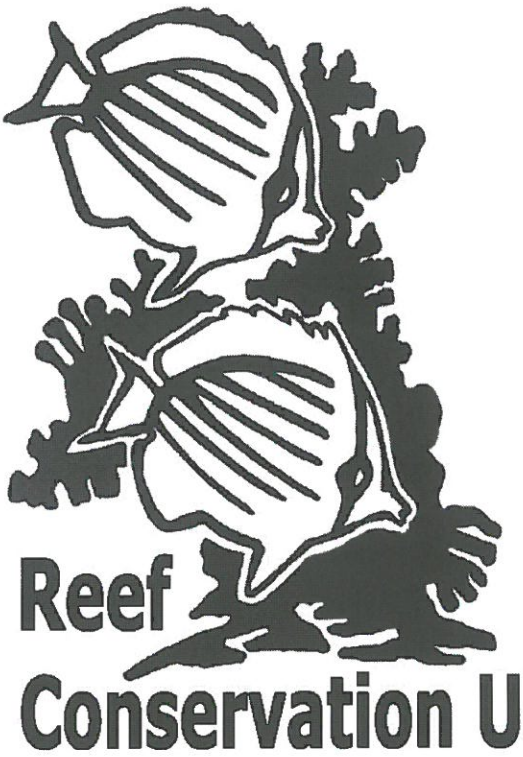
HEATHER

Reef Conservation UK

2004

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



PROGRAMME & ABSTRACTS

Zoological Society of London

6th November 2004

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 was only carried out to ensure uniformity. The responsibility of the content of each abstract rests solely with their authors.

Welcome to RCUK (Reef Conservation UK) Meeting 2004

Welcome to the 7th RCUK Meeting at the London Zoo. 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@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. There will be comment forms near the registration desk and do feel free to let us know what you think or if you have any suggestions for RCUK.

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

RCUK Committee

6th November 2004

PROGRAMME

Time	Title	Speakers / Authors
8.30 - 9.00	**Registration and Coffee**	
9.00 - 9.10	Introduction	K. Teleki
1.	Session 1: Reef Fish Dynamics and Management	Chair: K. Teleki
9.10 - 9.30	The effectiveness of small scale 'no-take areas' as tools in conservation management of locally exploited coral reef fisheries	R.K.F. Unsworth, D.J. Smith, A. Powell & F. Hukom
9.30 - 9.50	Are shallow-water biotopes important juvenile fish habitats within the Nabq MRPA?	J. Ashworth, R. Ormond & A. Mabrouk
9.50 - 10.10	Coral reef fish size structure and biomass spanning 40 years of closed-area management	N.A.J. Graham, N.V.C. Polunin & T.R. McClanahan
10.10 - 10.30	The affect of tidal cycles on the fish diversity, abundance and usage of the reef flats, Pulau Hoga, SE Sulawesi	P. Mansell
10.30 - 11.00	**Coffee**	
	Session 2: Reef Fish Dynamics and Management/ Ecological Monitoring	Chair: E. Wood
11.00 - 11.20	Sound: the essential navigation cue for young reef fish to find their way home	S.D. Simpson
11.20 - 11.40	Alternative livelihoods through income diversification: for sustainable coral reef and associated ecosystem Management in Sri Lanka	N. Perera
11.40 - 12.00	An example of a sustainable and well managed community based lobster (*Panulirus argus*) fisheries within the UNESCO Bioreserve of Sian Ka'an, Mexico	D.J. Ponce-Taylor, R.C.J. Walker, R. Borges Arceo & P.S. Raines
12.00 - 12.20	Scuba diving as a tool for the study of subtidal communities: the influence of sampling unit size	C.N.S. Poonian
12.20 - 12.40	Using stable isotope data to elucidate variable food web structures	A. Mill
12.40 - 12.50	Working towards best practice; scrutinising and optimising the ethical balance sheet of coral reef volunteer projects	T. Daw & J. Broderick
12.50 - 14.00	**Lunch**	
	Session 3: Coral Reefs in Space and Time	Chair: R. Walker and D. Ponce-Taylor
14.00 - 14.20	Long-term records of coral reef community development in nearshore turbid environments: towards an alternative to the clear-water reef model	C. Perry, P. Larcombe & S. Smithers
14.20 - 14.40	The $CaCO_3$ budget of two contrasting sites along a fluvial gradient, Rio Bueno, Jamaica	J. Mallela & C.T. Perry
14.40 - 15.00	Zooxanthellae clade DNA analysis from corals in the Wakatobi Marine National Park, E.E. Sulawesi, Indonesia, and Discovery Bay, Jamaica	J.P. Carlin & M.J.C. Crabbe
15.00 - 15.20	Scleractinian coral ecomorphology and community structure in Eastern Indonesia	J. Trebilco, D.J. Smith & A. Budiyanto
15.20 - 15.50	**Coffee**	
	Session 4: Coral Reefs in Space and Time	Chair: A. Harborne
15.50 - 16.10	Reef regeneration at Alphonse atoll, Western Indian Ocean following the 1997-98 ocean warming event	A.B. Hagan
16.10 - 16.30	*Eunicella verrucosa* in the UK - emergent trends from different southwest locations	C. Wood, J-L. Solandt & J.I. Doyle
16.30 - 16.50	Experimental artificial reef structures from rubble	R. Stein-Rostaing & M.L. Taylor
16.50 - 17.10	Anthropogenic and natural impacts to the coral reefs of Rodrigues	E. R. Hardman, J.R. Turner & M.S. Meunier
17.10 - 17.30	Feedback monitoring in environmental impact assessment on coral reefs	J.R. Turner, R. Boak, R. Klaus & E. Hardman
	Discussion and Conclusions	

17.45 - **Reception**

Okinawa Declaration on Conservation and Restoration of Endangered Coral Reefs of the World

Coral reefs and associated ecosystems are invaluable human treasures. They support the most diverse marine communities and beautiful seascapes on the planet, and provide wave-resistant structures and resources for local communities, fisheries, and tourism. However, coral reefs and associated ecosystems are now under serious threat of collapse because of over fishing, development of the coastal zone, including dredging and landfill, and terrestrial run-off. Moreover, the increase in sea surface temperatures, the decrease in carbonate levels as well as sea-level rise, caused by increasing anthropogenic CO2 in the atmosphere, all act synergistically to stress coral reefs, which lead to severe bleaching and extensive coral mortality. The degradation of coral reefs by local, regional, and global environmental stresses is at the very least destroying the health, function, and positive values associated with coral reefs, and at the worst leading to loss of this treasure.

We, the participants of the **10th International Coral Reef Symposium** (28 June to 2 July, 2004, Okinawa, Japan) acknowledge that the degradation of coral reefs worldwide has now reached a critical stage. We declare in the strongest terms that additional destruction of coral reefs must be avoided and more effort is necessary to prevent further reef demise. Conservation and restoration of coral reefs should be made without delay in each nation acting individually and in concert through closer international cooperation. To this end, we advocate scientific research and rigorous monitoring, management-tool development, and appropriate measures for conservation and sustainable use of coral reefs. In addition, scientifically sound restoration measures for already-degraded coral reefs must be applied.

A twin strategy must be taken over the longer term to reduce human induced climate change by reducing green-house gases, but at the same time a reduction in CO2 must be matched by action to reduce immediate threats of declining water quality because of land-use changes and pollution, and mass exploitation of fish biomass. To achieve these goals, we recommend four key strategies: 1) achieve sustainable fishery on coral reefs, 2) increase effective marine protected areas on coral reefs, 3) ameliorate land-use change impacts, and 4) develop technology for coral reef restoration. Such efforts must be fostered and sustained through stewardship and cooperation among scientists, managers, policymakers, non-governmental organizations, and the general public. The task must be enhanced through international linkages among the principal global scientific body (International Society for Reef Studies [ISRS]), the main international management initiative (International Coral Reef Initiative [ICRI]), as well as leading international organizations (e.g. UNESCO, UNEP, IUCN) and NGOs.

As participants in the 10th International Coral Reef Symposium, we collectively appeal to all researchers, managers, users, and lovers of coral reefs to accomplish the above tasks, and we urge relevant international organizations, national governments, and NGOs to find common understanding and means to collaborate towards this goal.

INTERNATIONAL CORAL REEF INITIATIVE (ICRI)

The International Coral Reef Initiative is a voluntary partnership founded in 1994 of countries, international environmental and development agencies, scientific associations, the private sector and NGOs that are linked by a global Secretariat, run and funded by the government of one country but often with assistance of others.

It seeks to help implement the recommendations on oceans of the Rio Earth Summit (Chapter 17 of "Agenda 21") and other international Conventions and agreements, to stop and reverse the global degradation of coral reefs and related ecosystems. ICRI, working with and through its sister networks, sets out to mobilise governments and a wide range of other stakeholders in an effort to improve international co-operation, management practices, increase capacity and political support, and share information on the health of these ecosystems.

The Johannesburg Plan of Action agreed at WSSD in September 2002 gives us a clear mandate to further raise awareness of the importance of coral reefs and press for action to better protect and manage them. There are a range of WSSD commitments that ICRI can help to implement, in addition to those set out in its own Call for Action:

- Well-managed marine protected areas
- Integrated coastal zone management
- Sustainable livelihoods, including fishing and tourism
- Development and application of the ecosystem approach
- Better oceans governance

Since July 2003, the UK has been co-chairing ICRI with the Seychelles, in conjunction with the UNEP World Conservation Monitoring Centre, and will continue to do so until next June when Japan and Palau will take over the Secretariat. While looking to meet these commitments, one of our aims has been and will continue to be to ensure greater active participation by governments and stakeholders in ICRI.

For more information please contact *icri@unep-wcmc.org* or you can find out more about ICRI at *www.icrifroum.org*

INTERNATIONAL CORAL REEF INITIATIVE (ICRI) Forum
www.icriforum.org

The ICRI Electronic Partnership Forum serves as a central gateway that compiles coral reef information, and offers an interactive space for its members (You don't have to be a member to use this Forum, but as the saying goes: membership certainly has it privileges.) One might view this forum as a house, a "mall" or even a meeting hall. The forum provides the space and some services in a centralized location, but there are specific rooms, shops, places or "desks", where various activities take place.

The left-hand menu shows the major themes by which ICRI-related information is being organized (such as the Secretariat, Members and New Users, ICRI Kiosks, ICRI Operational Networks, etc). Users can go into each of these areas to learn about the main Networks that help form the ICRI partnership.

Registered users can:
Create and submit a "Kiosk" that reflects your organization and its role in coral reef conservation and management. Once you register, you can create a Kiosk by going into the "ICRI Kiosks" section of the left-hand menu. There is an application to complete, where you can specify preferences you want Forum members to know about. You can list your organization's web site, post calendar events and news items for others to see. The Kiosks are easily searched and can help other members find information about you and your organization more readily.

Members can post information to the Forum's bulletin board in most any file format for others to review and download.

Members can open either public or private discussions, and can even select which of the Forum's members can participate.

Members can also have various types of information posted under the ICRIForum's "Information Resources" section. For example, this area holds an on-line Library, a volunteer section, job postings, among other items. However, user demand will dictate when features appear under this heading. If there are topics or thematic areas you would like to see posted please contact the administrator.

Registration is free. You have to complete a registration form to become a member of this Forum. Registration is not some form of Big Brother watching; it is simply a way for the system to recognize you, allow access to certain features, and help with information processing. You can still browse the ICRIForum without having to become a member, but will not be able to access certain features. If you decide to sign up, please click the "Members and New Users" link on left menu bar of the home page screen. After you become a member, then every time you visit the site you should log-in to gain access to the other features of the Forum.

Register at for the ICRIForum at www.icriforum.org and please contact the ICRIForum administrator (administrator@icriforum.org) with any problems, comments or suggestions.

Oral Presentations

ARE SHALLOW-WATER BIOTOPES IMPORTANT JUVENILE FISH HABITATS WITHIN THE NABQ MRPA?

J. ASHWORTH[1]*, R. ORMOND[1] AND A. MABROUK[2]

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The fish assemblages of shallow-water biotopes in the Nabq MRPA, South Sinai, Egypt, were investigated to assess whether they were important juvenile habitats. Fish assemblages of coral patches, reef flat, seagrass beds and sandy lagoons were compared using UVC while fyke nets allowed comparison of fish within mangroves and seagrasses across two seasons. The fish assemblages of shallow-water biotopes using UVC were more variable between biotopes than between sampling areas and between take and no-take zones. Little differences between take and no-take zones suggest fishing pressure has not influenced the overall fish assemblage to a great extent. Approximately one-third of the fish recorded were most likely juveniles. For species where length at maturity data were available and fish were almost certainly juveniles, 94% of the fish recorded on seagrass beds and 76% of the fish on sand, were juveniles, suggesting that shallow-water biotopes are important juvenile fish habitat. The fish assemblages of mangroves and seagrasses were overlapping, with differences more apparent between habitats than between seasons. 95% of individual fish, for which data on length of maturity are available, were found to be juveniles; of the other species, almost 70% of individuals were less than a third of their maximum reported length, and so most likely also juveniles. Important commercial fish such as *Acanthopagrus bifasciatus*, Mugilidae, *Gerres oyena*, *Lethrinus mahsena* and *L. nebulosus* were present only as juveniles suggesting mangroves and seagrasses are important juvenile habitats. 70% of taxa recorded during the fyke net survey can be seen on coral reefs in the region, especially many commercial species suggesting that shallow-water biotopes might have a nursery role. It is clear that many of the shallow-water biotopes in the Nabq MRPA, especially the mangroves and shallow seagrass beds, are important juvenile fish habitat.

Used fishbase to look @ length at maturity. Nagelkerken + van der Velde study.

• ~~No take areas~~ - lack of compliance.
• Grouper - UVC.
Distrib^n influenced by fisheries utilisation — Underwater seen
- diff. spp. occupied diff. niches.

Implications on mesh size and presence of diff. habitats in fished + non-fished areas for mgmt.

ZOOXANTHELLAE CLADE DNA ANALYSIS FROM CORALS IN THE WAKATOBI MARINE NATIONAL PARK, S.E. SULAWESI, INDONESIA, AND DISCOVERY BAY, JAMAICA

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We have analysed LSUrDNA (Large Subunit ribosomal DNA) from corals and zooxanthellae collected using FTA cards (Crabbe 2003) from reefs near Discovery Bay, Jamaica (Crabbe, et al. 2002) and the Wakatobi Marine National Park, S.E.Sulawesi, Indonesia (Crabbe and Smith 2002; Crabbe and Smith 2003; Crabbe et al. 2004).

Primers (Baker et al. 1997) were used to simultaneously amplify the D1 and D2 variable region of the LSUrDNA from both zooxanthellae and coral. The sequenced samples were subjected to alignment (ClustalX), manual editing (BioEdit) and Parsimony phylogenetic analysis using Paup* 4.0.

Phylogenetic analysis of the LSUrDNA from a coral host (*Seriatopora hystrix*) at a pristine site in Indonesia (Kaledupa) showed it was closely related to that from the coral *Montastrea franksei*.

We found that two separate *Acropora cervicornis* colonies from an impacted site (Columbus Park) near Discovery Bay hosted two different clades of zooxanthellae (A and C respectively). *Acropora digitifera* and *Fungia concinna* colonies taken from Indonesia, the former from an impacted site (Sampela) and the latter from a pristine site (Kaledupa) hosted clades A and H respectively. Both impacted sites had high levels of sedimentation (c. 50 g m-2 d-1 at Columbus Park and c. 20 g m-2 d-1 at Sampela), while the pristine site (Kaledupa) had low levels (c. 5 g m-2 d-1). It is interesting that clade A was present at both impacted sites. While clade D might be the preferred Symbiodinium for thermal adaptation (Rowan, 2004), clade A, and possibly clade C, might be preferred in areas of high sediment impact.

References

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Rowan, R. (2004) Thermal adaptation in reef coral symbionts. Nature, 430, 742.

other should proteins.

Rodriguez-Lanetty, Cha et al, in press - zooxanthellae diversity

- FTA classic cards - coral DNA transport
- 60-70% sample contamination - Aspergillus fumigatus & A. sydowii
  ? on coral or ? water column. & silica pouches in bags
  ? terrestrial contaminant

WORKING TOWARDS BEST PRACTICE; SCRUTINISING AND OPTIMISING THE ETHICAL BALANCE SHEET OF CORAL REEF VOLUNTEER PROJECTS

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Given the growth of volunteer-based reef conservation organisations VBRCOs and projects, particularly in the UK, it is timely to make an assessment of their impacts, both positive and negative. Most critiques of the work of these organisations have focussed on the scientific rigour of research conducted or quantity of habitat designated for protection. Given that the stated objectives of organisations often include references to livelihoods, poverty eradication and sustainable development, it is also important to bear in mind wider social, economic and environmental outcomes of their work and presence in remote, developing-country communities.

In the upcoming months we propose to engage with volunteers, scientists, host country professionals, explicit development organisations and particularly the VBRCOs themselves to produce a catalogue of successes, shortcomings and solutions. Current disillusionment within the sector can be understood by reference to the free market in which multiple competing organisations operate. Although the stated aims of VBRCOs are based around conservation and sustainable development, financial practicalities dictate that their primary objective must be to recruit volunteers and give them an enjoyable and rewarding experience.

Drawing from examples around and without the sector we will try to answer a range of questions. For example; How does volunteer based conservation implement sustainable development? Are there areas of cultural conflict? Do volunteers adopt sound environmental practices after leaving their project? Ultimately, the recognition and adoption of best practice will be to the benefit of all. We ask for your time, ideas and experience in drawing together this assessment.

* www.iaia.org

CORAL REEF FISH SIZE STRUCTURE AND BIOMASS SPANNING 40 YEARS OF CLOSED-AREA MANAGEMENT

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Recovery of fish from fishing has implications for the design of closed-areas and determining the equilibrium abundance and structure of assemblages, which can help with conservation, harvesting models and decisions. Some recent studies and reviews suggest that the effects of fisheries closures on fisheries target groups are rapid, on the scale of a few years. There are, however, time-dependent processes in ecosystems that operate and interact on many scales and theory suggests that only a few of these processes will be rapid. The few site-specific studies of recovery of harvested fish in coral reefs indicate that full recovery of fish populations may be considerably more extended than a few years. This study examines the size structure and biomass of coral reef fishes in Kenyan coral reefs by examining four fully-closed MPAs that vary in their time of establishment, from 1968 to 1991, such that data are available from four years prior to and 36 years after closed-area management. Here, we focus on the recovery of biomass and size structure of the total fish population as a function of the age of protection to determine if there are consistent and general patterns and equilibrium levels for each of these factors. Both the height of the size structure graph and the assemblage biomass graph are convex polynomials with an equilibrium biomass of 1200 kg/ha at 21.5 years. This suggests that full recovery of coral reef fish assemblages in terms of abundance-biomass within fully-closed MPAs is considerably longer than generally perceived and that beyond 20 years there is some loss in biomass. This loss of biomass could result from several processes including reduced net primary production associated with increased abundance of calcifying algae attributable to intense grazing. Clearly, extended periods of effective closure are necessary to ensure coral reef MPAs reach their potential.

MPAs -ves - loss of fishing grounds
- User conflicts.
- low levels of poaching may ~~make~~ eliminate +ve effects.
- Neutral/-ve results rarely published

Recovery in Kenyan MPAs.

Stenecia + Denhier 1994 - % calcifying vs non-calcifying algae as measure of net prod^{n}.

Size spectra analysis - regression of community size freq. distrib^{n}.

Decline after 25 yrs?
- NOT density/biomass dependent emigration
- NOT predator/prey interactions.
- Final red^{n} of net benthic prod^{n} that may effect animal biomass
  - Final ↓ is of herbivores.
- Russ & Alcala (2004) - Apo recovery.
  McClanahan (2000).

- Need long term well enforced enclosures
- Don't tell communities into false sense of security

REEF REGENERATION AT ALPHONSE ATOLL, WESTERN INDIAN OCEAN FOLLOWING THE 1997-98 OCEAN WARMING EVENT

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Considerable debate on reef survivorship has focussed on possible near-future changes in coral bleaching frequencies, driven by a global environmental change signal embedded within increasingly frequent El Niño ocean warming events. Such questions require a better appreciation of rates and characteristics of reef recovery following catastrophic bleaching yet few studies extend beyond the immediate post-bleaching period.

Indian Ocean reefs were particularly badly affected by the global 1997-98 ocean warming event, suffering up to 90% coral mortality. Repeated quantitative reef surveys (Video Transects and Line Intercept Transects) have been conducted at up to 30 sites around Alphonse Atoll, Seychelles (7°01'S; 52°44'E) in 1998, 1999 and 2001-2003. Data has been analysed to show changes in percentage cover for 7 benthic categories (sand, rubble, bare substrate, calcareous algae, scleractinia, non-scleractinia and macroalgae).

One year after the bleaching event, scleractinia cover was greatly reduced (10%) but macroalgal cover increased (up to 27%). This high level of macroalgae has not persisted and scleractinia cover has been progressively increasing, reaching 23% by 2003. At the same time, substrate coverage of calcareous algae has increased from 10% (1998) to 40% (2003). However, there has been no associated increase in coral diversity, with much of the percentage increase being attributed to colonisation by opportunist species of *Pocillopora* and *Acropora*.

Alphonse reefs appear to be in the early stages of recovery following the 1997-98 bleaching. The results suggest that it may take up to 10 years for these reefs to re-gain their pre-bleaching level of scleractinia cover, but possibly over 30 years to regain their generic diversity.

ANTHROPOGENIC AND NATURAL IMPACTS TO THE CORAL REEFS OF RODRIGUES

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The island of Rodrigues remains undeveloped however soil erosion, due to deforestation, is a serious problem, causing siltation within the lagoon. The reefs are also affected by natural impacts such as coral bleaching and cyclones. This study investigated the interaction between natural and anthropogenic impacts to the reefs in Rodrigues. Sediment deposition and coral growth rates were measured at 3 sites at varying distances from the terrestrial environment over two 4-month periods and coral settlement was investigated over 1 year. The results show that at the 2 inshore sites (Totor and Trou Malabar) sediment deposition was well above 'normal' sedimentation rates for coral reefs (up to 96 mg cm-2 d-1). Sediment deposition appeared to be linked to the very high rainfall and wind associated with Cyclone *Kalunde*, which affected Rodrigues in March 2003.The growth rate of *Acropora austera* appeared to be negatively affected by the high sediment load. Sediment deposition increased significantly between 2002 and 2003 (Mood's Median Test, $X2 = 31.11$, $df = 2$, $p<0.0$), whereas the growth rate of *A. austera* decreased at all 3 sites (1-way ANOVA, $F = 61.49$, $df = 2$, $p<0.05$). Settlement was very low and at Totor all coral spat were smothered with a layer of sediment. In addition to physical damage from the cyclone, corals in Rodrigues were affected by coral bleaching events in 2002 and 2003, resulting in mortality. Predicted increases in sea temperature, may result in a greater frequency of coral bleaching events and an increase in the frequency and severity of cyclones. Healthy reefs are able to recover after natural disturbances, however the addition of human stresses means that reefs may fail to recover. Rodrigues is undergoing rapid development and it is suggested that management measurements are put in place to prevent further sediment deposition on inshore reefs.

THE CACO3 BUDGET OF TWO CONTRASTING SITES ALONG A FLUVIAL GRADIENT, RIO BUENO, JAMAICA.

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The coral reef framework is the result of constructive processes that produce calcium carbonate (*e.g.* coral growth), and destructive processes that remove carbonate (*e.g.* bioerosion and wave energy). In order to effectively assess and monitor the health of a coral reef it is necessary to determine how these processes interact. This study focuses on Rio Bueno, Jamaica and details the key biological processes that are influencing reef framework development. Data on carbonate production, grazing (*e.g.* fish and urchins) and internal bioerosion (macro- and microboring) are presented in order to construct a biological carbonate budget for two contrasting sites along a fluvial gradient. Whilst many studies have looked at these processes individually very few studies have considered the combined effects of both grazing and boring.

We chose two sites: a turbid water site located close to a river mouth, characterised by high sedimentation rates and elevated nutrient levels and a contrasting outer embayment site, characterised by clear water and reduced riverine inputs (sediment and nutrients). Results highlight that both sites, whilst actively accreting, were heavily bioeroded. At the clear water site, macroborers were the most important bioeroders, accounting for 66% of the total carbonate loss, microborers were responsible for 32%, whilst urchin and fish grazing were minor contributors (0.2 and 2.3% respectively). In contrast, microboring dominated the turbid water site, accounting for 67% of bioeroding activity. Macroboring was responsible for 32% of carbonate removed, whilst urchin and fish grazing levels were low (0.01 and 0.4% respectively). Results from this study highlight the importance of considering both internal and external bioerosion when assessing reef health.

THE AFFECT OF TIDAL CYCLES ON THE FISH DIVERSITY, ABUNDANCE AND USAGE OF THE REEF FLATS, PULAU HOGA, SE SULAWESI

P. MANSELL

University of Plymouth

The coral reefs of Eastern Indonesia are some of the richest and most diverse on earth with 80 genera and more than 450 species of corals. Coral reefs, as highly complex marine ecosystems, also have the potential for fish communities to show exceptionally high degrees of diversity, particularly the Indo-Pacific region with a wide range of varying habitats being provided by the complex reef morphology and the lack of large scale disturbance events such as those recently devastatingly affecting the Caribbean. This particular study looks at the factors influencing the diversity, abundance and usage behaviour of fish communities on the reef flats of Pulau Hoga in South East Sulawesi. Two areas on the reef flat were studied, namely that of the coral bombie zone and the reef crest. These were considered in both the fishing zone and the 'No Take' zone. At these locations, two differing microhabitats were investigated; hard coral and soft coral, at varying tidal heights. Taking all of the above factors into consideration, the physical measurements of the coral were collected and the fish size, diversity, abundance and usage behaviour among the reef flats investigated. The data were collected by snorkelling, observing each of the 'haphazardly' selected coral colonies for 20 minute periods monitoring the fish communities present. The general findings from the study show a greater diversity and abundance of fish at the reef crest than the coral bombie zone with the high and mid tides indicating both a greater number of species and fish than the low tide. Diversity indices calculated also appear to show no significant difference within the fishing and 'No take' zones. The ecological importance of these differing microhabitats and the importance in maintaining these diverse communities is of particular significance with this study.

USING STABLE ISOTOPE DATA TO ELUCIDATE VARIABLE FOOD WEB STRUCTURES

A. MILL

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Food webs are generic models that describe the mechanics of marine ecosystems and stable isotope analysis has become an accepted method of elucidating their structure and dynamics. Stable isotopes techniques provide an alternative method of calculating trophic level to gut contents analysis. However, to determine trophic level stable isotope analysis assumes that the system being studied is in a relatively unperturbed state, i.e. signals in the 'isotope signature' of consumers do not vary significantly over time. In order to estimate the trophic level of a higher consumer, it is necessary to first establish a baseline; an organism with a known trophic level. In a marine setting, primary producers (notably phytoplankton) and their consumers (e.g. zooplankton) exhibit marked short term variability, hence are not a suitable baseline. Large-scale variation in primary productivity that is not averaged at the primary consumer level will affect assessment of relative trophic levels. The coral reef and associated upwelling system in Oman experiences marked seasonal variability and shall be employed to explore changes in isotope signature in a number of organisms over time. It is the aim to develop a predictive model that can be used to assess the impact of the temporal variability in primary producers on food web structure, in particular how changes in the baseline can influence large predators at higher trophic levels. This project will enhance the usefulness of stable isotopes in food web research.

- field work in Oman.
- Scattered non-linear food web.

- Reviewed alt. livelihoods in rest of world + took @ best practices.
- Good legislation but poor enforcement.

ALTERNATIVE LIVELIHOODS AS AN OPTION FOR SUSTAINABLE MANAGEMENT OF CORAL REEF RESOURCES IN SRI LANKA

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As an island nation, Sri Lanka's socio-economic development has always been closely linked with coastal and the marine habitats as they provide significant benefits, especially in the form of food security and livelihood options. Coral reefs occur mainly as nearshore fringing reefs and patch reefs along 2% of the coastline. Fisheries are the main economic use of reefs of the country and it may constitute around 15% of the total fish landing. The minimum economic value of coral reefs in Sri Lank has been estimated at US$ 140,000 - 7,500,000 per km^2 reef over a 20-year period.

- 5% ornamental fish species. Ban on export - said 50000 people affected

According to the Reef at Risk Assessment, 86 percent of the reefs in Sri Lanka are under high risk. Bleaching due to increased seawater temperature (El Niño related) is becoming a major threat to their survival while anthropogenic activities such as over exploitation, use of destructive fishing methods (dynamiting and the use of moxy-nets) have seriously destroyed the reef habitats and the fish stocks. At Hikkaduwa and Pigeon Island, the reefs are heavily exploted by tourists and boat operators. Sea coral mining has resulted in large-scale destruction leading to increased coastal erosion in several places.

The country does not lack laws to protect its coral reefs and on surface they seems to provide all the answers for physical breakage of coral, pollution and over harvesting of the fishery resource. Various studies have shown that the implementation of these laws were problematic as poverty and lack of other employment opportunities force people to continue in unsustainable methods of harvesting or illegal mining of the reefs.

Policy makers have now realized the importance of a strong commitment from the local community for effective management of reefs. To motivate a community to protect the resource, the management options should be able to provide direct benefits to them. Provision of alternative livelihoods or diversification of livelihood options of the coral reef users is one such management option identified. A consolidated effort is required to generate additional employment and high income for the rural poor in coastal areas, as it has to absorb the present labour force as well as the increasing populations of working age. This is an issue that not only concerns the conservation sector, but also a national problem that cut across all the different sectors of the country.

LONG-TERM RECORDS OF CORAL REEF COMMUNITY DEVELOPMENT IN NEARSHORE TURBID ENVIRONMENTS: TOWARDS AN ALTERNATIVE TO THE CLEAR-WATER REEF MODEL

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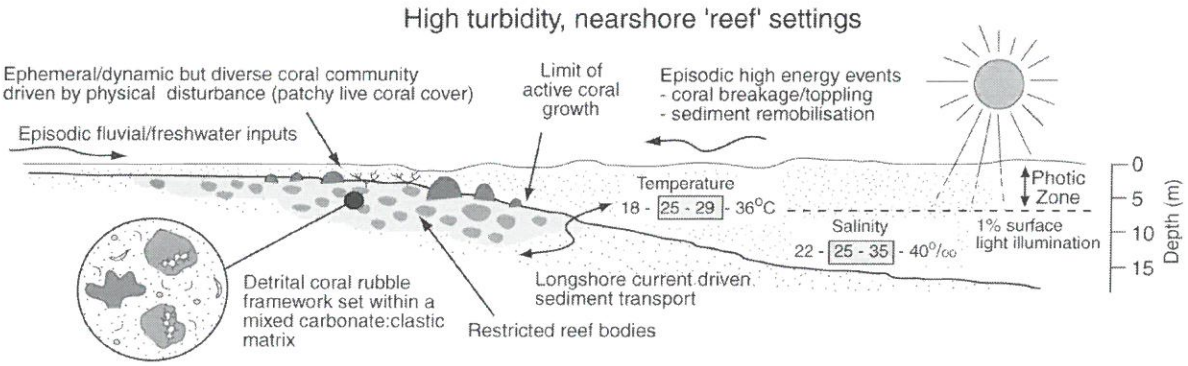
The short-term ecological effects of high sedimentation rates and elevated turbidity regimes on corals have been well documented. Experimental data often indicates that as levels of these parameters increase so there will be a detrimental effect upon coral vitality, and that consequently areas of high turbidity or sedimentation are unfavourable for reef development. This view is often reinforced by the fact that the majority of reef research is conducted within clear-water environments where reef structures are characterised by extensive framework accumulation. Whilst these environments have provided the basic models for understanding tropical reef carbonate production, they represent only one end member in a diverse range of environments in which coral communities occur, e.g., turbid settings, upwelling-influenced settings, high latitude settings. These are not 'impacted' or 'disturbed' reefs, but represent alternative states of development. This paper describes examples from two nearshore settings where coral communities occur intimately associated with conditions of high sediment mobility and high turbidity; Inhaca Island (southern Mozambique) and Paluma Shoals (central GBR). At both sites coral diversity and coral cover is high, despite the fact that the coral communities occur intimately associated with terrigenoclastic sediments (and appear to have done so throughout their growth history). The reefs at Paluma Shoals initiated around 1,300 ybp and underwent initial slow seaward progradation followed by more rapid vertical and landward accretion. At Inhaca Island the majority of the reef deposits date from 6,500-4,500 ybp and since this time limited seaward accretion has occurred. This is consistent with the ephemeral nature of the active coral communities. On the basis of our studies, we outline an initial model for the occurrence of coral communities associated with nearshore, highly turbid sites, closely associated with terrigenous sediment. This differs from classic clear-water models in terms of the extent of 'reef' development and the nature of framework development.



AN EXAMPLE OF A SUSTAINABLE AND WELL MANAGED COMMUNITY BASED LOBSTER (*PANULIRUS ARGUS*) FISHERIES WITHIN THE UNESCO BIORESERVE OF SIAN KA'AN, MEXICO

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The community based artisanal Spiny Lobster (*Panulirus argus*) fishery has been in operation, within the Ascension Bay region of The UNESCO Sian Ka'an Biosphere Reserve, Yucatan, Mexico, for approximately 50 years. Fishermen are organized in a community based cooperative, Cooperativa de Pescadores Vigía Chico. The cooperative shows exemplary management techniques, obtaining sustainable and constant landings within the shallow lagoonal patch reef environment, compared with many lobster fisheries within the Caribbean that have experienced a sharp decrease or collapsed in recent years. Sustainability of this fishery has been achieved by establishing a sense of stewardship in all fishermen, dividing the lagoon into individually owned 'fishing-fields'. The use of concrete lobster aggregating devices ('shades' or 'sombras') was developed from techniques used by Cuban fishermen who fished in the area in the 1950s. Fishermen check their individual shades every couple of days with the use of snorkel equipment. These aggregation devices, in combination with the shallow nature of the reef, allow fishermen to be selective and to land full body lobsters, permitting fishermen to comply with national and park regulations on minimum carapace size and no landing of berried females. Seasonal restrictions also apply, allowing for the natural re-stocking of populations. Local fishermen have been developing alternative livelihood strategies such as eco-tourism in order to maintain the long-term sustainability of the lobster fishery. Future plans include the introduction of an eco-labelling programme in order to promote sustainable practices and to be able to target specific market niches.

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- Have sole rights to fishing ground divided up into 'fields' w/in co-op. If poach, gear confiscated + have no income.
- fishing restriction - no SCUBA. seasonal restrictions. Minimum Carapace length. No landing berried ♀. (July–Feb incl).
- Mean abundance 4 than av. in Caribbean in 8/12 sites (Waller et al 2004)
- → Darwin project.

SCUBA DIVING AS A TOOL FOR THE STUDY OF SUBTIDAL COMMUNITIES: THE INFLUENCE OF SAMPLING UNIT SIZE

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Several studies have attempted to experimentally compare population estimates obtained from different SCUBA survey techniques and have demonstrated significant levels of variability between techniques and observers. However, published work investigating sources of variation within a single technique remains scarce. This study investigated scale-induced variation through analysis of population density estimates obtained from five different sized quadrats. Two shallow subtidal sites on the west coast of Scotland were sampled: a natural rocky slope and a recently deployed artificial reef. Organisms investigated varied in size, abundance, mobility and detectability. Estimates obtained from photographic sampling were compared with those obtained from visual survey. Variability in estimated densities between different sizes of sampling unit was found to be considerable. A decreasing asymptotic relationship with quadrat size was evident for estimated density, coefficient of variation and number of samples required to attain a given precision. Thus even small increases in quadrat size have the potential to create significant improvement in data quality to an optimal point after which there are diminishing returns. The sampling unit must be large enough to encompass the variability in spatial distribution of the target organism. Mobility can be beneficial to the precision of estimates for rare animals by increasing detection rates; and detrimental to those for common animals because of observer confusion. Improved precision for estimates of cryptic species is obtained from small sampling units, which focus the observer's attention. Artificial reefs constructed from standardized material may be useful in experimental studies, because their homogeneity increases the validity of replication. Underwater photography as a population estimation technique can produce data comparable to that from visual surveys, but is limited by field of view. Owing to financial and practical considerations, pilot studies are recommended to ensure the necessity of SCUBA and the employment of an efficient sampling unit size.

Acknowledgements

This study was supervised by Dr. Martin D. J. Sayer, leader of the Animal-Environment Interactions Group within the Scottish Association for Marine Science at Dunstaffnage Marine Laboratory near Oban, Scotland. Diving and underwater photography were arranged by Dr Simon Thurston and Mr. Hugh Brown.

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SOUND: THE ESSENTIAL NAVIGATION CUE FOR YOUNG REEF FISH TO FIND THEIR WAY HOME

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We have recently learnt that, far from drifting pathetically at sea while they develop, larval coral reef fish are intelligent fit young individuals, and so are very choosy about where they make their home.

In the first part of this presentation, I will describe several studies that have identified sound as a vital cue for navigation during this settlement process. In the first, we attached sound systems playing reef sounds to some light traps, and found significantly greater numbers of fishes from many reef fish families in these traps coupled with noise compared to the catches from silent traps. We then successfully used sound to enhance recruitment of fishes at artificial reefs with speakers broadcasting reef noises compared to the recruitment at silent reefs, and even selected for different fish using different noises. In the lab, we found that embryonic clownfish can hear noises in the egg, raising the possibility that they may have the sounds of home imprinted on them before ever heading to sea. Finally, we used electrophysiological methods to measure the hearing capabilities of larval clownfish, and from this, calculated that larval fishes may hear reefs at distances of 100s of metres. Our findings not only have major implications for how we model recruitment, but may also offer some potential management tools for reef systems.

In the second part of this presentation, I will describe my plans, through the support of a NERC Fellowship, to study what aspects of this response are instinctive and innate, and what parts are based on early life experiences, and so are learned. My approaches combine field, laboratory and theoretical approaches, to enable realistic, controlled, and large-scale implications of these findings to be understood and applied to essential issues of management.

Sound - current independent.
Navy - fish choruses - daily + seasonal rhythms.
- light traps, speaker systems (synchronised swimmers).
noisy ↘ silent shows response to noisy boxes across all spp.
Then did on artificial reefs.
Esp. impt. for Apogonids / Pomacentrids.

EXPERIMENTAL ARTIFICIAL REEF STRUCTURES FROM RUBBLE

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Small quantities of unconsolidated rubble were removed from inner lagoonal areas cleaned and dried. Rubble was placed upright in cement bases to create three-dimensional structure. 1m by 5m of these structures were placed in The Bay of Ranobe lagoon on a 10m by 5m limestone base. Structures were 100% covered with coralline algae and filamentous algae within 3 months and had resident fish populations.

After a year 36 juvenile corals (mostly Pocillopora spp.) had settled on the structured area (8.6 per m^2), 5 on the unstructured base (0.12 per m^2) and 2 on the rubble controls (1 per m^2). All structures are in tact and the base is stable.

It cost £50 per m^2 of structure (including boat fuel, staff costs, tanks, all materials). The most expensive element was the boat fuel, tanks and cement.

Rubble does have a role in a coral reef ecosystem (algae grow on it, juvenile recruits of many species settle on rubble, invertebrate often live in rubble etc) however due to the sheer extent of rubble coverage within some areas of the Bay of Ranobe it does not seem to be deleterious to remove small quantities, as we have, to be restructured.

The experimental rubble structures are a feasible and relatively cost effective fish attractant. On such a small scale these structures are not a FAD for fishery species however over larger areas they may be. Small sections such as this experiment may be useful as corridors between areas of diversity / different habitats within the lagoon.

SCLERACTINIAN CORAL ECOMORPHOLOGY AND COMMUNITY STRUCTURE IN EASTERN INDONESIA

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Eastern Indonesia is a region of maximum global hard coral species and generic richness but its reef ecosystems are experiencing rapid degradation as a result of human usage. Since scleractinian coral communities are the physical basis for habitat and faunal diversity on tropical reefs, it is important to understand the processes that influence their physical structure. Two key questions are whether corals will respond morphologically to environmental changes such as increased sedimentation or rising sea surface temperatures, and whether these responses will scale up to the community level. We employ a three-fold approach to address questions regarding coral ecomorphology and community structure in the Wakatobi Marine National Park, South-east Sulawesi. 1) To use digital still photography and morphometric measurements to assess morphological responses within colonies of hard coral species that are dominant in the region. Results indicate that the size and shape of polyps in the massive coral *Diploastrea heliopora* change in response to environmental variables, in particular light availability. 2) Reciprocal transplantation of coral fragments to investigate morphological responses to environmental change. This technique distinguishes genetic variability and phenotypic plasticity as causes for morphological variability. 3) Long-term monitoring of coral communities to detect community level change across a broad range of sites. Preliminary findings suggest that the abundance and distribution of different coral species can be related to the degree of morphological variability observed at the individual level. Further questions to be addressed include whether changes in the physical form of coral communities under different scenarios of environmental change can be predicted.

Rhodes TV87.

FEEDBACK MONITORING IN ENVIRONMENTAL IMPACT ASSESSMENT ON CORAL REEFS

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Environmental Impact Assessment (EIA) is a more effective tool in reef management when feedback loops are employed during the construction and operational phases of a development. Monitored environmental parameters become thresholds or 'control panel criteria' within which developers must work. If thresholds are exceeded in the near-field of the development, then a far-field (control) site is monitored to assess whether a change in parameter is due to the development (in which case construction must cease) or another cause. Feedback monitoring was embedded in an EIA for a major wastewater scheme employing primary treatment, chlorination and a sea outfall through a coral reef on Mauritius in the western Indian Ocean. The new outfall replaces existing outfalls which discharge domestic and industrial effluent directly onto shores, into lagoons and onto a reef crest, causing eutrophication, sedimentation, and pathogen levels above acceptable limits. The project was novel, because one option involved bore hole injection of wastewaters into a lava tunnel under the reef, while another involved construction of a submarine pipeline to -35m depth on the reef front. A baseline coral reef and water-quality survey, in which permanent monitoring stations were established, was undertaken at the construction site, near-field sites and far-field sites to determine a suite of realistic control panel criteria which could be monitored by the developer and scrutinised by the Chief Engineer and Scientific Advisor. The survey quantified the physical structure and benthic cover at the sites to provide a baseline against which change could be measured, and to accurately determine spatial and temporal mitigation measures for construction activities (such as anchoring, rock cutting, dredging, armouring, rock dumping). The case study illustrates how good practice in Coastal Zone Management involves EIA with direct feedback monitoring underpinned by sound scientific data to determine realistic, usable criteria.

Charles Henry
Foyle Trust
Fox Mem Trust

- Feedback loop monitoring → reactive mgmt.
- 50 – 90% ~~from~~ of effluent from textile industry.
- Were going to build outfall towards
- World Bank $12.5M

CAN PARTIALLY PROTECTED AREAS BENEFIT CORAL REEF FISH COMMUNITIES? EVIDENCE FROM TANZANIA, E. AFRICA

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Allowing fishing within marine protected areas (MPAs) provides a variety of options for management without having to restrict access completely, as is the case for No-take areas. Such MPAs, termed partially protected areas, can manage fishing by regulating gears and effort. Partially protected areas can be much larger than No-take areas, due to the inclusion of local communities. They are being applied worldwide, but this is not reflected in the current literature. We assess a partially protected area, Menai Bay Conservation Area, Tanzania, in terms of its effects on the overall size, density and species richness of nine commercially important coral reef fish families. We use Mantel's tests to incorporate the non-random spatial distribution of sites in the analysis, a common problem in marine reserve studies, and assess the relative effects of partial protection, habitat and the distribution of sites on the fish variables. The size and number of species of commercial fish were 31% and 25% greater respectively in partially protected sites than in unprotected sites, but density was not altered. Partially protected areas could be worthwhile management tools, and more assessments of their effects are needed. These should reflect the range of management policies being applied in partially protected areas.

THE EFFECTIVENESS OF SMALL SCALE 'NO-TAKE AREAS' AS TOOLS IN CONSERVATION MANAGEMENT OF LOCALLY EXPLOITED CORAL REEF FISHERIES

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For successful management of marine biological resources in areas of artisanal fisheries, small 'No-take areas' (NTA) provide an important means of increasing social capital. This research demonstrates the biological success of a small NTA in the Wakatobi Marine National Park, Indonesia; the size and location of which was agreeable to local user groups.

Using underwater visual censuses (UVC) over a four year period since the creation of the 'No-take area' and intensive grouper surveys over varying habitat; this research demonstrated that a 'small' NTA could significantly enhance the numbers and size of groupers, whilst other fishery grounds incurred detrimental declines in numbers of groupers. Increased numbers and maturity of individuals have the potential to cause spill-over and seeding to other areas of reef; nearby areas do not have reduced grouper numbers suggesting that such an effect may be present. Populations within the NTA have yet to reach maturity therefore the full benefits are unlikely to become evident for a number of years. This NTA did not benefit all the species that were recorded; why this is the case is not clear, further research about the population and behavioural ecology of Indo-Pacific grouper species is necessary for the development of informed fisheries management.

These results agree with the theoretical findings of Hapern (2003) who found that reserve benefits (in terms of abundance, size, and weight of focal species, and overall species richness) were not closely related to reserve size, with small reserves achieving a similar range of per area benefits compared to larger reserves. The use of 'small' NTA's within networks of reserves should become useful tools in the management of the coral reef fisheries and an important strategy in the future management of the Wakatobi Marine National Park. The NTA is a success as it demonstrates to the local people that such an area can be beneficial to the fishery.

EUNICELLA VERRUCOSA IN THE UK - EMERGENT TRENDS FROM DIFFERENT SOUTHWEST LOCATIONS

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Over 130 survey dives were carried out between 2001 and 2002 between St Davids in Wales, west to the Isles of Scilly and east to Poole Bay in Dorset to record density, depth distribution, morphometrics and condition of the UK pink seafan *Eunicella verrucosa*. Surveys identified a new range extension for the species of some 15km north along the Welsh coast, and 50km east along the English Channel to Poole Bay. Density of seafans differed considerably on reefs between the eight different study areas. Seafans were most densely aggregated in southern Cornwall and off Plymouth, where maximum densities on dives commonly reached 8 colonies/m2. Seafan numbers increased in density from shallow to deeper waters, with the highest densities found on hard-hulled shipwrecks and horizontal bedrock in 25m-30m of water. Colony height varied with depth, with a maximum of approximately 27cm between 10 and 15m of water. Colony density and size are thought to be affected by local current regimes, substrate type and orientation, and food supply at small (10m2) scales.

Condition of pink seafans was 'good' for all sites other than at Lundy Island. 80% of seafans at this site were colonized by at least one form of epiphyte, and most colonies showed evidence of tissue damage (on average a mean of only 6.5% of the surface area of the corals had extended polyps). *Tritonia nilsodhenri* nudibranchs were recorded on seafans at all sites apart from Pembrokeshire, where none of colonies had any associated molluscs.