

**PROGRAMME & ABSTRACTS**

**Zoological Society of London**

**4<sup>th</sup> December 2010**

**Presented by  
REEF CONSERVATION UK**

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

## Conference Committee

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3. Any specific inquiries can be directed towards: ***[rcuk@zsl.org](mailto:rcuk@zsl.org)***

**Many thanks to Guylian Chocolates (Belgium), for their support of this event. Guylian have been a long-term supporter of coral reef conservation through their partnership with Project Seahorse.**

## **Welcome to the 13<sup>th</sup> RCUK (Reef Conservation UK) Meeting 2010**

Welcome to the **13<sup>th</sup> annual meeting of RCUK** at the Zoological Society of London. Once again we are pleased to have been able to assemble, what we think you will agree, is a very interesting programme. This meeting continues to illustrate the impressive array of coral reef interests and activities here in the UK.

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

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

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

***RCUK Committee***

***4<sup>th</sup> December 2010***

## **From Science to Policy – The Role of GLOBE International**

Many of today's environmental challenges require global responses. However, international agreements, such as those to address climate change or biodiversity issues will only be successful if they are underpinned by robust and consistent domestic legislation.

Despite greater awareness of the economic and social values of ecosystems and the services they provide, the legislative response from across the world to the growing environmental crisis has been inadequate. This is partly due to the lack of effective links among scientists, economists, policy experts and legislators at the global level. The Global Legislators Organisation for a Balanced Environment (GLOBE International) is a unique political forum that has succeeded in creating these links, and is making clear recommendations for progressive environmental policies at both national and international levels.

GLOBE International consists of senior cross-party members of parliament from all G8 countries and from the +5 countries of Brazil, Russia, India, China and South Africa, and has been a significant contributor to international negotiations on major environmental issues since its creation in 1989. GLOBE has considerably expanded its activities since 2005 with the establishment of two targeted 'Policy Commissions' on 'Land Use Change and Ecosystems' and 'Climate and Energy Security'.

The work of the GLOBE International Commission on Land Use Change and Ecosystems (ICLUCE) has been supported by a small, dedicated team comprised of the GLOBE Secretariat, the Zoological Society of London (ZSL), and the Grantham Research Institute at the London School of Economics (LSE). ZSL and LSE are the main scientific and economic advisors to the Commission.

The marine side of the scientific advisory programme has been coordinated by ZSL staff at the Institute of Zoology. Working with the GLOBE Secretariat the focus has been to develop a Marine Ecosystems Recovery Strategy (MERS) that provides policy recommendations for three main areas of the marine environment; Marine Fisheries, Coral Reef Ecosystems and Coastal and Marine Shelf Ecosystems. The first two parts of this strategy have already been discussed and endorsed by GLOBE legislators at Commission Meetings held in 2010. The third and final part will be completed in 2011. Part two of the MERS focuses on policy recommendations to increase the resilience of coral reefs in the face of climate change and is presented during this RCUK meeting.

For more information on ZSL's marine conservation policy work with GLOBE please contact Simon Harding ([simon.harding@ioz.ac.uk](mailto:simon.harding@ioz.ac.uk)) or visit [www.zsl.org/conservation/conservation-policy/globe/](http://www.zsl.org/conservation/conservation-policy/globe/).

## RCUK ANNUAL MEETING: 2010 PROGRAMME

Time	Title	Authors
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### 8.30 – 9.00 Registration and Coffee

9.00 - 9.05	Introduction	K. Teleki
	Session 1: Coral biology	Chair: K. Teleki
9.05 – 9.20	Are ciliates the key infectious agents of White Syndrome in corals of the Great Barrier Reef?	J. Bythell, A. Croquer and M. Sweet
9.20 - 9.35	Environmental effects on coral growth and recruitment in the Caribbean	M.J.C. Crabbe
9.35 – 9.50	Sedimentary and hydrodynamic controls on coral growth rates on an inshore turbid zone reef	N. Browne, S. Smithers and C. Perry
9.50 – 10.05	Coral bleaching: the effects of environmental stress induced towards hard corals	J.R. Turner and Tengku Farak Kamilia Tengku Mohd Kamil
10.05 – 10.20	Investigation of the controls on bacterial community development in the reef coral <i>Acropora muricata</i> using experimental antibiotic treatment	M.J. Sweet, A. Croquer and J.C. Bythell
10.20 – 10.35	Investigating the properties and potential applications of the skeletal organic matrix in corals	P. Tomiak, E. Hendy and K. Penkman

### 10.35 - 11.10 Tea and Coffee Break

	Session 2: Indian Ocean	Chair: E. Wood
11.10 – 11.25	Episodic heterogeneous decline and recovery of coral cover in the Western Indian Ocean	M. Ateweberhan, T. McClanahan, N.A.J. Graham and C. Sheppard
11.25 - 11.40	Dugong without borders: building capacity for Indian Ocean sirenian conservation	P.Z.R Davis
11.40 – 11.55	Artisanal fishing in the Comoros: current status and opportunities for effective management	C. Poonian, K. Maoulida, Y. Mouzidalifa, J. Mouhhidine and I. Wanyonyi
11.55 – 12.10	Can coral industries play a role in the future conservation of coral reefs with a changing world?	P. Mansell, E. Wood, D.J. Suggett and D.J. Smith
12.10 - 12.25	Using social marketing to support local management of marine resources	G. Andriamalala and S. Peabody
12.25 – 12.45	The Chagos MPA story – so far	C. Sheppard

### 12.45 - 14.00 Lunch Break

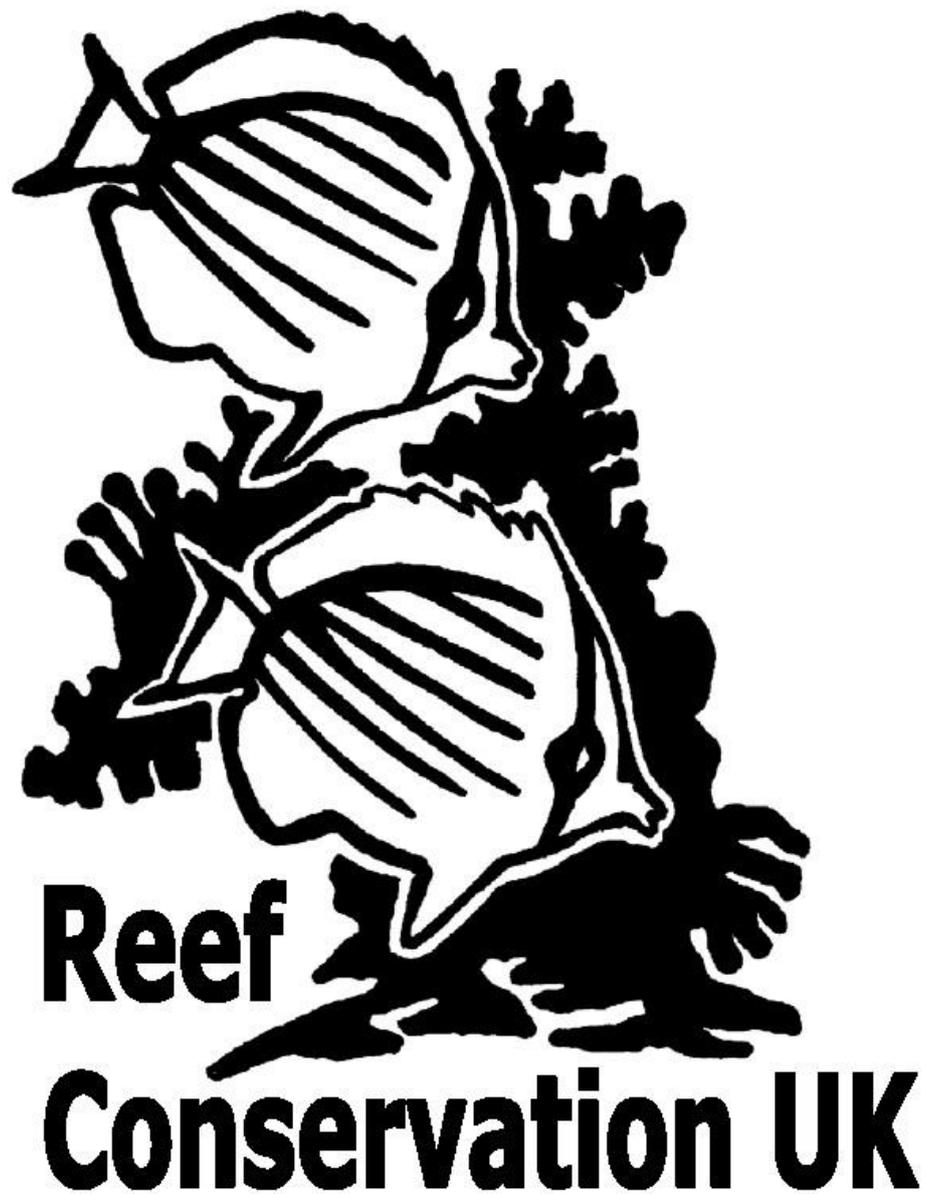
	Session 3: Biology of reef organisms	Chair: S. Harding
14.00 - 14.15	Reef fish functional redundancy in the Indo-Pacific	J. Curtis-Quick
14.15 - 14.30	A direct link to the nursery function of mangrove forests: the remarkable predator-avoidance strategy of the interrupted Dartfish ( <i>Parioglossus interruptus</i> , Ptereleotridae) exploits vacant Shipworm Tunnels ( <i>Bivalvia</i> , <i>Teredinidae</i> )	I.W. Hendy and S.M. Cragg
14.30 – 14.45	Behavioural ecology of the southern stingray ( <i>Dasyatis americana</i> ) and associated cleaner species in relation to symbiotic cleaning interactions, Glover's Reef Atoll, Belize	B. Shoosmith and A. Tilley

14.45 - 15.00	Innovative mapping technique reveals cold-water coral refuge in the Whittard Submarine Canyon, Celtic Margin	V.A.I. Huvenne, D.G. Masson, P.A. Tyler and V. Hühnerbach
15.00 – 15.15	The effects of algae on foraging efficiency of mangrove-dwelling fish	J. Jaxion-Harm and M. Speight
15.15 – 15.30	First recording of coral disease in Sabah, Borneo”	J. Miller, M. Sweet, E. Wood, and J. Bythell

**15.30 – 16.00      Tea and Coffee Break**

	Session 4: Management and Conservation	Chair: H. Koldewey
16.00 – 16.15	Are alternative occupations useful as an exit strategy for artisanal fishers? Seaweed farming in the Central Philippines	N. Hill, H. Koldewey, M. Rowcliffe and E.J. Milner-Gulland
16.15 – 16.30	Effectively managing coral reef related fisheries in the Philippines at the barangay level	J. Van Bochove and P. Raines
16.30 - 16.45	Community-based mangrove rehabilitation in the Philippines	D. Curnick, H. Koldewey and J. Primavera
16.45 – 17.00	Towards enhancing an established marine protected area system, Cayman Islands	J.R. Turner, C. McCoy, J. Byrne, A. Barton, C. Dromard, J. Campbell, S. Gall, B. Henshall, and N. Pisani
17.00 - 17.15	Evolutionary distinctiveness: a consideration for the conservation of coral reefs in a world experiencing accelerated environmental change	C. Head, M. Gollock, C. Waterman, D. Curnick and H. Koldewey
17.15 - 17.30	GLOBE Action Plan for Coral Reefs: Policy Proposals for Legislators	S. Harding, E. Clark, C. Stephens, B. Gardiner-Smith, A. Rogers

**17.30-                      Conclusions and Reception**



# Oral Presentations

### **Abstracts**

Abstracts for oral presentation are arranged in alphabetical order of first authors. Abstracts were printed as they were received and have not been edited for content. Reformatting was only carried out to ensure uniformity. The responsibility of the content of each abstract rests solely with their authors.

## USING SOCIAL MARKETING TO SUPPORT LOCAL MANAGEMENT OF MARINE RESOURCES

**G. ANDRIAMALALA AND S. PEABODY**

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Destructive fishing amongst traditional Vezo fisherman along Madagascar's southwest coast is a growing threat to the sustainability of the marine ecosystem upon which these semi-nomadic seafaring people depend. In the Velondriake locally managed marine area (LMMA), the first and largest LMMA in the Indian Ocean region, three types of destructive fishing have been banned by local communities; poison fishing, beach seine fishing, and use of mining picks to break or overturn coral. These bans, formalised in customary local laws (Dina), took effect in 2006, yet have until recently have been considered largely ineffective as a result of poor enforcement by communities.

In 2009, a social marketing campaign was launched within Velondriake to improve local awareness and enforcement of the Dina and bring about behaviour change to improve compliance with local resource management and access regulations.

The campaign, developed from socioeconomic studies carried out to assess community perceptions and knowledge gaps relating to Dina enforcement, and barriers to the behaviour change necessary for effective enforcement, targeted local leaders, pirogue (fishing canoe) owners and local beach seine fishers with messages tailored to each group.

The campaign, entitled Vezo Aho (literally 'I am Vezo'), focused on celebrating Vezo identity and self-perception as pro-active guardians of the marine and coastal environment, who utilise the marine environment using traditional knowledge, seamanship, and acquired skill, rather than through destructive, non-selective, low-skill destructive fishing techniques.

Campaign messages were delivered using posters, t-shirts, radio advertisements, songs, festivals, and community theatre, in conjunction with a series of workshops and leadership training sessions with the Velondriake management association.

Post-campaign survey results showed widespread exposure to campaign messages and marked changes in knowledge and attitudes toward the Dina. Empirical conservation results will take longer to demonstrate, however our findings show the power and suitability of social marketing as a tool for fostering sustainable fishing behaviour in traditional fishing communities.

## EPISODIC HETEROGENEOUS DECLINE AND RECOVERY OF CORAL COVER IN THE WESTERN INDIAN OCEAN

M. ATEWEBERHAN<sup>1,2\*</sup>, T. MCCLANAHAN<sup>2,3</sup>, N.A.J. GRAHAM<sup>4</sup> AND C. SHEPPARD<sup>1</sup>

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Long term changes in coral cover for the Caribbean and the Pacific/Southeast Asia regions (PSEA) have proven extremely useful in assessing the main drivers, magnitude and time scales of change. The one major coral reef region where such assessments have not been made is the Western Indian Ocean (WIO). Here we compiled coral cover survey data from across the WIO into a database of ~2000 surveys from 366 coral reef sites collected between 1977 and 2005. The compilation shows that the 1998 mass coral bleaching event was the single most important and widespread factor influencing the change in coral cover across the region. The trend in coral cover followed a step-type function driven by the 1998 period, which differs from findings in the Caribbean and the PSEA regions where declines have been more continuous and mostly began in the 1980s. Significant regional variation was observed, with most heterogeneity occurring during and after 1998. There was a significant relationship between cover and longitude for all periods, but the relationship became stronger in the period immediately after 1998. Before 1998, highest coral cover was observed in the central WIO region, while this changed to the eastern region after 1998. Coral cover and latitude displayed a significant U-shaped relationship immediately after 1998, due to a large decrease in cover in the northern-central regions. Post-1998 coral cover was directly correlated to the impact of the disturbance; areas with the lowest mortality having the highest cover with India-Sri Lanka being an outlier due to its exceptionally high recovery. Marine Protected Areas (MPAs) were more heavily impacted than unmanaged reefs before 1998 and lost a greater total cover. MPA recovery was greater so that no differences were observed by 2001-2005. This study indicates that episodic and acute stress has driven patterns in the WIO.

## SEDIMENTARY AND HYDRODYNAMIC CONTROLS ON CORAL GROWTH RATES ON AN INSHORE TURBID ZONE REEF

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Inshore reefs on the Great Barrier Reef (GBR) are regularly exposed to highly turbid conditions and to levels of sedimentation considered harmful to clear-water marine biota. Despite this deleterious pressure, many inshore reefs support high coral cover (>30%) and diversity (>50 species). However, turbidity reduces light availability and coral energy production suggesting that although corals are surviving, coral growth rates are potentially lower than on clear-water reefs. To date, few field studies have been conducted on inshore reefs compared to those growing in clearer offshore waters and consequently, sedimentary processes and their influence on inshore reef ecology, growth and development remains poorly understood. Just how resilient inshore reefs are to increasing sediment stress and deteriorating water quality remains uncertain. Middle Reef, an inshore turbid reef situated on the central GBR, is regularly exposed to high turbidity conditions (<50 mg.l<sup>-1</sup>), yet is characterised by a spatially heterogeneous benthic community and mean live coral cover of >39%. Coral growth and skeletal densities of *Acropora*, the dominant branching hard coral genera, were measured in relation to spatial and temporal variations in sediment processes. Growth rates ranged from 3 cm.y<sup>-1</sup> observed on the leeward reef flat edge, to >15 cm.y<sup>-1</sup> in the sheltered inner-reef regions and at the base of the windward reef slope. Skeletal density also varied with high densities observed in shallow regions (< -1 m LAT) lined with gravelly sands (1.46 g.cm<sup>-3</sup>), and low densities (1.09 g.cm<sup>-3</sup>) at deeper sites (> -2 m LAT) characterised by the deposition of sandy muds. Differences in coral growth and skeletal density would result in spatially variable gross carbonate production rates and therefore influence reef growth and development. This study demonstrates that coral growth rates can be high on inshore reefs, but vary spatially due to morphological influences on the local hydrodynamic and sedimentary regimes.

## ARE CILIATES THE KEY INFECTIOUS AGENTS OF WHITE SYNDROME IN CORALS OF THE GREAT BARRIER REEF?

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White Syndrome (WS) in *Acropora muricata* (= *formosa*) from two locations on the GBR was found in all cases (n = 18) to be associated with mixed-species ciliate assemblages. Two dominant morphotypes were observed to ingest coral tissues and contained coral symbiotic algae as a result. 18S rDNA analysis identified one of these as the ciliate previously reported in association with Brown Band Disease (BrB). However, a smaller, more numerous and highly motile ciliate from the same subclass (Scuticociliatia) appeared from time-lapse micro-videography to contribute most to coral tissue loss and advance of the disease lesion. The ciliate assemblages included members from 5 distinct 18S rDNA clades, 3 of which were consistently detected in the two field locations and in experimental aquaria. Whether ciliates, bacterial pathogens or other, as yet unidentified, agents are the primary cause of WS and related syndromes remains to be determined, but the macroscopic patterns of tissue loss associated with this syndrome can most easily be explained by the phagocytic activity of mass ciliate infections.

## ENVIRONMENTAL EFFECTS ON CORAL GROWTH AND RECRUITMENT IN THE CARIBBEAN

M.J.C. CRABBE

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Knowledge of factors that are important in coral reef growth help us to understand how reef ecosystems react following major anthropogenic and environmental disturbances. In addition, they help the industry understand how aquarists can improve the health of their corals. We have studied environmental and climate effects on corals on fringing reefs in Jamaica. Radial growth rates (mm/yr) of non-branching corals and linear extension rates (mm/yr) of branching corals calculated on an annual basis from 2000-2008 showed few significant differences either spatially or temporally along the North coast, although growth rates tended to be higher on reefs of higher rugosity. We have also reconstructed recruitment patterns, using growth modelling, for non-branching corals at sites on the North coast of Jamaica near Discovery Bay, and near Kingston Harbour, on the South coast. For all the sites, recruitment of non-branching corals was lowered due to hurricanes or severe storms. Interestingly, recruitment of *Siderastrea siderea* on to the side of the ship channel at Rackham's Cay (c. 100 m from the path taken by large ships) outside Kingston Harbour had been consistent since its construction ( $14 \pm 2.9$  colonies for each year from 2002-2007). These findings have important implications for aquarists and the maintenance of coral reef species in artificial environments.

## COMMUNITY-BASED MANGROVE REHABILITATION IN THE PHILIPPINES

**D. CURNICK, H. KOLDEWEY AND J. PRIMAVERA**

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Mangroves are coastal forests comprising a variety of uniquely adapted flora and fauna that characterize many tropical coastlines. Mangroves provide coastal protection, food resources and building materials for local communities whilst also providing essential ecosystem services such as physical and chemical filtration, nursery habitats and carbon sequestration (almost 25.5 million tons per year globally). These services are thought to have a total worth of US\$1.6 billion annually and up to 80% of global fish catches are thought to be directly or indirectly dependent on mangrove habitats. Coral reefs, sea grass beds and mangroves co-exist to create a complex, interconnected coastal ecosystem along many tropical coastlines, and it is therefore imperative that any strategies incorporate all components of the system to ensure effective management. It has been estimated that between 20-35% of all mangrove forests have been lost since 1980, with the Philippines losing over 65% in this period. ZSL are working with local communities on the island of Panay, Philippines, to rehabilitate degraded mangroves with the aim of providing increased coastal protection, food resources and livelihoods through sustainable and equitable management of these ecologically important forests. One of the main aims of the project is to obtain tenurial rights for at least 25 years, thus allowing coastal communities to manage their local forests sustainably. The project has already secured one community-based mangrove forest agreement with another five due for approval over the next two years. Another aspect of the project is to facilitate lease cancellation by the Fisheries Bureau of abandoned fish ponds and their reversion to the Department of Environment so that they can be reverted to mangroves. ZSL have already established nurseries in four project sites which have outplanted approximately 34,000 seedlings, whilst also drafting and teaching best practice guidelines. These nurseries provide the seedlings that are used to re-plant the abandoned fishponds and coastal greenbelts. The project completed the development of the Ibajay KII Eco-park – a 1.1 km long boardwalk through some of Asia's oldest mangroves - in January 2010 with local fisherfolk trained to give guided tours to locals and tourists alike. It is hoped that this successful model can be applied throughout the Philippines and beyond, and set a global precedent.

## REEF FISH FUNCTIONAL REDUNDANCY IN THE INDO-PACIFIC

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Increasing anthropogenic disturbances are resulting in the degradation of many reef systems worldwide leading to the reduction of coral reef fish diversity and abundance. Many reef fish play important ecosystem functional roles and their demise can lead to a negative feedback, which results in a further decrease of habitat quality. It has been theorised that reef resilience is strengthened by functional redundancy, in other words high diversity equals high redundancy therefore high resilience. The Indo-Pacific has especially high diversity, which means that reefs in this area are more capable to resist and recover from disturbance. This study examines 6 reefs in South East Sulawesi, Indonesia from 2002 to 2009. The reefs habitat quality was examined alongside the fish assemblage data. All sites showed a decline of habitat quality together with a decline in abundance and biomass of reef fish overtime. However, the number of species of fish was consistent temporally. The reef fish recorded were divided into feeding guilds and the numbers of species within each guild were examined as an assessment of functional redundancy..

**DUGONG WITHOUT BORDERS: BUILDING CAPACITY FOR  
INDIAN OCEAN SIRENIAN CONSERVATION**

**P.Z.R DAVIS**

Community Centred Conservation (C3), London UK

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After decades and in some cases, centuries, of intensive hunting for its tasty meat, the dwindling remnants of dugong populations in the southwestern Indian Ocean (SWIO) number only handfuls of individuals around small island groups and just hundreds off eastern African states. Clinging precariously to the coastlines where their sole source of food, seagrass, grows, they are frequently entangled in artisanal gill nets, currently the greatest threat to their existence. The main barrier to dugong conservation in East Africa and the West Indian Ocean islands is the lack of technical and financial capacity to implement suitable conservation management actions. As one of the first Signatory States of the UNEP-CMS Memorandum of Understanding (MoU) for the Conservation and Management of Dugongs and their Habitats throughout its Range, it was particularly apt that Madagascar played host to the first regional technical meeting on this species in August 2010. The meeting, organized by Community Centred Conservation (C3) convened government, UNEP-CMS technical staff, fisheries and wildlife management representatives and NGOs currently engaged in dugong research. All range states in the region except Sudan were present; Comoros, Kenya, Madagascar, Mayotte, Mozambique, Somalia, Seychelles and Tanzania. An internationally-standardised method for low-cost rapid assessments of this species in developing countries was introduced and new insights were provided into the status and distribution of the species and threats to its continued existence. The overwhelming consensus was that immediate regionally-coordinated action, relying on technical and financial capacity levered through the UNEP-CMS, is required if this species is to be saved from imminent extinction in the SWIO.

## GLOBE ACTION PLAN FOR CORAL REEFS: POLICY PROPOSALS FOR LEGISLATORS

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Tropical coral reefs are the most biodiverse marine ecosystems. Although coral reef ecosystems represent just 0.2% in area of the marine environment, they are estimated to harbour around one third of all described marine species (Reaka-Kudla, 1997), and more than a quarter of all marine fish species. Tropical coral reefs are also amongst the most productive ecosystems. More than 100 countries have coastlines with coral reefs and almost half a billion people (8% of the world's population) live within 100 km of a reef (Moberg and Folke, 1999). Consequently, tens of millions of people depend on reef ecosystems for food, coastal protection, building materials and income from tourism. Coral reefs supply about 10% of the world's marine fisheries landings and are of particular importance to small-scale fishers (Allsop et al, 2009; Wilkinson, 2008).

Despite their critical importance in terms of biodiversity and human well-being, it is estimated that 19% of the world's coral reefs were lost by 2008 through anthropogenic disturbance, with a further 35% under threat of loss in the next 20 to 40 years (Wilkinson, 2008). However, these estimates do not take into account the combined effects of climate change on coral reefs such as acidification, increases in sea temperature, sea level rise and more frequent occurrence of large storms (Wilkinson, 2008). When these are factored in, all remaining coral reefs are categorised as critically endangered or threatened with destruction.

Given the above, and the lack of political agreement to reduce the level of carbon emissions, there is a clear need to develop a global action plan for coral reefs in response to the multiple and synergistic effects of anthropogenic degradation and climate change facing coral reef ecosystems. As there is little possibility of significantly reducing global atmospheric CO<sub>2</sub> levels in the near future it is imperative to increase the resilience of coral reefs and provide them with the best 'fighting chance' to withstand these effects by eliminating or significantly reducing all other direct anthropogenic impacts on these ecosystems.

An Action Plan for Coral Reefs was developed with the prime aim of protecting and restoring coral reef ecosystems globally through a coordinated initiative at multiple levels and geographic scales. The initiative was specifically aimed at providing policy recommendations directly to international legislators via the Global Legislators Organisation for a Balanced Environment (GLOBE International).

### References

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## **EVOLUTIONARY DISTINCTIVENESS: A CONSIDERATION FOR THE CONSERVATION OF CORAL REEFS IN A WORLD EXPERIENCING ACCELERATED ENVIRONMENTAL CHANGE**

**C. HEAD, M. GOLLOCK, C. WATERMAN, D. CURNICK AND H. KOLDEWEY**

Conservation Department, Zoological Society of London, United Kingdom

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The EDGE of Existence conservation programme is based on a novel index that prioritises threatened species that represent high levels of evolutionary history. Launched in 2007, the programme has focused on Evolutionarily Distinct and Globally Endangered (EDGE) mammals and amphibians species, and is now applying this approach to Scleractinian corals.

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

Top priority Evolutionarily Distinct and Globally Endangered (EDGE) hard coral (order: Scleractinia) species have been identified through an international workshop, based on the best available phylogenetic information and expert opinion. The species identified are considerably different from those that result from commonly-used considerations, such as functionality and fragility. Notably very few evolutionarily distinct species identified are typical reef-building species. Considering most coral reef conservation programmes are ecosystem-based this indicates that large numbers of evolutionarily and genetically distinct species may not be safeguarded by current conservation initiatives. Disregard of evolutionarily distinct species risks the loss of a disproportionately large amount of Scleractinian evolutionary and genetic diversity and with this the likely loss of potential adaptive traits, crucial in the face of climate change and other anthropogenic pressures.

The EDGE coral reef programme aims to secure the future of these top priority EDGE Scleractinian species, by building in-country capacity through the establishment of community-based networks of marine protected areas (MPAs), ensuring that viable populations of these EDGE species are incorporated in the spatial design of the protected areas. These MPAs will be implemented in conjunction with other species-specific conservation measures.

**A DIRECT LINK TO THE NURSERY FUNCTION OF MANGROVE FORESTS: THE REMARKABLE PREDATOR-AVOIDANCE STRATEGY OF THE INTERRUPTED DARTFISH (*PARIOGLOSSUS INTERRUPTUS*, PTERELEOTRIDAE) EXPLOITS VACANT SHIPWORM TUNNELS (BIVALVIA, TEREDINIDAE)**

**I.W. HENDY AND S.M. CRAGG**

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Fringing mangrove forests are replete with resident and reef-associated fishes. Direct information linking the nursery function to mangroves is limited with exception towards crustaceans. Our study represents a group of inter-tidal fishes, the Interrupted dartfish with a unique behaviour by seeking the vacant tunnels in large woody debris (LWD) created by shipworms. We surveyed one mangrove site to describe the cryptic environment of vacant shipworm tunnels by using replicate thermo-data-loggers measuring the internal temperature within LWD and the ambient temperature adjacent the LWD. In addition, five replicate fringing mangroves were used to describe the ecology of dartfish. Woody debris with increasing shipworm attack intensity had increased numbers of dartfish. Furthermore, temperatures within vacant shipworm tunnels were lower compared to recorded temperatures outside LWD highlighting that dartfish within the shipworm tunnels do receive some metabolic cooling benefit. Dartfish were observed in large numbers shoaling within the complex roots systems of *Rhizophora stylosa* trees but never seen out in open channels during high tidal events. During low tide, within woody debris that had an increased level of shipworm activity (tunnels) large numbers of dartfish were found. Given that dartfish were observed in large numbers within the relative safety of the complex root systems at high tide away from potential danger, and in large numbers within vacant shipworm tunnels inside LWD at low tide but never seen exposed in open water – it is likely that dartfish use shipworm tunnels as a predator-avoidance strategy and may also exploit the tunnels to avoid desiccation due to the relatively cooler internal environment within shipworm tunnels.

## ARE ALTERNATIVE OCCUPATIONS USEFUL AS AN EXIT STRATEGY FOR ARTISANAL FISHERS? SEAWEED FARMING IN THE CENTRAL PHILIPPINES

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Overfishing on coral reefs in developing countries is often linked to a lack of other employment opportunities. A lack of such opportunities may lead to a vicious circle of increasingly intense or widespread harvesting to try to offset declining yields. However it is unclear whether and when artisanal fishers will exit fishing even if more lucrative alternative occupations become available. Seaweed farming (SWF) is frequently promoted as a lucrative alternative occupation for artisanal fishers in South East Asia. We surveyed ten communities on the Danajon Bank, Central Philippines, where fishery yields have substantially declined. To determine whether SWF had led to exit from fishing in any of these communities, we completed 300 timelines with community members, using key informants and secondary data sources to reconstruct fisher numbers before and after SWF started. Three communities exhibited sustained exit from fishing due to SWF, but high rates of population growth offset an overall reduction in total fisher numbers. Another community showed initial exit from fishing followed by re-entry due to increased stealing and decreased prices of seaweed. Four other communities showed no exit from fishing despite high uptake of SWF and fisher numbers continued to increase due to population growth. SWF failed in two other communities. Analyses of SWF assets within communities showed size of seaweed farm and source of capital may contribute to these different outcomes, but the direction of causation is unclear. Exit from fishing depended not only on the lure of SWF but on pressure from declining catches and may be influenced by fisher's preferences or abilities to adapt to declining catches. This highlights the heterogeneity of fisher responses, suggesting that simplistic assumptions about livelihood interventions as an incentive for wildlife preservation may not be justified; the lure of alternative occupations may not be sufficient on its own.

## INNOVATIVE MAPPING TECHNIQUE REVEALS COLD-WATER CORAL REFUGE IN THE WHITTARD SUBMARINE CANYON, CELTIC MARGIN

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The importance of submarine canyons as ecosystem hotspots and sediment transport pathways has been recognised for decades (e.g. Heezen et al., 1955; Vetter & Dayton, 1998). However, studying canyon systems in detail is a challenge, because of the complexity and steepness of the terrain. The increasing availability of underwater vehicles, however, opens new opportunities. During summer 2009, we carried out habitat mapping work at several spatial scales within the Whittard Canyon, along the Celtic Margin, using the UK deep-water Remotely Operated Vehicle (ROV) ISIS. In particular, we developed a new methodology to map vertical cliffs and overhangs by placing the high-resolution multibeam system of the ROV in a forward-looking position rather than in the traditional downward-looking configuration. With this approach, we could visualise the spatial structure and density distribution of a unique and previously unknown cold-water coral reef, formed as a hanging garden under a 1600 m long and 120 m high overhanging wall, at 1350 m water depth.

The coral colonies and associated fauna preferably settle on the slightly harder and protruding strata, and provide a faunal coverage of ca. 70%. The community is healthy and well-developed, and more importantly: has received minimal human impacts.

The new coral reef proves that typical canyon processes such as enhanced internal tides and focussed downslope sediment transport can provide the correct setting for a rich cold-water coral reef to form, even outside the optimal depth and potential density conditions reported elsewhere in the NE Atlantic. Furthermore, it illustrates that submarine canyons can act as natural refuges for faunal communities affected by anthropogenic disturbance, and that they can create potential larval sources for recolonisation of other, damaged sites along the continental margin.

Heezen, B.C., Ewing, M. and Menzies, R. (1955). The influence of submarine turbidity currents on abyssal productivity. *Oikos*, 6, 170-182.

Vetter, E.W. & Dayton, P.K. (1998). Macrofaunal communities within and adjacent to a detritus-rich submarine canyon system.

## THE EFFECTS OF ALGAE ON FORAGING EFFICIENCY OF MANGROVE-DWELLING FISH

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Arguments have been made that optimal habitat of carnivores would consist of intermediate complexity that attracts ample amounts of prey, but does not reduce encounter rate and foraging efficiency. Previous studies in seagrass and freshwater habitats have shown increased vegetation can negatively affect foraging success of carnivorous fish. Therefore, it was hypothesized that macroalgae in mangrove habitat would also reduce predation efficiency of carnivorous fish. This relationship between substrate algal cover and fish distribution was studied in a Caribbean mangrove lagoon using visual surveys and algae removal experiments. In addition, the effect of algae on foraging efficiency was tested by calculating survival of tethered invertebrate prey whose predators are known to include carnivorous lutjanid (snapper) juveniles. Algae had a negative effect on abundance of carnivorous fishes in two (out of three) locations in the lagoon. In addition, tethered prey had a significantly higher proportional survival in plots with algae relative to plots with algae removed. These observations imply vegetation characteristics must be considered when protecting mangrove habitat.

## **CAN CORAL INDUSTRIES PLAY A ROLE IN THE FUTURE CONSERVATION OF CORAL REEFS WITH A CHANGING WORLD?**

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Coral reef products are heavily utilised by the aquaria trade; as this industry expands, natural reef systems are degrading. Literary examples identify poor non-sustainable exploitation practices whilst other research and initiatives point to commendable procedures and practices that establish strict guidelines. Both UK-based academic coral researchers and independent commercial aquarists have been pursuing answers to the same questions in parallel, albeit independently for some time. Researchers have focused on maximizing coral growth, decreasing coral mortality and increasing the understanding of how past, present and future environmental conditions regulate growth, fecundity and mortality. Similar issues have also been at the forefront of the aquarium industry; where, economic drivers have resulted in advancements in technologies which have not been effectively translated to the academic community. Conversely, knowledge gained from academic research of environmental regulation of growth, high level sustainable harvesting, and physiological controls of coral form, which would be of major benefit to the aquarist trade and ultimately the economic potential of the industry, has not been effectively transferred to industry. Corals within the aquaria trade come from wild type collections, in situ farming or through in-country husbandry. As industries knowledge of environmental regulation of growth expands so do the regularity of these techniques. Opportunities exist to utilize collections from the wild, through coral harvesting or mariculture providing strong linkage with direct conservation actions and reducing the pressure on wild stocks but knowledge of species sensitivity and resilience needs to be incorporated if they are to have a conservation value in a changing world. Can artificially held corals now represent a viable option for restocking reefs of the future? What problems will such activities bring about and should researchers and conservationist engage more with industry to enhance the impact of research activity and the conservation advantages of an expanding industry?

## FIRST RECORDING OF CORAL DISEASE IN SABAH, BORNEO

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Two of the most significant threats to coral reefs worldwide are bleaching and disease. However, there has been a scarcity of research into coral disease in South-East Asia, despite its ecological significance and the strong dependences of local communities on natural resources of coral reefs and previous research has led to the consensus of a comparatively lower level of disease at Indo-Pacific reefs than Caribbean.

This study provided pioneering baseline data on coral disease abundance from three national parks with varied disturbance levels and histories. High coral cover (48.8 %) and low disease abundance (0.1 colonies per m<sup>2</sup>) was found across the three sites (total = 266 diseased colonies). Significantly higher density ( $p < 0.001$ ) and frequency ( $p = 0.006$ ) of coral disease were observed at reefs within the park of coastal proximity and highest mean sea temperature recorded, with white syndrome being the most frequently observed disease. Significant relationships were found between disease and bleaching occurrence ( $r = 0.39$ ;  $p \leq 0.01$ ) and between coral cover and syndrome density at two of the parks ( $F = 20.4$ ,  $p < 0.001$ ;  $F = 6.6$ ,  $p = 0.042$ ). However, the relationship between coral cover and syndrome density differed significantly between the three marine parks ( $p = 0.012$ ), indicating that factors other than host density affect disease prevalence. This relationship between disease density and coral cover may be a more informative indicator of reef health status than disease prevalence alone.

These findings indicate that coral disease may be of greater significance to Indo-Pacific reefs than previously thought and suggests anthropogenic stressors may increase coral susceptibility to contracting such disease.

## ARTISANAL FISHING IN THE COMOROS: CURRENT STATUS AND OPPORTUNITIES FOR EFFECTIVE MANAGEMENT

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The Union of the Comoros is among the world's poorest and least developed nations. As an island state, with limited natural resources, burgeoning demographic pressures have led to serious environmental degradation, particularly in coastal areas. There is thus an urgent need for the implementation of effective natural resource management processes. This work, conducted as part of the Western Indian Ocean Socioeconomic Monitoring (SocMon-WIO) initiative, investigated artisanal fisheries characteristics and management on the three islands of the Comoros (Grande Comore, Anjouan and Mohéli) using Household Surveys (n=825) and Key Informant interviews. Artisanal fishers in the Comoros most commonly used hook and line to catch pelagic fish species, although reef fisheries were more widespread on Mohéli, due to its more extensive coastal lagoon. Significant net fisheries also occurred on Mohéli and Anjouan, and were often restricted to particular villages. There was a strong awareness of the need to sustainably manage marine resources and fisheries management was generally implemented at the community level by local fishing associations, and included gear, catch and spatial restrictions. Fishers were well-organized in local and national associations to ensure safety at sea and enforce regulations; however the effectiveness of these associations varied substantially between villages. Traditional and religious beliefs also played a significant role in fisheries management and could prove to be a useful tool in implementing effective conservation measures.

The national SocMon-WIO network in the Comoros was funded by the National Oceanographic and Atmospheric Administration (NOAA), USA Coral Reef Conservation Program.

C3-Comores is a collaborative initiative between Community Centred Conservation (C3) and the National Ministry of the Environment, Union of the Comoros.

## THE CHAGOS MPA STORY – SO FAR

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In 2010 the Government declared the British Indian Ocean Territory an MPA, with no-take status over almost all of it. This is currently the largest in the world, being roughly circular with diameter of about 450 nautical miles. This followed from a large scientific input over several preceding years, including science workshops and involvement of numerous science and conservation bodies who formed a 'Chagos Environment Network'. This presentation outlines some of the latest discoveries on benthic reef science and island condition, emphasising in what ways this archipelago differs from most others, and why the MPA was sought in the first place. This MPA has also doubled the world's total of no-take marine area, and will also provide substantial benefits to pelagic fish and seamounts as well as the reefs.

**BEHAVIOURAL ECOLOGY OF THE SOUTHERN STINGRAY (*DASYATIS AMERICANA*) AND ASSOCIATED CLEANER SPECIES IN RELATION TO SYMBIOTIC CLEANING INTERACTIONS, GLOVER'S REEF ATOLL, BELIZE**

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Cleaning interactions between client southern stingrays, *Dasyatis americana*, and associated host cleaner species were investigated at Glover's Reef Atoll, Belize, to analyze the behavioural ecology of clients. The temporal variation of visits was tested for evidence of behavioural thermoregulation, and critical habitat was quantified through site fidelity. From 1,991 minutes of in-situ underwater observations made by snorkeling between June and July 2010, 362 interactions involving 120 *D. americana* individuals were recorded. Clients were catalogued by distinguishing features, sex and size (disc width) at two identified cleaning stations. Adapted behaviours to solicit and facilitate cleaning inspections were documented. 66 of 106 individuals were recorded returning to the southern station, indicating site fidelity. Significantly more individuals were observed visiting and interacting during the morning hours with numbers decreasing steadily as the time of day progressed ( $F_{1,10} = 26.895$ ,  $r^2 = 0.729$ ,  $P < 0.001$ ). A significant inverse relationship between the number of hourly visits and hourly sea temperatures ( $F_{1,10} = 27.581$ ,  $r^2 = 0.734$ ,  $P < 0.001$ ), together with changes in temperatures caused by stochastic storm events, which altered the temporal trend of visits, possibly indicates *D. americana* behaviour to be, at least in part, dictated by temperature. The functional aspects of cleaning were also examined; 23 of 25 individuals which bore injuries had their injured locations inspected on more than one visit, providing evidence for cleaners assisting in wound healing. Individual host follows showed preferential foraging across anatomical locations with 45.3% of inspections occurring on the tail; the most commonly injured and documented ectoparasite location, implying hosts forage optimally on *D. americana* clients. These findings show cleaning stations provide critical habitat for a significant function in the life cycle of *D. americana* whilst providing important information for management decisions both here and throughout the species range.

**INVESTIGATION OF THE CONTROLS ON BACTERIAL COMMUNITY DEVELOPMENT IN THE REEF  
CORAL ACROPORA MURICATA USING EXPERIMENTAL ANTIBIOTIC TREATMENT**

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Development of the bacterial (16S rDNA) community associated with the coral *Acropora muricata* (= *formosa*) was monitored over time following experimental modification of the existing microbial community using the antibiotic ciprofloxacin. Abundance of bacteria was reduced >99% by the treatment, resulting in significant changes in bacterial community structure. Following redeployment to their natural environment, some settlement and re-growth of bacteria took place within a few hours, including ribosomal types that were not present, or in low abundance, in the natural microflora. However, complete recovery of the bacterial community required longer than 96 h, which indicates a relatively slow turnover of the natural community. The early developing community was dominated by antibiotic-resistant bacteria from the natural microflora that survived the treatment and proliferated in the absence of natural competitors, but also included some non-resident ribotypes colonizing from the water column. Almost all these opportunists were significantly reduced or eliminated within 96 h after treatment, demonstrating a high resilience in the natural bacterial community. Potential pathogens including a *Clostridium* sp. inhabited the coral at low abundances, only becoming prevalent when the natural microbiota was disturbed by the treatment. The healthy coral-associated microflora appears to be strongly controlled by microbial interactions.

## INVESTIGATING THE PROPERTIES AND POTENTIAL APPLICATIONS OF THE SKELETAL ORGANIC MATRIX IN CORALS

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Coral skeletogenesis is a biologically controlled process involving a set of organic molecules, collectively termed the “organic matrix” (OM), which are secreted by the calciblastic cells and subsequently incorporated into the coral skeleton. Although the OM constitutes only a small fraction of the aragonite skeleton, it is fundamental to the calcification process.

By examining the distribution, composition and degradation of the skeletal OM, I aim to explore its role in calcification, determine how it can be used to record past environmental perturbations, and evaluate its potential in dating coral specimens. In this talk I will discuss two examples; (1) using racemisation of amino acids present in the OM as a geochronological tool, and (2) examining compositional changes in response to environmental stress.

(1) The OM is rich in amino acids, the basic building blocks of protein in living organisms. If entrapped in the biomineral, these amino acids undergo racemisation; the slow inter-conversion of L-amino acids into an equilibrium mixture of L- and D- amino acids. Long cores collected from massive *Porites* colonies, spanning over four centuries of coral growth, were used to evaluate the potential of amino acid racemisation as a dating technique. Although a relatively well-constrained racemisation vs. time curve was evident for each colony, differences in OM degradation through time were observed between the different colonies. This may relate to variations in the prevailing environmental conditions.

(2) “Unfavourable” environmental conditions, impacting coral metabolism, physiology and calcification, are likely to also manifest in the composition of the OM being concurrently secreted. One way of investigating this is through OM analysis of coral colonies cultured under differing abiotic conditions (e.g. varying pCO<sub>2</sub>, flow regimes) or exposed to known stress events (e.g. bleaching events). Here I will show preliminary results of compositional OM changes associated with different flow regimes.

## TOWARDS ENHANCING AN ESTABLISHED MARINE PROTECTED AREA SYSTEM, CAYMAN ISLANDS

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The Cayman Islands present a rich marine environment, seemingly benefiting from over two decades of world-class in situ conservation through the active enforcement of zoned MPAs. However, local development, regional degradation and increasing risk from climate change impact have necessitated a review of the MPA system, to assess whether MPAs are optimal in area, appropriately located, and provide maximum resilience. Initial studies addressed: (1) the current level of reef resilience within and outside all marine protected areas of Grand Cayman, Little Cayman and Cayman Brac; (2) the overspill of fish biomass from all No-Take zones; and (3) the impact of the artisanal/recreational fishery. Study 1 identified that the coral-algae dominance phase shift has occurred on Caymanian reefs; algal cover now dominates (80%) but species diversity, richness and coral cover are greater within MPAs and algae cover lower than outside protected areas. Study 2 surveyed reef fish within and outside MPAs and demonstrated that fish biomass within protected zones was 2 x higher for herbivores, and 4 x higher for carnivores than fished areas, and there was evidence for a 'Spillover' of higher fish biomass up to 5km beyond the MPA boundary. Study 3 used structured questionnaires to identify that 87% of fish caught were reef species including important and vulnerable species such as herbivores and those forming spawning aggregations. Habitat maps, Ecological Gap Analysis and Protected Area GIS Tools (Marxan, Marzone) are now being used together with stakeholder consultation to review, plan and promote an extended MPA system. Long term benefits from resilient reefs will be the protection of biodiversity, people, critical infrastructure, property and coasts, and enhance sustainable use by residents and visitors, and thus economic development, demonstrating the benefits of an enhanced zoned MPA system to the wider Caribbean and beyond.

## CORAL BLEACHING: THE EFFECTS OF ENVIRONMENTAL STRESS INDUCED TOWARDS HARD CORALS

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Coral reefs are an essential part of marine ecosystems because they are very highly productive and rich in species diversity which supports many organisms. Nowadays, coral reefs are under severe threat from many sources, including high sea water temperatures, solar irradiance and anthropogenic impacts including in Peninsular Malaysia. South East Asia encompasses approximately 34% of the world's reefs and between a quarter and a third of the world's mangroves, as well as the global biodiversity triangle formed by the Peninsular Malaysia, the Philippines, and New Guinea (Todd et al., 2010). These frequent occurrences of coral bleaching and ensuing damage to coral reefs have generated interest in studying the stress responses that precede bleaching. Thus, the aim of this laboratory study is to improve the knowledge of synergistic effects of bleaching-induced stress and the bleaching mechanism. The primary goal of this study are to determine; 1) the tolerance of corals in laboratory after being exposed to thermal stress in terms of their physiological response, 2) how the corals react to the synergistic effects of high temperature and enrichment of dissolved inorganic nutrients (nitrate) in terms of their biological effects. To achieve this purpose, there will be two treatments (high temperatures and light; high temperatures and nitrate) using 10 coral nubbins in 3 replicate tanks for each experiment. A few species of hard corals will be examined. This study will investigate the visual paling and mortality of the bleached corals by using colour reference card, besides study on the damage of zooxanthellae; measurement of zooxanthellae density and chlorophyll *a* concentration. This research should result in a significance way to contribute for coral bleaching data in Malaysia and create an indicator that raise awareness about threat to coral reefs and highlight the linkages between human activity and coral reef conditions.

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## **EFFECTIVELY MANAGING CORAL REEF RELATED FISHERIES IN THE PHILIPPINES AT THE BARANGAY LEVEL**

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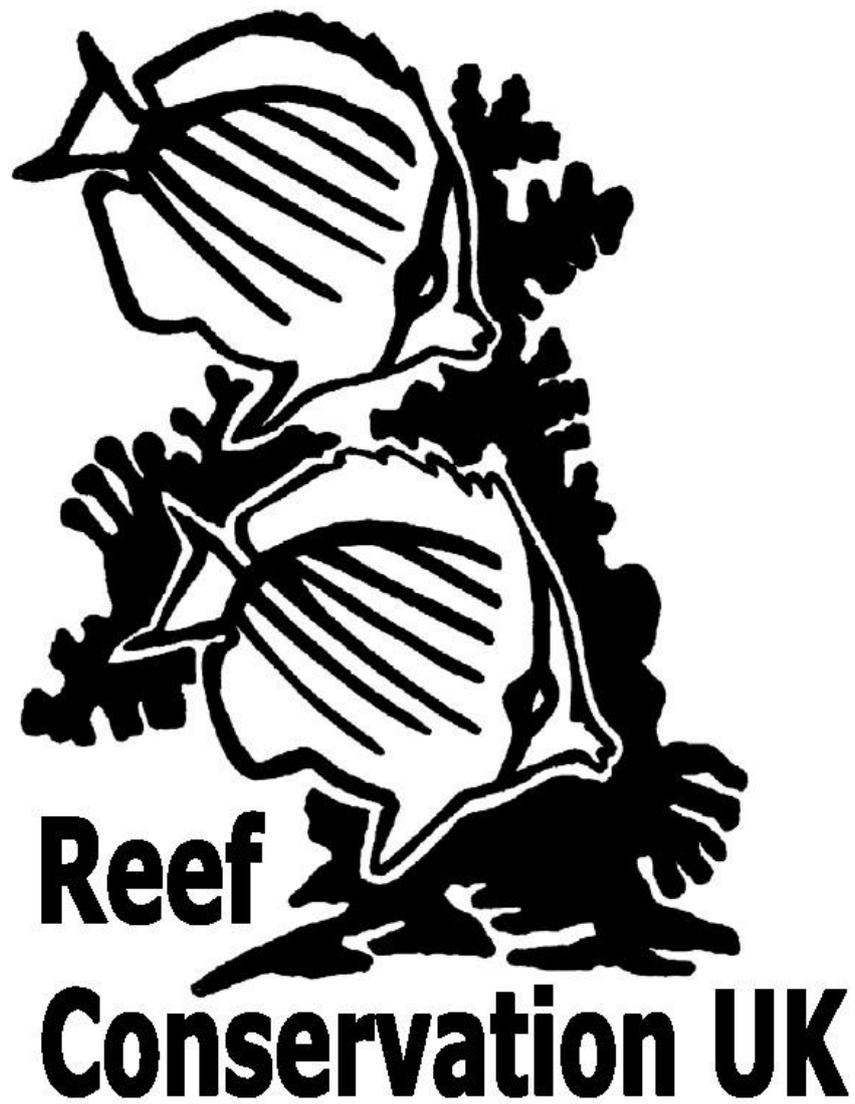
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Community-led Marine Protected Areas (MPAs) have become a popular tool for fisheries management in the developing world. Although it is clear that large-scale MPAs have a greater chance of meeting fisheries and conservation goals, these ideals are unrealistic in the Philippines where local authority of coastal waters by barangays (local communities) has created significant hurdles, making holistic approaches towards coastal zone management challenging.

The local governance system installed under the Fisheries Code of 1998 can therefore be seen both as a blessing and a curse to fisheries management in the Philippines. It empowers local communities to manage their own coastal waters but at the same time, it makes the instalment of larger, integrated coastal management zones an immense challenge as it requires the cooperation of several independent barangays who will inevitably pursue their own interests.

This talk proposes a means to develop networks of closely associated, small-scale MPAs in order to meet both local governance requirements and conservation goals. Under the guidance of the provincial government, barangays are assisted in setting aside a fraction of their coastline as a no-take MPA. The combined effect means a greater proportion of reef habitats are protected and barangays share the responsibility for their management.

In Sogod Bay, Southern Leyte, Coral Cay Conservation (CCC) has been working closely with the Provincial Environmental and Natural Resource Management Office (PENRMO) to develop such a network. This project was initiated in 2005 and has incorporated 7 community-led MPAs into a network of 14 MPAs. The project provides a good case study for locally led micro management of coral reefs in the Philippines.



# Poster Presentations



## VARIATION IN SEVERITY OF BLEACHING IN RESPONSE TO THERMAL STRESS IN SOUTHWESTERN MADAGASCAR DURING THE 2010 BLEACHING EVENT

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Large scale bleaching events and associated mortality caused by unseasonably warm sea temperatures are recognised as one of the major threats to coral reefs worldwide. This study describes regional variation in bleaching intensity observed at 26 sites in southwestern Madagascar during a period of prolonged warm water temperatures between January and March 2010. Sea surface temperatures (SST) peaked at 30.4°C at the end of February with a mean SST of 28.7 °C recorded over the next 6 weeks (1st March- 12th April), showing 4.8 Degree Heating Weeks (DHWs) relative to the 4-yearly mean value (1.32; 2005 to 2009) for the same 6 week period . Bleaching and subsequent mortality and/or recovery of common coral genera were monitored using underwater visual assessment. We found significant differences in bleaching response between the studied areas, with bleaching severity decreasing with increasing latitude. Forty-two genera were observed throughout the study areas. Genus susceptibility to bleaching varied across sites with branching *Pocillopora* most affected at all latitudes and massive *Porites* colonies more susceptible at lower latitudes. *Acropora* showed low levels of bleaching throughout the region. Mortality of bleached corals was low (<5%) in all studied areas during the survey conducted in March. Surveys carried out in May 2010, 6 weeks after the peak in SST, reported an increase in the abundance of dead coral colonies (12%) on the northernmost reefs of Belo-sur-mer. These observations indicate that the 2010 thermal stress event of 4.8 DHWs was insufficient to cause mass mortality on bleached reefs despite widespread observations of bleached colonies, a result of elevated DHWs following a peak in SST. Environmental differences between regions, including latitudinal variation, habitat variability and differences in coral community composition may have determined the variation in bleaching intensity and response observed.

## RECOVERY OF CAYMANIAN REEFS AFTER A CORAL BLEACHING EVENT; CAN MARINE PARKS HELP?

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In Collaboration with the Department of Environment, Government of the  
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Coral Reefs are under threat from a growing number of environmental impacts and have already entered a period of decline and degradation, with especially severe loss of coral cover in the Caribbean. Reefs in the isolated Cayman Islands, encompassed by a long established network of protected areas, have however, fared better than most. Despite low levels of direct anthropogenic impacts, the Caymans suffered a severe coral bleaching event in September 2009. Bleaching was unusually observed down to depths 60 metres. This study is the first to document the state of Caymanian reefs following the disturbance, and to examine to what extent recovery has occurred within and outside Marine Parks. Fifty five sites were accordingly surveyed by underwater visual census between June and August 2010. Macro algal and hard coral cover, coral community composition and incidence of bleaching and disease were recorded and compared between protection levels, islands and aspects. The effectiveness of Marine Parks in aiding recovery was found to be highly variable between islands, with more success on Grand and Little Cayman than on Cayman Brac. It is hypothesised that impacts in addition to those that can be mitigated by the implementation of protected areas are having negative effects on Caymanian reefs. Therefore it is suggested that while Marine Parks can be beneficial, alone they may not be sufficient to allow full recovery from bleaching events and prevent further declines in coral reef health.

## THE CURRENT STATE OF CORAL REEFS ALONG THE NORTH WEST COAST OF MAHÉ, SEYCHELLES FOLLOWING THE 1998 MASS BLEACHING EVENT

S. COURTNEY

[www.gvi.co.uk](http://www.gvi.co.uk)

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The 1998 El Nino induced bleaching event severely affected coral reef ecosystems around the islands of the Seychelles. Approximately 40-95% of corals were bleached while 50-95% coral mortality was recorded in some areas, affecting the artisanal and tuna fisheries in 1998 drastically. The Seychelles Centre for Marine Research and Technology in conjunction with Global Vision International have been monitoring specific aspects of the marine environment since 2005, documenting the recovery of the reefs around the most populous and tourism orientated island – Mahé.

Since surveying began in 2005 recruitment density has exhibited an overall increase among the sites, however with slight fluctuations between phase periods. In 2005 recruit density was found to be 5.4 individuals per m<sup>2</sup> as compared to the 2009 recording of 12.8 individuals per m<sup>2</sup>. The most recent results indicate granitic reefs support higher recruit density within the 2.1 – 5.0cm size class (14.89m<sup>2</sup> ±0.64SE) as compared to carbonate reefs (10.73m<sup>2</sup> ± 0.4SE).

Live hard coral cover at both carbonate and granitic sites has continued to display an overall increasing trend to 31.7% and 37.5% respectively since 2005, however did decline during the 2008 survey period. Sponges and soft coral have increased at carbonate sites while at granitic sites all epibenthic organisms have decreased in percentage cover. Coral diversity remains high at survey sites, with the average number of genera being around 29, which has been consistent since surveying began.

Results from the most current fish phase in Jan – Mar 2010 shows increased fish density and diversity within marine protected areas as compared to outside the boundaries. Interestingly, individuals from Chaetodonidae and Serranidae families did not confer to this trend. There was no correlation found between fish density and diversity compared with hard coral density and diversity at sites.

**EFFECTS OF HURRICANE DEAN ON PUNTA GRUESA CORAL REEFS,  
QUINTANA ROO, MEXICO**

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The state of Quintana Roo, Mexico is internationally renowned for its diverse habitats, especially its coral reefs which make up part of the Mesoamerican Barrier Reef System. Few studies had described the condition of the reefs in Punta Gruesa (PG; N19.00865, W087.58977) before 20th August 2007, when category 5 hurricane Dean hit the southern coast of Q Roo directly impacting PG and the neighbouring town of Mahahual. Since January 2008, Amigos de Sian Ka'an (ASK) and Global Vision International (GVI) have conducted a baseline reef health monitoring programme on the PG reefs. Data collected by the ASK-GVI Coral Reef Synoptic Monitoring programme have been compared with pre-Dean data from previous studies to assess the effect of this severe meteorological event. This study is key to be able to provide local reef managers with accurate information on reef resilience due to severe hurricanes since models predict an increase in both hurricane numbers and strength in the future. The study also aims to highlight any downfalls in current research methods to determine the direct effect of hurricanes on the PG reefs. The results obtained from this comparison revealed that the hard coral cover and the reef fish density of PG reefs have undergone a considerable reduction in the last 16 years, previous to hurricane Dean's impact. The analysis also showed the negative influence of Dean on the condition of coral communities with regards to mortality, presence of disease, and bleaching, as well as in the reduction of fish stocks. Additionally, this study highlights the necessity of implementing a hurricane specific monitoring methodology to assess the effects of these powerful meteorological events. The ASK-GVI programme aims to implement such methodology alongside the SMP methodology, beginning with the 2011 hurricane season, to be able to extract more specific comparisons and conclusions.

**OCCURRENCE, DIET AND MANAGEMENT OF THE INVASIVE LIONFISH PTERIOS SPP. IN THE SIAN KA'AN BIOSPHERE RESERVE, QUINTANA ROO, MEXICO**

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Invasive lionfish have spread extensively throughout the Caribbean and Western Atlantic, through repeated intentional or accidental releases originating from the Florida Peninsula. Attempts to control the spread of lionfish have been implemented in many locations in the Caribbean with limited success. Their diverse diet, voracious appetite and high fecundity is expected to severely impact an ecosystem already under pressure. Global Vision International (GVI) and Amigos de Sian Ka'an A.C., working in and around the Sian Ka'an Biosphere Reserve and UNESCO World Heritage Site, have documented all lionfish sightings at two locations since the first sighting in June 2009. Lionfish sightings have increased exponentially since the initial sighting. With the support of CONANP (Comisión Nacional de Áreas Naturales Protegidas) a culling programme was implemented in February 2010 using nets and spearguns. Dissection of captured fish reveals the diverse nature of the diet of Pterois spp. GIS software is used to track the occurrence and spread of lionfish at the two sites, Pez Maya (N20.00222, W087.28.624) located inside and Punta Gruesa (N19.00865, W087.58977) outside the Biosphere Reserve. The behaviour and preferred habitats of the lionfish are also noted on each sighting.

A recently implemented study with local fishermen in the villages of Punta Allen and Mahahual highlights the potential economical effects and the results presented here for the first time.

## THE CASE FOR THE 'POPULATION, HEALTH AND ENVIRONMENT' APPROACH IN RELATION TO THE MILLENIUM DEVELOPMENT GOALS

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Blue Ventures (BV) has been working in partnership with coastal communities of 24 villages in the Toliara province of southwest Madagascar since 2003, with the shared goal of developing and enabling sustainable marine resource management. This has led to the development of Velondriake, the largest network of community managed marine reserves in the Indian Ocean. Velondriake covers an area of 800 square kilometres, has a population of 10,000, and consists of coral reefs, mangroves, seagrass beds, baobab forests and other threatened habitats.

Since 2007, Blue Ventures' sexual and reproductive health programme has been developed and integrated into the portfolio of projects running as an integrated Population, Health and Environment (PHE) component of our conservation work within Velondriake. The first family planning clinic was established in the village of Andavadoaka in August 2007 in response to a resounding need expressed by the community.

A rapid rise in the coastal population would overwhelm the already stretched marine resources which the coastal communities depend upon. BV's approach to conservation seeks to address this imbalance through integrated and holistic channels.

In just three years, and a limited budget, the clinical outputs of our interventions provide a compelling case for this integrated approach. Data from 3 years of clinical activity in the village of Andavadoaka, and more recent information from the expansion of our activities to surrounding villages, is presented. In this time we have seen over 1700 female clients and have increased 'Contraceptive Prevalence Rate' (CPR) from 9% to 36.6% from July 2007 to October 2009 in the village of Andavadoaka and from 10% to 15% from October 2008 to October 2009 in the Velondriake region as a whole. The programme has also increased awareness relating to HIV/AIDS prevention and the use of condoms.

**THE ECOLOGY AND PHYSIOLOGY OF FREE-LIVING *PORITES LUTEA* COLONIES WITHIN THE LAHOA MANGROVE, INDONESIA**

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Coral assemblages that grow under sub-optimal conditions in marginal environments such as mangroves are important to study because they may be representative of the corals that are best equipped to deal with future environmental change. A preliminary survey in an Indonesian mangrove system discovered a high occurrence of a unique, spherical, free-living growth form of the cosmopolitan species *Porites lutea* existing in marginal habitats. This observation suggests that phenotypic plasticity allows certain coral species to exist under a range of environmental conditions. This present study aimed to further investigate the physiology and ecology of these free-living colonies. Data presented here indicates that a combination of environmental conditions such as high flow, low amounts of potentially anoxic sediments and high cover of rubble drives the formation of spherical colonies that greatly enhances the standing coral biomass. Due to the nature of a spherical growth form, it is inevitable that live tissue is periodically subjected to sediment exposure and darkness. Experimental data showed that spherical *P. lutea* colonies can withstand periods of up to ~30 days under these conditions without exhibiting tissue necrosis. However, a loss in photosynthetic efficiency (Fv/Fm) is observed after one day. There is an initial decline in Fv/Fm of up to ~30 % within the first four days, but there is no further loss over the next 25 days. In colonies that were overturned after experiencing this initial loss in Fv/Fm, rapid recovery to full efficiency (~90 % and above) was recorded within six hours of re-exposure to light. This study demonstrates how some coral species such as *P. lutea* are more tolerant to extreme conditions than what perhaps the general perception for coral is. This, together with a combination of environmental conditions allows *P. lutea* to occupy a highly specified niche within an already marginal environment.

# THE IMPACT OF OVERFISHING ON THE AVAILABILITY OF FUNCTIONAL TRAITS IN CORAL POPULATIONS IN SOUTHWEST MADAGASCAR AND ITS RELATIONSHIP TO PHASE-SHIFTS.

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My PhD research examines how different fishing regimes correlate with shifts in the abundance and diversity of functional traits of coral populations in southwest Madagascar. A 'trait' here is considered as a "well-defined, measurable property of an organism, which can be measured at the individual level and used comparatively across species". A trait that "strongly influences organismal performance" in its environment is a 'functional trait' (McGill et al., 2006). Examples of coral functional traits include: rugosity, growth rate, sensitivity to bleaching, sensitivity to disease etc. The cumulative abundance and diversity of functional traits present in the coral population on the reef are the 'pool' of functional traits that the reef has 'available' to resist or recover from 'drivers' of phase-change such as overfishing and warming-events.

The questions my research aims to address include: 1) How does fishing intensity affect the available pool of coral functional traits on reefs of different geomorphological structure and at different depths? 2) How does a shift in the quantity and type of available coral functional traits in the coral population on a reef affect its likelihood of recovering from or resisting slow drivers (overfishing, sedimentation etc.) and fast drivers (warming events, storms etc.; see Hughes, 2010)?

To explore these questions 7,500 geo- and depth-tagged photoquadrat images were collected from 68 different reefs (fringing, patch, spur and groove) at depths ranging from 1-35m and spanning over 200km of coastline. The data was collected in southwest Madagascar from September 2009 to March 2010. The benthic composition of each image was assessed using random point count methodology (CPCe; Kohler and Gill, 2006). Corals were identified to species level where possible, or were grouped into categories based on morphology (i.e. *Acropora digitate*, encrusting *Montipora* etc.). To examine how functional trait availability varied between reefs of the same geomorphology and at the same depth range along a gradient of fishing intensity, species composition at each site will be mapped onto a multi-dimensional trait space. The trait space will be created using an attribute matrix for the 277 species of corals in the region based on published values (i.e. growth rate of x cm/yr) of functional traits. A fishing intensity ranking for each study site will be estimated from interviews conducted with artisanal fishermen teams (112 interviews representing the fishing activity of 450 people) across the region.

The results from this study, when complete, could help shed light on shifts that occur within coral populations (in terms of available functional traits) and how these relate to phase-shifts from coral to alternative assemblages (see review Norström et al., 2009). If we can then incorporate the information gleaned from the study into a model, we may be able to explore aspects of phase-shift such as the dynamics of thresholds, reinforcing feedbacks, hysteresis and the reversibility of phase-shifts, all of which are of importance to resilience-based management (Bellwood et al., 2004).

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## **CORAL REEF CONSERVATION: CHAMPIONING THE ROLE OF CITIZEN SCIENTISTS**

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A broad range of natural and human-induced factors threaten coral reef ecosystem health globally. Warming ocean temperatures, decreasing oceanic pH, overfishing, increasing storms, sedimentation and eutrophication are all increasing in intensity and frequency. Compounded they reduce biodiversity and degrade coral reef habitats.

Coral reefs are an important economic resource, with reef tourism worldwide valued at over US\$5 billion annually. Conservation or volunteer tourism is a rapidly growing trend and citizen science coral reef projects are part of this field. Coral reef survey techniques can be quickly and easily taught to the snorkelling or diving public and with research sites relatively easy to access, significant data collection can be achieved. International NGO Earthwatch has been championing citizen science for nearly 40 years, bringing scientists and members of the public together to carry out scientific research in the field. A significant part of this work is in marine science, and Earthwatch has supported over 50 coral reef ecology projects with grants for research exceeding US\$3.2 million (1973-2009). The outcomes have been instrumental for coral reef conservation from local to international scales.

Recognising the critical level of threats now faced by the marine environment globally, many NGOs have responded to the increased public and policy awareness; and moved beyond baseline monitoring to ecosystem based management and applied conservation. In the field, this means no longer studying reefs in isolation, but examining ecosystem complexity and the connectivity between coral reefs, mangroves and seagrass bed habitats. Across our portfolio, Earthwatch projects apply scientific data to restoration activities and conservation strategy. For example, evaluating the success of MPAs in restoring reef health, to inform policy makers. Earthwatch funded research in collaboration with scientists raises public understanding of threats to the marine environment and the need for conservation – starting with the volunteers.

# NOTES

**The RCUK Organising Committee would like to thank everyone for participating in the  
RCUK 2010 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 2011 for the 14<sup>th</sup> RCUK Annual Meeting!