if conditions at the restoration site are favorable for coral survival (i.e. stable algae control, low sedimentation). Under less favorable conditions, temporary culture in an in situ nursery may be necessary to allow settlers gaining size in a semi-protected environment before they are transferred to the reef.

Project Curacao is part of an international initiative of the SCORE Foundation and partners ([www.score.org](http://www.score.org)) to address coral conservation through research, education, outreach, and restoration.

## Reef cryptofauna of the Chagos Archipelago

Catherine Head<sup>1,2</sup>, Alex Rogers<sup>1</sup>, Heather Koldewey<sup>2</sup> & Morgan Pratchett<sup>3</sup>

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Coral reefs are thought to be the most species rich marine ecosystem, and the majority of this biodiversity lies within the so-called reef cryptofauna, the communities of animals that live hidden within the coral framework, e.g. crabs, brittle stars, and shrimp. The cryptofauna are a functionally important suite of animals but are understudied. Many of these invertebrates have evolved to form close symbiotic associations with corals, particularly branching Scleractinia corals. Reef invertebrates that have evolved close associations with live coral and are believed to have specialised to such an extent that they are depend on their coral host for survival are known as obligate coral dwellers. An estimated 56% of coral invertebrate associates are coral obligates indicating an extremely high proportion of coral associated invertebrates have a heavy reliance on their coral host for food, habitat and reproduction and will hence be extremely vulnerable to coral loss.

Here we detail the observed prevalence of so-called coral obligate decapods found on dead branching Scleractinia corals across the Chagos Archipelago in the Indian Ocean, widely acknowledged as one of the most undisturbed marine environments globally. We explore the spatial and ecological patterns within these populations, and the potential implications of this finding to their vulnerability to disturbance. This study forms part of a larger PhD project that aims to assess the diversity of select groups of the reef cryptofauna in the Indian Ocean to better understand their role in coral reef ecosystem function and resilience.

# Defended territories of an aggressive damselfish contain lower juvenile coral density than adjacent non-defended areas in Kenyan lagoon patch reefs

Timothy A.C. Gordon<sup>1,2</sup> & Benjamin Cowburn<sup>1,3</sup>

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**Introduction:** Several damselfish species, including the jewel damsel (*Plectroglyphidodon lacrymatus*), aggressively defend small territories on coral reefs, in which they cultivate lawns of edible macroalgae. Previous research on the effects of these territories on corals has been inconclusive and focussed on percentage cover, overlooking effects on juvenile corals.

**Methods:** Frequency counts were used to establish paired comparisons of juvenile coral density inside and outside jewel damselfish territories on lagoon patch reefs in Watamu Marine National Park, Kenya. Visually conspicuous damselfish territories were sought every 5m along 20 transects of 40m, spread over 6 reefs. Quadrats (0.25m<sup>2</sup>) were placed centrally in each territory, and in paired adjacent non-defended areas of similar habitat. Juvenile corals were counted and classified by length of longest axis (0-2.5cm, 2.6-5cm, 5.1-7.5cm and 7.6-10cm). Differences in coral density were assessed using a two-tailed paired sample Wilcoxon test.

**Results:** 41 territories were found within 3m of 17 different transects across the 6 reefs. Pairwise comparisons showed that juvenile coral density was similar for all size classes in non-defended areas (range 1.95-2.45 corals/m<sup>2</sup>). In defended areas, however, juvenile coral density was reduced 12-fold compared to non-defended areas for the 0-2.5cm class ( $p < 0.001$ ), 5-fold for the 2.6-5cm class ( $p < 0.001$ ) and 2.4-fold for the 5.1-7.5cm class ( $p = 0.03$ ), but was not different for corals of 7.6-10cm ( $p = 0.88$ ).

**Discussion:** Reduced density of small juvenile corals in defended territories could be explained by several hypotheses including direct farming effects of the damselfish, indirect inhibitory effects from higher algal densities inside territories, or habitat choice in damselfish seeking areas of low juvenile coral densities in which to establish territories. The territories of damselfish can occupy a large proportion of a coral reef; territorial behaviour in fish may have greater impacts on reef structure, in particular the resilience and growth-rate of juvenile corals, than previously appreciated.

## Dairy Bull reef: a resilient fringing reef on the north coast of Jamaica

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Diary Bull reef has for several years been the fringing reef around Discovery Bay, Jamaica, with the most coral cover, with a benthic community similar to that of the 1970s, and it was the subject of the study which suggested a rapid phase-shift reversal. The reef provides a positive example of how reefs can recover after major environmental disturbance. After the Caribbean-wide bleaching event of 2005, live coral cover increased from  $13 \pm 5\%$  in 2006 to  $31 \pm 7\%$  in 2008, while live *Acropora cervicornis* increased from  $2 \pm 2\%$  in 2006 to  $22 \pm 7\%$  in 2008. Coral cover levels have been maintained up to 2012. It is encouraging that coral cover and the rapidly growing *A. cervicornis* colonies have returned to the reef at levels approaching pre-bleaching values. This site shows relatively high rugosity and the influence of *M. annularis* colonies on the reef, acting as structural refugia and maintenance of biological legacies and reasonably fast growth may have facilitated this recovery.

Establishing and maintaining fully-protected marine parks in Jamaica and elsewhere in the Caribbean is one tool to help the future of the fishing industry in developing countries. Developing Marine Protected Areas (MPAs) as part of an overall climate change policy for a country may be the best way of integrating climate change into MPA planning, management, and evaluation.

## Using a conceptual Bayesian network to investigate rate of changes and uncertainty in coral reef ecosystem

Chiara Franco<sup>1</sup>, David J. Smith<sup>1</sup>, Stephen Nimrod<sup>2</sup>, Allan Tucker<sup>3</sup>, Leanne J. Hepburn<sup>1</sup>

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Increasing climate variability underline the urgency of taking remedial actions to buffer anthropogenic pressures and reduces coral reef deterioration. In order to promote coral reefs endurance, it is critical to understand the influences of anthropogenic and climate change disturbances on coral reef growth and erosive processes, thus to avoid shifts from accretive to erosive states with loss of reef framework.

To date, carbonate budget assessments provided a quantitative tool to evaluate spatial and temporal variations of coral reef framework. However, the uncertainty associated with emerging scenarios and coral reef complexity limit the application of this methodology for long term management actions. Therefore, there is a need for more comprehensive approaches that incorporate a quantitative evaluation of the uncertainty associated with coral reef complexity and that are able to adapt to emerging scenarios.

In this context, a Bayesian Network (BN) model was developed to identify and evaluate to which extent anthropogenic and climate change impacts determine coral reefs budgetary states. BN are flexible models that decompose the complexity associated with a system in solvable steps, examine cause-effect relationships occurring across variables and provide a user-friendly frame to communicate the results.

The Carbonate Budget BN was parameterised on empirical data collected in southeast Sulawesi (Indonesia), Grenada (Caribbean) and data derived from the literature. To implement and update the structure of the model was used a participatory approach through key stakeholders' engagement. Environmental and biological variables were described using ranges in recognition of the non-dynamic nature of coral reefs and of the natural fluctuations occurred within the variables. Parameter estimation was conducted on discretised data and model validation through accuracy and sensitivity analysis. The predictive ability and sensitivity of the model reflected the high variability in net carbonate production between impacted and non-affected sites.

## **Assessing the impacts of dive conservation initiatives on diver behaviour and coral reefs in South-East Asia**

Ronan C. Roche<sup>1</sup>, Chloe V. Hunt<sup>2</sup>, James J. Harvey<sup>2</sup>, Vivienne Johnson<sup>2</sup>

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Scuba diving is a rapidly expanding recreational activity globally, and particularly in global hotspots of coral reef biodiversity such as South East Asia. As a result there have been concerns that intensive scuba diving activity will contribute to reef degradation in sensitive areas, and calls for scuba diving management and diver education programmes. The Green Fins approach is an initiative for reducing dive impacts which has been widely adopted within key dive sites of South-East Asia.

Research which has taken place to date has generally focussed on documenting the impacts of scuba diving on coral reefs, rather than examining for evidence of positive effects resulting from conservation initiatives. Some studies indicate that the procedures and attitude of the dive centres involved in bringing divers to a site are key to determining dive behaviour underwater.

We summarise existing global research on the interactions between conservation initiatives, diver behaviour, and coral reef damage, and outline the research approach being taken in an on-going project at dive sites around South-East Asia. We present initial data from the project and outline potential implications for coral reef management approaches.

## Impact hypothesis for offshore wind farms: explanatory models for species distribution at extremely exposed rocky reefs

Marie-Lise Schläppy<sup>1</sup>, Aleksej Šaškov<sup>2</sup> & Thomas G. Dahlgren<sup>1</sup>

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The increasing need for renewable and clean energy production is likely to result in a diversification of locations of offshore wind farms which have been so far predominantly sited on soft substrata. In contrast, offshore wind turbines placed on rocky reefs in highly exposed areas are much less common and the impacts on local flora and fauna can only be hypothesized. On the Western coast of Norway underwater video analyses and multibeam bathymetry data with a generalized linear model were used to investigate the influence of geomorphic explanatory variables on the occurrence of selected taxa (algae, sea urchins and sea stars) identified at a planned wind farm. The study revealed that the geomorphic descriptors aspect, slope, rugosity, and benthic position indexes (BPI), were of significance for algae, sea urchins and sea stars and showed their habitat preferences before impact. Kelp occurred in areas of high rugosity, on gentle slopes, in elevated areas with a southerly orientation and on the sheltered side of rock or bedrock. Thus, construction disturbance that modify those variables may lead to a change in kelp distribution. Turbines that shade southerly aspects may affect kelp plants in reducing their available habitat. Sea urchins were more abundant on steep slopes and both sea stars and sea urchins showed a preference for a complex local relief and heterogeneity in fine and broad elevation (shown by BPI). Thus, foundations and cable route preparation may significantly change the slope, rugosity of BPI broad, which may change the distribution of sea urchin populations. It may likewise significantly change the rugosity or BPI which may change the distribution of sea stars. The model used yields useful information about the potential impacts of the construction of an offshore wind farm on rocky substratum and allows us to generate impact hypotheses that go beyond what could be hypothesized through a mere general knowledge of the area.

## Protecting temperate reefs using MPAs: the UK approach

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There are currently 108 EU marine Special Areas of Conservation (SAC) MPAs in the UK, covering 8.4% of our territorial seas. These sites can be designated to protect any of the 13 marine habitats and 8 marine species listed by the European Commission under the Habitats Directive. Reefs are one of these habitat types and for more than 10 years JNCC have been identifying SACs to protect reefs in offshore waters.

Reef habitats, separated into three distinct sub-types (bedrock, stony [cobble] and biogenic), occur across UK waters, from the English Channel to far off of north-west Scotland, and are home to a host of marine species.

Bedrock and stony reefs occur where the bedrock or stable boulders and cobbles arise from the surrounding seabed creating diverse community assemblages and can be very variable in terms of structure. Biogenic reefs such as those created by the scleractinian hermatypic coral *Lophelia pertusa* can occur down to 1,000 m in depth, in temperatures down to 4°C, and have in some cases existed for many thousands of years. Reefs formed by the mussel *Modiolus modiolus* similarly form large 'bioherms' on the seafloor hundreds of metres across, and host a rich community of free living and sessile epifauna and predators. Biogenic reefs can also be made by reef-building worms such as the honeycomb worm *Sabellaria alveolata*, the ross worm *Sabellaria spinulosa* and the serpulid worm *Serpula vermicularis*.

The designation of these MPAs follows three main principles. 1. Natural Range, 2. Sufficiency, 3. Proportionality. This ensures: that the UK protect the habitats or species in question right across their known range within the UK; that we protect a sufficient amount to make these areas viable; and that we protect a proportionate amount relative to the species/habitat distribution across the North Atlantic biogeographic region.

For more information please visit our website at: <http://jncc.defra.gov.uk/page-1445>

Or use our interactive MPA mapper at: <http://jncc.defra.gov.uk/page-5201>

## Is aquaculture the future of the marine ornamental trade?

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Coral reefs are increasingly suffering from a plethora of impacts so it is no surprise that the growth of the marine aquarium industry is perceived as an additional threat to their conservation. Trade in marine ornamentals has increased dramatically during the last decade with an estimated 300 million marine invertebrates traded each year. Over-collection is of major concern and exacerbated by the absence of a coherent monitoring or reporting framework for the industry. Achieving increased sustainability as a goal for the aquarium industry has prompted developments in aquaculture as an alternative to wild collection, but this has suffered from critical life-history and technological bottlenecks. Firstly, we describe two novel methods that have the potential to offset the impacts for two key groups of marine invertebrates traded: regeneration of fanworms (sabellids) and using non-tropical gastropod species (*Osilinus lineatus* and *Gibbula umbilicalis*) as alternative clean-up crew. To assess the industry-level capacity to supply cultured species, data were gathered from online hobbyist-driven sources (e.g. the Marine Breeders Initiative) in conjunction with a number of commercial organisations that supply the trade. An assessment of aquaculture potential for key families and groups of all traded organisms (fish and invertebrates) is presented. Using demand data from consumers, a measure of future risk of over-reliance on wild stocks has also been developed. The implications of these results are discussed in the context of the future sustainability of the industry and the impact on coral reefs.

## Systematic description of an unknown disease; the case of the black spot

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The increase in reports of novel diseases in a wide range of ecosystems, both terrestrial and marine, has been linked to many factors including exposure to novel pathogens and changes in the global climate. In 2010 an unknown disease was reported off the east coast of Australia which affected 15% of populations of an iconic, commercially-important marine fish, the coral trout *Plectropomus leopardus*. Lesions were raised and dark black/brown in colour, which is a change from the characteristic blue-spotted patterning seen on healthy individuals. Location of the lesions on the body varied between individuals and coverage of the lesions varied from < 10% of body surface to almost complete coverage. The fish displaying these skin lesions struck fishing hooks as strongly as healthy individuals and appeared to have good muscle tone. When assessed by external examination they appeared as healthy, aside from the reported skin discolouration. Here we describe a systematic approach utilised to describe an unknown disease which further allowed hypotheses to be formed about disease causation in this specific case study.

## Unravelling the virulence of the coral pathogen *Vibrio coralliilyticus* and its role in *Acropora* White Syndrome

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Coral reefs harbour one of the most diverse ecosystems on the planet and provide substantial revenue to coastal communities through fishing, tourism and coastal protection. Recent decades have seen an unprecedented rise in coral mortality and microbial diseases are emerging as a very real threat to coral reefs worldwide. The marine bacterial pathogen *Vibrio coralliilyticus* has been identified as a causative agent of white syndrome in corals in the Indo-Pacific and previous research suggested the involvement of certain bacterial enzymes in pathogenicity. In this study, the gene encoding one of these enzymes, VcpA, was cloned and sequenced from global *V. coralliilyticus* isolates. Diagnostic tools were developed to detect the enzyme gene, transcript and protein, whilst its role in virulence was investigated by mutagenesis studies and infection challenges. We also carried out coral disease surveys on reefs around American Samoa to assess the prevalence of *Acropora* White Syndrome (AWS) and characterise the composition and diversity of the bacteria associated with healthy and diseased corals - and appraise the contribution of *V. coralliilyticus* to global coral disease. These data will be presented and the role of the much-maligned coral pathogen *Vibrio coralliilyticus* discussed.

## The discovery of a new asynchronous broadcast spawning location in SE London

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Whilst considerable progress has been made in spawning brooding coral species in captivity, the precise environmental cues that trigger broadcast spawning corals to release gametes remain largely unknown and spawning events within aquaria are rare. Taking advantage of the latest microprocessor technologies and environmental sensors we have replicated in captivity the precise environmental conditions found on Beqa lagoon, SE Fiji. Through the replication of lunar cycle, photoperiod, seasonal temperature changes and heterotrophic feeding we aim to better understand spawning cues in captivity and are investigating the influences that these variables have on gamete production and release.

This multiyear collaborative project commenced in January 2013. Current methodology has been proven successful, with spawning events of multiple Acroporid species in the coral laboratory at the Horniman Museum & Gardens, UK.

A series of control experiments are taking place to further refine the methodology, with the ultimate goal of using these environmental cues to analyse the effect that climate change and the resulting coral bleaching will have on broadcast coral fecundity and reproductive rates.

This ambitious project is supported by the following people and organisations without whose generous contribution this work would not be possible. Barnaby Shearer, Tropical Marine Centre, SECORE Foundation, CISECO, RLab (Reading Hack Space) Rock Seven, IZVG and University of Derby.

## Triggerfish as primary agents of coral reef bioerosion and coral rubble generation

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Corallivory is the process through which animals exploit corals as a food source, and a number of species of reef fish, annelids, crustaceans, echinoderms and molluscs are known to directly impact coral reef benthic ecology through this feeding strategy. For fish, it is the corallivory (alongside herbivory) of parrotfish that has been especially well documented, with parrotfish feeding directly influencing coral-algal space interactions on reefs, contributing to reef framework erosion and, as a by-product, producing abundant sand-sized carbonate sediment. Here we show that another group of corallivorous fish, the triggerfish, also exert an important influence on reef benthic ecology (through feeding-related coral breakage) and on the generation of sedimentary carbonate material. Data collected from Vakkaru island in Raa Atoll, Maldives, show that triggerfish actively target and break several branched coral species (*Acropora digitifera*, *Acropora hyacinthus* and *Pocillopora verrucosa*) that collectively comprise ~65% of the reef flat coral community. This process can be very rapid (as borne out by video evidence) and appears to be associated with triggerfish targeting cryptic food sources between coral branches. Nearly 25% of all reef flat coral colonies at this site exhibit evidence of some degree of triggerfish damage. This process acts to directly denude (and in some cases kill) branched coral taxa, thus influencing benthic ecology and associated net rates of reef carbonate production. The process also generates large amounts of branched coral rubble which is variously deposited on the reef flat surface, or on adjacent coral colonies. The size frequency distribution of rubble varies with coral species, but rubble averages ~3-4 cm in length (range: 1 to 14 cm). This study thus highlights what has, until now, been an ignored process of direct reef bioerosion, but one that has potentially important implications for reef benthic ecology, for reef carbonate production rates, and for understanding detrital reef framework production (in the sedimentary record the assumed origin for such branched coral rubble would be physical breakage during storm events).

## Thresher sharks use tail-slaps as a hunting strategy

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The hunting strategies of pelagic thresher sharks (*Alopias pelagicus*) were investigated at Pescador Island in the Philippines. It has long been suspected that thresher sharks hunt with their scythe-like tails but the kinematics associated with the behaviour in the wild are poorly understood. From 61 observations recorded by handheld underwater video camera between June and October 2010, 25 thresher shark hunting events were analysed. Thresher sharks employed tail-slaps to debilitate sardines at all times of day. Hunting events comprised preparation, strike, wind-down recovery and prey item collection phases, which occurred sequentially. Preparation phases were significantly longer than the others, presumably to enable a shark to windup a tail-slap. Tailslaps were initiated by an adduction of the pectoral fins, a manoeuvre that changed a thresher shark's pitch promoting its posterior region to lift rapidly, and stall its approach. Tail-slaps occurred with such force that they may have caused dissolved gas to diffuse out of the water column forming bubbles. Thresher sharks were able to consume more than one sardine at a time, suggesting that tail-slapping is an effective foraging strategy for hunting schooling prey. Pelagic thresher sharks appear to pursue sardines opportunistically by day and night, which may make them vulnerable to fisheries. Alopiids possess specialist pectoral and caudal fins that are likely to have evolved, at least in part, for tailslapping. The evidence is now clear; thresher sharks really do hunt with their tails.

## Modelling dispersal as a control on coral biogeography under climate change

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Of the various processes affecting coral reef biogeography, dispersal of coral larvae by ocean currents may have particular significance to the future of reef ecosystems; affecting resilience to disturbance, potential for adaptation and distribution shifts in response to changing environments. However, dispersal patterns are also predicted to change under future climate, via changes to adult populations, larval physiology and reef habitats, with implications for reef resilience.

I present the first global biophysical model of coral larval dispersal, developed to investigate the factors controlling this process on scales relevant to biogeography. The model uses high resolution oceanographic data to track individual larvae from release to arrival at suitable reef habitat, allowing potential dispersal paths and important source or vulnerable isolated reefs to be identified. I discuss recent work investigating coral larval dispersal across the eastern Pacific, along with implications regarding theories of the origin of the depauperate tropical eastern Pacific coral faunas and their future viability. I discuss ongoing work to incorporate the effects of environmental factors on larval development and survival in the model, as well as potential applications of the model in aiding predictions of future coral distributions.

## **Nutrient impacts on coral reefs: New perspectives and implications for coastal management and reef survival**

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Anthropogenic nutrient enrichment of coral reef waters is often associated with coral reef decline. The mechanisms underlying the negative effects imposed by dissolved inorganic nutrients, however, are subject to controversial debate. In this presentation we discuss how nutrient enrichment affects the heat and light stress tolerance of corals and their bleaching susceptibility. We integrate direct and indirect effects of nutrient enrichment on corals in a model that explains why healthy coral reefs can exist over a rather broad range of natural nutrient environments at the lower end of the concentration scale and that anthropogenic nutrient enrichment can disturb the finely balanced processes via multiple pathways. We argue that the effects of nutrient enrichment and eutrophication beyond certain thresholds are negative for both, the physiological performance of the coral individual and ecosystem functioning. Hence, the immediate implementation of nutrient management strategies is crucial for coral reef survival.

## Status, distribution and temporal change in traditional fisheries landings, western Madagascar: Two decades of change

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Small-scale fisheries are fundamental to livelihoods and food security worldwide with particular significance in coastal areas of developing nations. They face unprecedented threats from overexploitation and because of their diverse and scattered locations; adaptive management of these important resources is compounded by problems of data deficiency. An effort to understand the complexities of small-scale fisheries is emerging as a priority for marine conservation. Madagascar's western region presents a valuable case study of small-scale fisheries in a developing country that is characterised by high resource dependence, poverty, diminishing natural resources and data deficiency.

A comparative study of fisheries landings data collected in 2011 with data from two decades beforehand, indicates that present-day catch rates have been artificially maintained by an increase in fisher numbers, diversification of fishing gears and improvements in gear efficiency.

A significant drop in trophic level from 3.92 in 1991 to 3.42 in 2011 ( $\chi^2 = 46.65$ ;  $p < 0.0001$ ) provides clear evidence of 'fishing down marine food webs'. A comparison of taxonomic composition and size frequency distribution of catches from different gear types indicates considerable overlap in selectivity of gear types, with less selective gears such as beach seine and small mesh gillnets catching fish before they reach sizes obtainable by other gears.

Findings indicate that the small-scale fisheries in this region are showing clear indications of overexploitation, and that effective, sustainable management is now essential.

## Spatial planning for MPA design- experiences from Cambodia

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Coral reef systems in Cambodia support abundant marine life, but the overall status of these reefs is poorly documented. National fishery laws and policies encourage and enable the establishment of multiple use marine protected areas (MPAs) that allow tourism and fishing in some areas while promoting biodiversity conservation in others. The government of Cambodia is currently working with local stakeholders and NGOs to implement a multiple use MPA known locally as a marine fisheries management area (MFMA) around the islands of the Koh Rong Archipelago. Ecological data was collected at 156 locations around the islands by staff and volunteers from Coral Cay Conservation (CCC) over a two year period from 2010-2012. These data were used to calculate and allocate conservation management values (CMVs) to each individual survey site via a scoring method. However, these values do not take into account the full range of biodiversity around the islands and other key variables which should be considered in MPA zoning. Therefore, in order to determine priorities for classification into different use areas, the spatial planning tool MARXAN with Zones (MARXAN-Z), was used to inform zoning of the MFMA. The tool uses ecological data on coral reef, mangrove and seagrass as well as cost layers derived for sedimentation and fishing impact within the proposed MFMA. We find that suggested conservation area zones derived from MARXAN-Z mostly correspond with areas of high conservation management value identified through the scoring method, with some notable exceptions. We conclude that ecological data, while insufficient to develop a zonation plan for the MFMA alone, provides important inputs for tools such as MARXAN-Z, and that Marxan Z is a useful tool for MPA zoning as it provides a more comprehensive analysis than other zoning methods incorporating multiple zone types.

## **Net-Works - working with industry to create an inclusive business model around a conservation issue**

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Net-Works, a partnership between the Zoological Society of London (ZSL) and Interface, is designed to tackle the growing environmental problem of discarded fishing nets in some of the world's poorest coastal communities and to support Interface's ambitious goals for recycled content in its carpet tile. These nets are highly dispersed and located in some of the most important yet vulnerable areas of marine biodiversity where ZSL operates. An example of an inclusive business model that has at its heart a conservation objective, Net-Works supports artisanal fishing communities in developing countries to establish a community-based enterprise based around clearing this destructive waste out of their marine environment whilst providing a valuable additional source of income. Through Net-Works this material is aggregated and exported to Slovenia where Aquafil recycle it into nylon yarn that is used in Interface's products. So far, around 900 households have engaged in the programme in the central Philippines, and collected enough waste net to stretch from London to Chicago and back with plenty to spare. The business model itself is designed to deliver social benefits above and beyond the income from the nets by linking it to the provision of essential financial services.

# Poster Abstracts

*Abstracts have not been edited by the committee in any way other than to standardise the formatting throughout the document. If you have questions about any of the abstracts, please send these to the email address provided.*

## The photo-physiological response of symbionts to combined effects of temperature and pH in a non-calcifying corallimorpharian, *Rhodactis rhodostoma*

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Recently IPCC projections suggest changes in air and sea surface temperature, precipitation, CO<sub>2</sub>, pH, and sea level all will significantly impact coral reef ecosystems. At the same time, human activities in the coastal zone (e.g. fishing activities and coastal development) have increased habitat destructions to coral reef ecosystems. Assessing how these ecosystems function and identifying the synergistic effects of local versus global stressors will help us to better manage them as a resource. During this study, polyps of *Rhodactis rhodostoma* were acclimated to 2 different pH treatments; 7.3 and pH 8.2, for one week before the temperature was raised from 26°C to 30°C in one of two aquaria in each pH treatment for 2 weeks. The combined effects of low pH and elevated temperature on the photo-physiological response of symbionts in corallimorpharian *R. rhodostoma* were investigated. The zooxanthellae density and chlorophyll *a* fluorescence parameters (effective absorption cross section of photosystem II ( $\sigma_{psII}$ ) and re-oxidation state of quinone A ( $\tau_{QA}$ )) remained constant in all treatment, while the maximum quantum yield of photosystem II (PSII) ( $F_v/F_m$ ), chlorophyll *a* biomass was significantly affected by temperature. Chlorophyll *a* per algal cell was highly reduced under the combined high-temperature and low-pH condition. pH had no significant effect on photosynthesis process of algae in *R. rhodostoma*. It is suggested that elevated temperature might possibly generate oxygen radicals in the algal cells which resulted in the observed reduction of  $F_v/F_m$  and algal chlorophyll *a* content. The host may have counteracted the levels of reactive oxygen species from the endosymbiotic algae, thus unaffected the zooxanthellae density within the host. Furthermore, these results are indicative of high temperature and not low levels of pH having a significant effect on photosynthesis of endosymbionts in *R. rhodostoma*.

## Do minor bleaching events matter? Ecological observations from a localised bleaching event in Kenya 2013

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The severe 1998 bleaching event caused approximately 80% coral mortality in Kenyan reefs, with severe long-term ecological impacts. Bleaching is predicted to become more common as climate change progresses. However, the impacts of the bleaching are highly variable with different frequencies of bleaching and then subsequent mortality and recovery. A minor bleaching event, caused by raised water temperature, was observed in Watamu Marine National Park, Kenya starting in March 2013. Data on adult and juvenile corals were collected prior, during and after the event from February until October 2013.

Bleaching was observed in 60% of colonies, in most genera of scleractinian corals as well as other zooxanthellate organisms on the reef. This included more resistant corals such as *Porites* and *Favidae*, as well as the susceptible genera *Acropora* and *Pocillopora*. Recovery to normal colour was fastest in acroporids, while some favids still showed pale colouration in July, four months after the event. Mortality of colonies was low in most genera, except for *Pocillopora* where 50% of colonies died.

Despite a high prevalence of bleaching observed during this event it seems that recovery was high, even among susceptible acroporids. The loss of *Pocillopora* may have an impact on certain fish and crabs, which are known to be dependant on this genus of coral, but on the whole it could be that this bleaching event had relatively little ecological impact on the reef. Whether the low mortality of reef-forming corals was a result of only a minor excursion in temperature or whether corals are adapting to exposures to high temperature remains open to question.

## **Coral juveniles in Chagos: the next generation**

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The Chagos Archipelago, the world's largest fully no-take marine protected area is well known for its unspoilt nature, but in our changing climate, we have in recent years seen a decline in coral reefs worldwide.

The health of reefs is dependent on numerous factors, but an abundant supply of juvenile corals is a crucial prerequisite for the long-term viability of coral reefs. A lack of this initial supply in many areas has seen continued decline of reefs.

As a method of accessing the current health and long term viability of the coral reefs in the Chagos Archipelago, we measured the distribution and abundance of juvenile corals in March 2013 to ascertain their abundance and distribution patterns in this area.

We found that recruitment patterns were significantly different in lagoon slopes and ocean facing slopes ( $p > 0.001$ ), with seaward slopes generally showing increasing juvenile densities to 15 m, while in lagoons densities declined strongly from about 10 m depth. These distribution differences were extremely significant at different depths (Chi squared = 1700,  $p > 0.0001$ ). There was also a correlation ( $p > 0.001$ ) between the amount of adult coral cover and juveniles, reflecting either an external factor such as grazing/rasping, or possibly chemotaxis. In contrast, there was no significant influence of geographical aspect (e.g. NW vs SE facing).

For Chagos these results show a continued healthy supply of juveniles which is encouraging for prospects of future coral growth.

## All boom and no bust: progress of the lionfish invasion in Bacalar Chico Marine Reserve, northern Belize

Jennifer K. Chapman<sup>1</sup>, [Charlotte Gough](mailto:charlotte.gough@blueventures.org)<sup>1</sup>, Joanna Hudson<sup>1</sup>, Frances Humber<sup>1</sup>, Alasdair Harris<sup>1</sup>

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Lionfish (*Pterois volitans*) were introduced to the Atlantic in the 1980s, with the first confirmed sighting in Belize in 2008. The species is now well established throughout the region, provoking concerns for already threatened fish stocks and overall coral reef health in the Caribbean.

In the Bacalar Chico marine protected area (MPA), lionfish monitoring and research activities have been carried out since 2011. Results show that the mean frequency of lionfish sightings whilst diving increased between 2011 (1.9 fish hr<sup>-1</sup> ± 0.1 SEM), and 2012 (2.7 fish hr<sup>-1</sup> ± 0.2 SEM). Despite similar mean total lengths in 2011 and 2012 (21.08 ± 0.22 cm and 23.84 ± 0.19 cm), there was a significant upward shift in size class frequency distribution between 2011 and 2012 ( $\chi^2=333.74$ , d.f.=4,  $P<0.01$ ), with 15% of lionfish observed were >30cm in 2012 compared with just 5% just one year earlier.

Culled lionfish were dissected to record stomach contents, sex and maturity. Mean number of prey items within lionfish (2.16 ± 0.13) was unchanged from 2011 to 2012, and the maximum number of prey items encountered within one lionfish was 19 in both years. A change in diet however was observed between the two years. In 2011, the majority of prey items were fish (68%), including parrotfish, wrasse, damselfish and grouper, while in 2012 invertebrates, predominantly shrimp, comprised a much larger proportion (56%) of the fish's diet.

Developing a market for lionfish meat is considered to be the most feasible management solution to impede lionfish population growth and spread. The consistent removal of more than one third of the population is required to prevent population growth and expansion; therefore an integrated approach to developing alternative management solutions for the invasion both within and outside of protected areas is essential.

## **Do mangrove forest restoration activities return biodiversity and ecosystem services to pre-impact levels?**

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Mangrove forests have been widely degraded or destroyed in many locations despite providing crucial ecosystem services to coastal communities such as increased reef fisheries yields. In response, many mangrove restoration initiatives have been established. Biodiversity and provisioning ecosystem services were assessed to evaluate the effectiveness of mangrove restoration asking whether: (i) biodiversity and provisioning ecosystem services are returned after restoration and (ii) current monitoring is assessing the right species to evaluate ecosystem service provision.

A global systematic review was used to identify all studies containing biodiversity or ecosystem service assessments from restored mangrove sites and adjacent low-impacted mature mangrove reference sites. Effect sizes were calculated and meta-analysis conducted providing a quantitative synthesis.

Major taxonomic biases towards sediment-associated macrofauna were identified in studies found. Abundances of fish, crustaceans, molluscs and polychaete worms in restored mangroves were greater, or equivalent to, reference sites. Crustacean abundance and biomass was higher in restored sites than reference sites, suggesting mangrove restoration could potentially return provisioning services. Leaf litter biomass was greater in reference sites than restored mangrove forests, but became less different with time since restoration, implying mature restored mangroves become similar to reference sites.

Studies failed to evaluate the abundance and biomass of key taxonomic groups that are of major livelihood and commercial importance, such as fish and harvestable crustacean species, resulting in a poor evidence base available to people making management decisions. Future mangrove restoration and rehabilitation practice and research would benefit from focusing on: (i) defining clear goals to allow for effective evaluation, (ii) implementing more rigorous experimental design for research and evaluation using a before-after-control-impact approach and (iii) identify species and taxonomic groups providing key ecosystem services, ensuring these are included in monitoring and assessment activities.

## A novel trait-based approach to assessing reef community similarity

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Dissimilarity coefficients (i.e. Bray-Curtis) are commonly used to assess the degree of species overlap between communities. A key shortcoming of such approaches is that they disregard the fact that some species are highly similar in terms of traits (and therefore have similar ecological roles) while others are not. Here we present a novel dissimilarity measure (*Tdis*) that compares ecological communities in terms of their overlap in trait-combinations (by trait we mean important morphological, physiological, and behavioral attributes).

*Tdis* is a widely applicable similarity index and can be used across Ecological disciplines. Here we give an example for the utility of *Tdis* using community composition data from 66 reefs located along sedimentation, fishing intensity, and fetch gradients in southwest Madagascar. The similarity of the reefs was compared in terms of 26 key life-history traits of 231 species.

We demonstrate how our trait-based dissimilarity coefficient could identify reefs that are functionally highly similar (i.e. they contain species with highly similar trait sets) despite being dissimilar in that they contain few overlapping species. Since traditional dissimilarity coefficients such as Bray-Curtis are unable to detect such functionally similar but mechanically different reefs we suggest that *Tdis* be added to the reef managers toolkit for monitoring and assessing reefs. Our R-based package for translating coral species composition into coral trait composition and calculating *Tdis* is also briefly introduced.

## Algal removal and its effects on coral recruitment

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One of the major detrimental effects of algal dominance on coral reefs is a reduction in coral recruitment. Corals struggle to settle and grow on algal covered substrates, meaning they cannot reproduce successfully. As with many of the world's reefs, in Bonaire (Dutch Caribbean) algal turf has become the dominant substrate on the island's fringing coral reefs. In September and October 2012, ten 12 cm squares of dense turf-algae covered rock from 9 – 25 m depth were scrubbed clean of algae directly proceeding coral spawning. These sites were compared to fully-paired untouched control sites, a maximum of 10 cm away from the clean sites. Following cleaning, each site was visited every seven nights for 28 nights, and using a fluorescent light any new coral recruits were recorded and photographed. In total nine new coral recruits were found. All recruits were either on the untouched control sites or just outside the cleaned sites, partially covered by dense algae. To allow successfully cleaning and repeated visual surveys at night, non-cryptic and low rugosity sites had to be used in this study. As cryptic areas are known to be preferential for coral larvae settlement, it is possible that in exposed sites the protection offered by the algae is necessary for successful recruitment. It is also possible that the invasiveness of the algae removal, led to the loss of chemical or physical cues that are needed for coral larvae to settle. Overall, it seems unlikely that physical algal removal would be a successful way to increase coral recruitment.

## SECORE Foundations coral spawning efforts move East

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Founded in 2001 and made into a foundation in 2012, SECORE (SExual CORal REproduction) Foundation is a non-profit initiative combining a global network of scientists, public aquarium professionals and local stakeholders. Using a multidisciplinary strategy SECORE combines research, education, outreach and active reef restoration with the aim of conserving coral reefs.

Since 2005 SECORE have run annual workshops, both laboratory and field based, covering techniques of gamete collection, fertilization, post fertilization care, larval rearing, larval transportation and subsequent larval settlement.

During 2013 SECORE has expanded the sites in which it operates to now include Curacao, The Philippines, Mexico and Guam. Each of these locations represents a multiyear coral conservation programme and in July 2013 the first workshop in Guam took place. In collaboration with the University of Guam (UOG) Marine Lab, Underwater World Guam, the Government of Guam, the Henry Doorly Zoo (USA) and the Columbus Zoo and Aquarium (USA), the workshop hosted 34 delegates from 8 nations.

During the 13 day event, over 600,000 larvae of two coral species, *Acropora humilis* and *Acropora surculosa*, were raised. In-vitro fertilization rates of 75% were achieved and the gastrulation period was documented photographically, mapping the embryonic developmental stages of these Acroporids. In addition construction of a new nursery facility began ahead of schedule, bringing the possibility of coral out-planting forward by a year.

## Potential implications of harvesting ornamental sabellids from the wild: a case study of Busuanga, Palawan, the Philippines

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Collection of live invertebrates from coral reefs has increased dramatically in response to the growing marine aquarium industry with more than 500 species (excluding corals) currently being traded. The majority of these are harvested from the wild, of which sessile and conspicuous species have been highlighted as a “risk group” due to the impacts of over-collection. Ornamental fan worms, such as sabellids, are routinely collected and at present all specimens are collected from wild sources. Sabellids build their own mucoid-sediment tubes which attach to the surrounding reef framework. Very little is known about their population ecology and therefore, an assessment of the likely impact of their removal to the surrounding coral reef community is difficult. The Philippines is one of the biggest exporters of the marine aquarium trade and was used as a case study to investigate the population ecology of ornamental sabellids. Population densities were quantified at six sites, including protected and unprotected areas, following a preliminary presence/absence assessment of local reefs. Swimming observers recorded: a count; genus-level identification; position in meters from the start of the transect; a measurement of each specimen’s branchial crown in cm; and a description of the habitat/coral species with which the specimen was associated along belt transects. Sabellids, of the genus *Sabellastarte* and *Bispira*, were found as individuals or in clusters of up to 12, attached to rocky rubble, in coarse sand and predominantly embedded within live coral across the shallow reef environment. *Porites sp.* coral was the dominant host and individual tubes were attached within cracks and crevices, often with only the branchial crown visible. The process of removal to supply the aquarium trade is therefore a delicate procedure which is exacerbated by their location within slow-growing *Porites sp.* coral. The potential interactions between these ecological factors and collection procedure are discussed.

## **Analysing the link between development and the health of the marine resources of the community of La Parguera, PR**

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This project is carrying out a time series analysis of the link between development and the health of the marine resources of the community of La Parguera, PR. The community is located in a Nature Reserve, but lacks any implemented management plan to control development and provide resource protections. La Parguera has also been designated a region of special interest for Ecotourism Development. This project intends to provide information to aid in establishing levels of appropriate development for an area zoned for ecotourism in order to facilitate a transition to sustainability. This is being accomplished by analyzing land use changes and patterns of development in the community over the course of 50 years in conjunction with the health of the coral reef ecosystem using biological and physical parameters as an indicator of disturbance. This is an attempt to improve on the information available for a Spatial Decision Support System (SDSS) towards developing Coastal & Marine Spatial Planning (CMSP) in this region. Methods being used include:

Image enhancements and subsetting of original digital ortho aerial photos of the region.

Image to image and image to map rectification with an USGS digital raster graphic map of the area using ERDAS Imagine 9.3 & ArcGIS 10.

Unsupervised classification & Multi-temporal compositing to carry out coastal change detection analysis using ERDAS Imagine 9.3 & ArcGIS 10.

Developing geodatabases of land use changes, socio-economic demographics, and health of the coral reef over time using historical digital ortho photos, parcel data, and archival and published data on reef health .

Statistical & spatial data analysis of geodatabase for land use changes, socio-economic demographics and the biological and physical parameters of reef to identify any correlations between land use and health of the reef.

## **Coral communities of inner-shelf turbid zone reefs: offshore Paluma Shoals reef complex, Great Barrier Reef**

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High terrigenous sedimentation loads within nearshore marine environments are considered to be detrimental to reef ecological “health” by reducing the growth and calcification, abundance and distribution, and species diversity of reef-building corals. However, established coral communities, with long-term persistence through the mid- to late Holocene, have been reported for several inner-shelf locations on the central Great Barrier Reef (GBR) where turbidity is high. Thus far, knowledge of the extent and ecological parameters of such reefs are lacking compared with their ‘clear water’ mid-shelf and outer-shelf counterparts. To generate a detailed assessment of ecological community structure, and to determine the spatial distribution of coral assemblages of non-emergent turbid zone reefs on the central GBR, we conducted towed video transect surveys across several reef structures (~3 km from the mainland) that form the Offshore Paluma Shoals reef complex within Halifax Bay, central GBR. Observations of substrate and habitat type, coral cover and coral species diversity were recorded at high-resolution sampling intervals across reef and inter-reef areas. Findings showed that coral cover was high (up to 100% in some areas) and comprised distinct coral assemblages. Coral growth was typically confined to rigid substrates on the reef structures with the exception of “coral carpets” which formed as highly rugose monospecific stands of *Turbinaria sp.* colonising sandy substrates in inter-reef areas. These may represent early or incipient phases of nearshore reef development. Results highlight the importance of turbid, inner-shelf environments as critical habitat for coral growth and for reef development. Furthermore, they suggest that there may be a current shelf-wide underestimate of coral cover on the GBR as the inner-shelf zone has largely been considered unsuitable for coral growth and as a result there is inadequate data on coral assemblages and reef development generally within this zone.

## Tides of change: 24 years of marine conservation in Tanzania

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Coral reefs are described as the rainforests of the sea, comprising the greatest wealth of biodiversity of any marine ecosystem. They also provide a number of goods and ecosystem services to humans, valuing in the region of £230 billion per year. However, coral reefs are currently in decline worldwide, largely due to climate warming and ocean acidification, and the overexploitation of marine resources. In Tanzania, East Africa, the rising number of people living along the coastline is putting particular pressure on these precious ecosystems. Frontier Tanzania was set up in 1989 to help assess the biodiversity of the coral reefs and ease this anthropogenic pressure. Up until 1995, Frontier Tanzania conducted baseline monitoring of coral, fish and invertebrates off the coast of Utende, Mafia Island. In doing so, a management plan was formed, which later led to the creation of the first multi user marine park in Tanzania (Mafia Island Marine Park). Over the following 15 years, Frontier Tanzania moved between different sites along the east coast, carrying out further biological surveys and socio-economic investigations, before returning to Utende, Mafia Island, in 2010. The aim of the current project is to produce an up to date management plan for, and a risk assessment of, the multi user marine park, through a five year monitoring programme. The work of this project to date and of those before it has provided a long-term data set of coral reef biodiversity and has made great strides in best management practices.

## Climate change impacts on coral reefs: synergies with local effects, possibilities for acclimation and management implications

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We reviewed recent research on the potential impact of global warming and ocean acidification, and their interactions with local stress factors. Our findings underline that coral bleaching, acidification and diseases are expected to interact synergistically, and will negatively influence survival, growth, reproduction, larval development, settlement and post-settlement development of corals. Interactions with local stress factors such as pollution, sedimentation and overfishing are further expected to compound effects of climate change.

Reduced coral cover and species composition following coral bleaching events affect coral reef fish community structure, with variable outcomes depending on their habitat dependence and trophic specialization. Ocean acidification itself impacts fish mainly indirectly through disruption of predation- and habitat-associated behaviour changes.

Zooxanthellate octocorals on reefs are often overlooked but are substantial occupiers of space; these also are highly susceptible to bleaching but because they tend to be more heterotrophic, climate change impact mainly manifests in terms of changes in species composition and population structure. Non-calcifying macroalgae are expected to respond positively to ocean acidification and promote microbe-induced coral mortality via the release of dissolved compounds, thus intensifying phase-shifts from coral to macroalgal domination.

Adaptation of corals to these consequences of CO<sub>2</sub> rise through increased tolerance of corals and successful mutualistic associations between corals and zooxanthellae is likely to be insufficient to match the rate and frequency of the projected changes.

Impacts are interactive and magnified, and because there is a limited capacity of corals to adapt to climate change, global targets of carbon emission reductions are insufficient for coral reefs, so that lower targets should be pursued. Alleviation of most local stress factors such as nutrient discharges, sedimentation and overfishing is also imperative if sufficient overall resilience of reefs to climate change is to be achieved.

## An ecosystem on the brink of collapse? A novel urchin disease epidemic in Australia

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Urchin disease has been documented in numerous countries and have been implicated in the dramatic decline of whole ecosystems. In particular, the well documented case of the disease induced functional extinction of *Diadema antillarum* throughout much of the Caribbean was thought to have been instrumental in the change from a reef dominated to algal dominated habitat. In this study we report a similar devastating disease affecting two species of Urchin in the Indo-Pacific. The disease is similar in pathology to bald urchin disease, which has been reported in California, the Mediterranean, the Atlantic Ocean and the English Channel but not previously in the Indo-Pacific. Two pathogens were identified as the likely causal agents in this study, both of which were from the genus *Vibrio* (*V. parahaemolyticus* and *V. anguillarum*). These were identified via non-cultured molecular techniques and histological sectioning and present in diseased yet absent in healthy tissues. The bacteria produced a zone of inhibition around themselves and degraded the tissues and connective fibres causing the skeleton to collapse in on itself resulting in rapid death. Previous studies have fulfilled Kochs postulates on both these bacteria in different areas of the world and this study complements these along with illustrating how the bacteria are able to cause the damage. The ability of these pathogens to move from species to species is worrying as this disease may lead to a similar ecosystem collapse as that in the Caribbean and urgent work is needed to monitor the effects of this disease and map its spread.

## Microplastics in tropical marine habitats in Lac bay, Bonaire (Dutch Caribbean)

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Plastic pollution on beaches is prevalent worldwide, but harder to observe and less well known, is the pollution from microplastics (<2cm). Microplastics pose a threat to many forms of marine life through ingestion; with gut content analysis finding plastic in crustaceans, fish and marine birds. Tropical and temperate beach sediments and temperate subtidal sediments are known to have microplastics in the sediments. Microplastics in the sediments of tropical ecosystems such as mangroves, seagrass beds and coral reefs remains little studied.

A field study was conducted to determine if microplastics were present in a tropical lagoon in Bonaire (Dutch Caribbean). Mangrove, seagrass, shallow back reef and forereef habitats were sampled. Sediments were dried and sorted using a sieve shaker, with sediments 251µm - >2mm examined and microplastics removed. Remaining sediment samples were placed in a concentrated saline NaCl solution (1.2 g cm<sup>-3</sup>) to assess for buoyancy. The solution was shaken, left to rest and microplastics removed from the supernatant were examined using a compound microscope.

Sediments from all habitats contained fragmented microplastics; predominately blue fibres. Although industrial microplastic pellets have been found on beaches in Bonaire, none were found in subtidal sediments in Lac bay ecosystems. There was an increase in the amount of plastic with decreasing size; with the largest number of items found in the smallest size category assessed 251µm - 500µm. The highest density of microplastics was found in the forereef habitat (5.75 ± 3.10 items l<sup>-1</sup>; mean ± se) followed by mangrove (4.63 ± 3.23 items l<sup>-1</sup>), seagrass (3.31 ± 2.60 items l<sup>-1</sup>), and shallow reef (1.58 ± 0.75 items l<sup>-1</sup>). Within the bay; sites along the western transect contained significantly higher densities of plastic (Kruskal-Wallis,  $\alpha = 0.05$ ,  $p = 0.016$ ) than eastern and central sites, probably due to the predominately westerly water currents.

## Historical photos as a source of determining coral reef baseline data

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Coral reefs have changed in recent decades due to climate change, overfishing, disease and pollution. Monitoring changes in coral reefs has become a popular area of research, but there is increasing discussion regarding baseline data to define a “healthy reef”. Many “healthy reefs” surveyed in monitoring programs over the last decade are likely to have already undergone changes. There are few surveys prior to the mid-nineties, meaning data on reefs more than two decades ago are limited. However, there are extensive photographic records. The Natural History Museum has received a donation of over 1000 photographs of reefs on the North Coast of Jamaica from photographer Eileen Graham that were taken in 1966. Collections like these may be available for reefs all over the world. We propose that these photos could be useful for gathering information such as cover and relative abundance of scleractinians (including different growth forms), soft corals, sponges, macroalgae and calcareous algae. The challenge of the work is selecting suitable photos and incorporating them in a way useful as baselines for modern day reef monitoring and policy makers. The depth, date and reef the photos were taken on is known, and there is often a sense of scale, however exact coordinates are unknown, and purpose of photos varies from scientific (photographing quadrats) to recreation. Despite the limitations, historic photographic collections have the potential to reveal vital information about coral reefs 40-50 years ago, which could complement modern day monitoring in investigating how reefs have changed in the past half a century. Retiring researchers are likely to have comparable collections. Making these photographs part of the permanent collections at the Natural History Museum will make this source of information available for researchers interested in changes in coral reefs over time.

## Rocky platforms of Watamu Marine National Park: biodiversity, conservation, and education

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Watamu Marine National Park, Kenya is renowned for its beautiful beach and nearby coral reefs. In addition, visitors to this national park are often observed exploring rockpools at low tide and an unofficial guide trade has developed around this activity. With the exception of some historical literature, little to no research has been completed in these rockpools and so there has been no assessment of conservation needs. A project was started in December 2012 to study the biodiversity of these rockpools, identify threats, suggest possible conservation interventions, and begin developing education products for use in the local community to raise awareness of these habitats. The initial phase of the project, completed in February 2013, focused on major taxonomic categories of organisms. Biodiversity included all three major algal phyla, lower animal forms such as sponges and corals and higher animal forms such as echinoderms and vertebrates. An educational package was developed and tested with both adult NGO workers and a group of 50 primary school students and their teachers. A guide to these major taxonomic groups was produced as well as presentation resources. Phase 2 of the project focuses on quantifying the abundance and biodiversity of these major taxonomic groups and is currently focusing on corals, fishes (both resident and juvenile reef fish), and echinoderms. Coral studies have identified a population of *Anomastreaa irregularis*, an EDGE coral species. Potential threats to rockpool biodiversity include overuse by tourists, runoff from land-based development, and poaching. Conservation activities include quantifying the full range of biodiversity, monitoring changes spatially and temporally, and continuing education of guides, tourists, and the local community.

## **Ecological effects of a community-managed marine reserve in the Bay of Ranobe, SW Madagascar**

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Community-managed marine reserves have been widely implemented as a conservation tool to sustain coral reef fisheries and improve reef resilience. The Bay of Ranobe, in southwest Madagascar, is under increasing pressure from overfishing and climate change. In 2007, one of the first community-managed marine reserves in the region, the “Rose Garden”, was established in the Bay of Ranobe as part of a marine management program to improve the overall reef resilience in the region. Despite the presence of several marine reserves in Madagascar, data on their effectiveness are lacking. In this study, the effects of protection on benthic cover and fish density at Rose Garden were evaluated using long-term underwater visual census data, collected before and after the designation of the marine reserve. We also compared fish density and benthic cover in Rose Garden with non-protected reef sites in the Bay of Ranobe. Our results indicate that the creation of the marine reserve at Rose Garden resulted in significant increases in: i) overall fish densities ii) densities of commercially important species, and iii) densities of carnivorous and herbivorous fishes, throughout the 6 year study period. Analyses of the benthic cover at Rose Garden demonstrated a significant increase in coralline algae, a decreasing trend in fleshy algae, and stable hard coral cover following the creation of the marine reserve. In comparison with non-protected reef sites, fish density and live coral cover were significantly higher at Rose Garden. This evaluation indicates that small community-managed marine reserves have the potential to promote the recovery of over-exploited reef fish populations and prevent the shift to macroalgae dominance, consequently enhancing the natural resilience of a coral reef system.

## The marine turtle fishery in the Bay of Ranobe, SW Madagascar and the transition towards a co-management protection strategy

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Marine turtles constitute an integral aspect of the cultural heritage for the Vezo fishing community who inhabit the coastal regions of Southwest Madagascar. However, turtles also represent enormous wealth owing to the capture, trade, and wholesale of turtle meat. Over a four year study period (2009–2012) social, economic and biological information was collated on the turtle fishery in the Bay of Ranobe, with the aim of implementing a co-management protection strategy for marine turtles. The study found that *Chelonia mydas* (green turtle) significantly dominates the fishery (95%), although all five species of marine turtle present in Madagascan waters; *Eretmochelys imbricata* (hawksbill), *Caretta caretta* (loggerhead), *Lepidochelys olivacea* (olive ridley) and *Dermochelys coriacea* (leatherback) are also targeted. Estimates of the annual income from the turtle fishery increased from £3,000 in 2009 (£2.60/ kg) to £6900 in 2012 (£3.60/kg). Over the same time period, average turtle length (straight carapace) decreased from 78 cm in 2009 to 69 cm in 2012 with the capture of large individuals becoming increasingly rare. Utilizing this information, the marine NGO 'ReefDoctor' assisted in the creation of the first grassroots marine turtle fisheries management association in Madagascar, which received legal status in late 2012. Through the alliance of turtle fishers, community leaders and elders, indigenous knowledge is translated into an informed and integrated management framework. The association aims to protect marine turtles through the strengthening of traditional customs and the implementation of traditional social codes or DINA's. A transition towards co-management can increase compliance and reduce friction and conflict with, within, and between communities. ReefDoctor has provided the Vezo community with the tools to make informed management decisions which has resulted in a highly dedicated community-lead team that seeks to become an innovative working model and platform for marine turtle conservation throughout the Western Indian Ocean.

## Corals from the Persian/Arabian Gulf as models for thermotolerant reef-builders: Prevalence of clade C3 *Symbiodinium*, host fluorescence and ex situ temperature tolerance

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The Persian/Arabian Gulf is often the hottest sea on Earth. Corals of the Persian/Arabian Gulf regularly endure temperatures of up to 36°C, making them ideal subjects to study the mechanisms underlying thermal tolerance. Here, we present findings from an experiment first proposed at RCUK 2011. Specimens of *Porites lobata* with characterised symbiont associations (C3 vs. C15) and host fluorescent protein (FP) patterns from two habitats with different temperature regimes (Abu Dhabi vs. Fiji) were aquarium cultured for more than 15 months. The characterised associations and FP patterns remained unchanged over this time and growth rates were comparable to those documented in the field. During temperature stress experiments host green fluorescent protein (GFP)-like pigments were strongly downregulated in both groups of corals. However, the Abu Dhabi samples were less prone to bleaching and showed lower mortality rates than the Fijian samples. To assess whether the *P. lobata* – C3 associations represented the majority of coral-symbiont associations in Abu Dhabi, symbiont types were characterised in six further species of coral. Corals were predominantly associated with the 'generalist' C3 or type A1 *Symbiodinium*. Both a lack of coral-*Symbiodinium* associations with purportedly thermally tolerant *Symbiodinium* types D1 or C15 and a lack of distinct expression pattern of photoprotective host pigments begin to elucidate the mechanisms behind the heat tolerance of Gulf corals. Knowledge gained from this, and subsequent experiments, will help evaluate whether Gulf corals could potentially be used for assisted migration in reef restoration projects outside their natural habitat. It will also aid in predicting the reaction of corals globally to future forecasted increases in sea surface temperatures.

## Oceanic sharks clean at coastal seamount

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Interactions between pelagic thresher sharks (*Alopias pelagicus*) and cleaner wrasse were investigated at a seamount in the Philippines. Cleaning associations between sharks and teleosts are poorly understood, but the observable interactions seen at this site may explain why these mainly oceanic sharks regularly venture into shallow coastal waters where they are vulnerable to disturbance from human activity. From 1,230 hours of observations recorded by remote video camera between July 2005 and December 2009, 97 cleaner-thresher shark events were analyzed, 19 of which were interrupted. Observations of pelagic thresher sharks interacting with cleaners at the seamount were recorded at all times of day but their frequency declined gradually from morning until evening. Cleaners showed preferences for foraging on specific areas of a thresher shark's body. For all events combined, cleaners were observed to conduct 2,757 inspections, of which 33.9% took place on the shark's pelvis, 23.3% on the pectoral fins, 22.3% on the caudal fin, 8.6% on the body, 8.3% on the head, 2.1% on the dorsal fin, and 1.5% on the gills respectively. Cleaners did not preferentially inspect thresher sharks by time of day or by shark sex, but there was a direct correlation between the amount of time a thresher shark spent at a cleaning station and the number of inspections it received. Thresher shark clients modified their behavior by 'circular-stance-swimming', presumably to facilitate cleaner inspections. The cleaner-thresher shark association reflected some of the known behavioral trends in the cleaner-reef teleost system since cleaners appeared to forage selectively on shark clients. Evidence is mounting that in addition to acting as social refuges and foraging grounds for large visiting marine predators, seamounts may also support pelagic ecology by functioning as cleaning stations for oceanic sharks and rays.

## **Preliminary assessment of coral reef health and extent in the Myeik archipelago, Myanmar**

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Globally, anthropogenic disturbance coupled with the effects of global climate change have had a significant impact on the world's coral reefs, emphasising the need for increased and improved conservation efforts regionally, nationally and internationally. The Myanmar coastline stretches for over 2,000km and supports diverse coastal and marine habitats including coral reefs, seagrass beds, mangroves, sandy beaches and mudflats. At present, a comprehensive understanding of the status of these ecosystems is lacking. Comprised of over 800 islands, Myanmar's Myeik Archipelago is situated in the north-eastern Andaman Sea. To address the need for improved mitigation measures in Myanmar, Fauna & Flora International (FFI) and the Biodiversity & Nature Conservation Association (BANCA) are working collaboratively to establish the country's first locally managed marine protected area. Baseline coral reef surveys based on global Reef Check Methodology were completed in 2013 for the Daung Island Group to assess the overall status of reefs in the region, and to identify areas of high conservation value that would benefit from the implementation of a marine protected area. Preliminary results indicate considerable anthropogenic impact to the coral reefs in the region. Here we discuss the findings of this survey, make recommendations for future monitoring protocols to support the implementation of effective mitigation measures and identify sites suitable for follow up surveys.

## Shallow-water gorgonians (*Octocorallia*) of Utila, Bay Islands, Honduras

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Abundance, size distribution, and health assessment of octocorals were determined from six sites in shallow reef-crest and reef-slope habitats around Utila, an island approximately 40km off the northern Caribbean coast of Honduras (Figure 1). The Bay Islands are the eastern-most extension of the Mesoamerican Barrier Reef System (MBRS) and an increasingly popular diving destination. Compared with the reefs of Belize and the Yucatan Peninsula, the Honduran Bay Islands are under-represented in the MBRS literature and comprise a distinct assemblage of species. Here we present the first species-level report in Utila of the characteristic Caribbean shallow-water octocorals. Communities differ from the neighbouring island of Roatan (~30km northwest of Utila), where the only other Bay Island octocoral species report exists, and this study adds a missing piece of information to the diversity of the MBRS. Reef monitoring data by Operation Wallacea are also reported. Volunteer collected data of coral, algae, and sponge cover as well as fish biomass are used for site description, and compared and contrasted to the in-depth octocoral study presented herein.

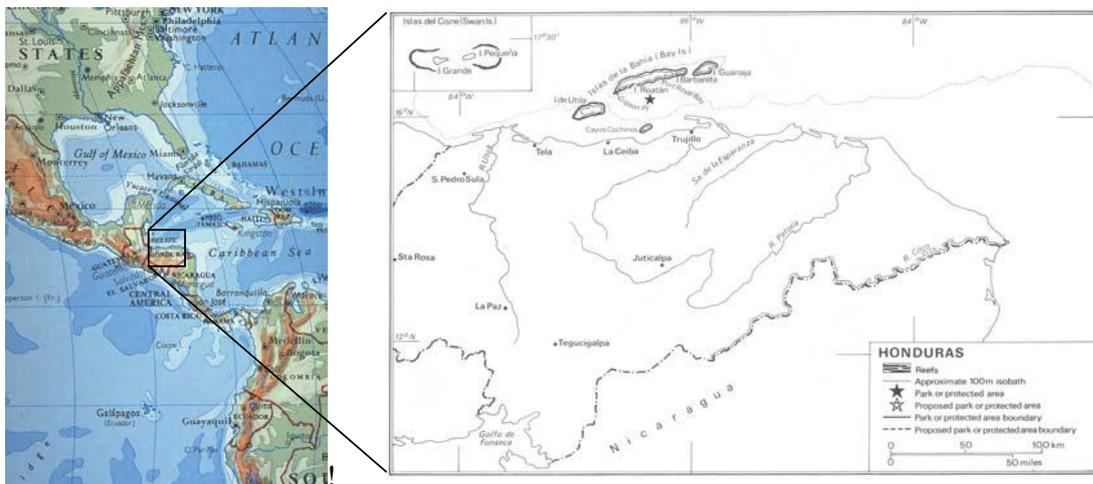


Figure 1 Map of the Caribbean Sea and location of the Bay Islands of Honduras (from Harborne et al. 2001).

## **The Green Fins approach for monitoring and promoting environmentally sustainable scuba diving operations**

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Coral reefs are threatened by a variety of direct and indirect impacts caused by irresponsible snorkelling and scuba diving practices. An expansion of coral reef tourism around the world has resulted in growing concern about the associated environmental impacts. In 2004, UNEP initiated the Green Fins (GF) project as part of an effort to reduce unsustainable coastal tourism practices. Green Fins is a tool for supporting adoption and implementation of best environmental practice through a set of diving standards known as the GF Code of Conduct (COC). Through the implementation of the COC, alongside a robust Green Environmental Assessment Rating system (GEARs) to monitor dive centre's environmental threat and compliance, it aims to reduce the impact of tourism-related stressors to corals reefs, thereby enhancing their resilience to larger scale threats. The approach is implemented and coordinated internationally by The Reef-World Foundation; to date it has been introduced to 262 members in Indonesia, Malaysia, Philippines, Thailand, Vietnam and the Maldives. Here we present an evaluation of the effectiveness of the approach as a tool for the promotion of environmentally sustainable dive tourism, using the Philippines as a case study. In the popular dive destination of Puerto Galera, 26 dive centres joined GF by agreeing to adopt and comply with the COC. Each dive centre then received free in-house environmental training, were assessed against set criteria to measure threat and offered consultation outlining simple solutions for compliance. Reassessments one year later revealed that there was a significant reduction in the overall environmental threat assessment score across this network of dive centres. These findings indicate that implementation of the GF approach within the dive tourism industry has the potential to promote compliance with environmental standards and may significantly reduce the impact of the diving industry on the marine environment.

**The RCUK Organising Committee would like to thank everyone for  
participating in the RCUK 2013 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 2014 for the 17<sup>th</sup> RCUK Annual Meeting!

