



# Reef Conservation UK

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



## Conference Committee

### RCUK Meeting Organising Committee

Heather Hall	Zoological Society of London
Alastair Harborne	Coral Cay Conservation
Jean-Luc Solandt	Coral Cay Conservation
Kristian Teleki	Cambridge Coastal Research Unit/International Coral Reef Action Network
Elizabeth Wood	Marine Conservation Society

The Organising Committee would to thank the following organisations and individuals for their valuable contribution to the success of the RCUK and the RCUK 2001 Meeting:

Mark Andrews  
Sarah Cadbury  
Rachel Jones  
Michelle Taylor  
Caroline Walsh  
Sian Young

Cambridge Coastal Research Unit  
Coral Cay Conservation  
International Coral Reef Action Network (ICRAN)  
Marine Conservation Society  
UNEP-World Conservation Monitoring Centre  
Zoological Society of London

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

1. A RCUK listserver (details of how to join can be found at: [www.jiscmail.ac.uk/lists/iyor-uk.html](http://www.jiscmail.ac.uk/lists/iyor-uk.html)) and
2. Our new RCUK website ([www.rcuk.org.uk](http://www.rcuk.org.uk))



## **PROGRAMME & ABSTRACTS**

**Zoological Society of London**

**8<sup>th</sup> December 2001**

**Presented by  
REEF CONSERVATION UK**

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

## ***ABSTRACTS***

***Abstracts for both oral and poster presentations are arranged in alphabetical order of first authors***

***Abstracts were printed as they were received and have not been edited for content. Reformatting only has been carried out to ensure uniformity. The responsibility of the content of each abstract remains with the authors themselves.***



# PROGRAMME

8:30 Registration, Posters and Coffee

9:20 Welcome to RCUK 2001

*Chairperson: Kristian Teleki*

9:30	✓ Sheppard	The Chagos Archipelago: A race between erosion and new growth
9:45	✓ Perry	Reef development at Inhaca Island, southern Mozambique: coral communities and impacts of the 1999/2000 southern African floods
10:00	✓ Chapman et al.	A Geographical Information System (GIS) for the Future Management and Protection of the Coral Reef Resources of Rodrigues
10:15	✓ Townsend	The Effects of Environmental Education on the Behaviour of Scuba Divers: a case study from the British Virgin Islands

10:45 Coffee / Tea

*Chairperson: Liz Wood*

11:15	✓ Jensen and Smith	An assessment of the interaction between conservation diving and coral reef communities: implications for the future management of a heavily dived coral reef
11:30	✓ De Meyer and Glass	The Coral Parks Programme – Securing a Future for Coral Reefs
11:45	✓ Davies and Widén	The Sustainability and Certification Potential of the Marine Aquarium Trade in Sulawesi, Indonesia
12:00	✓ Kemp	Some recent developments in marine conservation in the Red Sea and Gulf of Aden

12:30 Lunch

*Chairperson: Heather Hall*

10	✓ 14:00	Cooney et al.	Characterisation of the microbial community associated with coral disease using molecular microbiological techniques
26	✓ 14:15	Kelmo and Attrill	Tumour formation in scleractinian corals as a consequence of the 1997-98 El-Niño Southern oscillation on northern Bahia, Brazil
40	✓ 14:45	Macdonald and Perry	The implications of sedimentation for reef accretion and preservation within Discovery Bay, north Jamaica.
	✓ 15:00	Schelten, <i>Univ. York</i>	Impacts of sedimentation on coral larval settlement
	✓ 15:15	Field, <i>Univ. Newcastle</i>	Succession and space on artificial substrates in a Tropical Fouling community

15:45 Coffee / Tea

**Chairperson:** Alastair Harborne

✓ 16:15	Crabbe	Real-time monitoring of reef health and coral recruitment using digital videophotography and computer image analysis and modelling in the Wakatobi Marine National Park, S.E. Sulawesi, Indonesia
✓ 16:30	Hedley	Modelling the Light Environment of Coral Reefs
✓ 16:45	Jackson	How does Wave Action affect the Benthos at Mu Koh Surin Marine National Park (Thailand)?
17:00	Bythell	Hurricanes and bleaching disturbance in a coral reef marine protected area

**Closing remarks**

**Reception**



## Welcome to RCUK (Reef Conservation UK) Meeting 2001

Welcome to the 4<sup>th</sup> RCUK Meeting at the London Zoo. We have had an excellent response to this years meeting and we think you will agree that it is very exciting to see such wide ranging coral reef interests and activities.

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@hotmail.com](mailto:rcuk@hotmail.com)) 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.

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

*RCUK Committee*

*This article highlighting RCUK recently appeared in the Who's Who section of Reef Encounter (the newsletter for the International Society for Reef Studies)*

## REEF CONSERVATION UK (RCUK)

In 1996 individuals and organizations involved with, and having interests in, coral reefs came together to discuss International Year of the Reef (IYOR). Not only was this an opportunity to formulate the United Kingdom IYOR strategy, but it also opened new lines of communication and collaboration between individuals and groups in the UK who had never been in contact before, yet had similar interests and were involved in similar activities. It seemed both beneficial and appropriate to maintain these established links and to generate more. The advantages of increased communication between coral reef people in the UK were obvious, maximizing efforts for coral reef conservation and awareness, while minimizing the time and money which is required - commodities which many are short of these days. For this reason Reef Conservation UK (RCUK) evolved out of the original IYOR-UK committee.

Before RCUK there were few networking opportunities for coral reef researchers working in UK. This limited the scope for establishing collaborative research projects, disseminating results and building links between academics, students, consultants, NGOs and aquaria. This was aided by the establishment of a RCUK list-server, but more importantly the RCUK committee has organized one-day meetings every year since 1998. These conferences have been extremely successful, with over 100 delegates at a time.

A core component of the RCUK meeting has been a series of presentations from a range of subject areas including academic and student research, reef expeditions, conservation initiatives and tropical aquaria. Talks are selected to provide a general overview of the status of coral reef research in the UK and expose the entire community to a variety of topics. The informal setting of the meeting facilitates discussions and information exchange throughout the day.

### RCUK Newsletter

There have been occasional newsletters since RCUK began, but is now produced on an annual basis in order to further boost the lines of communication within the UK.

This has been an ideal way of letting other UK reef workers know what reef related work/interests individuals and organizations/departments are currently pursuing or are planning. The newsletter has included short articles, news items and announcements and details of current research, survey work, expeditions, educational initiatives etc.

### Grant scheme

Although RCUK receives no core funding, the annual conference and charitable donations have provided sufficient funds for a small grant scheme (maximum donation £300). Funds are only for UK-based applicants/researchers/organizations who are conducting research or projects related to the study of coral reefs and adjacent environments and can encompass disciplines such as conservation, education, public awareness, ecology, resource management, and mapping. RCUK grant recipients are requested to give an oral presentation or a poster at the annual meeting.

To date RCUK has provided funding for the following projects:

- Conversion of a diving etiquette video to allow it to be shown by airlines en route to the Red Sea.
- Acoustic sea floor mapping in the San Andres Archipelago, Colombia.
- Surveying the effects of sedimentation on reefs in Fiji.

RCUK has also provided two grants for environmental education in Honduras. Initial funding provided snorkeling and interpretative materials, and the second extended this work by facilitating the production of a series of 'Reef Briefs' for distribution in local Honduran communities.

RCUK aims to expand its activities in the future with plans to promote its role as a focus for UK media agencies who are increasingly covering issues relating to reef conservation and who require accurate summary information and specialist contacts. RCUK also hopes to provide advice and guidance to UK based NGOs and governmental institutions on key conservation topics and recent advances in scientific coral reef research.

If you are interested in being kept informed about the activities of RCUK please contact [rcuk@hotmail.com](mailto:rcuk@hotmail.com)



*Earlier this year the International Society for Reef Studies (ISRS) was asked to prepare a statement on sustainable reef fisheries for the International Coral Reef Initiative (ICRI)*

## **SEEKING SUSTAINABLE SOLUTIONS: FISHING AND CORAL REEFS**

### **A STATEMENT FROM THE INTERNATIONAL SOCIETY FOR REEF STUDIES**

Coral reef fisheries have an important place in many human societies. But problems of unsustainable fishing are commonplace, and their detrimental social and ecosystem consequences can be far-reaching. Sustainable solutions are a major challenge.

#### ***The vision: sustainable fishing for food security and other benefits***

Sustainably fishing diverse coral reef species could open up many economic opportunities for local communities, businesses, and government administrations. Sustainability, which can be measured by long-term reliability of stocks, protection of the coral reef habitat, and avoidance of detrimental cascading ecosystem effects, can also protect other properties of coral reefs that are of great value to humans. In particular, sustainable fisheries can:

- a) Contribute to food security and to the cultural, social and economic fabric of local communities;
- b) Make money through nature-based tourism and diving revenues. These revenues are highest from beautiful and diverse coral reefs that retain abundant fishable species – some species may be worth more alive than dead. Well regulated fisheries or aquaculture for the aquarium and curio trades can also generate wealth;
- c) Save money by having healthy, growing near-shore coral reefs that protect the coast and remove the need for expensive beach restoration projects (the cascading effects of chronic overfishing can flip a reef barrier from a state of net growth to net erosion).

#### ***The problem: unsustainable fishing undermines food security and ecosystem processes***

1. Many reef-based fisheries across large expanses of the tropics have disappeared or become severely diminished under pressures from both local populations and distant markets. Predatory fish, which are vulnerable to most fishing gears, usually disappear first. Fishers may take fish before they reach their most productive size (Growth Overfishing). Intense exploitation can drive numbers so low there are not enough individuals to maintain a viable population (Recruitment Overfishing). This can in turn cause a progressive shift in the balance of species on the reef (Ecosystem Overfishing) and distort the trophic pyramid, i.e. the natural balance of energy flow from the bottom to the top of the food chain. Some fishing techniques, such as dynamite and cyanide fishing, harm the reef and the complex environment fish and other creatures need to survive (Destructive Fishing).
2. Scientific evidence shows that when unsustainable fishing decimates the trophic pyramid, ecosystem-wide declines over large areas of coral reefs can occur, including more frequent incidences of:
  - a) Under-grazed reefs, where seaweeds pre-empt space formerly occupied by corals, and prevent coral recovery after natural or anthropogenic disturbance;
  - b) Over-grazed reefs, where an overabundance of invertebrates that graze by scraping food from the reef (notably sea-urchins), erodes reef structure much faster than it accretes;
  - c) Over-predation of live corals, by invertebrates such as crown-of-thorns starfish and coral-eating gastropods.

#### ***Unsustainable fishing in concert with other anthropogenic pressures***

3. Detrimental effects of unsustainable fishing are exacerbated by other anthropogenic pressures such as land-based pollution by sediments, fertilizers, sewage, toxins and trash.
4. Unsustainable fishing may itself exacerbate the poorly understood, ecosystem-wide impacts of coral bleaching and diseases of coral reef organisms<sup>2</sup>. The future extent, frequency and intensity of bleaching are predicted to increase under the influence of global climate change.



5. Because of these other anthropogenic pressures, it is more important than ever that reefs should be fished sustainably if they are to continue to support food security of local populations, and to offer other sustainable opportunities for local income generation.

#### ***Management problems specific to coral reef fisheries***

6. Several key factors make coral reef fisheries difficult to manage:
- a) The greatest pressures on reef fisheries can in some cases be generated by demand from international markets for reef products that are insensitive to the capacity of the coral reef ecosystem to meet those demands, let alone local needs. Products include frozen products, live fish for restaurants, and live corals and reef rock for aquaria.
  - b) Coral reef fisheries that recruit through long-distance larval dispersal can effectively be transboundary stocks, a viable fishery in one country, requiring well managed parental stocks is another.
  - c) Coral reef fisheries take an enormous diversity of creatures compared to fisheries in temperate seas, which may target only a few species. The data required for conventional management techniques that depend on an understanding of each species' biology and life history characteristics are prohibitively expensive for most countries with coral reef fisheries.
  - d) Catches are often brought ashore at numerous and disparate landing sites, making enforcement of quotas or even monitoring catches problematic.
  - e) Coral reef fisheries are often the last resort of the landless poor. Where no alternative incomes are available there may be no economic 'brake' on exploitation even where intense fishing drives catches, and hence earnings, very low.
  - f) Coral reef fish have a bi-partite life cycle which is still poorly understood. Although adults are relatively sedentary, fertilized eggs and developing larvae disperse away from the natal reef. How far they travel before they return inshore is a topic of considerable debate between proponents of 'widespread dispersal' and 'local retention'. If larvae are widely dispersed, managing an adult population of reef fish may not guarantee a healthy stock if that managed population depends on an upstream source of larvae for replenishment. This is particularly relevant to Small Island Developing States where larval dispersion may act across international borders separating healthy and overexploited reef systems. Conversely, if larvae are locally retained (and there is mounting evidence that at least a proportion of larvae may return to near their natal reef) local actions have local consequences. Where local retention is significant, poor ecosystem and fisheries management may cause declining stocks; but good management will lead to local recovery of fished populations.
  - g) Because of the patchy nature of coral reefs, recruitment overfishing of the replenishing population (whether local or upstream) can lead to local extirpation of an exploited species. If this happens, recovery may take decades rather than years, and may not happen at all without interventions such as stock enhancement.

#### ***Towards international solutions***

7. International solutions are required for two problems:
- a) Unsustainable pressures on local stocks generated by international market forces, and;
  - b) The undermining of one country's coral reef fisheries through overexploitation and/or habitat destruction of parental stock in another.

We believe there is an urgent need for interventions that are based on a) knowledge, understanding and regulation of the chain of supply from local fisher to international market place, and b) consideration of coral reef fisheries, where appropriate, as transboundary stocks that require management through bilateral and international agreements targeted at protection of reef habitats, spawning aggregation areas and parental stocks.

#### ***Towards locally effective solutions***

8. Despite the difficulties described above, coral reef fisheries research can draw some general conclusions:



- a) Effective habitat management (for example through rigorously enforced No-Take Zones and amelioration of pollution) is a critical tool for management of the fisheries of coral reefs and associated habitats. Habitat management refers not only to coral reef areas, for at certain crucial periods in their lives, reef fish may need habitats away from their normal adult environment. For example, many commercially important groupers and snappers aggregate to spawn, and protecting these aggregations should be a priority. Also, it may be important to protect inshore nursery habitats such as seagrasses and mangroves where some juvenile fishes live before they move to their adult reef environment. Protection of such habitats may require that measures be taken onshore to reduce pressures from coastal development or pollution.
- b) On their own, No-Take Zones will not be sufficient to halt reef declines. Reductions in effort and elimination of destructive fishing are also needed.
- c) The scientific consensus is that a balance of widespread dispersal and local retention affects larval replenishment of reefs. Irrespective of the exact balance, coral reef fisheries need a network of interacting management initiatives at a variety of spatial scales in order to remain sustainable.

### Call for action

8. The International Society for Reef Studies calls on the International Coral Reef Initiative (ICRI) to draw attention to the serious problems posed by unsustainable fishery practices and failures in integrated coastal zone planning. The Society further calls for immediate and effective action to ensure the sustainability of coral reef fisheries.

We believe that solutions will need to be implemented through complementary international policies, regional agreements, and local management prescriptions. We note that the 'Code of Conduct for Responsible Fisheries' of FAO Fisheries Department provides an excellent conceptual and institutional foundation for promoting the special needs of coral reef fisheries and ecosystems.

9. We believe that such actions will require both international and local interventions, and a 'whole coral reef ecosystem and society' approach to management. Attention should be paid to the nature of the fishery, the stocks themselves, their encompassing ecosystems, and the pressures exerted by both local needs and foreign markets. Effective management institutions and expertise must be supported where they exist, and established where capacity is lacking.

10. We believe important ingredients of international policy development, regional agreements and local management should include local, regional and international appraisals of stocks and fishery practices, market forces, broader ecology, and socio-economic particulars that canvas:

- a) the relative pressures of local, regional and foreign demands on the reef fisheries;
- b) alternative uses of coral reefs for activities such as nature-based tourism;
- c) the development of non-reef options for food security;
- d) the efficacy of tools and practices supporting sustainable fishing within the local socio-economic, cultural and ecological context, such as:
  - expansion and enforcement of no-take areas of appropriate sizes and in appropriate locations
  - regulation of total allowable catch
  - aquaculture - that is neither polluting, nor dependent on coral reef production for its artificial food supply - to reduce fishing pressure on the reefs
  - methods for reef restoration and biodiversity augmentation of reef species, including aquaculture of valuable specimens for the aquarium trade
  - amelioration of other detrimental effects on coral reef habitats and fisheries (such as destruction of adjacent habitats, and the influx of pollutants including fresh water, silts, and fertilizers)

### Notes

- 1 This statement was originally published in Reef Encounter (no. 30), the newsletter for ISRS.
- 2 The International Society for Reef Studies (ISRS) is the premier professional society focusing on the science and management of coral reefs. The Society has a membership of over 1000 researchers and supporters from more than eighty countries. ISRS is part of the International Coral Reef Initiative, tasked with ensuring that issues concerning the well-being of coral reefs and allied human populations are kept before the public, as well as appropriate government and inter-governmental agencies.
- 3 The ISRS Statements 'Coral bleaching - a global concern' and 'Diseases of coral reef organisms' are printed in Reef Encounter Nos. 24 and 25, and available therein on the ISRS web site at [www.uncwiled.edu/isrs](http://www.uncwiled.edu/isrs).







# ANNOUNCEMENT/ CALL FOR CONTRIBUTIONS

European Meeting of the  
International Society for Reef Studies (ISRS)

4-7 September 2002  
Cambridge, England

**You are cordially invited to participate in the European ISRS meeting to be held in Cambridge, England on 4-7 September 2002.**

**This meeting marks the return to Cambridge for the first time since the formative meeting of the society in 1980.**

Proposed themes for the meeting are as follows:

- evolution of reef biota
- advances in molecular biology and their application to reef sciences
- dynamics of reef ecosystems in space and time
- disease in the reef ecosystem
- management of reefs and marine parks
- reef geometries and sea level fluctuations
- corals as recorders of ocean-atmospheric processes
- coral growth and reef growth
- geological record of reefs and their diagenesis

***[www.isrs2002.org](http://www.isrs2002.org)***

## Submission of Abstracts

1. Authors will be able to submit one paper as lead author and one paper as secondary author only for both oral and poster presentation. Early abstract submission is encouraged.
2. Abstracts should be formatted for A4 size paper and no more than 500 words.
3. Please use Arial font, size 12.
4. Margins: 2.5 cm on all sides of the page.
5. Type title in CAPITAL LETTERS, 2.5 cm from the top of the page, centred.
6. Please type the name of the author(s) with appropriate upper and lower case letter. Underline the name of the author presenting the oral or poster presentation.
7. Type the institution and the full address of the first author on separate lines.
8. Skip two lines and type the body of the abstract, single-spaced.
9. When submitting the abstract authors should indicate to which theme(s) their paper is best suited.
10. Abstracts must be submitted by mail or email as Word attachment. They will be reproduced as submitted. If the abstract is sent by mail, please provide a laser quality original and three copies with the disk.
11. Abstracts must be received by 1 June 2002.
12. Submissions should be sent to:  
Abstracts ISRS 2002  
Cambridge Coastal Research Unit  
Department of Geography  
University of Cambridge  
Cambridge CB2 3EN  
United Kingdom  
Tel : +44 1223 339 775  
Fax : +44 1223 355 674  
Email : [info@isrs2002.org](mailto:info@isrs2002.org)

## Deadlines

<b>Registration without penalty</b>	<b>15 February 2002</b>
<b>Abstract submission</b>	<b>1 June 2002</b>
<b>Acceptance of contributions</b>	<b>30 June 2002</b>
<b>Final Registrations</b>	<b>21 August 2002</b>

(note: participants will not be able to register on the day of the meeting)





**ORAL**

**PRESENTATIONS**





# HURRICANES AND BLEACHING DISTURBANCE IN A CORAL REEF MARINE PROTECTED AREA

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Two vital characteristics of coral reefs are that they are in a continual state of change and that they are patchy. Natural change on reefs is brought about by mortality from various forms of disturbance. This promotes high species diversity by preventing one or a few species from becoming dominant and by opening up space for more species to colonise. The patchy nature of reef communities ensures that not all the reef system is at the same state at any one time, maximising larger-scale diversity.

A spate of intense hurricane activity and the 1998 bleaching event have impacted the protected area of Buck Island Reef National Monument, St. Croix, US Virgin Islands since a long-term monitoring programme was established in 1988. Live coral cover on the southern fore-reef is now 15% compared to 25% in 1989 (pre-Hurricane Hugo). Even with this pressure of disturbance, not all sites have shown similar declines, however. At another monitoring site on the northern back-reef, coral cover has increased from 32% in 1989 to 40% in 2000. The monitoring record also shows that hurricane disturbance leads to improved coral species diversity, once the reef has had a period of recovery from the disturbance. We have previously shown that the sites that were most impacted by Hurricane Hugo increased in biodiversity, while sites that were not significantly impacted did not increase in diversity.

The natural patchiness and state of flux of coral reefs means that it is extremely difficult to judge the status or 'health' of a reef system from a single survey. We have seen that each of the three permanent transect sites that were established in 1988 have changed in very different ways over the past 12 years, but the overall community structure has remained virtually the same. That is, the differences between these different 'patches' are greater than the changes we have seen over time.

# **A GEOGRAPHICAL INFORMATION SYSTEM (GIS) FOR THE FUTURE MANAGEMENT AND PROTECTION OF THE CORAL REEF RESOURCES OF RODRIGUES**

**Chapman, B.<sup>1</sup>, Turner, J.R.<sup>1</sup>, Genave, J.T.<sup>2</sup>,  
Hooper, T.<sup>3</sup>, Lynch, T.<sup>3</sup>, Hardman, E.<sup>1</sup>, and West, F.<sup>1</sup>**

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<sup>2</sup>Department of the Environment, Ministry of Rodrigues, Port Maturin Rodrigues, Mauritius

<sup>3</sup>Shoals of Capricorn Rodrigues, Fisheries Research and Training Unit, Pointe Monier, Rodrigues, Mauritius

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The marine fauna and flora of Rodrigues (an island state of Mauritius) is under pressure from unsustainable natural resource exploitation, sedimentation, and increasingly from tourism. There is a clear need for an integrated coastal management system and yet there remains a paucity of accessible information about the island's marine resources on which to base sustainable resource use decisions. The development of a Geographical Information System for the marine resources of Rodrigues was instigated in 2000 as a collaborative project by School of Ocean Sciences, University of Wales, Bangor, and Shoals of Capricorn Programme, with the Rodrigues Fisheries Research and Training Unit. Its aim was to provide a practical means of integrating data on various environmental parameters from research projects in the lagoon. The GIS was established in MapInfo<sup>TM</sup>, with a georeferenced, and ground truthed satellite image derived base map of the marine biotopes of the lagoon. Site data from surveys of bathymetry, biotopes, octopus resources, octopus fisheries, and coordinates of marine protected areas proposed in 1988, were incorporated into a relational database and linked to map layers by their geographic coordinates. GIS overlays revealed preferred habitats of octopus. Successful fishing outings outnumbered unsuccessful ones at just five stations, all situated in the north west lagoon. Catches of other species by octopus fishers were mostly unsuccessful despite widespread employment of other fishing methods. When the boundaries of reserves were displayed over the biotope map, many of the original reserve areas now represent heavily impacted regions. With the integration of additional data (for example species data from a coral reef biodiversity workshop, held in September 2001), the GIS will expand and provide a valuable and easily accessible source of data on the marine environment of Rodrigues, as well as potentially highlighting relationships, and consequences of particular resource use policies. The system is providing a useful tool for those endeavouring to establish sustainable utilisation of the island's marine resources. As a highly visual and interactive system, the GIS will be used for education and public awareness activities. The principal end users are government and non-governmental bodies involved in environmental and fisheries research and educational projects.



# CHARACTERISATION OF THE MICROBIAL COMMUNITY ASSOCIATED WITH CORAL DISEASE USING MOLECULAR MICROBIOLOGICAL TECHNIQUES

Cooney, R.P., Pantos, O., Le-Tissier, M.D.A. and Bythell, J.C.

Department Marine Sciences & Coastal Management, Newcastle University NE1 7RU

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It is widely accepted that diseases of reef corals make a significant contribution to the decline of coral reef communities. Although a major ecological phenomenon very little is known about the aetiology and pathology of these diseases. Modern molecular techniques can be used to investigate the microbial community and pathogens involved with many of these diseases. This approach avoids many of the limitations associated with traditional microbiological and empirical microscopy techniques. In summary, nucleic acid is extracted from diseased corals, bacterial 16S/fungal 18S ribosomal DNA is amplified using the polymerase chain reaction (PCR), microbial ribosomal species are resolved using denaturing gradient gel electrophoresis (DGGE) and/or clone libraries, and identified by sequencing. In addition, fluorescent *in situ* hybridisation (FISH) is used to locate, identify and quantify the changes in the microbial community during transition from healthy to diseased tissues.

# REAL-TIME MONITORING OF REEF HEALTH AND CORAL RECRUITMENT USING DIGITAL VIDEOPHOTOGRAPHY AND COMPUTER IMAGE ANALYSIS AND MODELLING IN THE WAKATOBI MARINE NATIONAL PARK, SE SULAWESI, INDONESIA

Crabbe, J.

University of Reading

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The aims of this study were:

1. To record massive coral surface areas at three sites (Sampela, Kaledupa, and Hoga reef) to understand the role of reef degradation on the recruitment and growth of coral species.
2. To compare digital imaging techniques with standard physical measurement techniques for coral reef complexity and growth patterns.

There was significantly higher species richness at Keledupa than at the other sites. Sampela had a significantly lower rugosity index than either Kaledupa or Hoga reef.

Three replicate transects, 10 m long, were laid at each depth at each site. Each transect was photographed by u/w video. Coral cover over each transect was then determined by u/w/videophotography. There was significantly less coral cover at Sampela than at Kaledupa, for both massive and branching species at all depths.

Physical measurements and digital video recordings of surface areas have been made on over 1,500 individual massive coral specimens on these transects, and on quadrats in similar areas. Coral growth has been modelled using a rational polynomial function and computer curve fitting. Using digital image analysis, mean *Acropora valenciennesi* linear extension rates were almost twice as much at the Kaledupa pristine site (c. 110 mm per annum) as at the impacted Sampela site (c. 60 mm per annum) only c. 1.5 km distant.

The Scleractinian coral community of Sampela is severely impacted by depositing sediments which can lead to the suffocation of corals, whilst also decreasing light penetration resulting in decreased growth and calcification rates. This is seen in the lower *Acropora* growth rates at Sampela relative to Kaledupa, while the latter also has a greater species diversity and coral abundance. We therefore anticipate that there is a net loss of material from Sampela, which if not checked, could result in the loss of this protective barrier which would be to the detriment of the sublittoral sand flats and hence the Sampela village. In this environment, the use of digital videophotography and computer image analysis can provide real-time monitoring of reef health. Such techniques could also be useful at other sites where there are large variations in degrees of impact over relatively small areas. In addition, digital videophotography allows many questions concerning growth rates, recruitment rates, modelling of coral morphology and coral energetics - questions which before have largely been ignored because of the amount of time required by underwater *in situ* measurements - to be addressed rapidly, precisely and accurately. It is not only useful for real-time studies, but by building up a library of digital video footage, allows for cost-effective long term monitoring programmes.



# THE SUSTAINABILITY AND CERTIFICATION POTENTIAL OF THE MARINE AQUARIUM TRADE IN SULAWESI, INDONESIA

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Can eco-labelled aquarium fish contribute to an ecologically, economically and socially sustainable aquarium trade? Indonesia is one of the major exporters of marine ornamental organisms. The aquarium trade is a small but lucrative sector of the Indonesian export fisheries where fishermen, middlemen and exporters have an established role in the trade chain with associated spiralling profits. However, due to the increasing business trend in marine aquarium organisms, the trade has raised concerns regarding the conservation of the targeted reef ecosystems.

The study was carried out in Northeast and Southwest Sulawesi as part of the WWF project on the mapping of the Indonesian aquarium trade. Data was collected through questionnaires and semi-structured interviews with fishers, middlemen, exporters and institutions, to gain an overview and understanding of the problems associated with the trade and opinions regarding the certification of aquarium organisms.

This study illustrates that the major threats to the sustainability of the marine aquarium trade in Sulawesi are due to destructive fishing practices, long trade chains, poor handling practices and long transportation. Depending on the number of middlemen involved in the trade chain approximately 80% of the coral and fish species may die before export. Given that the stakeholders involved within the trade chain i.e. fishermen, middlemen and exporters, only receive payment for the fish that arrive healthy and alive, they recognise these problems and welcome solutions to regulate the problems.

## THE CORAL PARKS PROGRAMME – SECURING A FUTURE FOR CORAL REEFS

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The Coral Parks Programme is a ten-year initiative launched two years ago by The Coral Reef Alliance (CORAL) to help create and support Coral Parks worldwide. Coral Parks are Marine Protected Areas, whether they are legally designated or not, which include coral reefs and allow visitation.

Proven to be one of the best ways of protecting coral reefs and their many inhabitants, Marine Protected Areas need active, effective management, support and public awareness to be successful. However, of the 564 existing Coral Parks, one third are under a kilometre in size and as few as 30% are thought to be effective. Most lack support, management capacity and sustainable funding.

The Coral Parks Programme aims to support the management of Coral Parks by assisting at all levels. Progress has begun with the development of management tools, such as guidelines, information kits, scientific fact sheets, as well as a website from which these tools can be downloaded.

Additionally, essential information is being collated to conduct a needs assessment for Coral Parks. Drawing on this and former marine park management experience, the Coral Parks Programme will provide an information service to aid Coral Park management.

The Coral Parks Programme is unique in its willingness to engage and work with the dive industry in coral reef conservation, an important sector whose consumer power can affect the fate of coral reefs worldwide.

In the longer term, the Coral Parks Programme is working to establish a communication network amongst active Coral Parks, and encourage an 'association' for Coral Parks. Plans are also underway to develop a Dive Operator Recognition Programme with voluntary standards of operation to give divers a more informed choice on their diving destination.

The Coral Parks Programme continues to focus on working in partnerships and with existing programmes, whilst raising awareness and support for Coral Parks.



# SUCCESSION AND SPACE ON ARTIFICIAL SUBSTRATES IN A TROPICAL FOULING COMMUNITY.

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Ship groundings cause small-scale perturbations of the benthic marine community altering both the physical and the biological structure of the reef environment. The resulting reef damage is not uniform over the site and can be classified into patches of continuous substrate type based on physical characteristics and stability.

Monitoring the change in benthic cover over time and the recruitment of new coral individuals on the natural substrate are important in determining trajectories of recovery within damaged areas. On the natural reef substrate, recognition of recruits is limited to the resolution of the photographic equipment or the vision of the researcher *insitu*. This leads to errors associated with quantification of newly settled recruits. The use of artificial settlement tiles attached directly to the substrate allows the investigation of spatial and temporal patterns of coral settlement and the cryptic community development.

At three ship grounding sites within the Straits of Tiran, Sharm el Sheikh, Egypt, artificial settlement tiles have been maintained from June 1999 until June 2001. Retrieval and replacement of tiles throughout the period have allowed the investigation of temporal patterns of recruitment while maintaining suitable surfaces for coral settlement.

Results have shown a significant temporal pattern of settlement of coral recruits in addition to a significant difference between damaged and undamaged areas. A similarly significant temporal pattern has been shown for the cryptic community development of tiles.

The importance of artificial settlement surfaces for monitoring recovery will be discussed along with the ramifications of the settlement discovered for the recovery of disturbed coral communities.

# MODELLING THE LIGHT ENVIRONMENT OF CORAL REEFS

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Optical remote sensing of coral reefs (from satellites or aircraft) is possibly the only method for effective large scale ( $>> 1000s\ km^2$ ) monitoring of reef community responses to anthropogenic and environmental stress. The basic aim in remote sensing is to be able to define biologically appropriate benthic classes (e.g. 'healthy' vs. bleached coral) and map them to a required degree of accuracy from remotely sensed data by means of their 'spectral signature' (i.e. colour). However, coral reefs are a challenging environment in which to apply remote sensing techniques. The visual appearance of a coral reef is a complex result of the pigments, morphology and distribution of a variety of corals, algae and other biota. Benthos is typically heterogeneous at scales smaller than the sensor resolution, and the reflected light will be further affected by the water and atmosphere above the reef before it reaches an airborne or satellite sensor.

Using field data alone to understand the processes which contribute to the remotely sensed light signal from a reef is impractical, as there are many interacting factors which are difficult to control or eliminate. Radiative transfer modelling (i.e. computer based modelling of light transmission and reflectance) is a more expedient approach. We are in the early stages of developing such a model, and the principal issues involved will be outlined. The work requires a cross-discipline approach, combining biology (pigmentation and morphology) physics (light transfer in water) and computer science (to develop practical approaches to modelling). When completed the model will allow 'virtual' experiments to be conducted, in which the utility of applying remote sensing in various circumstances (e.g. dependent on water quality, benthic categories and sensor employed) can be assessed and maximised.

# HOW DOES WAVE ACTION AFFECT THE BENTHOS AT MU KOH SURIN MARINE NATIONAL PARK (THAILAND)?

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This project was to set up a suitable survey method by which Park Rangers could monitor the Coral Reefs at Mu Koh Surin Marine National Park in Thailand. We used Line Intercept Transects Surveys and Sessile Benthic Lifeform Categories based on English et al (1997).

Results from the survey were compared to a Wave Exposure Index calculated following Thomas (1986). Multivariate analysis showed that the exposure and depth affect the composition of the benthos in coral communities at Mu Koh Surin. The greatest effect is at 1m deep where MDS plots showing % coverage of certain coral lifeforms show tight groupings in different parts of the MDS plot. As you go deeper, the groupings of the %coverage plots for each lifeform get looser. This implies that depth and exposure interact, that at depth the coral lifeforms can inhabit a larger range of exposures worked out by the Thomas method than in shallower water.

A modification of Thomas's equation would be useful as a quick reliable method of integrating exposure to wave action into the design of experimental and monitoring programmes.



# AN ASSESSMENT OF THE INTERACTION BETWEEN CONSERVATION DIVING AND CORAL REEF COMMUNITIES: IMPLICATIONS FOR THE FUTURE MANAGEMENT OF A HEAVILY DIVED CORAL REEF

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The number of newly qualified sub-aqua divers is increasing world-wide as is the number of divers visiting coral reef systems. There are many types of diver-based operations which enable divers to visit pristine reefs and one such market is that of scientific organisations carrying out conservation work. The amount of good conservation divers actually do relative to the damage they inflict on reef systems has been hotly debated but there are limited studies examining the eco-tourism market where the level of awareness should be much higher than in the general *sub aqua* world.

This investigation aimed to understand the level of impacts bestowed on the reef by large numbers of divers with different dive-experiences, qualifications and underwater objectives. Results presented here represent the largest study of diver behaviour and their interaction with reef organisms and are part of a two-year study, which aims to produce a comprehensive education program package to reduce the impact conservation divers have on reef habitats. The research also aims to understand which types of reef are most susceptible and the recovery rates of reef communities that have been impacted by diver damage. The ultimate aim of the research is to produce a management strategy which will take into account carrying capacities of different reef habitats and different scuba activities and to determine whether a sacrificial dive site is more beneficial than dispersed diving pressures, in respect to community diversity.

Direct observations were made of divers *in situ* and the numbers of contacts with the substratum were recorded in ten minute segments. These were categorized according to type of contact (whether fin, hand, equipment or body) and the type of substratum contacted (rock, sand, dead coral or live coral together it's growth form or type). A number of variables were recorded for each diver observed (including current, training, experience, activity) to determine which were significant risk factors for contacting the reef. The sample size (over 12,000 minutes of observation in water) makes this the largest study yet undertaken into diver behaviour and the only one to focus on an ecotourist operation. Results indicate that mean numbers of contacts are very low compared to studies from traditional tourist areas and that neither training nor experience correlate with numbers of contacts with the reef, contradicting the general belief that inexperienced novices do the majority of the damage to reefs. The most significant high risk groups were camera users and male divers.

The most striking indication is that those divers being guided are just as likely to make contact with the reef as those diving alone, indicating that training of dive guides and instructors should be an important part of any strategy put in place to reduce overall impacts.

# TUMOUR FORMATION IN SCLERACTINIAN CORALS AS A CONSEQUENCE OF THE 1997-98 EL-NIÑO SOUTHERN OSCILLATION ON NORTHERN BAHIA, BRAZIL

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Colonies of the scleractinian corals *Porites astreoides* and *Agaricia agaricites* with abnormal tissue growth have been discovered in Bahian Coral Reefs [Brazil]. Although the area has been monitored since 1995, scleractinians with chaotic porous proliferation, irregular shape and discolouration were first observed in April 2000. Colonies of both species were sampled from four separate coastal emergent and shallow bank reefs. The number of healthy and neoplastic colonies was quantified with 35 1m<sup>2</sup> quadrats, randomly placed at each reef. In each species, the tumorous coenosteum was more fragile than in the healthy parts of the colony. The tumours possessed a definite structural organisation based on the chaotic porous proliferation of gastrovascular canals over the surface. Microscopic analysis revealed hyperchromatic nuclei, thus indicating rapid evolution of the neoplasms and high metabolic activity of the afflicted cells. Repeat surveys in 2001 recorded reduced densities of healthy *A. agaricites*, with no tumorous colonies apparent. No colonies of *P. astreoides* were recorded during the 2001 survey. The relative severity in population reduction reflects the proportion of tumorous colonies in 2000; 100% of *P. astreoides* were affected, with a consequent total mortality. In 2000, only 67% of *A. agaricites* were tumorous, allowing the survival of colonies into 2001. It would therefore appear that tumours have directly induced mortality in these two coral species. The large-scale impacts of the 1997-98 El-Niño on these reefs were linked with factors additional to the abnormally high seawater temperatures. These included reduced cloud cover, resulting in increased levels of solar ultraviolet radiation (UVR) reaching the reef. Increased UVR exposure during 1997-98 contributed to reductions in the density of both coral species, and also induced late activation of oncogenes, either by some genetic predisposition to mutation or by direct damage to DNA via cyclobutane pyrimidine dimer photoproduct-formation, from where the neoplasms originated.



## **SOME RECENT DEVELOPMENTS IN MARINE CONSERVATION IN THE RED SEA AND GULF OF ADEN**

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The marine environment of the Red Sea and Gulf of Aden region was until recently relatively unimpacted by human activities but, while this is still the case in many areas, the situation is changing rapidly. Marine and coastal conservation efforts, which first started in the region in the 1970s, did not begin to develop significantly until the 1980s. More recent conservation initiatives have taken place at a range of scales from local to regional, and the establishment of a Regional Network of Marine Protected Areas is a major initiative currently being developed at the regional scale, under the provisions of the Jeddah Convention of the UNEP Regional Seas Programme. This Regional Network will consist of proposed new MPAs in Djibouti, Somalia, Sudan and Yemen, in addition to established MPAs in Egypt, Jordan and Saudi Arabia. The design and implementation of the proposed MPAs is planned to take place over the next two years, in areas of outstanding importance for habitat and biodiversity conservation. Habitats in all of the proposed MPAs are currently in good condition, but a number of impacts and immediate threats are present, ranging in severity from minor to potentially catastrophic.

# THE IMPLICATIONS OF SEDIMENTATION FOR REEF ACCRETION AND PRESERVATION WITHIN DISCOVERY BAY, NORTH JAMAICA

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The effects of sedimentation upon scleractinian corals in relation to their growth, reproduction and hierarchy of species tolerance have been widely documented through the past 30 years. However, the impact of elevated sedimentation rates upon coral associates, especially those responsible for modification of reef framework (i.e. encrusters and internal borers), has received only cursory examination. Discovery Bay represents an excellent site to investigate the effects of varying levels of sedimentation upon the styles and rates of reef accretion and preservation. Data collected will enable for the description of encrusting organisms (crustose coralline algae, foraminiferans, serpulid worms etc.) that are of critical importance for framework binding in shallow clear-water environments and have significance as palaeoenvironmental indicators. In addition examining the infestation of coral by boring organisms (sponges, bivalves etc.) will provide novel data with respect to sediment production and framework degradation from such an environment. This information will be useful for predicting the impact of increasing coastal sedimentation reported and predicted to occur from a framework perspective.

Discovery Bay, north Jamaica, is a confined large (~1.5km wide) and deep (~56m) embayment. Due to its structure the bay is naturally turbid and there exists an additional anthropogenic input from a loading terminal (a source of fine bauxite dust). This establishes two reefs (Columbus Park and Red Buoy) with distinct and elevated sedimentation rates. These conditions contrast markedly with those in adjacent fore-reef settings. Sedimentation rates can reach those perceived to be at the threshold for reef development. Accordingly the coral community is depauperate and dominated by *Montastrea annularis* and *Agaricia* sp. The bay reefs also have greater light intensity attenuation compared with the fore-reef and show a consequential decrease in encrustation. Macroboring, however, still remains high but with a change from a typically sponge dominated boring assemblage to one where bivalves are relatively more important.



# REEF DEVELOPMENT AT INHACA ISLAND, SOUTHERN MOZAMBIQUE: CORAL COMMUNITIES AND IMPACTS OF THE 1999/2000 SOUTHERN AFRICAN FLOODS.

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Inhaca Island, southern Mozambique (lat: 26°S, long: 33°E) is located towards the southerly latitudinal limits of coral reef growth. Reef development is, at best, patchy and currently restricted to the margins of channels which dissect the extensive intertidal flats on the Maputo Bay side of the island. Active framework accumulation is also bathymetrically restricted, with coral growth limited to the upper 4-6m at each site. In addition, the diversity of the reef-associated fauna is severely restricted. In contrast to lower latitude reef systems, reef development is therefore both spatially and bathymetrically constrained (in large part due to high turbidity and high sedimentation rates). These natural stress levels were exacerbated, via increased levels of freshwater and sediment discharge, during the prolonged and severe flooding that affected southern Mozambique in late 1999/early 2000 (three main rivers, the Incomati, Umbeluzi and Maputo influence Maputo Bay). This study assesses both the structure and composition of these marginal coral communities, and the impacts of this recent natural disturbance event. Impacts of the flooding vary but appear most significant on reefs on the inner (western) side of the island where live coral cover has reduced from 60.5% (1999) to 24.5% (2001) (mostly affecting *Acropora* species). There has also been an associated increase in dead *in-situ* coral cover from 4.8% (1999) to 37.6% (2001) much of which is undergoing intense biological erosion. Reefs on the southern tip of the island appear, in contrast, relatively unaffected and it is suggested that this in part resulted from different faunal compositions of the reefs and in part from a closer proximity to the open Indian Ocean. It is likely that further such events over short timescales will have severe implications for continued reef carbonate accumulation.

# IMPACTS OF SEDIMENTATION ON CORAL LARVAL SETTLEMENT

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Rising sea temperatures and other human-induced factors such as overfishing and increasing pollution have contributed towards recent global declines of coral reefs. To prevent degradation damaged corals need to be replaced by new juveniles. The settlement rate of coral larvae is one factor determining how many juvenile corals can develop. Deposition of sediment on newly settled coral larvae will impede this process. Levels of sedimentation that may not affect adult corals could be harmful to the more susceptible larvae. This study compares levels of coral larval settlement on reefs in St. Lucia, West Indies, which receive different quantities of sediment input. Ceramic tiles screwed to a PVC-pipe construction at different positions were used as artificial substrate for larval settlement. The tiles were left under water for around six months, then collected and analysed. This process was undertaken twice. Results suggest that sedimentation decreases the success of coral larval settlement. It also changes the composition of species settling. However, at the sites studied in St. Lucia settlement rates were very high compared with that of other coral larval settlement studies elsewhere in the Caribbean.



# **THE CHAGOS ARCHIPELAGO: A RACE BETWEEN EROSION AND NEW GROWTH**

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Three years after most corals died on the central Indian Ocean reefs of Chagos, erosion and recovery were studied to 30 m depth. Mortality was very high to 15 m deep in northern atolls, and to >35 m in central and southern atolls. Some reef surfaces have 'dropped' 1.5 m due to the loss of dense coral thickets.

Coral bioerosion is substantial, reducing 3-D reef 'structure' and forming unconsolidated rubble. Juvenile corals are abundant, though most settlement is on eroding table corals or other unstable substrates, and are of less robust species.

New SST data set shows that the critical SST causing the mortality in Chagos was 29.9°C, and that mean SST has risen 0.65°C since 1950.

Sea levels are predicted to rise by 5-20 cm in this region by 2020. Profiles across several islands shows that most have a depression in their middle, to present sea level or below. Possibility of sea water intrusion, and of island rim breaching, are clearly significant. It is concluded that at present erosion is 'winning' over new growth. Increased recruitment may reverse this, although only if no further mortality occurs caused by repeat warming episodes.

# **THE EFFECTS OF ENVIRONMENTAL EDUCATION ON THE BEHAVIOUR OF SCUBA DIVERS: A CASE STUDY FROM THE BRITISH VIRGIN ISLANDS**

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The study aimed to modify and improve existing environmental education and interpretation for divers and to test this for its effect on their behaviour and consequent environmental impact.

Observation was carried out on two groups of recreational divers in the British Virgin Islands. The number of times that divers touched the bottom or any other marine life was recorded and classified as voluntary or involuntary. Divers also completed questionnaires, which gave information on their knowledge and awareness of basic coral reef ecology and threats to reefs, demographic information and customer satisfaction levels.

Questionnaires and touch rates were compared between the control group, who were observed under normal conditions, and the experiment group, who experienced educational materials and modified briefings. The materials and briefings were designed on the basis of information collected locally and internationally from academics and practitioners in the field of environmental and coral reef education/interpretation. Psychological theories of the promotion of environmental behaviour change were also used.

Rates for the experimental group dropped from a mean of 6.56 to 1.95 number of touches per dive. This significant drop was attributed to the change in education and specifically the inclusion of short but specific behavioural instructions in the pre-dive briefings. Further training for dive guides in understanding and communicating the relevant messages, as well as greater emphasis on environmental considerations in all diver training is recommended.

Management of marine ecosystems affected by tourism lags behind terrestrial theory and practice. Interpretation is a key management tool and it is important to establish interpretive tools that are effective for natural resource managers, private operators and tourists.







**POSTER**

**PRESENTATIONS**





# IMPORTANCE OF BIOGENIC REEFS OF *SERPULA VERMICULARIS* AS A HABITAT FOR MACROFAUNAL INVERTEBRATES AND FISH IN A SCOTTISH SEA LOCH

Chapman, N.D. Moore, C.G., Lyndon, A.R.

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Biogenic reefs of the tubicolous polychaete *Serpula vermicularis* are a striking and unusual feature of the fauna of Loch Creran, Argyll, Scotland. The extent to which these reefs provide a habitat for other invertebrates and fish was addressed in this study. Macrofauna sampling of the reefs was principally by limited whole reef removal, while fish were recorded by diver observation and diver-deployed traps. The reefs were found to support a diverse community of macrofaunal invertebrates. The most abundant associated invertebrate groups were generally polychaetes, echinoderms and crustaceans, although the relative abundance of particular groups on a given reef appeared to be related to reef size. Estimated abundance of fish associated with reefs was not different to that seen away from reefs, although some otherwise scarce fish species appeared to be associated with reefs. It is concluded that *S. vermicularis* reefs provide an important habitat for many benthic and epifaunal invertebrates, but they do not lead to significant aggregation of fish species common in the loch. Nevertheless, that they do provide an important habitat for some otherwise uncommon fish species. The information gained from this study will provide a sound basis for future monitoring protocols, as well as raising public awareness of these unusual and important reef structures.



# IMPACT OF REEF-TOP GLEANING BY BEDOUIN WOMEN ON MOLLUSC SIZE AND ABUNDANCE IN NABQ MANAGED RESOURCE PROTECTED AREA, SOUTH SINAI, EGYPTIAN RED SEA

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Increased fishing pressure on coral reefs has led to extensive overfishing of reef stocks, and recently to the promotion of no-take (non-fishing) areas as a means of regulating fishing effort. Nabq Managed Resource Protected Area, located to the north of Ras Mohammed National Park, has a resident Bedouin population which is permitted to undertake fishing and gleaning within the MPA so long as this is using traditional methods and for their own consumption. In 1996, in order to manage this fishery more sustainably the area was zoned into sections open for fishing and gleaning and no-take zones closed to exploitation. In order to assess the effectiveness of this scheme on the stocks of invertebrates we compared mollusc abundance and size between take and no-take zones. For this we (supported by a team of University of Glasgow students) surveyed the abundance and size of molluscs (including species of *Tridacna*, *Strombus*, *Trochus*, *Lambis*, *Cheronia* and *Octopus*) along 30m x 5m band transects located within three different reef flat zones. Preliminary analysis of the data indicates a much greater abundance of *Tridacna* and *Trochus* in closed areas. The size of *Tridacna maxima* is also significantly larger in closed areas.

# THE MICROBIAL ECOLOGY OF WHITE BAND DISEASE AND WHITE PLAGUE

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Coral disease is becoming an increasing threat to the health of coral reefs throughout the world. Many studies have shown the presence of microorganisms associated with diseased tissue and some have been suggested as causal agents of disease. However, it is not clear whether the range of observed diseases are caused by different pathogens or have the same etiology but different secondary invaders. This study aims to identify the microbes associated with White Band Disease (WBD) and White Plague (WP) on a range of coral species. Denaturing gradient gel electrophoresis and amplified ribosomal DNA restriction analysis were used to determine the microbial communities associated with WBD and WP. Bacterial species found in association with the diseased tissue include *Chlorobium* sp., *Roseobacter* sp., *Agrobacterium* sp. and *Sphingomonas* sp. The spatial association of bacteria within both diseased and healthy coral tissue was observed by hybridisation with horseradish peroxidase (HRP)-labelled eubacterial oligonucleotide probes (EUB338) and tyramide signal amplification (TSA). It was concluded that bacteria are associated with the coral tissues and that variation exists within the microbial communities of diseases and between those on different coral species. However, it is still unclear as to whether a single species of bacterium is responsible for pathogenesis in either disease.

# RELATIVE COST-EFFECTIVENESS OF THREE METHODS OF MONITORING CORAL COVER AND DAMAGE ON A HEAVILY USED RED SEA REEF

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Global environmental pressures on coral reefs have led to an increasingly urgent and widespread need to monitor these fragile environments. The South Sinai of the Egyptian Red Sea has seen exponential growth in tourism and associated development with visitor numbers now at >200 000 yr<sup>-1</sup>. Even in such small reef areas usage is so widespread that ideally a hundred or more sites would be monitored on an annual or biannual basis. As this is beyond the manpower and resources of even the wealthiest environmental agency, emphasis must be placed on using the most cost-effective monitoring strategy available.

In response to this need, a team of University of Glasgow undergraduates recently compared the speed with which three sampling methods could be used to determine coral cover and damage to a required degree of precision on a heavily used section of fringing reef at Ras Umm Sid, Sharm El Sheikh. One method used 1 m<sup>2</sup> quadrats placed at 20m intervals along a transect line. The second method involved subjective estimates of cover within 7 x 7 m<sup>2</sup> areas at 20 m intervals along the same transect. The third method used video film of the whole transect line which was analysed using a five-point method to record cover within still-frames at five second intervals. For each method two data sets were gathered: one was live scleractinian coral cover according to growth type (e.g. massive, branched, encrusting), the other was recent coral damage according to damage type (e.g. trampling, bleaching, disease).

The video transect method was the most cost-effective of the three methods tested in terms of reducing the error of the estimate of coral cover and damage to a low level in the shortest total time required (in and out of water). It also has the advantages of providing a visible archive, and requiring less training and practice to acquire repeatable results.







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