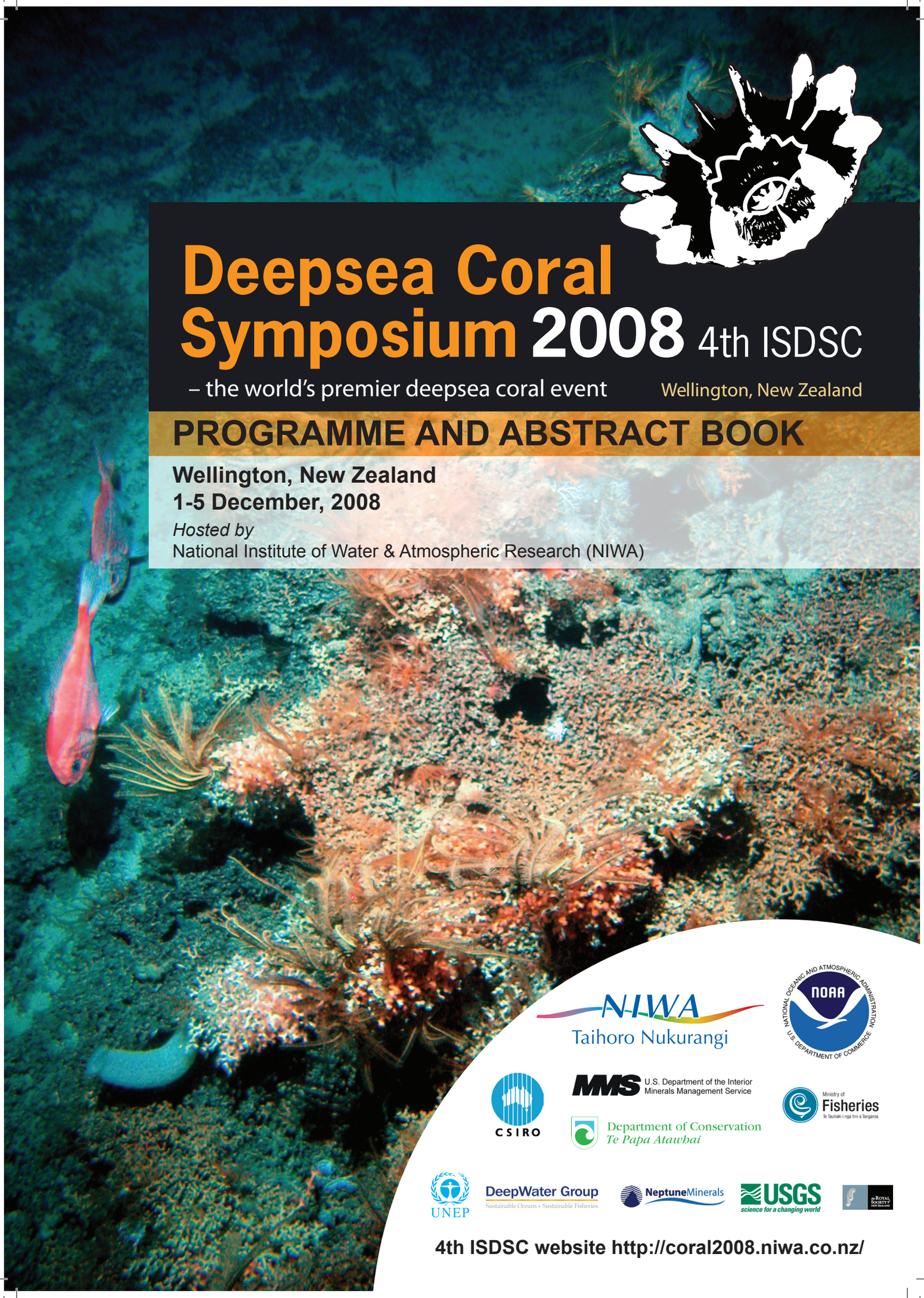

Deepsea Coral Symposium 2008 4th ISDSC

– the world's premier deepsea coral event

Wellington, New Zealand

PROGRAMME AND ABSTRACT BOOK

Wellington, New Zealand
1-5 December, 2008

Hosted by
National Institute of Water & Atmospheric Research (NIWA)

NIWA Taihoro Nukurangi

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

CSIRO

MMS U.S. Department of the Interior Minerals Management Service

Ministry of Fisheries Te Tautiaki i nga tini a Tangaroa

Department of Conservation *Te Papa Atawhai*

UNEP

DeepWater Group Sustainable Oceans • Sustainable Fisheries

NeptuneMinerals

USGS science for a changing world

The Royal Society of New Zealand

4th ISDSC website http://coral2008.niwa.co.nz/

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Hosted by
National Institute of Water & Atmospheric Research (NIWA)

Co-convenors, 4th ISDSC 2008
Helen Neil and Di Tracey (NZ)

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Alan Williams

4th ISDSC website http://coral2008.niwa.co.nz/

Contents

Conference Website http://coral2008.niwa.co.nz/

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Wellington
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Welcome

Welcome, and thank you for joining us 'downunder' at the 4th International Symposium on Deepsea Corals.

This international event is designed to bring together scientists, resource managers, students, and policy-makers from around the world who are actively involved in research and management of deepsea corals and other deepsea habitats.

Understanding the ecosystem role, function and value of deepsea corals and associated fauna has become a priority for many national governments and international resource management bodies. Continuing the tradition of the previous symposia, the 4th International Symposium on Deepsea Corals will allow attendees to share their research results, discuss collaborative opportunities, identify information gaps, and discuss deepsea coral protection and the statutory means available to do so.

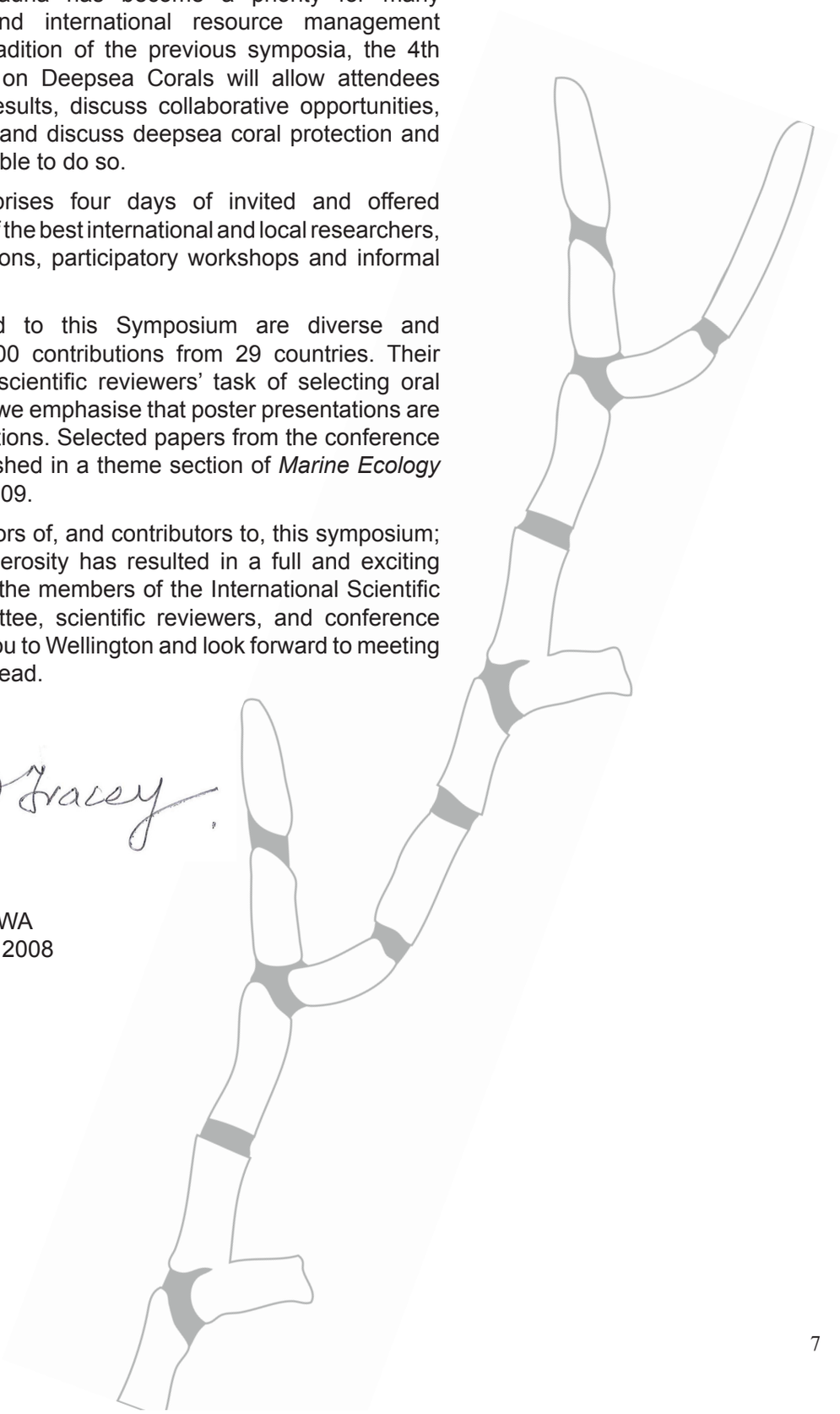
Our programme comprises four days of invited and offered presentations from many of the best international and local researchers, and includes poster sessions, participatory workshops and informal discussion groups.

The papers submitted to this Symposium are diverse and stimulating with nearly 200 contributions from 29 countries. Their high standard made the scientific reviewers' task of selecting oral presentations difficult and we emphasise that poster presentations are equally important contributions. Selected papers from the conference are scheduled to be published in a theme section of *Marine Ecology Progress Series* by late 2009.

We thank all the sponsors of, and contributors to, this symposium; your enthusiasm and generosity has resulted in a full and exciting programme. On behalf of the members of the International Scientific Committee, Local Committee, scientific reviewers, and conference organisers, we welcome you to Wellington and look forward to meeting you all during the week ahead.

H.L. Neil D Tracey.

Helen Neil & Di Tracey, NIWA
Co-convenors, 4th ISDSC 2008



General information

Registration and Information Desk
The registration desk will be located in the foyer of Rutherford House, Pipitea Campus (Bunny St entrance), and will be open as follows:

Monday 1 Dec	1500 – 1700
Tuesday 2 Dec	0700 – 1900
Wednesday 3 Dec	0800 – 1800
Thursday 4 Dec	0800 – 1700
Friday 5 Dec	0800 – 1500

also at Te Papa, Oceania Room,

Monday 1 Dec	1830 - 2000

You can contact the conference organisers on 021 225 0337 for any conference enquiries.

Teas and Lunches
Tea and coffee breaks and lunches will be served on the mezzanine floor at the times indicated in the symposium programme.

Messages
Messages received for participants will be put on the notice board by the registration desk.

Mobile Phones and Pagers
As a courtesy to others, please ensure that all mobile phones and pagers are turned off (or set to vibrate) while sessions are in progress.

Name Badges
Please wear your name badge at all times during the conference. Badge security is in place throughout the conference.

Email and Computer Access
All the computers on the ground and mezzanine floors are available for delegates for email and web access. A login access code is available from the registration desk.

Photocopying
Small amounts of photocopying may be arranged at the registration desk. Cost: B&W A4 = 10c; A3 = 20c. Colour A4 = $1; A3 = $1.50. One hour notice please.

Parking
Street parking in the vicinity of the campus costs $4 per hour (maximum time 90 or 120 minutes). A number of parking lots with all-day rates are located close by. Most central city accommodation is within walking distance of the venue.

Taxis and Shuttles
A number of taxi and shuttle companies operate from the airport to the city. The fare for a taxi will be about $32, for a shuttle $16, and for the airport bus $10. The journey will take about 20 minutes, depending on traffic.

Green Cabs Tel: 0508 447 336
Wellington Combined Taxis Tel: 0800 38 44 44
Corporate Cabs Tel: 387 4600
Cooperative Shuttles Tel: 387 8787

Seminar Rooms
A room is available for informal meetings; please book at the registration desk.

Accommodation
Your acommodation has not been pre-paid
Please ensure accounts are settled in full on departure, including all meals, telephone calls and mini-bar charges. No accounts can be charged to the Symposium.

Storage of Luggage
Storage of luggage on departure date should be arranged through your accommodation.

Smoking is strictly prohibited in all areas of Rutherford House.

Health and Safety

General Emergency
For fire, ambulance or police, dial 1 for an outside line, then 111.

Fire
If you discover a fire or hear continuous ringing of the fire alarm, leave the building immediately. Assemble on Bunny Street.

Earthquake
In an earthquake, please remain in the building. Move away from any windows or equipment that may fall and take immediate shelter under, or close to, solid furniture such as tables or desks. If no furniture is available, drop to your knees, with your back to windows, clasp both hands firmly behind your head and bury your head in your hands. Keep calm.

Evacuation
The continuous sounding of an alarm will indicate that the building is to be evacuated. On activation, all magnetically locked doors will be released, making emergency escape routes available. Leave the building immediately, using the nearest stairway or exit. Assemble on Bunny Street

Doctors and Pharmacies

City Medical Centre, Tel: 471 2161
10 Brandon Street,
0800–1800 weekdays

After Hours Medical Centre, Tel: 384 4944
17 Adelaide Road, Newtown,
0800–2300 every day
(no appointment necessary)

Sunley Chemist, Tel: 472 0293
74 – 82 Lambton Quay,
0730–1800 weekdays

Urgent Pharmacy Tel: 385 8810
17 Adelaide Road, Newtown,
1700–2300 weekdays,
0800–2300 weekends

Disclaimer of Liability
We reserve the right to amend any part of the programme should it be necessary. The Committee and Conferences and Events Ltd will not accept any liability for damages of any nature sustained by participants, or their accompanying persons, or damage to their personal property as a result of Deepsea Symposium 2008 or related events.

Presenters' information

Speakers and Presenters
Please report to the AV Room once registered and hand in your presentation on CD or flash pen. A minimum of two hours before your session start time is required. We will arrange for an Audio Visual Technician to upload your presentation onto the laptop in the Lecture Room.

Chairpersons of sessions are asked to be present at least five minutes before the session starts so that speakers can introduce themselves. All speakers are requested to remain within their allocated time of **12 minutes** (leaving 3 minutes for questions from the audience).

Posters
Please hang poster once registered. Posters will be available to view throughout the conference. We ask presenters to be in attendance during poster sessions on Monday and Wednesday. Your assigned poster position will be available at the registration desk. Velcro will be provided.

Publication A theme section entitled 'Conservation and management of deep sea corals and coral reefs' will be published in *Marine Ecology Progress Series* (MEPS). The theme section will highlight key research findings and outcomes from the Deep Sea Coral Symposium 2008, and is expected to be published by late 2009.
(see http://www.int-res.com/journals/meps/ theme-sections).

All contributors (oral and posters) to the symposium are encouraged to submit a paper for publication. Submission of papers opens 1 Dec, 2008 and closes 27 Feb, 2009. Late submissions will not be accepted.

Papers to be considered for publication in the theme section must be submitted via the MEPS online XPressTrack system and will be subject to the usual rigorous peer review (3 to 4 referees). For author guidelines see http://coral2008.niwa.co.nz.

Coordination: Karen Miller, Di Tracey, Helen Neil.

Social programme

Welcome Reception, Monday 1 Dec Venue: Oceania Room, Te Papa
Time: 1830–2000
Drinks and canapés will be served.

As part of the reception a deepsea coral display "**Corals – hidden beauties of the deep**" will be launched.

Poster session, Tuesday 2 Dec
Venue: Rutherford House
Time: 1715–1900
During this evening poster session drinks and canapés will be served.

Conference Dinner, Thursday 4 Dec
Venue: Icon, Te Papa
Time: 1900–2400
The Conference dinner will be held at Icon, overlooking Wellington's stunning harbour. Attendees can choose from a menu comprising tastes of NZ.
Dress code: smart casual.

Coral display

Please take the time to view and enjoy this new deepsea coral display "Corals – hidden beauties of the deep" during the Welcome Reception or make a return visit.

Museum of New Zealand Te Papa Tongarewa – known familiarly as Te Papa – is in a striking location on the waterfront (off Cable Street). The interior spaces and great exhibitions make it well worth a visit. It has free admission, with ticketed (paid) entry to some exhibits.
(www.tepapa.govt.nz)

Workshops

(i) TRACES workshop
Workshop to be chaired by Murray Roberts
Venue: Rutherford House Meeting Room
Time and date: Wed 3 Dec, 1815–2000
The Trans-Atlantic Coral Ecosystem Study 'TRACES' will meet during the Symposium and provide an update from the recent Woods Hole Workshop.
Please register interest at registration desk

(ii) Acidification workshop
Workshop to be chaired by Bob George & Ron Thresher
Venue: Rutherford House Lecture Room
Time and date: Thurs 4 Dec, 1245–1445
The Workshop will provide:

- an overview on research priorities of ocean acidification and deepsea corals
- a discussion of ASH and CSH shoaling, with emphasis on New Zealand and Australia waters
- an open discussion will follow and ocean acidification research questions will be prioritised.

Please register interest at registration desk

(iii) Coral Identification Seminar
A half day deepsea coral morphology and identification seminar will take place post the 4th ISDSC. The seminar is primarily targeted at NIWA staff so they can become more familiar with distinguishing characteristics of New Zealand coral fauna and further develop their coral identification skills. Symposium attendees are most welcome to attend the seminar.
Date: Monday 8 Dec
Time: 0900–1300
Venue: Main Conference Room, Allen Building NIWA

Outline
One hour talk on hard corals (Scleractinia and Stylasteridae); Steve Cairns (Smithsonian Institution).
One hour talk on black corals (Antipatharia); Dennis Opresko (Smithsonian Institution) with input from Tina Molodtsova (Shirshov Institute of Oceanology).
One hour talk on gorgonians (Octocorallia): Juan Sanchez (Universidad de los Andes, Colombia) with input from Les Watling (University of Hawaii), Scott France (University of Louisiana at Lafayette), and Asako Matsumoto (University of Tokyo).

Please contact Sadie Mills (s.mills@niwa.co.nz) if you are interested in attending the coral identification seminars.

Tuesday			Wednesday			Thursday			Friday		
			8:00	Registration		8:00	Registration	Ecology			
7:30	Registration		8:35	Cairns: Frederick M. Bayer's Impact	Systematics	8:35	Shank: Genetic connectivity of coral associates		8:00	Registration	
9:00	Mihi whakatau		9:00	Watling: Atlantic-Pacific relationships		9:00	Fautin: Occurrence of corallimopharians		8:50	Clark: Mgmt of Graveyard "Seamounts" in NZ	Management
9:15	Official Opening		9:15	France: On the origin of deep-sea octocorals		9:15	Heifetz: Coral distribution, Aleutian archipelago		9:15	English: VMEs etc. protecting corals, N Atlantic	
9:30	Robertson: Coral Research 'Down Under'		9:30	Dueñas: Molecular phylogenetics, octocorals		9:30	Edinger: Distributions N. British Columbia		9:30	Ahlfeld: Interagency board on corals and VMEs	
9:45	Wratt: Climate Change 'Down Under'		9:45	Ardila: Systematics of precious corals		9:45	Hovland: A rare purple coral, Norway		9:45	Penney: NZ implementation of protection measures	
10:00	Housekeeping		10:00	Lin: Evolutionary analysis of *Madrepora oculata*		10:00	Mortensen: Biodiversity of *Lophelia* reefs, Norway		10:00	Parker: Criteria for managing high sea VMEs	
10:05	Morning Tea Break		10:15	Morning Tea Break		10:15	Morning Tea Break		10:15	Morning Tea Break	
10:35	Thresher: Paleo-climate reconstruction, S. Hemi	Geology	10:45	Miller: Assessing seamount connections, S. hemi	Systematics	10:45	Davies: Predicting stable habitat, *Lophelia*	Ecology	10:45	Roberson: Too precious to wear	Management
11:00	López Correa: Coupled AMS-^{14}C & U series dating		11:00	Morrison: Genetic discontinuity, *Lophelia*		11:00	Försterra: Fjord regions: deep sea in reach		11:00	Bruckner: Decline in *Corallium* populations	
11:15	Roark: Sr/Ca as a potential proxy of subsurface temp		11:15	Dahl: Genetic diversity, *Lophelia*		11:15	Roberts: Mingulay Reef complex, NE Atlantic		11:15	Grehan: Ecosystem based mgmt in Europe	
11:30	Guilderson: Minor and major elemental composition		11:30	Schroeder: *Lophelia* colonisation, Gulfpenn		11:30	Weinbauer: Ecological interactions, *Lophelia*		11:30	Campbell: Conservation status, British Isles	
11:45	Noé: Paired stable C/O isotopes and trace elements		11:45	Kitahara: Diversity of scleractinia, New Caledonia		11:45	Demopoulos: Macrofaunal community structure		11:45	Galvez: Seamounts of Nazca & Salas-Y-Gómez	
12:00	Fink: Cold-water corals in the central Mediterranean		12:00	Baco-Taylor: Genetic variation, N. Pacific		12:00	Hyland: Deep-water gorgonians		12:00	Rowe: Assessing incidental catch of corals, NZ	
12:15	McCulloch: Proliferation & demise of deep-sea corals		12:15	Molodtsova: Antipatharia, NE Atlantic		12:15	Messing: Forams role in coral bioherm growth		12:15	Hourigan: Managing fishery impacts, USA	
12:30	Lunch		12:30	Lunch (informal Geology and Management discussions)		12:30	Lunch		12:30	Lunch	
13:20	Linder: Islands of the deep, seamount endemism	Ecosystems	13:20	Hall-Spencer: Effects of ocean acidifcation	Acidification		12:45	Poster Acidification	13:30	Livingston: Science & fisheries mgmt, NZ	Management
13:45	Sulak: Utilization of *Lophelia* reef fish biotopes		13:45	George: Thermal & acidification impact					13:45	Helson: Benthic protection areas, NZ	
14:00	Kiriakoulakis: Interactions between a shallow reef		14:00	Maier: Calcification rates, rise in pCO_2 & temp		12:45	Acidification Workshop		14:00	Brouwer: Managing coral ecosystems, SE USA	
14:15	Williams: Patterns of composition		14:15	Guinotte: Calcite saturation horizon, N. Pacific		13:00	Poster Session 2		14:15	Lundälv: Development in a trawl-damaged habitat	
14:30	Rowden: Distribution of scleractinian corals		14:30	Bostock: Carbonate concentrations, NZ					14:30	Boutillier: Steps towards coral conservation, Canada	
14:45	Gori: Habitat features of *Madrepora oculata*		14:45	Barry: Amplified ocean acidification			15:00		14:45	Hocevar: Science-based advocacy as a tool	
15:00	Afternoon Tea Break		15:00	Afternoon Tea Break		15:00	Afternoon Tea Break		15:00	Closing	
15:30	Dorschel: Carbonate mounds, NE Atlantic	Geology	15:20	Waller: Reproductive strategies, Southern Ocean	Biology	15:20	Lavaleye: Coral community, Hatton Bank	Sampling			
15:45	Foubert: Impact of early diagenesis, mounds		15:45	Pires: Reproductive biology, *Anthoptilum murrayi*		15:45	Brooke: Distribution of reefs, Florida, USA				
16:00	De Mol: Palaeo-environment, coral mounds		16:00	White: Benthic boundary layer, contrast ecosystems		16:00	Wareham: Coral research Labrador and Arctic regions				
16:15	Huvenne: Hydrodynamics, Challenger Mound		16:15	Thiem: Numerical studies currents & particles		16:15	Conway: Reef building corals, W Canada				
16:30	Mienis: Environmental constraints on growth		16:30	Auster: Composition & foraging behaviour		16:30	Le Guilloux: Habitat mapping of Italian reefs				
16:45	Rüggeberg: Reef development, mounds		16:45	Grange: Black coral ecology		16:45	Nodder: Biodiversity and habitat mapping, NZ				
17:00	Risk: Tracking sewage using antipatharians		17:00	Houlbrèque: U-series dating, *Enallopsammia*		17:00	Purser: Applicability of learning algorithms				
			17:15	Brooke: In situ growth *Lophelia pertusa*		17:15	Costello: Distinguishing habitat classification				
17:15 - 19:00 Poster Session 1		Poster	17:30	Parrish: Growth validation of gold coral							
			17:45	Wisshak: Antiquity & longevity, Azores Penninsula							
			18:15 - 20:00 TRACES Workshop			19:00 - 24:00 Dinner at Icon, Te Papa					

Conference programme 'at a glance'

Conference programme

Monday 1 Dec

15:00 - 17:00 Registration at Rutherford House

18:30 - 20:00 Welcome Reception and Registration at Te Papa

Tuesday 2 Dec

9:00 **Official Opening of the 4th ISDSC** will include a Karakia and Mihi Whakatau; a traditional welcome ceremony involving prayer, greetings and song.

Important: please be seated by 08:55 for this formal opening of the meeting.

9:30 Coral Research 'Down Under' ***Robertson D***

9:45 Climate Change 'Down Under' ***Wratt D***

10:00 Housekeeping

10:05 **Morning Tea Break**

Geology, Palaeontology and Palaeoclimate

Chair: Veerle Huvenne (Abstracts 1.01–1.07)

10:35 **Keynote** Paleo-Climate Reconstruction of Southern Hemisphere Intermediate Water Formation over the Last Millennium from Analysis of the Skeletal Composition of Deep-Water Isidids. **(1.01)**
***Thresher R**, Neil H, MacRae C, Wilson N, Fallon S, Sherwood O, Richer de Forges S, Correge T, Marriott P, Tracey D, Gurney R*

11:00 Coupled Ams-^{14}C And U-Series Dating Reveals Preboreal Onset for the World's Northernmost *Lophelia pertusa* Mounds in Norway (Stjernsund). **(1.02)**
***López Correa M**, Fietzke J, Bednorz A, Freiwald A*

11:15 Sr/Ca as a Potential Proxy of Sub-Surface Temperature Variability in *C. secundum.* **(1.03)**
***Roark B**, Fallon S, Guilderson T, Dunbar R, McCulloch M*

11:30 Minor and Major Elemental Composition of 4 Species of Deep Sea Proteinaceous Corals. **(1.04)**
*Dunbar R, Roark B, **Guilderson T**, McCulloch M, Kinsley L*

11:45 Paired Stable C/O Isotopes and Trace Elements in a Deep-Water Bamboo Coral Skeleton from Chatham Rise (New Zealand): Metabolic versus Environmental Controls. **(1.05)**
***Noé S**, López Correa M, Montagna P, McCulloch M, Freiwald A*

12:00 Cold-Water Corals in the Central Mediterranean Sea during the Holocene. **(1.06)**
***Fink H**, Hebbeln D, Wienberg C, McGregor H, Taviani M, Freiwald A*

12:15 Proliferation and Demise of Deep-Sea Corals in the Mediterranean during the Younger Dryas. **(1.07)**
***McCulloch M**, Taviani M, Montagna P, López Correa M, Remia A, Mortimer G*

12:30 **Lunch**

Coral Ecosystems and Habitats associated with Seamounts

Chair: Stephanie Rowe (Abstracts 2.01–2.06)

13:20 **Keynote:** Islands of the Deep: Molecular Evidence for the Seamount Endemism Hypothesis. **(2.01)**
***Lindner A**, Cairns S, Cunningham C*

13:45 *Lophelia* Reef Fish Biotopes as Defined by Submersible Video Frame Analysis of Megafaunal Invertebrate Community Structure, Northern Gulf of Mexico. **(2.02)**
***Sulak K**, Luke K, Norem A, Randall M*

14:00 The Interactions between a Shallow Cold-Water Coral Reef (Tisler Reef Skagerrak) and its Close Environment. **(2.03)**
***Kiriakoulakis K**, Blackbird S, Lündalv T, White M, Guihen D, Duineveld G, Lavaleye M, Wolff G*

14:15 Patterns of Composition, Fine-Scale Distribution and Resilience of Seamount Corals in Marine Reserves off Tasmania, SE Australia, related to Different Histories of Bottom Trawling. **(2.04)**
***Williams A**, Althaus F, Schlacher T, Barker B, Green M, Schlacher-Hoenlinger M, Kloser R, Bax N, Alderslade P*

14:30 Distribution of Structure-Forming Scleractinian Corals in the New Zealand Region. **(2.05)**
***Rowden A**, Tracey D, Mackay K, Leathwick J*

14:45 Habitat Features, Spatial Distribution and Demography of the *Madrepora oculata* Populations in the Cap De Creus Canyon (Northwestern Mediterranean). **(2.06)**
*Orejas C, **Gori A**, Puig p, Gili J-M*

15:00 **Afternoon Tea Break**

Geology, Palaeontology and Palaeoclimate cont.

Chair: Tjeerd van Weering (Abstracts 1.08–1.14)

15:30 Cold-Water Coral Carbonate Mounds in the NE Atlantic: Distribution, Characteristics and Volumes. **(1.08)**
***Dorschel B**, Wheeler A, de Haas H, Monteys X*

15:45 Impact of Early Diagenesis on the Palaeoenvironmental Record Registered In Cold-Water Coral Carbonate Mounds. **(1.09)**
***Foubert A**, Swennen R, Rüggeberg A, Henriet J, Hebbeln D, IODP Exp. 307 Scientific Party*

16:00 Palaeo-Environment at the Start-Up and Restart Phase of Cold-Water Coral Mounds, Porcupine Seabight, Ireland. **(1.10)**
***De Mol B**, Cacho I, Martrat B, Grimat J, Urgeles R, Huvenne V*

16:15 Hydrodynamics and Palaeo-Environment of the Initial Challenger Mound and its Surroundings. **(1.11)**
***Huvenne V**, Van Rooij D, Thierens M, O'Donnell R, IODP Exp. 307 Scientific Party*

16:30 Environmental Constraints on Cold-Water Coral Growth and Mound Formation on the Penduick Escarpment, Gulf of Cadiz. **(1.12)**
***Mienis F**, De Stigter H, De Haas H, Bicchi E, Van Weering T*

16:45 Cold-Water Coral Reef Development on Carbonate Mounds in Relation to Paleo-Density Estimates. **(1.13)**
***Rüggeberg A**, Liebetrau V, Flögel S, Dullo W*

17:00 Tracking Sewage Using Antipatharians and Gorgonians: Examples from Florida and the Red Sea. **(1.14)**
***Risk M**, Sherwood O, Nairn R*

17:15 Poster Session until 1900

Systematics and Biogeography
(Abstracts 10.01–10.19)
Sampling Methods and Mapping
(Abstracts 11.01–11.15)
Coral Ecosystems and Habitats associated with Seamounts
(Abstracts 12.01–12.04)
Geology, Palaeontology and Palaeoclimate incl. Ocean Acidification
(Abstracts 13.01–13.18)
Biology: Feeding, Growth and Reproduction
(Abstracts 14.01–14.08)
Ecology and Species Associations
(Abstracts 15.01–15.15)
Management Decisions and Policy for Corals, Conservation and Human Impacts
(Abstracts 16.01–16.15)

Wednesday 3 Dec
Systematics and Biogeography

Chair: Karen Miller (Abstracts 3.01–3.06)

8:35 **Keynote:** Frederick ('Ted') M. Bayer's Impact on Deep-Water Octocoral Biology. **(3.01)**
Cairns S

9:00 Atlantic – Pacific Relationships of Deep-Sea Octocorals. **(3.02)**
***Watling L**, France S, Pante E, Thoma J, Simpson A*

9:15 On the Origin of Deep-Sea Octocorals: Patterns Revealed from Molecular Phylogenies. **(3.03)**
***France S**, Pante E, van der Ham J*

9:30 A Molecular Phylogenetic Analysis of the Bamboo Deep-Sea Corals (Octocorallia: Isididae) Based on Predicted RNA Secondary Structures (lsu-rRNA 16s). **(3.04)**
***Dueñas L**, Sánchez J*

9:45 Systematics of the Precious Corals (Cnidaria: Octocorallia: Coralliidae) With Emphasis on the Fauna from New Zealand Seamounts. **(3.05)**
***Ardila N**, Sánchez J*

10:00 Evolutionary Mitogenomic Analysis of *Madrepora oculata*: the First Case of Gene Rearrangement in the Scleractinian Mitochondrial Genome. **(3.06)**
***Lin M**, Chen C*

10:15 **Morning Tea Break**

Chair: Juan Sanchez (Abstracts 3.07–3.13)

10:45 Assessing Connections among Seamount Corals in the Southern Hemisphere. **(3.07)**
***Miller K**, Williams A, Rowden A*

11:00 Genetic Discontinuity among Regional Populations of *Lophelia pertusa* in the North Atlantic Ocean. **(3.08)**
***Morrison C**, Ross S, Nizinski M, Brooke S, Waller R, Johnson R, King T*

11:15 Genetic Diversity and Clonal Structure of the Cold-Water Coral *Lophelia pertusa* in NE Skagerrak Based on Microsatellites. **(3.09)**
***Dahl M**, Lundälv T, André C*

11:30 *Lophelia pertusa* Colonization on the WWII Tanker *Gulfpenn* in the Northern Gulf of Mexico: Patterns of Growth and Genetic Affiliations. **(3.10)**
***Schroeder W**, Morrison C*

11:45 Diversity of Deep-Sea Corals (Cnidaria, Scleractinia) From New Caledonia and Adjacent Waters: A Central Pacific Hot-Spot for Azooxanthellate Scleractinians. **(3.11)**
***Kitahara M**, Cairns S*

12:00 Genetic Variation and Phylogeographic Patterns of Deep-Sea Corals on North Pacific Seamounts. **(3.12)**
*Baco-Taylor A, **Cairns S**, Sánchez J*

12:15 Deep-Sea Antipatharia (Anthozoa: Cnidaria) of the North-East Atlantic: Continental Slope vs. Seamount and Island Faunas. **(3.13)**
Molodtsova T

12:30 **Lunch**
(Informal lunch meetings:
Geology – Trace elemental discussion
Management – Vulnerable Marine Environments)

Ocean Acidification

Chair: Simon Davy (Abstracts 4.01–4.06)

13:20 **Keynote:** Effects of Ocean Acidification on Temperate Corals. **(4.01)**
***Hall-Spencer J**, Fosså J, Rüggeberg A, Fine M, Rodolfo-Metalpa R*

13:45 Thermal and Acidification Impacts on Cold Corals: Experimental Evidence and Conceptual Models. **(4.02)**
George R

14:00 Calcification Rates of Cold Water Corals from Mingulay (NE Atlantic), Skagerrak (North Sea) and the Mediterranean Sea and Response to Rise in PCO_2 and Temperature. **(4.03)**
***Maier C**, Hegeman J, Weinbauer M, Orejas C, Vendrell B, Taviani M, Gattuso J*

14:15 Is the Calcite Saturation Horizon Limiting the Distribution and Abundance of Corals in the North Pacific Ocean? **(4.04)**
***Guinotte J**, Stone R, Feely R*

14:30 Carbonate Concentrations and Deep Sea Coral Distribution in the New Zealand Region. **(4.05)**
***Bostock H**, Currie K, Tracey D, Neil H*

14:45 Amplified Ocean Acidification in the Deep-Sea and the Threat to Deep-Sea Ecosystems. **(4.06)**
***Barry J**, Pane E*

15:00 **Afternoon Tea Break**

Biology: Feeding, Growth and Reproduction

Chair: Pål Mortensen (Abstracts 5.01–5.10)

15:20 **Keynote:** Reproductive Strategies in Southern Ocean Cold-Water Corals. **(5.01)**
Waller R

15:45 Reproductive Biology of the Deep-Sea Pennatulacean *Anthoptilum murrayi* (Cnidaria, Octocorallia). **(5.02)**
***Pires D**, Castro C, Silva J*

16:00 Benthic Boundary Layer Characteristics in Contrasting Cold Water Coral Ecosystems. **(5.03)**
***White M**, Guihen D, Mienis F, de Stigter H, Lundälv T*

16:15 Numerical Studies of Near Bottom Currents and Food Particle Propagation over a Deep Water Coral Reef. **(5.04)**
***Thiem Ø**, Fosså J, Berntsen J., Selvikvåg K*

16:30 Species Composition and Foraging Related Behaviors of Deep-Sea Fishes from Submarine Canyons and Seamounts in the Northwest Atlantic Based on Direct Observations. **(5.05)**
***Auster P**, Moore J, Heinonen K, Hecker B, Janssen J*

16:45 Black Coral Ecology, Growth Rates, and Population Structure In Fiordland, New Zealand: an Overview. **(5.06)**
Grange K

17:00 Precise Uranium-Series Dating and Growth Characteristics of the Deep-Sea Scleractinian Coral: *Enallopsammia rostrata* from the Equatorial Pacific. **(5.07)**
***Houlbrèque F**, Roark B, Guilderson T, McCulloch M, Mortimer G, Meibom A, Cuif J, Dunbar R*

17:15 In Situ Growth of *Lophelia pertusa* in the Northern Gulf Of Mexico. **(5.08)**
***Brooke S**, Young C*

17:30 Growth Validation of Gold Coral (*Gerardia* sp.) in the Hawaiian Archipelago. **(5.09)**
***Parrish F,** Roark B*

17:45 Antiquity and Longevity of a deep-sea oyster/crinoid association (Azores Archipelago). **(5.10)**
***Wisshak M**, Neumann C, López Correa M, Gofas S, Salas C, Taviani M, Jakobsen J, Freiwald A*

18:15 **'TRACES' Workshop until 2000**

Thursday 4 Dec
Ecology and Species Associations

Chair: Martha Nizinski (Abstracts 6.01–6.06)

8:35 **Keynote:** Genetic Connectivity of Cold-Water Coral Associates Inhabiting Seamounts of the North Atlantic. **(6.01)**
***Shank T**, Cho W*

9:00 The Occurrence of Corallimorpharians (Naked Corals). **(6.02)**
***Fautin D,** Guinotte J*

9:15 Deep Sea Coral Distribution and Habitat in the Aleutian Archipelago. **(6.03)**
***Heifetz J**, Woodby D, Reynolds J, Stone R*

9:30 Coral Distributions around Learmonth Bank, Northern British Columbia, Canada: Influence of Surficial Geology and Tidal Currents. **(6.04)**
***Edinger E**, Boutillier J, Workman G*

9:45 Rare, Purple Octocoral Discovered in Pockmark Lophelia-Reef at the Morvin Field, off Mid-Norway. **(6.05)**
***Hovland M**, Jensen S, Ferriday I, Nilssen I, Ekrheim A*

10:00 Biodiversity of *Lophelia* Reefs in Northern Norway. **(6.06)**
***Mortensen P**, Fossså J, Hassel A*

10:15 **Morning Tea Break**

Chair: Alan Williams (Abstracts 6.07–6.13)

10:45 Predicting Suitable Habitat for the Cold-Water Coral *Lophelia pertusa* (Scleractinia). **(6.07)**
***Davies A**, Wisshark M, Orr J, Roberts M*

11:00 Fjord Regions: Where the Deep Sea Comes within Reach. **(6.08)**
***Försterra G**, Häussermann V*

11:15 The Mingulay Reef Complex, Northeast Atlantic: An Interdisciplinary Study of Cold-Water Coral Habitat, Hydrography and Beta Diversity. **(6.09)**
***Roberts M**, Davies A, Henry L, Duineveld G, Lavaleye M, Maier C, Bergman M, Hühnerbach V, Dodds L, Sinclair D, Watmough T, Long D, van Haren H*

11:30 Ecological Interactions between *Lophelia pertusa* and Micro-Organisms. **(6.10)**
***Weinbauer M**, van Noort G, de Kluyver A, Ogier J, van Duyl F, Maier C*

11:45 Macrofaunal Community Structure and Trophic Function in Deep-Sea Coral Ecosystems of the Gulf of Mexico. **(6.11)**
***Demopoulos A**, Sulak K*

12:00 Deep-Water Gorgonians: Critical Nursery Habitat for Catsharks? **(6.12)**
*Etnoyer P, Brancato M, Bowlby E, **Hyland J***

12:15 A Possible Role for Agglutinated Foraminiferans in the Growth of Deep-Water Coral Bioherms. **(6.13)**
***Messing C**, Brooke S, Reed J, Richardson S*

12:30 **Lunch**

12:45 **Ocean Acidification Workshop until 1500**

13:00 **Poster Session until 1500 (Abstracts see listing on Monday 2 Dec)**

15:00 **Afternoon Tea Break**

Sampling Methods and Mapping

Chair: Ashley Rowden (Abstracts 7.01–7.08)

15:20 **Keynote:** The Cold-Water Coral Community of Hatton Bank, NE Atlantic. **(7.01)**
***Lavaleye M**, Duineveld G, Bergman M, Jeffreys R, Davies A, Roberts M*

15:45 Distribution and Areal Extent of Deep-Water Coral Reefs off Florida, USA. **(7.02)**
*Reed J, Messing C, **Brooke S**, Correa T*

16:00 A Review of Deep-Sea Coral Research Conducted in the Newfoundland Labrador and Arctic Regions by the Department of Fisheries and Oceans Canada. **(7.03)**
***Wareham V**, Baker K, Gilkinson K, Edinger E*

16:15 Sponge Reefs and Reef Building Corals in the Coastal Waters of Western Canada. **(7.04)**
***Conway K**, Barrie V, Krautter M, Austin W, Thomson R*

16:30 High-Resolution Habitat Mapping of Italian CWC Reefs: Results from ROV's Optical and Acoustic Survey Coupling. **(7.05)**
***Le Guilloux E**, Scalabrin C, Loubrieu B, Vangiresheim A, Chailloux C, Vertino A, Savini A, Sarazzin J, Olu K*

16:45 Broad-Scale Biodiversity and Habitat Mapping in the Deep-Sea around New Zealand with a Focus on Corals and Associated Fauna. **(7.06)**
***Nodder S**, Bowden D, Clark M, Rowden A*

17:00 The Applicability of Machine-Learning Algorithms for Automated Detection and Classification of Cold-Water Coral Habitats from Video Transect Data. **(7.07)**
***Purser A**, Bergmann M, Lundälv T, Nattkemper T, Ontrup J*

17:15 Distinguishing Marine Habitat Classification Concepts for Data Management. **(7.08)**
***Costello M**, Rose-Taylor C*

19:00 **Dinner at ICON, Te Papa until 2400**

Friday 5 Dec
Management Decisions and Policy for Corals, Conservation and Human Impacts

Chair: Robert Brock (Abstracts 8.01–8.05)

8:50 **Keynote:** Management of the Graveyard "Seamounts" in New Zealand: An Example of Balancing Fisheries Exploitation and Conservation of Benthic Habitat. **(8.01)**
***Clark M**, Rowden A, Stewart R*

9:15 VME'S, HAPC'S, EFH'S, MPA'S, HADD'S, and SAC'S: The Alphabet Soup Associated with Protecting Deepsea Coldwater Corals in the North Atlantic. **(8.02)**
***English E**, Brock R, Kenchington E, Tasker M*

9:30 Interagency Board on Deep-Sea Corals and Other Vulnerable Marine Ecosytems - Enhancing U.S. Interagency Cooperation. **(8.03)**
***Ahlfeld T**, Hourigan T*

9:45 New Zealand Implementation of Protection Measures for Vulnerable Marine Ecosystems in the High Seas of the South Pacific Ocean. **(8.04)**
***Penney A**, Parker S, Brown J*

10:00 Information Needs and Identification Criteria for Managing Vulnerable Marine Ecosystems in the South Pacific Ocean. **(8.05)**
***Parker S**, Penney A, Clark M*

10:15 **Morning Tea Break**

Chair: Mireille Consalvey (Abstracts 8.06–8.12)

10:45 Too Precious to Wear - Creating a Demand for Coral Conservation. **(8.06)**
Roberson J

11:00 Rate and Extent of Decline in *Corallium* Populations: are Existing Data Adequate to Justify a CITES Appendix II Listing? **(8.07)**
***Bruckner A**, Roberts G, Hourigan T*

11:15 Ecosystem Based Management of Corals, Fish and Fisheries in the Deep Waters of Europe and Beyond. **(8.08)**
Grehan A

11:30 Distribution and Conservation Status of Deep-Sea Corals off the British Isles. **(8.09)**
***Campbell M,** Hall-Spencer J*

11:45 Seamounts of Nazca and Salas-Y-Gómez: a Review for Management and Conservation Purposes. **(8.10)**
Galvez M

12:00 Assessing the Incidental Catch of Corals in New Zealand Fisheries. **(8.11)**
***Rowe S**, Tracey D*

12:15 Managing Fishery Impacts to Deep-Sea Coral Ecosystems of the United States: Emerging Best Practices. **(8.12)**
Hourigan T

12:30 **Lunch**

Chair: Pamela Mace (Abstracts 8.13–8.18)

13:30 Deep Sea Coral Matters: Science and Fisheries Management Development in New Zealand. **(8.13)**
***Livingston M**, Halley S*

13:45 Benthic Protection Areas: Protecting New Zealand's Deepwater Habitats. **(8.14)**
***Helson J**, Clement G, Wells R*

14:00 Managing Deepwater Coral Ecosystems off the Southeastern United States. **(8.15)**
***Brouwer M**, Pugliese R, Reed J, Ross S, Udouj T*

14:15 Development in a Trawl-Damaged Coral Habitat (Tisler Reef, NE Skagerrak) during Four Years of Trawl Protection. **(8.16)**
***Lundälv T**, Fossså J, Buhl Mortensen P, Jonsson L*

14:30 The Steps Taken towards Coral Conservation on the West Coast of Canada. **(8.17)**
***Boutillier J**, Francis K*

14:45 Science-Based Advocacy as a Tool to Overcome Institutional Obstacles to Deep Sea Conservation. **(8.18)**
***Hocevar J**, Johnston P*

15:00 **Closing** will include a Karakia by NIWA Matua Weno Iti followed by a waiata

Poster Presentations

Systematics and Biogeography

10.01 Deep-Water Coral DNA Repository For The NE Pacific
***Berntson E**, Clarke E, Park L*

10.02 Cold-Water Corals of the Azores: Preliminary Assessment of Distribution, Diversity and Associated Fauna
***Braga Henriques A**, Porteiro F, Sampaio Í, Matos V, Carreiro-Silva M, Ocaña O, Morato T, Tempera F, Serrão Santos R*

10.03 Hexacoral and Octocoral Communities on the Unexplored Great Barrier Reef Shelf-Edge
***Bridge T**, Webster J, Beaman R, Abbey E, Williams S, Pizzaro O, Woolsey E, Thornborough K, Done T*

10.04 Geographic Distribution and Biodiversity of Deep-Sea Azooxanthellate Corals (Hexacoralia, Anthozoa, Cnidaria) in Taiwan
***Lin M**, Tachikawa H, Chao S, Lee K, Chen C*

10.05 Biogeography and Community Structure of the New England and Corner Rise Seamounts
***Cho W**, Shank T*

10.06 Revision of the Occurrence and Distribution of *Leiopathes* spp. (Anthozoa: Antipatharia) from the NE Atlantic
***de Matos V**, Ocaña O, Rogers A, Henriques A, Sampaio Í, Porteiro F*

10.07 Cold-Water Coral Growth in Relation to the Hydrography of the Celtic and Nordic European Continental Margin
***Flöegel S**, Rüggeberg A, Dullo C*

10.08 Cold-Water Corals and the Hydrochemistry of Ambient Bottom Water Masses – Results from the NE-Atlantic and the Mediterranean
***Flöegel S**, Rüggeberg A, Mienis F, Dullo C*

10.09 Deep-Sea Corals Show No Evidence of Endemism on Northwestern Atlantic Seamounts
*Thoma J, Pante E, Brugler M, **France S***

10.10 Mitochondrial Genome Studies of the Black Coral Family Leiopathidae Haeckel, 1896
*Brugler M, **France S**, Opresko D*

10.11 The First Molecular Phylogenetic Reconstruction of the Chrysogorgiidae (Anthozoa: Octocorallia) Questions its Monophyly
*Pante E, **France S***

10.12 Evolution in the Bubblegum Octocorals: DNA vs. Morphology
***Herrera S**, Sánchez J*

10.13 Phylogenetic Relationships among the Scleractinia (Cnidaria, Anthozoa) Inferred from Mitochondrial COI Sequence Data
***Kitahara M**, Miller D, Cairns S, Stolarski J*

10.14 The Nephtheid Soft Coral Genus *Gersemia*, Marenzeller 1878, With the Description of a New Species from the Northeastern Pacific Ocean (Octocorallia, Alcyonacea)
*Williams G, **Lundsten L***

10.15 Black Corals of European Continental Margin: Alpha Diversity and Reliability of Historical Data for Biogeographic Speculations
***Molodtsova T**, Le Guilloux E*

10.16 Systematics and Distribution of Deep-Sea Bamboo Corals (Octocorallia: Isididae) in New Zealand Waters
***Sánchez J**, Dueñas L, Tracey D*

10.17 Molecular and Morphological Diversity of Stylaster Corals in the Central Aleutian Islands, Alaska
***Schultz A**, Drovetski S*

10.18 Hidden Diversity in the Order Zoantharia (Cnidaria: Anthozoa) Revealed by Molecular Analyses: Taxonomic Implications for Parazoanthidae (Hexacorallia: Zoantharia)
***Sinniger F**, Reimer J*

10.19 Coral ID – No Longer 'All at Sea': Marrying Taxonomic Descriptions of Deepsea Corals with At-Sea ID Guides
***Tracey D**, Mackay E*

Sampling Methods and Mapping

11.01 Gloria Knolls: a New Coldwater Coral Habitat on the Great Barrier Reef Margin, Australia
***Beaman R**, Webster J*

11.03 Quantitative Habitat Characterization and Benthic Assemblage Structure of Deep-Water Scleractinian Reefs off Eastern Florida
*Shirur K, **Brooke S**, Messing C, Reed J*

11.04 Deep-Sea Corals of Campos Basin (Brazil): Results and Perspectives
***Cavalcanti G**, Curbelo-Fernandez M, Morosko E, Falcão A, Brasil A*

11.05 Advancing Marine Habitat Classifications through a New Global Terrain Map to Integrate Ecology in Biodiversity Data Systems
***Costello M**, Cheng A*

11.06 GIS Strategy for Mapping Cold-Water Coral Habitats in the Western Mediterranean Sea, Spain
***De Mol B**, Querol N, EUROLEON, Darwin 178, COBAS Shipboard parties*

11.07 Predictive Modelling of Coral and Sponge Distribution in the Central Aleutian Islands (Alaska, U.S.A.)
Woodby D, Carlile D, Hulbert L (presented by Heifetz J)

11.08 Consistent Quality Long-Term Habitat Mapping and Monitoring – Sidescan versus Multibeam
***Hüehnerbach V**, Huvenne V, Blondel P, Le Bas T*

11.09 Deep-Water Alcyonacea of Flower Garden Banks, Northwestern Gulf Of Mexico
Etnoyer P, Hickerson E (presented by Hyland J)

11.10 Seascape Description of an Unusual Coral Reef Area off Vesterålen, Northern Norway
***Mortensen P**, Buhl-Mortensen L, Dolan M*

11.11 Sùil Na Mara, the 'Eye of the Sea', a Microlander System for Monitoring Cold-Water Coral Habitats
***Roberts M**, Davies A*

11.12 Classification of Benthic Habitats from Video and Still Photographs
***Rose-Taylor C**, Costello M*

11.13 Using Museum Records to Investigate Distributions of Deep-Sea Corals: How Valuable Are They?
***Ross S**, Carlson M, Quattrini A*

11.14 New Zealand Deep-Sea Cnidaria: Past, Present and Future
***Mills S,** Schnabel K, Tracey D,*

11.15 Habitat Mapping and Facies Distribution through Time at S. Maria Di Leuca Coral Mound Province: Main Results from the APLABES Project
***Rosso A**, Vertino A, Corselli C, Di Geronimo I, Taviani M, Tursi A*

Coral Ecosystems and Habitats associated with Seamounts

12.01 Meadows of Antipathella Subpinnata (Myriopathidae, Antipatharia) in the Calabrian Twilight Zone (Southern Tyrrhenian Sea, Italy)
Bo M, *Bavestrello G, Canese S, Giusti M, Salvati E, Angiolillo M, Greco S*

12.02 The Importance of Particle-Rich Downward Water Motion and Bottom Water Advection as Food Supply Mechanisms to the Cold-Water Coral *Lophelia pertusa* (Scleractinia) at the Mingulay Reef Complex.
Davies A*, Duineveld G, Lavaleye M, Bergman M, van Haren H, Roberts J*

12.03 Distribution Patterns of Deep Corals and Other Megafauna on a Ridge and Seamount in the Northwestern Hawaiian Islands
Kelley C*, Smith J, Culp J*

12.04 Deep-Water Corals in the Southern Ocean - The NBP08-05 Expedition
Waller R, *Robinson L, Scanlon K, Blackwood D, NBP08-05 Science Party*

Geology, Palaeontology and Palaeoclimate, incl. Ocean Acidification

13.01 The P/Ca, Ba/Ca, and B/Ca Proxies in the Solitary Deepsea Coral *D. dianthus*: Sampling and Analytical Strategies
Anagnostou A*, Sherrell R, Lavigne M, Adkins J, Gagon A*

13.02 A New Paleoclimate Archive from Intermediate Water Depths
Burgess S*, Henderson G, Hall B*

13.03 Deep-Sea Bamboo Corals from the Tasmanian Seamounts: Isotopic Evidence for Benthic-Pelagic Coupling and Centennial Constancy of Oceanographic Conditions.
Sherwood O, Thresher R, Fallon S, ***Davies D****, Trull T*

13.04 Environmental Setting of Cold-Water Coral Locations in the Strait of Gibraltar and Alboran Sea, Spain.
De Mol B*, Busquets P, Álvarez-Pérez G, Sandoval N, Canals M*

13.05 Compound Specific $\delta^{13}C$ and $\delta^{15}N$ in Gold Coral Gorgonin
Guilderson T*, McCarthy M, Dunbar R, Roark B*

13.06 High-Resolution U-Series Datings of *Lophelia pertusa* from a Carbonate Mound in the Banda Mound Province off Mauritania
Eisele M, Frank N, ***López Correa M****, Douville E, Hebbeln D, Freiwald A*

13.07 Patterns of Trace Elemental and C and O Stable Isotopic Variability in Deep-Sea Bamboo Corals of Newfoundland and Labrador
Sherwood O, ***López Correa M****, Roark B, Edinger E, McCulloch M*

13.08 Trace Elements and Stable Isotopes in Recent North Atlantic *Lophelia pertusa* along a Latitudinal Gradient and from Fossil Mediterranean Sites
López Correa M*, Montagna P, Rüggeberg A, McCulloch M, Taviani M, Freiwald A*

13.09 Benthic and Planktonic Foraminifera and Other Proxies for Determining Environmental Parameters in Cold-Water Coral Ecosystems along the European Margin
Margreth S*, Rüggeberg A, Tamburini F, Spezzaferri S*

13.10 Cold-Water Octocorals' Contribution to Carbonate Production on the NW-Pacific Seamount
Matsumoto A

13.11 Growth Rate, Trace Elements and Stable Isotopes in *Corallium rubrum* from Shallow and Bathyal Settings in the Mediterranean Sea.
Montagna P*, Vieulzeuf D, López Correa M, Garrabou J, Taviani M, Marschall C, Linares C, McCulloch M, Silenzi S, Freiwald A*

13.12 Paleo-Reconstruction of East Australian Current Variability over the Last Century Using Deep-Sea Coral Proxies
***Neil H**, Thresher R, MacRae C, Wilson N, Marriott P, Gurney R*

13.13 Ground-Truthing an Ocean Circulation Model for the Straits of Florida: An Application of Deep-Sea Coral Geochemical Proxies
***Rosenberg A**, Swart P, Eberli G, Grasmueck M, Mooers C, Reed J*

13.14 Mediterranean Cold-Water Coral *Lophelia pertusa* as a High-resolution Archive of Paleo-environmental Conditions
*Riethdorf J, **Rüggeberg A**, López Correa M, Montagna P, Fietzke J, Eisenhauer A, Taviani M, McCulloch M, Dullo W*

13.15 X-Ray Vision – a First Look inside the Mingulay *Lophelia* Reef
*Sinclair D, Douarin M, Long D, **Roberts J**, Elliot M*

13.16 Unravelling the 2.7 Ma Depositional Sequence from the Challenger Cold-Water Coral Mound (IODP Exp. 307): Sediment Contributors and Palaeo-Environments
***Thierens M**, Titschack J, Huvenne V, Dorschel B, Stuut J, O'Donnell R, Wheeler A*

13.17 Development and Structure of Cold Water Coral Carbonate Mounds at the Rockall Trough Margins, NE Atlantic Ocean
***van Weering T**, de Haas H, van der Land C, Mienis F, de Stigter H*

13.18 Drilling Complete Sequences through Cold-Water Coral Carbonate Mounds (ESF-Carbonate): Drilling Expedition Results and Core Analysis
***Wheeler A**, Freudenthal T, Dorschel B, de Haas H, Wienberg C, Mayvis B, Joseph N, Freiwald A, Hebbeln D, Swennen R, Van Weering T*

Biology: Feeding, Growth and Reproduction

14.01 Aquarium Culture and Ecophysiology of the Cold-Water Coral *Lophelia pertusa*
***Davies A**, Last K, Dodds L, Roberts M*

14.02 Age Determination and Ecological and Compositional Correlates of Growth Rates in Deep-Water Bamboo Corals (Isididae)
***Fallon S**, Thresher R, Adkins J, Sherwood O, MacRae C, Wilson N, Gurney R*

14.03 A Pilot Experiment of Restoration of *Lophelia pertusa* Reefs Using Transplants
***Jonsson L**, Lundälv T, Dahl M*

14.04 Age and Growth of Three Bamboo Coral Species from the Northeastern Pacific Ocean
***Andrews A**, Stone R, Lundstrom C, DeVogelaere A*

14.05 Spatial Distribution of the Gorgonian Octocoral *Bayergorgia vermidoma* (Anthozoa: Plexauridae) in the Drake Passage
***Wagner D**, Waller R, Toonen R*

14.06 Oxygen Measurements at the Tisler Cold-Water Coral Reef
*Guihen D, **White M**, Woolf G, Duineveld G, Kiriakoulakis K, Lavaleye M, Lundalv T*

14.07 The Importance of the Permanent Thermocline to the Depth Distribution of Carbonate Mounds in the NE Atlantic
***White M**, Dorschel B*

14.08 Skeletal Reorganisation and Stable Isotope Signature of the Stylasterid *Errina dabneyi* (Azores Archipelago)
***Wisshak M**, Jakobsen J, Freiwald A*

Ecology and Species Associations

15.01 Deep-Sea Corals (Octocorallia and Scleractinia) Associated With Oceanic Water Masses: a Case Study in Brazil
***Arantes R**, Castro C, Seoane J, Pires D*

15.02 In-Situ Observations of Deep-Sea Coral Communities on the Southwest Grand Banks, Newfoundland
***Baker K**, Wareham V, Gilkinson K, Haedrich R, Snelgrove P, Edinger E*

15.03 Observations of Deep Coral and Sponge Assemblages in Olympic Coast National Marine Sanctuary USA, and a Comparison of Community Structure in Clusters of Biogenic Structure versus Non-Biogenic Structure
***Brancato M**, Hyland J, Bowlby E*

15.04 Cold-Water Coral Associations on the Graveyard Seamount Complex (Chatham Rise, New Zealand Region)
***Clark M**, Stewart R, Baird S*

15.05 Coral Communities of the Lower Continental Slope of the Gulf of Mexico
***Cordes E**, Lessard-Pilon S, Becker E, Fisher C*

15.06 Diversity and Seasonal Distribution of Near-Bed Associated Zooplankton to Cold-Water Corals in the Cap De Creus Canyon (North Western Mediterranean)
Madurell T, Venus M, Sabatés A, Orejas C, Gili J-M (presented by Gori A)

15.07 Ichtyofauna Diversity and Distribution in the Cap De Creus Canyon (Northwestern Mediterranean) from Video Transects
*de Lucia A, **Gori A,** Orejas C, Marti-Puig P, Gili J-M*

15.08 Cold Water Coral Disease
***Hall-Spencer J**, Pike J, Thomas S, Rowley S, Ticehurst R, Munn C*

15.09 Chirostylid-Deep Sea Coral Associations in the NE Atlantic
***Le Guilloux E**, Hall-Spencer J*

15.10 Food Web Structure of a Recently Discovered Deep Mediterranean Coral Reef: a Stable Isotope Insight
*Carlier A, **Le Guilloux E**, Olu K*

15.11 Carnivorous Sponges Associated with Deep-Sea Scleractinia from off Southwestern Atlantic (Brazil)
***Lopes D**, Hajdu E, Pires D*

15.12 Cuticular Spines of *Oxynaspis* spp. (Pedunculata: Cirripedia): An Inheritance from Antipatharian Host
***Molodtsova T**, Poltarukha O*

15.13 Observations on Species Composition and Distributional Ecology of Echinoderms from Lophelia Banks off the Southeastern United States.
***Nizinski M**, Mah C, Ross S*

15.14 Mapping Benthic Habitat and Megafauna on a Deepwater Coral Mound off North Carolina, USA
***Quattrini A**, Carlson M, Ross S, Nizinski M*

15.15 Obligate Commensalism of the Brittle Star *Ophiocreas oedipus* on the Ocotocoral *Metallogorgia melanotrichos* on the New England and Corner Rise Seamounts
*Mosher C, **Watling L***

Management Decisions and Policy for Corals, Conservation and Human Impacts

16.01 A Precautionary Approach for Minimizing Impacts from High Seas Fisheries on Vulnerable Marine Ecosystems
***Auster P**, Rogers A, Gjerde K*

16.02 Management Implications from Recent Deep Sea Coral/Sponge Findings in the Olympic Coast National Marine Sanctuary, USA
***Bowlby E**, Brancato M, Hyland J*

16.03 Determining the Distribution of Deep-Sea Corals in the Northern Gulf of St. Lawrence (Atlantic Canada)
***Colpron E**, Edinger E*

16.04 New Zealand's Protected Corals: What Do We Know?
***Consalvey M**, Mackay K , Tracey D*

16.05 Damage and Disturbance to Coral and Sponge Habitat of the Aleutian Archipelago
***Heifetz J**, Stone R, Shotwell S*

16.06 The Application of a Federal Mandate to Protect and Conserve Essential Fish Habitat and Deepsea Corals in Review of Coastal Construction Projects off Southeast Florida, USA
Karazsia J

16.07 International Registry of Coral Pathology
***McLaughlin S**, Howard D, Billmyre M, Tyler S, Hyland J*

16.08 Challenges in the Management of Coral Reefs in the Seas around India
Nair S

16.09 Distribution of Precious Corals in the Ryukyu Archipelago
***Nonaka M**, Muzik K*

16.10 NOAA's Deep-Sea Coral and Sponge Strategic Plan: a 5-Year Outlook
***Palmigiano K**, Tomczuk J, Hourigan T, Puglise K, English E, Parsons T, Gittings S, Brock R*

16.11 Classification Guide for Potentially Vulnerable Invertebrate Taxa in the Ross Sea Long-Line Fishery
***Parker S**, Tracey D, Mackay E, Mills S, Marriott P, Anderson O, Schnabel K, Bowden D, Kelly M*

16.12 A Framework for Deep-Sea Coral Management under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479)
*Meaney C, **Parsons T**, Hourigan T, Palmigiano K*

16.13 The CORAMM (Coral Risk Assessment, Monitoring And Modelling) Project
*Thomsen L, Abed R, Allers E, Bergmann M, de Beer D, Johnse S, de Laender F, Larsson A, Lundälv T, Nattkemper T, Nilssen I, van Oevelen D, Ontrup J, **Purser A**, Rønning I, Smit M, Unnithan V, Wagner H, Wang T*

16.14 CITES – A Conservation Mechanism for Deep-Sea Corals
Roberson J

16.15 The Trans-Atlantic Coral Ecosystem Study 'TRACES'
***Roberts M**, Ross S*

Scientific reviewers

Robert Brock
Steve Cairns
Malcolm Clark
Mark Costello
Bob George
Anthony Grehan
Tom Guilderson
Jason Hall-Spencer
Veerle Huvenne
Karen Miller
Pål Mortensen
Helen Neil
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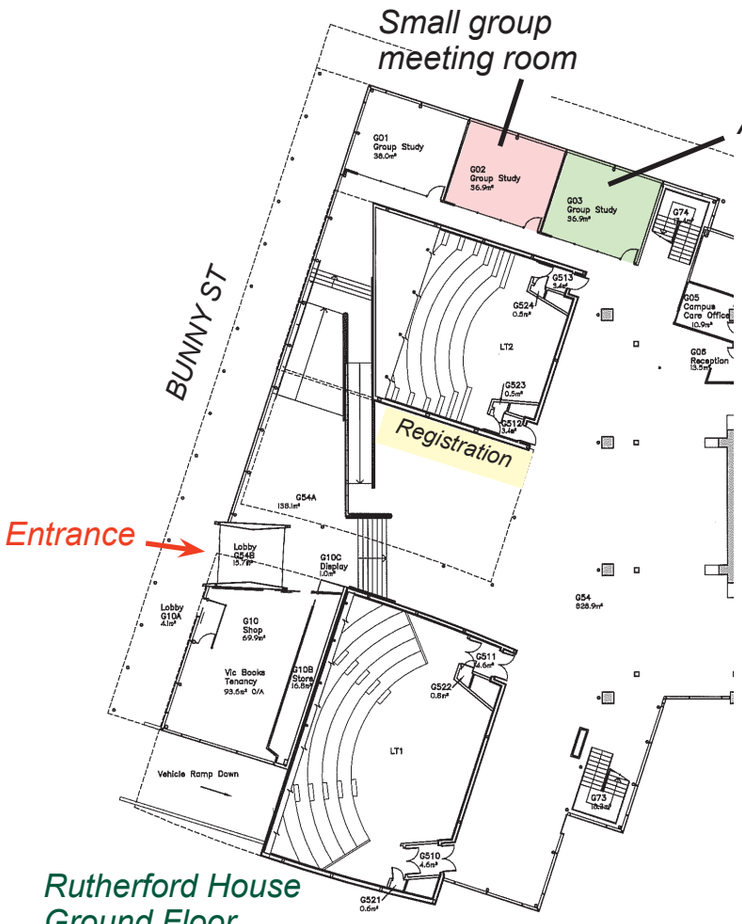
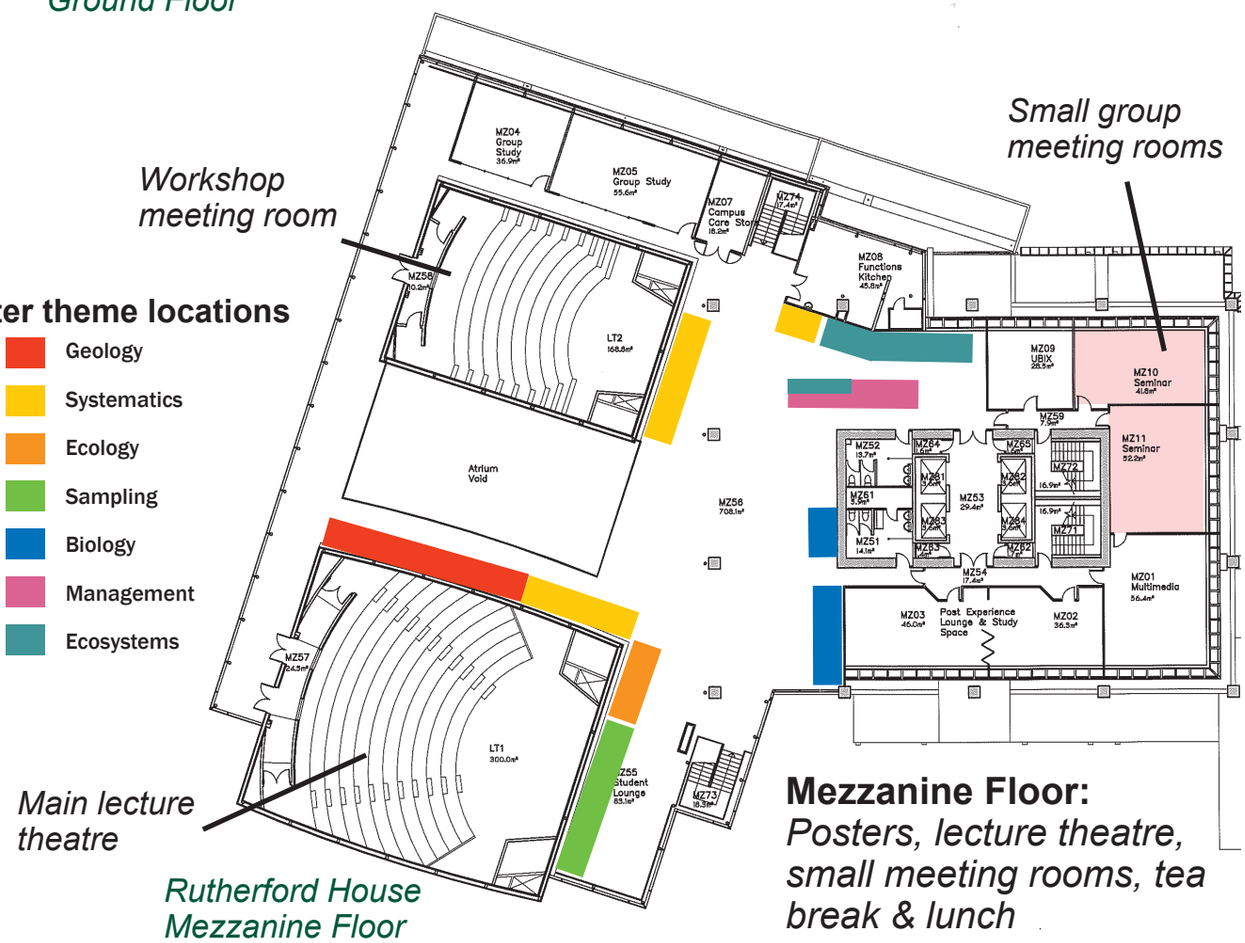
Murray Roberts
Juan Sanchez
Kenneth Sulak
Mark Tasker
Marco Taviani
Di Tracey
Ron Thresher
Les Watling
Alan Williams

Poster and Floor Plan, Rutherford House



Rutherford House Ground Floor

Ground Floor:
Registration, audio visual, & small meeting room



Poster theme locations

- Geology
- Systematics
- Ecology
- Sampling
- Biology
- Management
- Ecosystems

Main lecture theatre

Rutherford House Mezzanine Floor

Mezzanine Floor:
Posters, lecture theatre, small meeting rooms, tea break & lunch

Tuesday 2 Dec

OPENING

0.01

CORAL RESEARCH 'DOWN UNDER'

Don Robertson

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New Zealand and Australian scientists are currently addressing several questions about deepsea corals (from ~200-2000 metres). Some of these questions relate to risks or threats corals face from climate change and trawl fisheries.

The first question: "What is living where?" requires identification to species as a first step along with sample cataloguing, the production of concise at-sea identification guides, and collaboration with taxonomic experts in describing the local coral fauna. Key questions include describing coral species composition and distribution on seamounts and rocky substratum within the NZ and Australian EEZ's. This research contributes to decisions to protect particular at-risk species, to assessment of the resilience of coral populations (e.g. in SE Australian marine reserves) relative to the history and frequency of bottom trawling, and to measuring impacts on vulnerable marine ecosystems (VMEs) in the South Pacific and Antarctic regions. With several coral groups shown to be very long-lived and slow growing, investigating deepsea coral recovery from age and growth studies continue. Some of the research is collaborative between NZ and Australia including for example biodiversity surveys, coral systematics and biogeography, and diversity and dispersal studies on the Norfolk and Macquarie Ridges.

This research has helped improve our knowledge of corals in the deepsea, enabled comparisons between and within areas, and provided a better understanding of coral assemblages around the Southwest Pacific. It has also improved our ability to assess human induced risks. The research in both countries is funded primarily by government agencies responsible for resource management or species protection.

0.02

CLIMATE CHANGE 'DOWN UNDER'

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The recent Fourth Assessment Report of the IPCC points out that the uptake by the ocean since 1750 of carbon dioxide resulting from human activities has led to an average decrease in pH of 0.1 units. Ongoing atmospheric carbon dioxide emissions, if they fall within the "SRES" scenario range, are expected to lead to a further reduction in average global surface ocean pH of between 0.14 and 0.35 units over the 21st Century. The IPCC assessment states: "While the effect of observed ocean acidification on the marine biosphere are as yet undocumented, the progressive acidification of oceans is expected to have negative impacts on marine shell-forming organisms (e.g. corals) and their dependent species". This paper will provide an outline of projected physical changes in the ocean to which deep-sea corals may be sensitive, and some preliminary comments on possible implications near New Zealand.

Reference: IPCC, 2007: *Climate Change 2007: Synthesis Report. Contributions of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. [Core Writing Team, Pachauri, R.K. and Reisinger, A. (eds)], IPCC, Geneva, Switzerland, 104pp.

Tuesday 2 Dec

Geology, Palaeontology and Palaeoclimate

1.01

PALEO-CLIMATE RECONSTRUCTION OF SOUTHERN HEMISPHERE INTERMEDIATE WATER FORMATION OVER THE LAST MILLENNIUM FROM ANALYSIS OF THE SKELETAL COMPOSITION OF DEEP-WATER ISIDIDS

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Circulation of the Southern Ocean, its water mass distributions and their rates of production are key elements in the global climate system. However, there is only sparse historical information on the oceanography of the region that could be used to constrain and test models of regional and global climate change and variability, limited to a small number of ship-based observations widely scattered in space and time. To overcome this problem, we have developed proxies for deep-ocean conditions, based on the composition of deep-water gorgonians in the family Isididae (bamboo corals). These proxies are validated and calibrated against seasonal, interannual and large-scale (geographic) variability. The growth rates and the ages of the corals themselves are determined in part by “wiggle mapping” element/Ca time series, but also by radiocarbon analysis of node and internode material from most specimens. Techniques applied to the reconstruction include electron probe microanalysis, isotopic analysis (for $\delta^{18}O$ and $\delta^{13}C$), analysis of increment width and number, radiocarbon and U-series analyses. Samples were obtained widely from the South West Pacific and Southern Oceans, ranging from deep tropical reefs (Fiji and New Caledonia) to south of New Zealand and Australia. All samples come from within or close to the depth range characteristic of Antarctic Intermediate water (AAIW), allowing us to reconstruct variability in this globally critical water mass.

The data indicate long-term (century-scale) variability in water temperatures at depth that is consistent over basin scales, indicative of large-scale water mass changes rather than changes due to localised climate variability. In-depth analysis of long-lived recent and sub-fossil samples shows that these temperature changes appear to coincide with changing patterns of calcification and ambient nutrient levels, but not water mass ages. The latter suggest the long-term variability is not due to shoaling of water masses, as we originally proposed, but rather changes in the formation of the AAIW. The implications of these long-term changes for Southern Ocean dynamics and global circulation are discussed.

1.02

COUPLED AMS-^{14}C AND U-SERIES DATING REVEALS PREBOREAL ONSET FOR THE WORLD'S NORTHERNMOST *LOPHELIA PERTUSA* MOUNDSIN NORWAY (STJERNSUND)

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Published radiometric ages document an occupation of the Norwegian shelf by *Lophelia pertusa* throughout the Holocene until today, with all Recent occurrences being situated within the North Atlantic Current (NAC). To date the earliest Norwegian cold-water coral ages have been reported at 8.8 ka BP from Sula Ridge. In the present work we have examined cold-water coral deposits on the mid-Norwegian shelf (Traenadjupet) and from Stjernsund, a glacially carved trough in Northern Norway, which hosts one of the world's northernmost sites with lush *Lophelia*-mounds. The Stjernsund-fjord has two connections (= "sund") to the open shelf and is flushed by intense tidal currents. There several meter high Recent mounds are rooted on a prominent Late Glacial terminal moraine crest between 400 and 250 m water depth. The adjacent fjord-trough bottom at 500 m depth is dominated by postglacial mud-deposits. A gravity-core transect has been taken during R/V Poseidon cruise POS-325 to examine the coral mound age-structures and their connection with the deglaciation history. This transect comprises coral mound deposits from the moraine crest and flanks, as well as glaciomarine rhythmites on the western (seaward-) moraine flank and postglacial trough deposits behind the moraine. The contact of moraine-material and younger coral deposits is exposed in several cores. These cores have been scanned with computed-tomography to facilitate carbonate budget assessment and to select the stratigraphically oldest corals. Coupled AMS-^{14}C and U-series dating unveiled a surprisingly early onset of coral growth at 10.9 ka BP, about 2000 years earlier than previously reported for Norwegian waters. This Preboreal onset of north-Norwegian *Lophelia*-growth witnesses the surprisingly early implementation of the North Atlantic Current (NAC) following the Deglaciation. An erosion hiatus marks each coral mound base and probably reflects the onset of the strong tidal currents in Stjernsund, following a rapid glacier retreat. Suitable conditions for *Lophelia* have been established within less than 500 years after the Younger Dryas. The glaciomarine rhythmites (underlying corals) were radiocarbon dated at 10.48 ka BP (*Delectopecten vitreus*). Calibrated against the MARINE04-dataset, an attribution to the Younger Dryas at ~13 ka BP can be made. It is yet not clear if these deposits are contemporaneous with the terminal moraine emplacement or younger. Potentially analogous terminal moraines on the mid-Norwegian shelf have been attributed to the Deglacial ice-stream re-advance during Heinrich-Event H1 (13.1 ka ^{14}C-yrs BP). Coupled U-series and ^{14}C-ages allow tracking local reservoir age changes over the last ~10 ka, which were similar to the mean global reservoir age estimate of 400 years (MARINE04) during the late Holocene. However, substantial Δ^{14}C-deviations during the early Holocene highlight the need to establish local calibration curves for the Norwegian Sea, to increase the precision of bathyal marine radiocarbon ages.

1.03

Sr/Ca AS A POTENTIAL PROXY OF SUB-SURFACE TEMPERATURE VARIABILITY IN *C. SECUNDUM*

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There is increasing interest in the development of proxy records of oceanographic variability from intermediate and deep-water environments using deep-sea corals. Recent work has focused on isotopic and elemental ratios as proxies for temperature with limited success. Here we explore the potential uses of Mg/Ca and Sr/Ca in the same *Corallium secundum* sample using both LA-ICP-MS and a high-spatial resolution NanoSIMS. *C. secundum* samples where collected from the Makapuu deep-sea coral off the coast of Hawaii at 400 m water depth. NanoSIMS measurements of Mg/Ca and Sr/Ca in 10 micron square at sub-μscale resolution show that the distribution of magnesium is not homogenous. There are many <1 micron features with Mg/Ca concentrations that are ~40% higher than the surrounding area. At this point we speculate that these features may be centers of calcification, or organic molecules rich in Mg. In contrast the Sr/Ca patterns are more homogenous and do not show features related to the high Mg/Ca spots. The heterogeneity observed in Mg/Ca ratios suggest it is not a suitable as a proxy for temperature while the more homogenous nature of Sr/Ca at this scale supports its use as a proxy for temperature. A ~70 year Sr/Ca time-series was developed using a laser ablation ICP-MS (LA-ICPMS) system in continuous scanning mode with a 20x200 micron slit. In addition a ~18 year Sr/Ca time-series using individual spot measurements with the NanoSIMS was developed from the outer most portion (e.g. most recent growth) of the same *C. secundum* specimen. Both time-series were compared to a ~35 year monthly averaged temperature record (WOD98 and GSTPP) from 400 meters. Both the NanoSIMS and LA-ICP-MS Sr/Ca data show a remarkable degree of correspondent variability over the most recent 18 and 35 years respectively to the sub surface temperature record at slightly greater than annual resolution. Water temperatures vary from 8.5 to 10°C while the Sr/Ca varies from 3.3 to 3.0 mmol/mol. Sub decadal variability of the temperature appears to match Sr/Ca variability reasonably well even when assuming a linear growth rate (170 μm/yr). Longer term (~25 year) cycles are evident in the 70 year LA-ICP-MS Sr/Ca time-series. These results suggest Sr/Ca measurements in *C. secundum* specimens may be a viable proxy of sub-surface temperature variability.

1.04

MINOR AND MAJOR ELEMENTAL COMPOSITION OF 4 SPECIES OF DEEP SEA PROTEINACEOUS CORALS

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Proteinaceous black and gold deep sea corals such as *Leiopathes* sp., *Gerardia* sp., and *Antipathes* sp. are widely distributed throughout the world ocean at water depths extending from the lower photic zone to at least 500 meters. Gerardia is a zooanthid deep sea coral that constructs a dense and strong arboreal skeleton composed of radially accreting bands of protein. Deep sea black corals are antipatharians (hexacorals) that also form hard, dense skeletons of protein, sometimes containing chitin fibrils. In deep water, proteinaceous corals are known to exhibit very low growth rates (5 to 40 μm y^{-1}) and living individuals with skeletal ages of greater than 4,000 years have been recovered. Following colony death, the skeletons of deep sea proteinaceous corals are not subject to carbonate dissolution but rather undergo slow microbial degradation of their outermost layers. In fact, fossil and sub-fossil specimens of deep sea proteinaceous corals are commonly observed adjacent to living colonies, suggesting that long time series of coral growth can be developed that extend through the Holocene (and possibly deeper in time) by employing cross-dating methods.

Here we explore the minor and major elemental composition of Black and Gold coral proteinaceous skeletons. Our sample set includes 4 different taxa: *Leiopathes glaberrima*, *Antipathes dichotoma*, *Gerardia* sp., and an as yet unidentified deep sea black coral. Multiple specimens were recovered using the HURL (Hawaii Undersea Research Lab) submersibles Pisces V and IV from the Line Islands (Palmyra Atoll and Kingman Reef), the Main Hawaiian Islands (Oahu, Hawaii), Cross Seamount, and the Northwest Hawaiian Islands National Monument (multiple seamounts). Age control is provided by AMS radiocarbon dating. Elemental composition was determined by Laser Ablation ICP-mass spectrometry using a scanning excimer laser system at Australian National University. Standardization is via NIST glass standards.

All proteinaceous corals examined thus far exhibit significant enrichments (in some cases many orders of magnitude over seawater concentrations in a variety of metals (Cu, V, Ni, Zn, Zr, Re, Mo, U). All proteinaceous corals are also highly enriched in I and Br, black corals more than gold corals. Although biological enrichment must be invoked, many elements exhibit complex and reproducible concentration patterns along radial transects through colony branches. Co-variation of Ca, Sr, and Mg suggest the presence of small amounts of carbonate phases. The composition of *Gerardia* sp. is significantly different from *Leiopathes glaberrima* and Antipathes dichotoma. The unidentified black coral has a compositional similarity to Gerardia suggesting that it may in fact be an unknown species of gold coral. Based on their distribution in corals from different sites and reproducibility in corals from specific sites several elements hold promise as tracers of environmental variability, e.g. P, Ba, B, and possibly Cd and U.

PAIRED STABLE C/O ISOTOPES AND TRACE ELEMENTS IN A DEEP-WATER BAMBOO CORAL SKELETON FROM CHATHAM RISE (NEW ZEALAND): METABOLIC VERSUS ENVIRONMENTAL CONTROLS

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Deep-water bamboo corals of the genus *Keratoisis* (Isididae; Octocorallia) are tested for high-resolution archives of paleoceanographic and climatic variability in deeper-water masses. We analysed a 10 mm thick cross section of a modern bamboo coral skeleton from Chatham Rise off New Zealand (~ 650 m water depth) by stable oxygen and carbon isotopes using a micromill (100 µm sample spacing), and by trace elements which were measured with LA-ICP-MS (10 µm steps) in a parallel transect. The Mg-calcitic internodes of the endoskeleton consist of fibrous, C_{org}-rich crystals assembled in fascicles which form annual concentric increments around the central axis. The conspicuous bright and dark colour banding is produced by varying orientations of fascicles towards the image plane. The skeleton represents a 27 year record, subdivided into a juvenile stage (~6 years) and an adult stage (~21 years). The juvenile phase consists of thin Mg-calcitic increments with the highest C_{org} content of the section. The adult stage is composed of fascicles with increasing length-width ratios, forming conspicuous colour bands of varying organic content.

Stable oxygen and carbon isotopes show a kinetic fractionation in the juvenile stage, characterised by depleted $\delta^{18}O$ and $\delta^{13}C$ values and a positive correlation of both isotopes. This phase is physiologically controlled, indicating a high metabolic activity of the calcioblastic cells. Major part of the adult stage reveals an ontogenetic decrease of $\delta^{13}C$ values by about 1‰, indicative of increasing rates of metabolic carbon uptake and calcification. The late adult stage on the other hand is characterised by short-term $\delta^{13}C$ fluctuations, whereas the peaks correlate with the colour bands. They also show some correlation with P/Ca and Ba/Ca fluctuations and hence indicate annual variations of paleoproductivity, possibly related to spring blooms.

The Mg/Ca ratio, tested as a paleotemperature tracer, closely reproduces the *in situ* annual mean temperature of 6.2°C. The Mg/Ca variations correlate with the banding pattern, indicating seasonal fluctuations of 1-2°C in 600-700 m water depth on Chatham Rise. These preliminary results support the hypothesis that temperature drives the Mg/Ca ratio in the skeletal calcite of *Keratoisis*, which allows using the Mg/Ca signal for paleotemperature reconstruction at annual to subannual scales.

The high-resolution stable isotope and trace element analyses in a parallel transect on a modern deep-water *Keratoisis* skeleton provided evidence that a combination of geochemical proxies allows for reliable paleoceanographic reconstructions at annual to subannual scales.

1.06

COLD-WATER CORALS IN THE CENTRAL MEDITERRANEAN SEA DURING THE HOLOCENE

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For long time, reef-forming cold-water corals from the Mediterranean Sea appeared to be restricted to a Pleistocene age only and it was assumed that their occurrence was mainly restricted to glacial periods (see Taviani et al., 2005). After discovering living *Lophelia pertusa* colonies on a gently dipping shelf off Apulia at Santa Maria di Leuca (Ionian Sea, central Mediterranean) in 2000 this cold-water coral mound area got into the focus of scientific investigations.

Sediment cores collected during an expedition with the German RV METEOR (M70-1) to the Mediterranean Sea in 2006 from the top of coral mounds from the area of Santa Maria di Leuca reveal sequences with abundant coral fragments (e.g. *Lophelia pertusa, Madrepora oculata*) embedded in hemipelagic fine grained sediments. AMS radiocarbon ages determined on coral fragments collected from these cores show that they comprise a time frame of the past ~12,000 years. Thereby coral ages point at two different phases of coral growth in this region. The older period coincides with the Younger Dryas (YD) including a short post-YD interval, while the younger period starts around 5.000 yrs BP up to the present. During the interval in between, which corresponds partly to the deposition of Sapropel 1 in the eastern Mediterranean, the environmental conditions must have been unfavourable for coral growth.

For a better understanding of coral growth history, also sediment cores from adjacent off-mound sites have been investigated. Since this material was apparently deposited continuously and undisturbed by any interference with coral framework it provides the possibility to compare changing ambient environmental conditions recorded in these hemipelagic sediments with the development of cold-water coral growth documented in those sediment cores taken directly from the coral mounds.

Taviani, M., Freiwald, A. and Zibrowius, H., 2005. Deep coral growth in the Mediterranean Sea: an overview. In: A. Freiwald and J.M. Roberts (Editors), Cold-Water Corals and Ecosystems. Springer, Berlin, Heidelberg, pp. 137-156.

1.07

PROLIFERATION AND DEMISE OF DEEP-SEA CORALS IN THE MEDITERRANEAN DURING THE YOUNGER DRYAS

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Although deep, cold-water corals are now in recession in many parts of the Mediterranean basin, pre-modern and fossil examples of the colonial *Madrepora oculata*, *Lophelia pertusa* and the solitary coral *Desmophyllum dianthus* are relatively abundant. Here we report U-series and ^{14}C ages for deep-sea corals from all the major Mediterranean basins, dredged from sedimentary mounds and patch reefs at depths ranging from 250 to 3000 metres. The corals are exceptionally well preserved with many still maintaining their original luster, sometimes making it difficult to discriminate between fossil and near modern samples.

U-series dating undetaken on these near pristine samples reveals a surprisingly narrow range of ages, with the most prolific growth occurring within the cooler Younger Dryas (YD) period in an ~1000 yr interval from 12,820 yrs to 11,850 yrs. A second slightly younger group of corals have ages ranging from 11,230 to 10,900 yrs, indicating a brief return to cool water conditions in parts the Mediterranean at ~11,000 yrs. Surprisingly there is a dearth of Last Glacial Maximum (LGM) or older corals indicating either a lack of preservation or more probably environmental conditions that were unsuitable for growth of deep-water corals. It is speculated that during periods of significantly lower sea-level that accompanied glacial periods and cool waters, increased sediment input and higher turbidity may have made conditions unsuitable for prolific coral growth.

Coral radiocarbon ages show that since the LGM the intermediate depth waters of the Mediterranean generally had $\Delta^{14}C$ compositions either the same or lying between surface waters and the atmosphere, indicating that the deeper waters of the Mediterranean remained extremely well ventilated. The only exception is several samples from the Ionian Sea that lie below the $\Delta^{14}C$ surface marine curve at ~12,500 yrs, consistent with isolation of those relatively deep (780-1100m) waters for several thousand years. There is no evidence however, for widespread intrusion of low $\Delta^{14}C$ Atlantic waters into the Mediterranean as previously proposed by Siani et al., (2001).

Prolific deep-sea coral growth in the Mediterranean ended abruptly at ~10,900 yrs BP, with many of the coral bearing mounds being draped in a thin veneer of mud. Their demise is attributed to a combination of factors, the 6-8°C rapid step-wise rise in ocean temperatures that marked the commencement of the Holocene warm period, combined with unusually high sedimentation into the Mediterranean from glacial meltwater pulses following the end of the YD-PB climate oscillations. This study further indicates the key role that both temperature (cool waters) and environmental conditions play in controlling the abundance and distribution of deep-water corals.

1.08

COLD-WATER CORAL CARBONATE MOUNDS IN THE NE ATLANTIC: DISTRIBUTION, CHARACTERISTICS AND VOLUMES

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The reef-building activities of cold-water corals, such as *Lophelia pertusa* and *Madrepora oculata,* have contributed to the formation of a large numbers of cold-water coral carbonate mounds along the eastern and western Atlantic margins. Recent advances in seabed mapping have revealed the full extent of the distribution of mounds and mound-like structures and have emphasised that not only the highest mound densities but also the largest mounds occur on the Irish seafloor.

Multibeam data collected during the Irish National Seabed Survey (INSS), provides bathymetric data with a resolution that allows for the identification of km-sized mound structures. Based on these data, 1550 often complex mound-like structures have been identified of which the vast majority are located along the continental slope at intermediate water depths (<1500 m). The INSS data shows, furthermore, that these structures do not occur randomly but are grouped into distinct provinces.

In total 20 provinces have been identified containing up to 300 mounds and mound-like structures. Within the provinces, the mound structures often have comparable shapes and dimensions. The vertical distribution patterns of their summits in correlation with their heights indicate an upper growth limit for many of the mounds. Groundtruthing has revealed that the mound structures in the provinces shallower than 1500 m water depth are mainly cold-water coral carbonate mounds covered by living and dead patches and thickets of cold-water corals and coral.

In this study, we present an overview of the distribution of provinces of mounds and mound-like structures in the Irish sector of the NE Atlantic, a compilation of available groundtruthing data in order to characterise the various mound provinces and statistical appraisals on depth distribution and height of cold-water coral mounds. And for the first time, we will be able to estimate and present the volume of the sediment that cold-water coral mounds contribute to the continental margin sedimentary systems.

1.09

IMPACT OF EARLY DIAGENESIS ON THE PALAEOENVIRONMENTAL RECORD REGISTERED IN COLD-WATER CORAL CARBONATE MOUNDS

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Recent carbonate mounds, mainly build up by cold-water corals and other biogenic fragments embedded in an alternating biogenous (carbonate-rich) to terrigenous (siliciclastic) matrix, appear to be an important feature along the European continental margins. The presence of giant carbonate mounds in Porcupine Seabight, on Porcupine Bank, in Rockall Trough and on Rockall Bank (W of Ireland) is already known since the nineties and has been the target of several cruises during the last decade. Similar mound structures, topping ridges and structural heights, are also observed along the Moroccan margins.

During IODP Expedition Leg 307, a recent carbonate mound, Challenger Mound (Porcupine Seabight, SW of Ireland), was drilled for the first time in history. Detailed studies of this particular mound structure highlighted how early diagenesis can overprint and/or mimic the primary environmental record of a recent carbonate mound. Geochemical and geophysical properties revealed a cyclic record most probably driven by the typical glacial-interglacial changes characterizing the northern hemisphere during the Quaternary. Early differential diagenesis overprints these primary environmental signals, with extensive coral dissolution and the genesis of small-scaled semi-lithified layers in the Ca-rich intervals. In particular, Ca and Sr count rates, the P-wave velocities and the densities are influenced by the observed diagenetic patterns. The low cementation rates compared to the extensive dissolution patterns can be explained by an open-system diagenetic model.

Along the Moroccan margins, fluid seepage and fluxes in pore water transport affect the development of mound structures, enhancing extensive cold-water coral dissolution and precipitation. However, only cold-water coral alteration but no obvious relation between cold-water coral growth and seepage is observed.

During the ESF-EuroCORES-EuroMARC programme CARBONATE, the early diagenetic processes as observed in Challenger mound and in mounds along the Moroccan margins, will be compared with other drilled mound structures. Recent carbonate mounds provide indeed an excellent opportunity to study early diagenetic processes in carbonate systems without the complications of burial and/or later meteoric diagenesis. Refining the geochemical signatures of the sediments helps to quantify the effects of early diagenetic processes, which change the geophysical and petrophysical characteristics of a carbonate mound and have an impact on the preservation of primary environmental signals.

PALAEO-ENVIRONMENT AT THE START-UP AND RESTART PHASE OF COLD-WATER CORAL MOUNDS, PORCUPINE SEABIGHT, IRELAND

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The most striking question in Atlantic coral bank research is why corals started to build huge coral banks, up to 300 m high and several kilometres wide at their base, in well delimited province, and started all more or less in the same time interval? Seismic profiles show that the cold-water coral banks are rooted at a regional erosional reflector, linked to the oceanographic changes in the Late Pliocene and in terms of the reintroduction of MOW and installation of the actual Atlantic circulation. It is believed that the coral banks started to develop shortly after the major erosional event of Late Pliocene – Pleistocene age that created the mound base and developed quickly, before drift sedimentation started (Kano et la., 2007). IODP Expedition 307 resulted in the first scientific drilling of a cold-water coral bank in the Belgica mound province and gives the opportunity to study the difference in palaeo-environment of the coral bank start-up period and restart of development.

In order to study the palaeo-environment at the initial development stage of the coral bank benthic foraminifera were picked and geochemically analysed for stable isotopes and trace elements. In the early development of the coral bank the results demonstrate significant changes in temperature (Mg/Ca), salinity ($\delta^{18}O$) and primarily productivity (($\delta^{13}C$). The results of the biomarkers indicate a mixed sedimentation of marine and terrestrial origin, but also a variation in between the different drilled sites, marking a downslope transport and drift of the sediments. At the mound site the levels of marine organic matter our relatively low; the temperature at this site is relatively high. Corals appear in relatively warm intervals and in sediments characterised by marine organic matter. Below the mound base marine organic matter dominates and all palaeo-environmental proxies indicate higher temperatures. It is clear that the area was under influences of other water masses during the coral growth than before and different of the upslope site. The upslope area of the mound seems to be characterised by saline, nutrient rich and colder waters during the period of the coral bank development these results are integrated with seismic data, well log cycles and geotechnical and grainsize results of the discussed interval. These cycles illustrate the difference in coral accumulation form the different mound sites and their relation to the off mound sites.

1.11

HYDRODYNAMICS AND PALAEO-ENVIRONMENT OF THE INITIAL CHALLENGER MOUND AND ITS SURROUNDINGS

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During IODP Expedition 307, a 3-site transect was drilled across Challenger Mound in the Porcupine Seabight. This large (>155 m high) cold-water coral bank is part of the Belgica Mounds, a cluster of cold-water coral mounds which are all seated on one regional unconformity ('RD1', Van Rooij et al., 2003) and are embedded in drift sediments of Quaternary age. The common base indicates a sudden mound initiation, dated by Kano et al. (2007) at 2.7 Ma ago. A major hiatus at ca. 24 m below the top of the mound (1.6 – 1.0 Ma) has been attributed to the environmental changes caused by the change in glacial/interglacial periodicity and amplitude during the Mid-Pleistocene Revolution (MPR; Foubert, 2007; Kano et al., 2007). Off-mound sedimentation did not start in earnest until ca 0.577 Ma ago.

Because this sudden onset of mound formation is still enigmatic, and because the controls on mound start-up and development are still not well known, the study presented here focuses on the interval just above the RD1 unconformity, as it has been recorded at the 3 drill sites (on-mound, off-mound and upslope 'background' site). High-resolution detailed grainsize analyses, planktonic foraminifera assemblages and stable isotopes have been used to identify the sedimentary regime and palaeo-environment that characterised the seabed in the region after the erosional event responsible for the formation of the RD1 unconformity.

The results provide new insights in the critical development phases of Challenger Mound, and allow for a more detailed and precise development model of the Belgica mound province. Three phases can be recognised in the intervals studied. They indicate that the RD1 erosional event was followed by deposits representing an overall trend towards cooler and less energetic conditions. At first, Challenger Mound developed under warm temperate conditions, showing repeated lateral expansions separated at the off-mound site by deposits indicating high current regimes (sandy contourites). This phase is characterised at the upslope site by a period of non-deposition, reworking and bed armouring. A second phase represents the changing environments of the MPR, with sandy, muddy and composite contourite sequences in the off-mound cores. Large proportions of *N. pachyderma* (s) indicate the arrival of cool-temperate to polar conditions. In the final phase, the environment seems to have stabilised into a slightly lower energetic regime (muddy to silty contourites that form the embedding sediment drift in the Belgica province) with a cyclic variation between temperate and polar foraminifera assemblages.

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ENVIRONMENTAL CONSTRAINTS ON COLD-WATER CORAL GROWTH AND MOUND FORMATION ON THE PENDUICK ESCARPMENT, GULF OF CADIZ

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In the southern Gulf of Cadiz, on the Moroccan continental margin, cold-water coral related carbonate mounds with maximum height of 60 m high are found at about 400 m water depth on the edge of an elevation delimited by the Penduick escarpment. A relation between active gas seepage in the area and the formation of these mounds has been postulated. Cold-water coral debris is abundantly present in the sediment on the carbonate mounds as well as on the escarpment, with *Lophelia pertusa* and *Madrepora oculata* as most common species, and in some places the branching coral *Dendrophylia*. However, living coral is rarely encountered in the area, and a mud drape of a few cm thickness is usually found covering the coral-bearing sediment. At several locations intact coral colonies were found preserved under the mud layer, suggesting that they were buried relatively quickly. The demise and burial of cold water corals might be related to an increased suspended sediment load in the area.

To investigate recent bottom water characteristics, CTD hydrographic transects were made across the Penduick escarpment, and benthic landers recording bottom water current speed, temperature, salinity and turbidity were deployed for variable duration (several days up to one year). The measurements indicate activity of internal waves in the area with 6-hour periodicity, inducing cyclic fluctuations in near-bottom current strength (peaks up to 25 cm s^{-1}), and a temperature varying around 11°C and the salinity around 35.8. These values fall within the range of what has been observed at other cold-water coral occurrences of the European continental margin. Mediterranean Outflow Water (MOW) is not present in this area. An intense bottom nepheloid layer extending 200 m above the seabed was observed in CTD transects, as well as a distinct intermediate nepheloid layer at 250 m depth. Although the hydrodynamic conditions at the Penduick escarpment seem favourable for coral growth, the high suspended sediment load in the bottom water may have hampered coral growth and stopped mound development. Sediment cores collected on the mounds are presently investigated in detail to determine the timing of the decline of cold-water coral communities on Penduick escarpment.

1.13

COLD-WATER CORAL REEF DEVELOPMENT ON CARBONATE MOUNDS IN RELATION TO PALEO-DENSITY ESTIMATES

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Cold-water coral reefs are very abundant along the European continental margin in intermediate water depths and are able to build up large mound structures. These carbonate mounds particularly occur in distinct mound provinces on the Irish and British continental margins. Previous investigations resulted in a better understanding of the cold-water coral ecology and the development of conceptual models to explain carbonate mound build-up. During past mound studies two different hypotheses were evoked to explain the origin and development of carbonate mounds, external *versus* internal control (e.g., Freiwald et al. 2004, Rüggeberg et al. 2007 *versus* e.g. Hovland 1990). Several short sediment cores have been obtained from Propeller Mound, Hovland Mound Province, Northern Porcupine Seabight, indicating that cold-water corals grew during interglacial and warm interstadial periods of the Late Pleistocene controlled by environmental and climatic variability supporting the external control hypothesis (e.g. Dorschel et al. 2005, Rüggeberg et al. 2007).

The recent discovery of Dullo et al. (in press) highlights the impact and importance of the external (environmental) control hypothesis with coral growth and distribution following the structure of seawater density, i.e. the potential density anomaly sigma-theta. This study evidences that all studied living coral reef sites of the NE Atlantic are occurring in water masses with a specific density window of sigma-theta = 27.5 ± 0.15 kg m^{-3}, whereas dead reefs are outside this density range. In order to transfer this idea to the paleo-record, we used the method of Lynch-Stieglitz (2001) and others for the determination of paleo-densities using stable oxygen isotope measurements ($\delta^{18}O$) of benthic foraminifera. The accuracy of the density reconstruction is well known for the Holocene, the Last Glacial Maximum, and past interglacials.

With this knowledge we are now able to test whether paleo-densities might be an important prerequisite for growth and development of cold-water coral reefs during the past interglacials. $\delta^{18}O$ records of benthic foraminifera from sediment cores of Propeller Mound indicate that paleo-density values have a similar range during interglacials and interstadials as for the present-day settings. However, the method of Lynch-Stieglitz (2001) is only valid for temperatures between 5° and 30°C. Therefore, mean glacial values of 27.8 kg m^{-3} are minimum estimates considering possible glacial temperatures below 5°C, but are clearly offset to the living-coral-reef-density-range of 27.35–27.65 kg m^{-3}.

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1.14

TRACKING SEWAGE USING ANTIPATHARIANS AND GORGONIANS: EXAMPLES FROM FLORIDA AND THE RED SEA

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Antipatharians and gorgonians are both widespread, locally abundant organisms that make annually-banded skeletons. Climate records spanning several centuries have already been obtained from both shallow and deep representatives; herein, we describe their utility in retrieving information on sewage input, with worked examples from Florida and the Saudi coastline of the Red Sea. This work is based on high-precision sampling of annual bands in the organic layers of the skeletons, and analysing these bands for ratios of stable isotopes of Nitrogen ($\delta^{15}N$).

On the east coast of Florida, $\delta^{15}N$ increased towards the outer (younger) layers, and were significantly higher at sites near discharge of sewage. This showed that sewage N was being taken up by reef organisms, a finding that was instrumental in the decision by the State of Florida to cease ocean dumping of sewage. Off the city of Jeddah, Saudi Arabia, antipatharians occurred at shallow depths, accessible to diving. $\delta^{15}N$ levels in these antipatharians allowed a detailed reconstruction of progressive sewage loading off the city over the past 60 years. This information is being used to plan future waste handling. These shallow examples demonstrate the potential for gathering useful environmental data, using shallow or deep organisms.

Tuesday 2 Dec

Coral Ecosystems and Habitats associated with Seamounts

2.01

ISLANDS OF THE DEEP: MOLECULAR EVIDENCE FOR THE SEAMOUNT ENDEMISM HYPOTHESIS

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Seamounts are elevations that rise from the ocean floor and provide a hard substratum for deep-water corals and other habitat-forming marine animals and their associated fauna. Because seamounts are relatively isolated 'islands' in the deep sea, it has been suggested that their rich fauna may be highly endemic. This Seamount Endemism Hypothesis, here abbreviated as SEH, holds that species and populations that occur on a given seamount or seamount chain are restricted to that area and are thus not found elsewhere. To investigate the SEH at the population level, we compared the distribution of mtDNA 16S haplotypes across 22 species of stylasterid corals (Cnidaria: Hydrozoa: Stylasteridae) in the northern Norfolk Ridge in the SW Pacific. Our results, based on a collection of 303 specimens, revealed a total of 151 unique haplotypes. Of these, (i) 139 (92%) are unique to a single seamount, (ii) 12 (8%) are shared among two or three seamounts, and (iii) none is found in more than three seamounts. For example, results for the species *Systemapora ornata*, found in eight seamounts less than 120km apart from each other, revealed 19 haplotypes, of which 17 are unique to a single seamount and only two are shared among seamounts (one haplotype shared between Stylaster Seamount and Refractaire Seamount, ~30km apart, and another haplotype shared among Jumeaux Est, Jumeaux Ouest, and Antigonia Seamounts, <50km apart). Moreover, only one among the 151 haplotypes was shared between distant seamounts (a single haplotype of *Stylaster imbricatus* shared between Zorro and Jumeaux Est Seamounts, ~180km apart). This result suggests that long-range dispersal events among seamounts are extremely rare. Albeit sampling for a number of species was limited, the overall result is strongly consistent with the SEH and suggests that genetic diversity of stylasterid corals in the SW Pacific is partitioned according to the spatial distribution of seamounts at even very small scales.

2.02

LOPHELIA REEF FISH BIOTOPES IN THE NORTHERN GULF OF MEXICO, AS DEFINED BY SUBMERSIBLE VIDEO FRAME ANALYSIS OF MEGAFAUNAL INVERTEBRATE COMMUNITY STRUCTURE

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The fish and invertebrate megafauna associated with *Lophelia pertusa* coral reefs and comparative biotopes was investigated at two depth horizons (325 m and 500 m) on Viosca Knoll on the northern Gulf of Mexico (NEGOM) slope using a manned submersible. This is the first statistically robust quantitative analysis of physical/biotic biotopes available to fishes associated with *Lophelia* reefs in the NEGOM, and western North Atlantic generally. Megafaunal taxa were quantified by occurrence data from high-quality 1-second digital frame grabs using Coral PointCount software. Megafaunal invertebrate assemblages were defined by Primer v6 multivariate analyses. Key biotopes determined for demersal fishes on Viosca Knoll included *Lophelia* coral 'Thicket', 'Rock', 'Plate', 'Plate/Chemo' and 'Open'. 'Thicket' biotope was extensively developed only at 500 m, with *Lophelia* occurring more sporadically at 325 m. Mixed species oases comprised of *Lophelia*, black corals, sponges and other taxa were prevalent at 325 m. However, in places, single species densely populated 'Plate' and 'Rock' biotopes. In striking contrast to *Lophelia* reefs in the Atlantic, coral 'Rubble' biotope was essentially absent in this study, perhaps due to rapid chemical or biological breakdown of dead branches. The atypical goethite (iron oxide) rock slab substrate (in lieu of biogenic carbonate) of Viosca Knoll also reflects an unusual chemical regime. Invertebrate species richness was highest for 'Rock' biotope, and lowest on *Lophelia* 'Thicket'. Thus, contrary to expectations, *Lophelia* biotope in the NEGOM does not support a richer invertebrate megafauna than that found on comparative hard-substrate or soft-substrate biotopes. The height and slope of the rarefaction curve for 'Open' biotope suggested that this inadequately sampled, but vast, biotope probably supports the highest invertebrate species richness in the NEGOM. Fish taxa occurrence and abundance differed significantly among the 5 biotopes. Only a few fish species were highly associated with *Lophelia* 'Thicket'.

2.03

THE INTERACTIONS BETWEEN A SHALLOW COLD-WATER CORAL REEF (TISLER REEF SKAGERRAK) AND ITS CLOSE ENVIRONMENT

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Although cold water coral reefs often show evidence for extensive damage from trawling, little is known about their ecological functioning. This is largely because of the difficulty of making long-term observations due to their size, water depth and remoteness.

The Tisler Reef is a relatively small cold-water coral reef (~1 x 0.2 km), dominated by *Lophelia pertusa* in the relatively shallow waters (70 - 160 m) of the Skagerrak at the Norwegian/Swedish border. Its near-shore location provides near ideal conditions for carrying out high resolution sampling and *in situ* experiments in order to study the reef system. As part of this work we have characterised the sinking and suspended particulate organic matter (POM) above the reef on long (1 month) and short (1 tidal cycle) time scales in an attempt to shed light on the interactions of this ecosystem and its immediate environment.

Total sinking particulate material, POC_{sink}, PN_{sink} chlorophyll and lipid fluxes were significantly lower ($P<0.05$) downstream of the reef (NW edge) during April 2006 due to high current velocities at that site that prevented material from sinking into the sediment trap. All fluxes increased during the 2nd half of the month, reflecting the onset of the spring bloom that “swamped” the reef. Before the spring bloom (i.e. steady-state conditions) C/N ratios were significantly ($P<0.05$) higher in the downstream site, indicating that POM_{sink} was more degraded than the upstream site. Furthermore, during the same period labile OM (i.e. PN_{sink} and fatty acids) was preferentially removed at the downstream site suggesting possible selective feeding/grazing at the reef that influences the composition of POM_{sink}.

These observations were supported by the composition of suspended $POM_{(susp)}$ determined during the course of a tidal cycle in late April 2007. During periods of high POM_{susp} loading, labile material such as PN_{susp} and essential fatty acids (EFAs; $C_{20:5}$ and $C_{22:6}$) were depleted, but herbivorous zooplankton markers ($C_{20:1}$ and $C_{22:1}$ fatty acids) were present in high proportions. These organic parameters were lowest above the reef as a result of intensive invertebrate feeding and consequently, the composition of POM downstream of the reef was significantly lowered. This work presents the first high resolution observations of a cold-water coral ecosystem and demonstrates an intricate but clear relationship of the reef and its close environment.

2.04

PATTERNS OF COMPOSITION, FINE-SCALE DISTRIBUTION AND RESILIENCE OF SEAMOUNT CORALS IN MARINE RESERVES OFF TASMANIA, SE AUSTRALIA, RELATED TO DIFFERENT HISTORIES OF BOTTOM TRAWLING

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There are few published studies on fishing impacts on seamounts, but a recent camera-transect survey of 27 individual remnant volcano seamounts off SE Australia provides an opportunity to quantify the scale of impact on, and subsequent recovery of, the epibenthos including deepsea corals. We use the historical distribution of commercial trawling as the basis to “compare and contrast” fished and unfished seamounts. Data from repeat surveys separated by ~10 years were used to identify change: The Sisters, unfished for 10 years, was examined to assess change in impacted areas; Hill K1, an unfished seamount, was examined to assess natural change as a control on the recovery observations. Initial observations show considerable spatial variation in the structural complexity of the epibenthos, with trawling implicated in the alteration of coral species composition and abundance. This talk will provide details of the analysis and interpretation of the patterns observed.

2.05

DISTRIBUTION OF STRUCTURE-FORMING SCLERACTINIAN CORALS IN THE NEW ZEALAND REGION

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Cold water corals can provide habitat for a variety of invertebrates and fishes. The New Zealand region possesses one of the world's most diverse deep-sea coral faunas. Understanding the distribution and relative occurrence of the deep-sea corals in the region, particularly structure-forming scleractinian or stony corals, is important. Such information will allow for a fuller appreciation of the ecological importance of these taxa and the likely impact of anthropogenic activities on their persistence. Historical data and records from recent research sampling for the structure-forming stony corals *Madrepora oculata*, *M. vitiae, Solenosmilia variabilis*, *Goniocorella dumosa*, *Enallopsammia rostrata*, and *Oculina virgosa* were compiled and analysed. All species, apart from *O. virgosa*, were distributed throughout the region and found mainly between water depths of ~200–1300 m. *O. virgosa* was restricted to warmer northern waters and most often occurred in relatively shallow waters (~40–250 m) on the shelf and shelf edge (88% of records). The species that have been commonly observed to form 'reef' or 'thicket' structures, *S. variabilis* and *M. oculata/vitiae*, were most frequently recorded on seamounts (63% and 53% of records, respectively). *E. rostrata* was also found predominantly on seamounts (55% of records). Records for *G. dumosa* were associated with seven geomorphic seabed features but these were mostly evenly distributed among slopes, seamounts and rises (34%, 32% and 29% of records, respectively). Data generated by the present study were used together with environmental data to predict the occurrence of the six stony coral species elsewhere in the region. The results of this modelling revealed the relative importance of particular environmental variables for controlling the distribution of these taxa. The predictive maps of the coral distributions can be used by environmental managers seeking to mitigate the negative effects of anthropogenic activities such fishing (e.g. to assess the potential vulnerability of corals and/or for selection of marine protected areas).

2.06

HABITAT FEATURES, SPATIAL DISTRIBUTION AND DEMOGRAPHY OF THE *MADREPORA OCULATA* POPULATIONS IN THE CAP DE CREUS CANYON (NORTHWESTERN MEDITERRANEAN)

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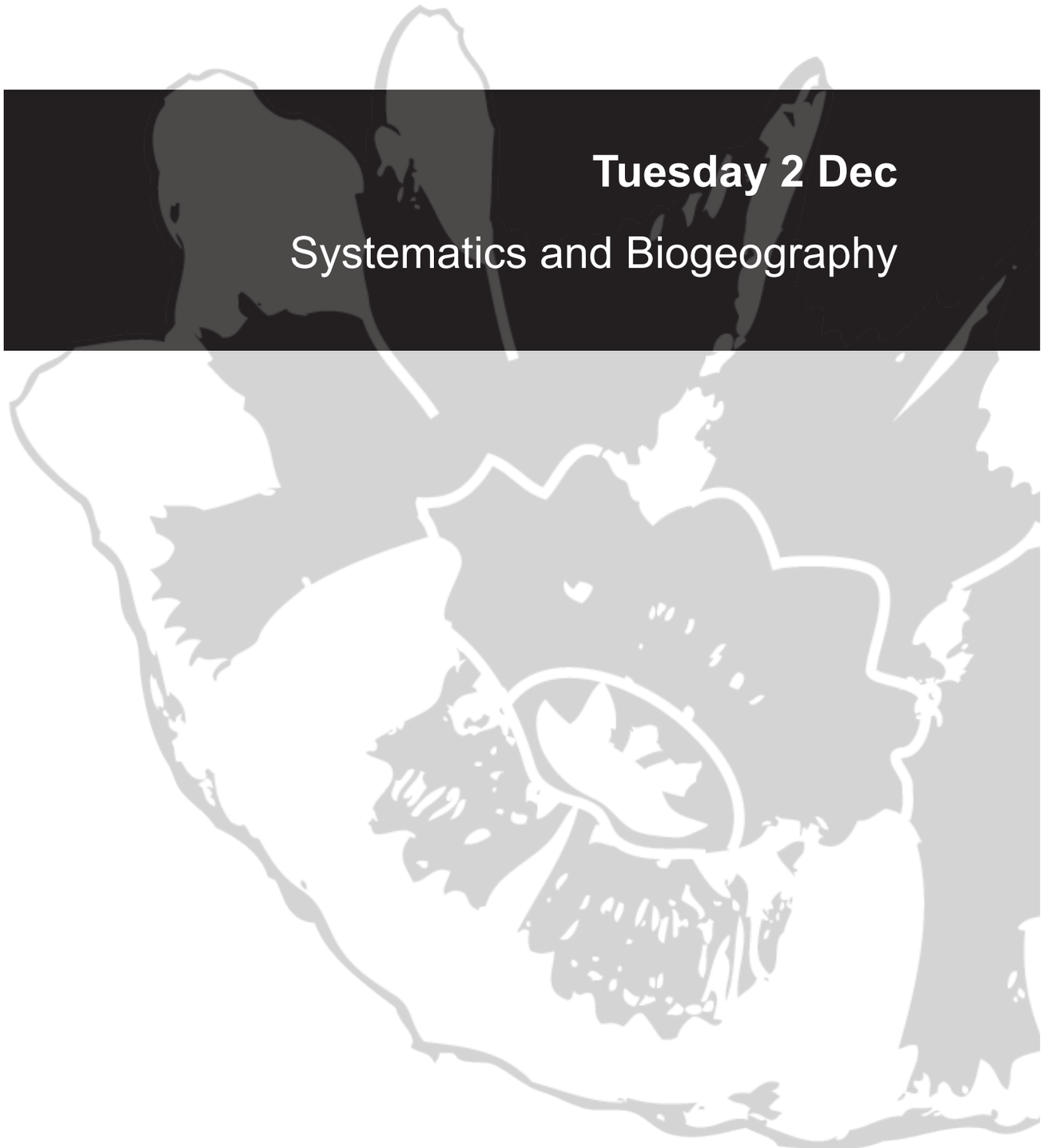
The Cap de Creus canyon in the Northwestern Mediterranean shelter populations of Deep corals (dominated by *Madrepora oculata*), which present different scenarios. During an oceanographic cruise (carried out in September 2007 on board of the RV García del Cid) we performed underwater video transects by using the man submersible JAGO (IFM-GEOMAR). The recorded images allow us to characterize the habitat and to perform a study of population's structure and distribution of *Madrepora oculata* along the southern wall of the canyon. Furthermore we quantify the density of colonies inside the populations as well as the demographic structure of them. Results of the analysed video transects revealed different population structures which reflect different features in the study locations at small scale, presenting very variable patterns (from predominance of well developed three-dimensional colonies – 40 cm height – to predominance of two-branches colonies of few cm.) at short distances (few meters) and patchy distribution (from minimal values of 1 col.m-2 to 5 col m-2). At the light of our results, we discuss the possible reasons for these different distribution and demographic patterns in such a short distance trying to understand the dynamic of these benthic systems dominated by corals.

Tuesday 2 Dec

Systematics and Biogeography



3.01

FREDERICK ("TED") M. BAYER'S IMPACT ON DEEP-WATER OCTOCORAL BIOLOGY

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The impact of Ted Bayer's research on octocorals was extraordinary and will long be used by any student of the group. He leaves behind a legacy of 107 published papers on octocorals, in which he described 4 new families, 1 new subfamily, 48 new genera, 2 new subgenera, 186 new species, and 10 new subspecies. An annotated list of his new taxa (arranged taxonomically) and all of his manuscripts (including nine unpublished) are provided. Few of his taxa have been synonymized. Although he published on most octocoral taxa, his favorite groups were the deep-water calcaxonian families from the western Atlantic, central Pacific, and Antarctic; he was also an expert of the precious coral family Coralliidae. He facilitated the study of the subclass by publishing classifications to the higher taxa, an illustrated trilingual glossary of morphological terms, a key to all genera (exclusive of the Pennatulacea), and an annotated bibliography of the literature of the group. He was the first to use SEM of sclerites to describe species, and perfected that technique in the use of SEM stereo pairs. He also made significant advances to the knowledge of octocoral axial microstructure, proving that all gorgoniids have a diagnostic type of axial mineralogy. He interacted and influenced virtually every octocoral worker in the last half of the twentieth century, co-authoring with many of them.

3.02

ATLANTIC – PACIFIC RELATIONSHIPS OF DEEP-SEA OCTOCORALS

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During the period 2003-2005 a series of 34 dives were made on 13 seamounts in the New England and Corner Rise Seamount Groups, NW Atlantic Ocean. Octocorals, black corals, and a variety of associated invertebrates were collected. Identification of the octocorals has proceeded slowly because most of the species are new to science and not associated with the otherwise moderately well-known North Atlantic fauna. As species have been documented, using both morphological and molecular data, it has become apparent that for a number of genera, the closest living relatives of several of the new North Atlantic species are to be found in the central and SW Pacific. Genera with sibling (geminate?) or similar species in the Atlantic and Pacific include *Paragorgia*, *Paramuricea*, *Chrysogorgia*, *Rhodaniridogorgia*, and *Iridogorgia*. Additional pairs will also be found in the Keratoisidinae, but the taxonomic work on that subfamily is not yet complete. We will examine the hypothesis that movement of North Atlantic Deep Water through the Central American Seaway as late as 11 mya, is the most likely explanation for these close relationships. The alternative hypothesis, that these species are ancient Tethyan hold-overs, will also be examined, but that the last possible date for Atlantic – Pacific connections through the Tethyan seaway is too long ago.

3.03

ON THE ORIGIN OF DEEP-SEA OCTOCORALS: PATTERNS REVEALED FROM MOLECULAR PHYLOGENIES

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There are 3 families of “gorgonian-type” corals (Chrysogorgiidae, Isididae, Primnoidae) whose diversity and abundance reaches a maximum at depths greater than 200 meters. These three families group as a monophyletic clade within the suborder Calcaxonia in the most complete molecular phylogenetic study of the Octocorallia to date (McFadden et al. 2006), which suggests a major radiation within the deep sea. However, only a small number of species from these families were included in the phylogeny, and none of the shallow-water representatives. We increased taxon sampling of both deep-water and under-represented shallow-water calcaxonians and sequenced multiple mitochondrial genes to more fully examine the patterns of evolution of these families.

Our results show strong support for a monophyletic Primnoidae, but both the Chrysogorgiidae and Isididae are polyphyletic. However, strictly deep-water genera from the latter two families do form robust monophyletic clades: isidid bamboo corals from the deep-water subfamily Keratoisidinae cluster together and are a sister group to the deep-sea genus *Isidoides* (Chrysogorgiidae), rather than to taxa from the shallower-dwelling isidid subfamilies Mopseinae and Circinisidinae. In his original description of *Isidoides*, Nutting (1910) noted it had a “close resemblance to certain Isidae, and would be placed in that family were the axis jointed.” The lack of monophyly of the taxa with jointed skeletons reaffirms the view that many skeletal characteristics may be convergent and not useful for evolutionary systematics of octocorals. The remaining deep-sea chrysogorgiids form a well-supported monophyletic clade, but the shallow-water genera (*Stephanogorgia*, *Trichogorgia*) are more closely related to tropical, shallow-water Ifalukellidae (*Ifalukella*, *Plumigorgia*; details in poster presentation by Pante & France).

Although there is clearly evidence for evolutionary radiation of deep-sea taxa, the relationships among the deep-water clades from the different families remains unresolved due to short internal branch lengths in the phylogeny, an indication of a relatively rapid radiation in the past. Our dataset still suffers from incomplete taxon sampling in the Chrysogorgiidae and isidid subfamilies Isidinae, Mopseinae and Circinisidinae, and future analyses will depend on acquiring tissue samples from colleagues and future cruises.

3.04

A MOLECULAR PHYLOGENETIC ANALYSIS OF THE BAMBOO DEEP-SEA CORALS (OCTOCORALLIA: ISIDIDAE) BASED ON PREDICTED RNA SECONDARY STRUCTURES (LSU-rRNA 16S)

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Bamboo corals (Isididae: Calcaxonia: Octocorallia: Cnidaria) are among the largest deep-sea octocorals, however little is known about their phylogenetic systematics. Secondary structures from RNA molecules are particularly useful in phylogenetic analyses because they include structural informative characters not found in the primary sequence alignment. In addition, there are relatively well-conserved secondary structures in the evolutionary phylogeny among eukaryotes regardless if they show substantial variability at its primary sequence. Furthermore, secondary structures help resolve alignment uncertainties that may result from INDELS when trying to compare distant species. Sixty-five sequences from lsu-rRNA (16S) region, corresponding to 31 haplotypes, were used from different specimens of bamboo corals belonging to the subfamilies Keratoisidinae (*Keratoisis, Lepidisis, Acanella, Isidella, Orstomisis* and *Tenuisis*) and Mopseinae (*Primnoisis, Echinisis, Sclerisis* and *Minuisis*). RNA secondary structures were reconstructed using minimum free-energy predictions and structural constraints from known 16S structures. Phylogenetic analyses were based on Maximum Parsimony criterion (for 16S mtDNA and secondary structures morphometrical matrices), Maximum likelihood (for molecular 16S mtDNA matrix), and Bayesian Inference (for 16S mtDNA, morphometrical information total evidence or combined matrices).

The topologies showed that the subfamily Keratoisidinae is not monophyletic due to the inclusion of the *Primnoisis* genera that belongs to the Mopseinae subfamily. It is also evident that four Keratoisidinae genera (*Keratoisis*, *Lepidisis*, *Acanella* and *Isidella*) are polyphyletic groups. The predicted secondary structures from the lsu-RNA (16S) sequences were conserved among the studied specimens. However, the helix G13 was the most variable region determining the phylogenetic relationships among bamboo corals. With the current evidence, there is no concordance with the taxonomic classification and the phylogenetic hypotheses presented here. Therefore, it is necessary to re-evaluate the current taxonomic classification not only of the Keratoisidinae subfamily but also the Isididae family. Thus, it is important the search for complementary DNA sequences of bamboo corals to corroborate these findings.

3.05

SYSTEMATICS OF THE PRECIOUS CORALS (CNIDARIA: OCTOCORALLIA: CORALLIIDAE) WITH EMPHASIS IN THE FAUNA FROM NEW ZEALAND SEAMOUNTS

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Deep-water octocorals are among the most ecologically important habitat-forming taxa that can be found on continental upper slopes and on seamounts. Corallidae comprises a group of highly calcified octocorals better known as precious corals, which have been exploited since prehistoric times. Recent explorations during multiple cruises along the continental slope of New Zealand resulted in the collection of a considerable number of colonies, representing unidentified and undescribed taxa of Coralliidae. A total of 54 lots of material collected in 41 stations between 276 and 1765 m were revised. The preliminary inventory was conformed by seven species belonging to two genera, including *Corallium reginae* Hickson, 1905 originally described from Timor, Indonesia, and *Paracorallium nix* Bayer, 1996 and *P. thrinax* Bayer & Stefani, 1996 described from New Caledonia.

The phylogenetic relationships among the Corallidae were first examined based upon morphological characters of several previously described species of additional Corallidae with the species of *Corallium* and *Paracorallium* from New Zealand. Molecular analysis using mitochondrial DNA (16S) sequences and RNA secondary structure strongly supports the sister relationships of Corallidae with the bubblegum corals Paragorgiidae, which is concordant with sclerite characters such as the polyps rods and surface radiates. Additionally, the internal transcribed spacer 2 (ITS2) using Denaturing Gradient Gel Electrophoresis (DGGE) coupled with DNA sequencing showed high intragenomic variation in New Zealand *Corallium* species, except for *C. reginae*. These multiple intragenomic ITS2 variants could be concordant with recent species radiations in octocorals as seen in other groups of octocorals elsewhere.

3.06

EVOLUTIONARY MITOGENOMIC ANALYSIS OF *MADREPORA OCULATA*: THE FIRST CASE OF GENE REARRANGEMENT IN THE SCLERACTINIAN MITOCHONDRIAL GENOME

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Mitochondrial (mt) genomes provide valuable information for phylogenetic studies, in particular of metazoan phylogeny because of the extensive taxon sample that is available. Beyond the traditional sequence-based analysis it is possible to extract phylogenetic information from the gene order. For scleractinians, over 20 mitochondrial genomes, mainly shallow-water zooxanthellate lineages, have been characterized, and results show a uniform mitochondrial gene order, suggesting that this conservative arrangement might represent the ancestral condition for the subclass Scleractinia. In this study, mitochondrial genome of a deep-sea azooxanthellate scleractinian coral, *Madrepora oculata,* was sequenced and compared the published data. The mt genome of *M. oculata* is compact with length of 15.8 kb. The gene order is similar to those of published zooxanthellate corals, except for a distinct gene rearrangement occurring between the cytochrome oxidsase subunit II (COII) and cytochrome oxidsase subunit III (COIII). This is the first gene rearrangement case reported in scleractinian mitochondrial genomes. Phylogenetic analysis of the completed mt genomes indicates *M. oculata* at the base position of robust clade, implying that COII-COIII gene rearrangement is a derived character in the lineage of *M. oculata.*

ASSESSING CONNECTIONS AMONG SEAMOUNT CORALS IN THE SOUTHERN HEMISPHERE

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Genetic diversity and relatedness of deep-sea coral populations was examined for the first time in the Southern Hemisphere as a way of assessing connectivity among seamounts in the Indian and Pacific oceans. The study was designed to complement active research programs on seamount biodiversity conservation being undertaken by Australia and New Zealand, by identifying the relatedness/uniqueness of coral populations at a range of spatial scales from coarse (between biogeographic regions) to fine (among individual seamounts within a cluster). We sequenced DNA from three gene regions (16S, ITS and mtControl region) and eight coral species, from samples held in museum collections in Australia and New Zealand as well as samples collected on recent voyages in 2004-2007. Although DNA quality and amplification success was often problematic, especially for the older museum samples, our genetic data indicate that ocean expanses are likely to be effective barriers to gene flow for many coral species. Phylogeographic analysis showed evidence of subdivision across major geographic divides. However, we found no evidence that seamounts within the same geographic region support genetically distinct populations, although this may reflect the resolution of the genetic markers used. Our genetic analyses indicated the presence of unidentified or cryptic species within some taxa. The identification of geographic variation (population structure) within wide-ranging species, and the identification of new species, show that levels of seamount biodiversity are likely to have been, and continue to be, underestimated – at least among corals. Our results so far emphasise the need to conserve seamounts at least at the scale of biogeographic region in order to effectively protect biodiversity.

3.08

GENETIC DISCONTINUITY AMONG REGIONAL POPULATIONS OF *LOPHELIA PERTUSA* IN THE NORTH ATLANTIC OCEAN

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The degree to which populations are demographically connected through larval dispersal is imperative to our understanding of resilience to disturbance, yet little is known about larval dispersal ability and population connectivity in *L. pertusa*, the dominant framework-forming coral on the continental slope in the North Atlantic Ocean. Using a suite of ten DNA microsatellite markers, we assessed the spatial scale and pattern of genetic connectivity among widely separated *L. pertusa* localities. Approximately 400 *L. pertusa* samples were collected from 22 sites including: (a) 13 deep reefs off the southeastern US coast (SEUS, from North Carolina to Florida, depth range 282-769m), (b) Manning and Rehoboth Seamounts off New England (NES, 1326-1922m), (c) three natural *L. pertusa* reef localities plus the *Gulfpenn* shipwreck in the Gulf of Mexico (GOM, 308-651m), and (d) Rockall Banks and Mingulay Reef off Scottland (149-591m), plus Stokkbergneset Fjord, Norway (111-160m), in the eastern North Atlantic Ocean (ENAO). Patterns of microsatellite differentiation reject the hypothesis that *L. pertusa* represents a single, interbreeding population in the North Atlantic Ocean. On the broadest scale, a Bayesian modeling approach without prior geographical information found three distinct groupings or clusters of individuals: GOM, SEUS, NES plus ENAO. Quantitative estimates of hierarchical gene diversity (AMOVA) were significant and 4% (based on the number of different alleles, *F*st) or 12% (based on the sum of squared size differences, *R*st) of the total variance was explained by between-cluster differences ($p<0.001$). Estimates of pairwise population differentiation were highest with NES populations (average *F*st = 0.187), intermediate with the ENAO populations (*F*st = 0.108), and smallest between SEUS and GOM populations (*F*st = 0.027). Within each of the regional clusters, we found increased connectivity across broader geographic distances suggesting that some larvae are broadly dispersed, as well as evidence for incomplete mixing at smaller spatial scales suggesting retention of larvae. Thus, dispersal of *L. pertusa* larvae appears generally localized, but long distance dispersal occurs with enough frequency for regional genetic cohesion. Further investigation of genetic connectivity patterns in *L. pertusa* and other deep coral organisms throughout the Atlantic Basin, along with improved oceanographic data, may elucidate mechanisms of population maintenance and isolation.

3.09

GENETIC DIVERSITY AND CLONAL STRUCTURE OF THE COLD-WATER CORAL *LOPHELIA PERTUSA* IN NE SKAGERRAK BASED ON MICROSATELLITES

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Lophelia pertusa is probably the most widespread scleractinian coral in the world. In the northeast Atlantic it is the main reef building species and regarded as an autogenic engineer or a key structural species. The three-dimensional reef structure constitutes the foundation for a diverse and complex habitat that provides food and protection for numerous other species, including several commercial fish species. The main depth distribution is between 200 and 1000 meters on the European continental shelf. Although in fjords, due to special conditions, reefs occur shallower than 100 meter. This is the situation in northeast Skagerrak between Sweden and Norway where five extant reef-complexes lives at 70-120 meters depth. A remotely operated vehicle (ROV) equipped with a manipulator arm was used (non-invasive sampling) to take a few polyps from coral colonies.

Microsatellites is a powerful genetic neutral marker. They are highly polymorphic and co-dominant which makes them very useful for population studies. 13 loci have been used to genotype all collected individuals. The results describe the genetic diversity and the genetic structure at a fine-scale in the area.

Additionally, microsatellites can with high confidence discriminate sexually derived individuals from clonally derived individuals. This attribute was utilized to construct a clone-map that describes the reefal architecture from a genetic individual perspective. The largest reef in the area, the Tisler reef (1200 meters long and 300 meters wide), has been exhaustively sampled. More than 80 samples have been collected to elucidate how the reefs are built up. Dense thicket of *Lophelia* cover the top of the deep reef mound, hitherto the genetic constitution of the reefs have been unknown. No one has to my knowledge ever been able to shown how genetic individuals are distributed throughout a cold-water coral reef.

3.10

LOPHELIA PERTUSA COLONIZATION ON THE WWII TANKER *GULFPENN* IN THE NORTHERN GULF OF MEXICO: PATTERNS OF GROWTH AND GENETIC AFFILIATIONS

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The tanker *Gulfpenn*, sunk by a German submarine on May 13, 1942, lies at a depth of 544 meters 60 km south of the Mississippi Delta. In the summer of 2004 an ROV survey of the *Gulfpenn* was conducted as part of an MMS/NOAA-OE/NOPP sponsored archaeological and biological study of ship wrecks in the northern Gulf of Mexico. Conditions at the *Gulfpenn* have resulted in exceptional coral growth. It is estimated that up to 15% of the exposed surfaces throughout the wreck have been colonized by *Lophelia pertusa*. Corallum range from small un-branched juveniles to individual colonies up to 3.0 m in height and/or breadth. In many locations colonies are coalescing forming thicket-like aggregations. The most extensive coral growth is occurring on the starboard side on surfaces or structures that have a vertical orientation and on catwalks and deck piping along the port side of the fore- and aft decks. The largest development of coral is a 6-7 m high by 3-3.5 m wide aggregation of an undetermined number of colonies growing on the forward starboard corner of the main superstructure from the bulwarks on the main deck to above the top of the decaying pilot house. This vertical assemblage of colonies has formed what amounts to an upright thicket. Colonies with radii in the order of 1.5 m would have a minimum linear extension rate of 24.2 $mm \cdot yr^{-1}$ if recruitment occurred the year it was sunk.

In order to make initial assessments regarding degree of clonality and potential source population(s) from which the *Gulfpenn L. pertusa* originated, samples collected with the ROV were genotyped using 10 microsatellite markers. Allele frequencies of *Gulfpenn* samples were compared with three populations from the Gulf of Mexico, 13 populations from the western North Atlantic and three populations from the eastern North Atlantic Ocean. *Lophelia pertusa* samples collected from distinct regions of the wreck had unique multi-locus genotypes, indicating multiple larval settlement events. Genetic analyses of *Gulfpenn's Lophelia* confirm their affiliation with other Gulf populations and showed closest affiliations with the most extensive *L. pertusa* population known in the Gulf, Viosca Knoll 826.

3.11

DIVERSITY OF DEEP-SEA CORALS (CNIDARIA, SCLERACTINIA) FROM NEW CALEDONIA AND ADJACENT WATERS: A CENTRAL PACIFIC HOT-SPOT FOR AZOOXANTHELLATE SCLERACTINIANS

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Recent studies on the species richness of deep-sea corals demonstrated that the Philippines is a biodiversity hot-spot, with more than 150 species of azooxanthellate scleractinians being reported for this area. Preliminary examination of over 2700 specimens of these cnidarians collected during the oceanographic campaigns Halipro 1, Bathus 3, Bathus 4, Norfolk 1, and Norfolk 2 carried out by the Paris Museum in New Caledonia and adjacent waters (from 170-1200 m depth), revealed the occurrence of more than 160 species. It is likely therefore that New Caledonia has an equal or even more diverse azooxanthellate scleractinian coral community. Amongst the identified species the most abundant ones are: *Javania fusca* (202 specimens examined), *Eguchipsammia fistula* (143), *Dactylotrochus cervicornis* (139), *Caryophyllia diomedeae* (102), *Javania exserta* (88), *Enallopsammia rostrata* (80), *Deltocyathus rotulus* (75), *Trochocyathus rhombcolumna* (74), and *Balanophyllia desmophyllioides* (64). On the other hand, more than 30 species, especially for the caryophylliid genus *Trochocyathus*, are reported based just in one specimen each one. Focusing on the bathymetric range of each species, the dendrophylliids *Balanophyllia rediviva* and *Dendrophyllia* cf. *oldroydae* are the ones restricted to the most shallow waters (170-190 m), and *Stephanocyathus moseleyanus* and *Trochocyathus* cf. *rawsonii* present the deepest records (1200 m). *Anthemiphyllia spinifera*, *Madrepora oculata*, *Caryophyllia elongata*, *Conotrochus brunneus*, *Trochocyathus vasiformis*, *Desmophyllum dianthus*, *Dactylotrochus cervicornis*, *Flabellum pavoninum*, *Javania fusca*, *J. exserta*, *Enallopsammia rostrata*, and *Gardineria hawaiiensis* have bathymetric range of more than 500 m between the shallowest and deepest new records

Among the approximately 706 valid Recent species of azooxanthellate Scleractinia, more than 410 (58%) occur in the western Pacific. Dividing this region into 5 distinct zoogeographical provinces (Japan region [1], Philippines and Indonesia region [2], Australia region [3], New Caledonia region [4], and New Zealand region [5]), it was observed that the highest species richness is observed in provinces 2 and 3 (200 and 210 species respectively) with a slight decrease in the direction of higher latitudes (100 species recorded for province 1 and 105 for province 5). However, the New Caledonia region has the highest diversity restricted to a single small area (between 18-26ºS and 159-176ºE). Here we listed all the new records and correlate them with bathymetric and temperature data. A brief discussion about the zoogeographical affinities of this region is provided.

3.12

GENETIC VARIATION AND PHYLOGEOGRAPHIC PATTERNS OF DEEP-SEA CORALS ON NORTH PACIFIC SEAMOUNTS

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Corals are a key component of the fauna of deep-sea hard substrate habitats and are of interest as habitat-forming organisms for invertebrates and fishes. They are the dominant taxon and the most diverse invertebrate group on seamounts. Deep-sea corals are generally long-lived and slow growing with potentially limited recruitment, making them particularly unlikely to recover from anthropogenic impacts. The threats to seamounts make their study time-critical, with corals making an ideal model organism for research into the biology, ecology and vulnerability of seamount fauna. However, a global deficiency of scientific expertise in morphological taxonomy has been cited as a significant impediment to our understanding of deep-sea coral diversity, coral biogeography, and seamount ecology. Molecular genetic methods can be used to overcome this impediment and more rapidly assess species diversity in archived specimen collections. However, these methods have not yet been widely applied to deep-sea corals. To determine the most effective marker(s) to assess species diversity, here we compare levels of interspecific and intraspecific genetic variation for six genes in two octocoral taxa, the Family Paragorgiidae and the primnoid genus *Narella*. All specimens were concurrently examined morphologically for species identifications. In contrast to previous studies of octocorals which showed the MshI gene to be the most variable, the ND6 gene was most variable in the Paragorgiidae. This contrasts with results for *Narella* which showed the lowest variability in the ND6 gene and the highest in MshI. If continued analyses confirm the difference in variation rates between these genes in different octocoral taxa, then an approach using multiple genes will be needed to separate species based on molecular identifications. Phylogeographic patterns of both taxa on North Pacific seamounts will also be presented.

3.13

DEEP-SEA ANTIPATHARIA (ANTHOZOA: CNIDARIA) OF THE NORTH-EAST ATLANTIC: CONTINENTAL SLOPE VS. SEAMOUNT AND ISLAND FAUNAS

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Previous preliminary estimations of the number of species of Antipatharia (Anthozoa:Cnidaria) (Molodtsova, 2005, 2006; Hall-Spencer, 2007) were based mainly on published data and they showed that this number is apparently underestimated and that the fauna of black corals of this area requires a revision. This finding stimulated an intensive study of black corals from the major European historical collections and recent cruises to the North-East Atlantic. A great attention was paid to re-examination of specimens from published records. It was supposed crucial to study these materials including type specimens since many species of black corals are known only from type localities and because descriptions provided by authors in the XIX and early XX century lack many details.

Studied material comprised antipatharians from several dozens of scientific cruises and fishery by-catches representing the most complete coverage of the European continental margin, the Reykjanes Ridge, the Mid-Atlantic Ridge, the Lusitanian seamounts, the Macaronesian seamounts and slopes of the Azores, Madeira and Canary islands. Almost 50 species of black corals of the families Antipathidae, Aphanipathidae, Cladopathidae, Myriopathidae and Schizopathidae, including several new species, were found at depths from 100 to 4500 m. Diversity of anthipatharians on oceanic islands and seamounts appeared much higher than on the nearby Iberian continental margin and it was close to diversity of rich antipatharian fauna of the Bay of Biscay. The Azores with adjacent seamounts have the highest species diversity in the region and are considered to be a local hot-spot of antipatharian fauna.

Present work is the first attempt to compare seamount and non-seamount fauna of black corals.

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Wednesday 3 Dec

Ocean Acidification

4.01

EFFECTS OF OCEAN ACIDIFICATION ON TEMPERATE CORALS

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The global oceans currently absorb over 25 million tons of CO_2 every day. This has caused surface waters to become 30% more acidic since wide-spread burning of fossil fuels began. As well as lowering pH, increased CO_2 levels are reducing seawater levels of aragonite which is required for scleratinian skeletal growth. This is a particular concern for corals living near the Aragonite Saturation Horizon such as in deep-waters or in surface waters at high latitudes.

We describe the first submersible observations of Rost Reef, the world's largest temperate coral reef, off northern Norway. We outline the main ecological features of this reef and the attributes of the ambient seawater carbonate chemistry. We then describe the changes in aragonite saturation that are predicted for this coral reef over the next 100 years and relate these predicted changes to the effects we have observed on temperate coral communities along CO_2 gradients caused by Mediterranean volcanic vents. The vent gases were at ambient temperature and lacked poisonous sulphur compounds which typify most volcanic vents. Coral communities, composed of *Cladocora, Caryophyllia* and *Balanophyllia* scleractinians, were common outside the vent systems but were absent at mean $\Omega_{arag} \leq 2.5$ (min Ω_{arag} 0.8-1.2). Transplantations provided *in situ* support for predictions of global coral reef dissolution at pH 7.6. While scleractinians can survive skeletal dissolution as polyps in the laboratory, we found that reduced calcification due to low Ω_{arag} may result in increased risk to predation or competition in open ecosystems.

Our study demonstrates what happens to temperate ecosystems when key groups of species are killed due to rising CO_2 levels. Given that we are probably undergoing the fastest rate of ocean acidification the Earth has seen for at least the past 20 million years, this work adds urgency to international policy drives to reduce CO_2 emissions.

4.02

THERMAL AND ACIDIFICATION IMPACT ON COLD CORALS: EXPERIMENTAL EVIDENCE AND CONCEPTUAL MODELS

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Recent laboratory studies, primarily on tropical shallow-water coral species and few deep-water scleractinian coral species (e.g. *Lophelia pertusa* and *Bathypssamia tintinnabulum*), indicate that pH reduction in the scale of 0.1 to 0.3 and temperature increase of > 5 C induces sublethal impacts by slowing metabolic performance and calcification and growth rate. Based on the experimental evidence and extrapolation to simulate future environmental scenario caused by global warming and ocean acidification trajectory, conceptual cold coral ecosystem models are generated, using the color-coded trophic spectra of George et al (2007), to depict present (380 ppm atmospheric carbon dioxide level) to future in 2050 (550 ppm).

Laboratory data on *Lophelia pertusa* at 5, 8 and 12 C and 8.2 and 7.9 pH suggest that acidification impact is more pronounced than thermal stress on survival and respiratory rate. Significant shift from habitat temperature, hydrostatic pressure and pH conditions also elicit behavioral responses in polyps' open-closed rhythms. It is important that ocean acidification threats on shell-bearing animals (including corals), particularly in relation to shoaling of aragonite saturation horizons (ASH) should be investigated both at *in situ* field conditions and in simulated laboratory conditions. The potential influence of ongoing climate change, which differs clearly between the North Atlantic and North Pacific Ocean as documented by existing data bank from U.S. Large Marine Ecosystems (LMEs), suggests that there is a latitudinal signature on cold coral ecosystems with high latitude environment more susceptible to both thermal and acidification stress.

4.03

CALCIFICATION RATES OF COLD WATER CORALS FROM MINGULAY (NE ATLANTIC), SKAGERRAK (NORTH SEA) AND THE MEDITERRANEAN SEA AND RESPONSE TO RISE IN pCO_2 AND TEMPERATURE

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Only few cold-water coral species are able to build reef-like structures in the deep oceans. These deep coral bioherms are likely among the first to be affected by ocean acidification i.e. decrease in pH due to an increase in pCO_2. Calcification rates of *L. pertusa* were assessed for Skagerrak and Mingulay corals and the response in calcification to lowered pH has been investigated for Skagerrak *L. pertusa* during 2 research cruises. Experiments were carried out directly onboard using freshly collected corals. Calcification rates were assessed using the $^{45}CaCl_2$ labelling technique under ambient pH and pH lowered by 0.15 and 0.3 units. Calcification rates were on average 0.07% d^{-1} ±0.02 S.E. and 0.05% d^{-1} ±0.01 S.E. (normalised to initial skeletal weight) for bulk calcification of small branches of Mingulay and Skagerrak corals, respectively. Highest calcification rates were found in youngest polyps. Lowering the pH by 0.15 and 0.3 pH units reduced coral calcification by 30 % and 56 %, respectively. Also, the effect of changes in pH (0.3 pH units lower than in ambient water) on calcification rate was stronger for fast growing, young polyps (59 % reduction) than for older polyps (40 % reduction). This first study on calcification rate and pH effects for *L. pertusa* implies that the young and fast calcifying corallites will be influenced most negatively by ocean acidification. Laboratory experiments on Mediterranean cold-water corals are presently underway and corals are studied under variable pCO2 and temperature range. The alkalinity anomaly technique is used to assess calcification rates and results will be compared with findings of Skagerrak and Mingulay *L. pertusa*.

4.04

IS THE CALCITE SATURATION HORIZON LIMITING THE DISTRIBUTION AND ABUNDANCE OF CORALS IN THE NORTH PACIFIC OCEAN?

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The chemistry of the oceans is changing at an unprecedented rate due to the influx of anthropogenic carbon dioxide to the atmosphere. The calcite and aragonite saturation horizons are moving to shallower depths as a result of this influx and could alter the global distribution of cold water corals. It has been hypothesized that the shallow depth of the aragonite saturation horizon is limiting cold water scleractinian corals from thriving in the waters of the North Pacific. The depth of the aragonite saturation horizon in the North Pacific is naturally shallow (≤ 150m) and moving towards the surface at a rate of 1-2m per year. The highest abundance and diversity of cold water corals in the waters of the Aleutian Islands occur between ~200-300m. The present depth of the calcite saturation horizon (CSH) in Aleutian waters is ~250-350m. Here we investigate the depth distribution of North Pacific cold water corals, which build their sclerites primarily of calcite (a less soluble form of calcium carbonate), with respect to the depth of the CSH in hopes of determining whether the CSH could be limiting the distribution and/or abundance of some cold water coral species found in North Pacific waters.

4.05

CARBONATE CONCENTRATIONS AND DEEP SEA CORAL DISTRIBUTION IN THE NEW ZEALAND REGION

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The oceans are absorbing a large percent of anthropogenic CO_2, lowering pH and reducing the carbonate ion concentrations. We have calculated carbonate saturation states at different depths for several World Ocean Circulation Experiment (WOCE) transects in the New Zealand region from 1993-2003. There are two main polymorphs of carbonate; calcite and aragonite (a less stable carbonate mineral). The aragonite saturation horizon (ASH) in the New Zealand region varies between 1050 to 1350 mbsl (metres below sea level). As a result of ocean acidification this horizon has shoaled since preindustrial times (Feely et al 2004) and is forecast to become significantly shallower in the next century (Orr et al 2005; Guinotte et al 2006).

We compare the present aragonite saturation horizon (ASH) with the distribution of deep sea corals from bycatch and scientific surveys in the New Zealand region. Scleractinian (stony) corals and the protected Stylasteridae (hydrocoral, *Errina* spp.) are aragonitic and the majority are found living above or near the present ASH. Using the IPCC IS92a "business-as-usual-scenario" the ASH is predicted to shoal to between 200-400 m by 2100 for the New Zealand region (Orr et al 2005; Guinotte et al 2006). If this eventuates and the ASH is the primary controlling factor of coral distribution, then by the end of this century the Challenger Plateau, and all but the very shallowest regions of the Chatham Rise and Campbell Plateau will be uninhabitable by aragonitic corals.

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Guinotte JM et al 2006. Will human-induced changes in seawater chemistry alter the distribution of deep-sea scleractinian corals? Frontiers in Ecology 4, 141-146.

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4.06

AMPLIFIED OCEAN ACIDIFICATION IN THE DEEP-SEA AND THE THREAT TO DEEP-SEA ECOSYSTEMS

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Acidification of ocean waters due to the influx of carbon dioxide from the atmosphere penetrates slowly to the deep-sea by mixing and stirring over time scales of several centuries. Although the pH of surface waters has already fallen by ~0.1 units, pH in the upper ocean (<300 m) is largely buffered by the high ambient concentrations of carbonate ions. In deeper waters (>500 m), particularly in oxygen minimum zones underlying highly productive regions in the Pacific and Indian Oceans, respiratory CO_2 has titrated much of the available carbonate, thereby reducing the buffering capacity of those waters. There, the additional burden of inorganic carbon by the downward mixing of the anthropogenic carbon signal will cause a much larger shift in ocean pH and pCO_2 than would be observed in the upper ocean. Considering an atmosphere with CO_2 levels of 700 ppm, upper ocean pH may fall by 0.3 to 0.4 units and pCO_2 will increase by 500 to 1000 ppm. In deep-sea waters, however, pH will drop by more than 0.5 units and pCO_2 could increase to over 2000 ppm. Shoaling of the carbonate compensation depth (CCD) due to the fall in ocean pH will result in some buffering of large pH changes at depth through the dissolution of the carbonate rain from surface waters. And over longer time scales (several thousand years) acidification of ocean waters will be buffered partially by the dissolution of carbonate sediments. But accelerating atmospheric CO_2 emissions and the possibility of large scale ocean carbon sequestration will lead inevitably to higher ocean carbon levels, with maximum shifts of ocean pH and pCO_2 in deep-sea waters.

Amplification of ocean acidification in deep-sea waters will very likely amplify physiological stress for deep-sea corals and other animals. In addition to compromising the calcification rates of corals and other taxa with carbonate skeletal elements, higher CO_2 levels will likely increase respiratory stress, acidosis, and metabolic depression for a variety of deep-sea animals. Differential tolerance to environmental hypercapnia may have led to many observed patterns of distribution for deep-sea organisms, and is almost certain to influence deep-sea biological patterns in the future.

Wednesday 3 Dec

Biology: Feeding, Growth and Reproduction

5.01

REPRODUCTIVE STRATEGIES IN SOUTHERN OCEAN COLD-WATER CORALS

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Cold-water corals are generally regarded to live in water temperatures of 4 - 12ºC, yet in Southern Oceanic waters, they are found in temperatures down to -2ºC. Though sessile invertebrates are abundant in Antarctic shelf communities and Anthozoans are a common component, they are poorly understood from this region. A total of 17 living species of scleractinian are known from Antarctic waters, yet knowledge of their basic biology and ecology is lacking. All of these species are azooxanthellate and occur from shallow inshore (~2m) to deeper waters off the continental shelf (~2000m), with solitary species being greater in numbers.

Reproduction and larval development was studied in three species of Flabellum (F. thouarsii, F. curvatum and F. impensum) and Balanophyllia malouensis, and initial results of the reproductive strategies of Caryophyllia antarctica, Desmophyllum dianthus and Solenosmillia variabilis all collected from the Southern Ocean are presented here. Results from histology, TEM, SEM and live larval cultures show that these cold-water coral species each employ different modes of reproduction and unique adaptations to this extreme environment that include prolonged development, large oocyte sizes with high lipid contents, internal fertilization and brooding.

5.02

REPRODUCTIVE BIOLOGY OF THE DEEP-SEA PENNATULACEAN *ANTHOPTILUM MURRAYI* (CNIDARIA, OCTOCORALLIA)

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The sea pen *Anthoptilum murrayi* Kölliker, 1880 has been reported from the North Atlantic and North Pacific oceans, from the continental shelf to the upper slope. This species was recently recorded to the South Atlantic (off Brazil). There is a large gap of knowledge on the reproduction of deep-sea octocorals. The reproductive biology of this species has been examined through histology. Specimens up to 66 cm in height were collected at depths between 1,300 and 1,800 m, along stations between 13° and 22° S. Material from off Bahia and Espírito Santo States (13° - 21° S) was collected in 2000 by the "REVIZEE Project – Assessment of the Sustainable Yield of the Living Resources in the Exclusive Economic Zone", and from off Rio de Janeiro State (Campos Basin, 21° - 22° S) by the "Campos Basin Deep-Sea Environmental Project/ CENPES, PETROBRAS", in 2003. Colonies were collected on February, June, July, and August. The species is gonochoric and the gametogenesis is described in male and female colonies. Almost all examined samples were fertile, with the exception of two colonies, where we did not find gametes. No larvae was seen in the examined preparations. Up to now, the number of observed colonies suggests a 1:1 sex ratio. Gonads were seen in the autozooids. Mature sexual cells are visible to the naked eye by transparency of the tissue; they are more frequent in the area immersed in the coenenchyme, but they can be seen throughout the polyp length. Large mature intact spermatic cysts were observed inside autozooid tentacles. Sexual cells were associated with follicle cells. Females produce large oocytes, with a maximum diameter of 1,000 µm, indicating the production of lecithotrophic larvae. The longest spermatic cyst axis was 740 µm. Oocytes and spermatic cysts of different sizes and stages of development were observed in the examined samples. However, male colonies collected on late August showed a predominance or, in one sample, the exclusive occurrence of spermatozoa, suggesting a reproductive peak near this time. The largest measured oocyte was also seen on a sample from August. Other studies on the reproduction of sea-pens showed the same reproductive features observed in *Anthoptilum murrayi* – gonochorism and probable broadcast spawning.

5.03

BENTHIC BOUNDARY LAYER CHARACTERISTICS IN CONTRASTING COLD WATER CORAL ECOSYSTEMS

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Dynamics within the bottom boundary layer (BBL) are fundamental to the control of the overall benthic ecosystem functioning through processes of organic matter fluxes, turbulence, seabed frictional stresses, and re-suspension processes. Observations of BBL structure using high frequency HF-ADCPs have been made to estimate the frictional stresses within, and adjacent to, coral reef habitats. Measurements at the Tisler Reef, Skagerrak, both in and outside the coral reef have shown that the logarithmic layer approach to estimating bottom stresses can be used and is comparable to directly measured Reynolds stress measurements. Outside regions of live coral clumps, where the seabed is characterised by rubble material, friction velocities (u_*, which determines the bottom stress, $\tau=\rho.u_*^2$) may reach values up to 2 cm s^{-1} with a mean of 1 cm s^{-1}. A corresponding roughness length, characterising the boundary layer height generated by the seabed, is 2 cm. In contrast, within localized live coral stands, a higher BBL is generated with a roughness length scale of 50 cm and higher friction velocity – a mean of 2.5 cm s^{-1} and maximum of 5 cm s^{-1}. Interestingly the friction velocities generated by the live reef are higher than those in a rubble area for any particular impinging flow speed, as a result of the greater turbulence generated by the larger bottom topography of the live reef system. This may result in an increased time period for particles to remain in suspension over a reef system compared to other seabed environments.

The measurements have been contrasted to those made at a deep carbonate mound located west of Ireland. Here, two bottom landers equipped with HF-ADCPs were deployed near the summit of a mound and in the adjacent gully between two mounds. Boundary layer characteristics in the gully region are similar to those found in the rubble region for the Tisler reef measurements. Measurements near the mound summit indicated higher frictional velocities present compared to the gulley region, again similar to the shallow water observations. The values of frictional velocity generated per impinging flow speed, however, fall between those found for the Tisler observations in and outside the reef, reflecting the bottom topography, which consisted of smaller scale, and more widely dispersed, coral clumps than at the Tisler reef.

The results have obvious implications for the fluxes of organic mater, material suspension (availability) and feeding behavior at a coral ecosystem and we suggest they require inclusion into micro habitat mapping and reef growth models.

5.04

NUMERICAL STUDIES OF NEAR BOTTOM CURRENTS AND FOOD PARTICLE PROPAGATION OVER A DEEP WATER CORAL REEF

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A two-dimensional current model was used to study the supply rate of food particles along an idealized deep water Lophelia coral reef. The study was set up to investigate the effect of reef morphology on the food supply dynamics.

This preliminary study investigates how the particle encounter are affected by the horizontal and vertical grid resolution, the viscosity and the bottom friction. The model is set up with a homogeneous water density and forced with a realistic constant current flow. The food particles are implemented as passive tracers that propagate by the current field. These parameters control the physics (for instance the bottom boundary turbulence) that can develop in the model and also quantify the importance of the physics.

These preliminary results show that food particle encounter is highest on the side of the reef facing the current. Thus, it is expected that this reef area will have optimal growth and survival conditions. The model simulations also indicate that the model´s grid resolution as well as the viscosity does not affect the location of the encounter area of the coral significantly, which means that key physical factors for food particle propagation are indeed included in all experiments. The study can be used to explain how currents govern the shape of coral reefs. In case of unidirectional currents, as is found in the Trena reef area in Norway, the shape of the reefs is characteristically elongated, with living corals facing the current (ie. the reef “head”) and dead corals at the rear (“reef tail”). On the other hand, environments which are characterized by multi-directional currents, the resulting reef will have a bell-shape. Food supply predominantly from one direction will give rise to elongated reefs, while food supply from several directions, will result in bell-shaped reefs.

5.05

SPECIES COMPOSITION AND FORAGING RELATED BEHAVIORS OF DEEP-SEA FISHES FROM SUBMARINE CANYONS AND SEAMOUNTS IN THE NORTHWEST ATLANTIC BASED ON DIRECT OBSERVATIONS

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Continental margins and seamounts provide relatively rare sedimentary and hard substrate habitats along the "edges" of the mesopelagic and bathypelagic realms of the deep ocean. There are 15 major submarine canyons and many smaller "canyon-like" features along the northwest Atlantic continental margin from south of Nantucket Shoals to the eastern side of Georges Bank. The New England Seamounts (NES) and the Corner Rise Seamount Complex (CRSC) rise from the Sohm Abyssal Plain and together have over 45 major peaks with summit depths that range from 900 – 3750 m. Both canyons and seamounts have steep and complex topographies that produce accelerated flows and upwelling that influence patterns of movement of fishes and their prey. The influence of such features on the large scale distribution and behavior patterns of fish has been studied primarily using net sampling. However, the relationships of slope and seamount associated fishes to attributes of seafloor habitats at small spatial scales (i.e., meters to 10s of meters - the scale of individual animals) are poorly known. Patterns of habitat associations and foraging behavior may ultimately provide insight into those factors that influence the distribution and abundance of fishes. Here we compare the composition and foraging behavior of the deep sea fish fauna at two northwest Atlantic submarine canyons and multiple seamounts in the NES and CRSC regions. Further, we describe behavior patterns related to foraging and habitat selection for selected fishes. Results suggest that while some demersal species are habitat generalists, many species are associated with either fine grained or basalt substratum. Only one species, *Neocyttus helgae*, was demonstrably associated with corals. Foraging behaviors of taxa occurring in both canyon and seamount landscapes were different, suggesting that fishes altered behavior based on flow and prey availability.

5.06

BLACK CORAL ECOLOGY, GROWTH RATES, AND POPULATION STRUCTURE IN FIORDLAND, NEW ZEALAND: AN OVERVIEW

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The fiords of south-western New Zealand, through a unique set of environmental conditions, are more like a deep sea habitat, with temperatures ranging from 11-15º, and photosynthetic light levels at 20 m equivalent to those at around 100 m in clear coastal or oceanic water. A large population of the endemic black coral, *Antipathes fiordensis*, occurs as shallow as 6 m in these fiords, which has provided an unparalleled opportunity to understand the ecology and biology of the species. The population structure is dominated by small colonies, but colonies > 2 m tall and over 150 years old are common. Growth rates have been estimated using a variety of methods, including X-radiography, monitoring tagged colonies, and autoradiography to mark individual growth rings. These methods all point to slow growth rates, less than 30 $mm.y^{-1}$. Recruitment and mortality were followed in a marked population for 7 years. Recruitment was highly variable, and there was significantly different mortality of different size classes of colonies. A simple model indicated that each colony must survive for over 30 years for the population to remain stable and since full reproductive output is not achieved until a colony age of over 100 years, any process that reduces recruitment or the reproduction of these old colonies may have serious consequences for the population. The results emphasise the role of large, old, black coral colonies, and support the recent management options developed to protect the unique Fiordland environment.

5.07

PRECISE URANIUM-SERIES DATING AND GROWTH CHARACTERISTICS OF THE DEEP-SEA SCLERACTINIAN CORAL: *ENALLOPSAMMIA ROSTRATA* FROM THE EQUATORIAL PACIFIC

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Degradation of deep-water coral ecosystems can arise from a wide range of human activities, including deep-sea fishing (direct) and effects related to emissions of carbon dioxide (indirect) such as ocean warming and acidification. As deep-water (coral) reefs are often in areas that already have low levels of calcium carbonate saturation it is also likely that they will be impacted by relatively small reductions in ocean pH and carbonate ion concentrations. In this particular context, better information on the size and age (longevity) of deep-sea corals is needed to assess the resilience of these species to disturbance.

Among deep-sea corals, *Enallopsammia rostrata*, belonging to the Dendrophylliidae family, is regarded as a major structure-forming species that creates massive dendroid colonies, up to 1m wide and 0.5 m tall. Living colonies of *E. rostrata* have been collected using the Pisces submersibles from three locations from 400-600m water depth in the Line Islands (~160°W) in the Equatorial Pacific. We have applied to these colonies a high-precision, low blank technique to measure ^{230}Th and ^{238}U-^{234}U in small amounts (70 ± 10 mg) of modern and near modern calcareous skeletons with methods developed at ANU using a Neptune MC-ICPMS (Multi-collector Inductively Coupled Plasma Mass Spectrometer). The application of these methods to living colonies from a range of sites as well as the observation of axial growth patterns in thin sections of their skeletons offer the first expanded and well constrained data on longevity, growth pattern and mean growth rates in *E. rostrata*. Absolute dated specimens exhibit radial growth rates from 18-70 µm/yr and vertical rates from 0.6 to 1.9 mm/yr. Colony life spans ranged from 214 ± 5 yrs to 607 ± 6 yrs. The growth rates reported here are lower than those reported for other deep-sea scleractinian corals (*Lophelia pertusa* and *Madrepora occulata*), but with ages approaching 2-3 times longer. In this study, the high precision U-series dating indicates that the growth ring pattern is not consistent with annual periodicity and indicates the importance of absolute radiometric dating methods to constrain growth rates of *E. rostrata*. Slow accretion rates and extreme longevity make this species and its habitat especially vulnerable to disturbances and impacts from human activities.

5.08

IN SITU GROWTH OF *LOPHELIA PERTUSA* IN THE NORTHERN GULF OF MEXICO

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Growth rates of *Lophelia pertusa* have been inferred using various indirect methods such as analysis of growth bands and stable oxygen isotopes, and direct measurement of samples maintained in the laboratory. However, direct measurement of *in situ* growth has not yet been documented for this species. In the field, growth rates of *L. pertusa* may vary between locations, and seasonally, due to differences in temperature and food supply. An area known as Viosca Knoll (430-520m depth) in the northern Gulf of Mexico supports abundant *L. pertusa* colonies that very robust and heavily calcified, unlike the skeletal morphology found at other locations in the region. This area was therefore chosen as the focus of this research. The objective of this study was to directly measure growth rates of *L. pertusa* using stained coral fragments, deployed *in situ* for approximately one year. Samples of *Lophelia pertusa* were collected from Vioska Knoll in July 2004, using the Johnson Sea-Link submersible. Fragments were stained with Alizarin Red, photographed and baseline morphometric data recorded before they were secured onto transplant units for re-deployment near the collection site. The transplants were recovered in September 2005 and each fragment was photographed and percent polyp survival, number of new polyps and polyp growth was recorded. In addition, pieces of the skeleton showing evidence of growth were cut into thin sections to enable visualization of the dye lines. In combination, these techniques provided measurements of linear extension, age, and growth ring deposition. The average growth rate observed in this study (~3 mm/yr^{-1}) fell at the lower end of the published range for this species and the number of new polyps per fragment was approximately 3 per fragment. The stain bands on the coral sections illustrated double growth centres, which introduces an additional level of complexity when assessing growth through lateral banding patterns. It also is apparent from the stain bands that lateral skeletal deposition is not equal around the polyp circumference, but the causes of this variability are unknown. Linear extension is a more reliable growth rate estimate than lateral banding, but given the observed highly variable growth between fragments (i.e., growth of existing polyps and production of new polyps), extrapolation from branch growth to whole colony expansion should be performed with caution.

5.09

GROWTH VALIDATION OF GOLD CORAL (*GERARDIA* SP.) IN THE HAWAIIAN ARCHIPELAGO

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A series of submersible dives were made to revisit sites where heights of individual colonies of gold coral had been visually estimated and marked years earlier. The purpose of the revisit was to verify a linear growth rate estimate (~ 6 cm/yr) used by management to regulate the commercial harvesting of gold coral. The estimate was derived from a height/age structure analysis that employed ring-count data from the basal cross section of the coral colony stems. Recent radiometric findings challenge the ring-count data with lifespans estimated from hundreds to thousands of years and annual radial growth approximated at 35µm/year (Roark et al. 2007) roughly equating to 0.004-0.0014 cm linear growth rate. Colonies were measured and marked at 6 sites including the main Hawaiian Islands and the Northwestern Hawaiian Islands. Fifty colonies were revisited with the interval since the initial measurement ranging from 1 to 9 years. No appreciable growth could be distinguished from the measurement error associated with estimating colony height. The estimated change in height clustered around zero including both positive and negative deviations despite having as much as 9 years of accumulated growth (potential change + 54 cm). The inability to confidently detect any change over a 9-year period indicates taking ring-counts of the basal section of gold coral is not a viable means to estimate growth and using radiometric techniques may be the only realistic alternative. Radiocarbon estimates of live and dead colonies from the same deep-sea corals beds confirm the long life spans and slow radial growth rates.

5.10

ANTIQUITY AND LONGEVITY OF A DEEP-SEA OYSTER/CRINOID ASSOCIATION (AZORES ARCHIPELAGO)

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From the steep submarine slope of the southern Faial Channel (Azores Archipelago), a conspicuous archibenthic community of two 'living fossils', comprising the up to 30 cm sized deep-sea oyster *Neopycnodonte zibrowii* and the sessile cyrtocrinid *Cyathidium foresti*, is reported. Both taxa thrive in particularly high densities concealed underneath volcanic bedrock overhangs in 420-500 m water depth under stable environmental conditions.

Radiocarbon dating of multi-generation oyster stacks (an effective measure to optimise shell stability with minimal biomineralisation effort) reveals that individuals reach an impressive lifespan of one to more than four centuries, placing them among the longest-lived molluscs known to date. This pronounced longevity in concert with a distinct incremental growth pattern, exhibiting a proposed reproductive cyclicity of few years (conchiolin-rich growth breaks), and an annual cyclicity potentially triggered by seasonal varying nutrient flux (distinct Mg and S fluctuations in the shell calcite), make *N. zibrowii* a promising geochemical archive (stable isotopes and trace element signatures) for the upper bathyal.

Submersible investigations showed that the direct association of *C. foresti* and *N. zibrowii* is not obligatory but that the crinoid is preferentially settling on oysters, which provide benefits for the crinoid in terms of substrate availability and/or participation in the oysters' active feeding current. The upside down position of both species provides protection from background sedimentation and possibly shelter from predators.

Closely related ancestors of both species are also found as fossils more than 60 million years old in the Danian (Paleocene) of Faxe in Denmark – associated with deep-water coral limestone. There *Cyathidium holopus* is found settling in impressive numbers settling on various substrata, such as scleractinian corals or, analogous to the Azorean occurrence, on pycnodontine oysters. This remarkable resemblance suggests that this association and semi-cryptic habitat preference was already established in the early Palaeogene. This stands in contrast to the Cretaceous (Cenomanian to Maastrichtian) records of *Cyathidium* which were exclusively reported from shallow-water palaeoenvironments. We thus assume a habitat-shift of these cyrtocrinids toward deeper waters during the transition of the Mesozoic and Cenozoic erathems. This reflects the escape from enhanced predation pressure (particularly teleost fishes) during the 'Mesozoic Marine Revolution'. Sessile crinoids almost completely vanished from shallow waters and were replaced by mobile and often strictly nocturnal comatulids. The *Cyathidium*/(*Neo*)*pycnodonte*-association did not only survive the Cretaceous/Palaeogene mass extinction, but the whole Cenozoic and can today be appreciated as a 'living-fossil community'.

Abstracts (6.01 – 6.13)

Thursday 4 Dec

Ecology and Species Associations

6.01

GENETIC CONNECTIVITY OF COLD-WATER CORAL ASSOCIATES INHABITING SEAMOUNTS OF THE NORTH ATLANTIC

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Seamounts around the world are currently threatened by destructive fishery practices (e.g., trawling and long-lining), emphasizing the need for greater understanding of the evolutionary processes structuring uncharacterized species in these natural laboratories. The effects of geographic separation, depth zonation/limitations, and ocean circulation patterns around commercially-important seamount habitats on both the historical migration of marine fauna and their modern rates of gene flow are generally unknown. In addition, the ecological and evolutionary significance of specific coral-host and invertebrate-associate relationships on the genetic connectivity of potentially isolated seamount populations present unexplored questions toward their conservation, including, “Are patterns of gene flow in associate species congruent across seamounts regardless of coral host and dispersal strategies?” “Is the realized dispersal of associated governed by the same dispersal strategies and limitations of their specific coral hosts?” To address these and other questions in the light of upcoming implementation of ecosystem approaches to management and conservation efforts, we investigated the genetic connectivity of cold-water coral host-invertebrate associate populations on the New England Seamounts and Corner Rise Seamounts, including a chirostylid crab (associated with the antipatharian *Parantipathes*), the ophiuroid *Ophioplinthaca abyssalis* and polynoid *Gorgoniapolynoe caeciliae* (associated with the primnoid octocoral *Candidella*), the ophiuroid *Ophiocreas oedipus* (associated with the coral *Metallogorgia melanotrichos*) and poecilasmatid barnacles (associated with octocoral skeletons). Intraspecific phylogeographic networks constructed from mitochondrial and nuclear markers reveal different patterns of gene flow among the New England Seamounts and Corner Rise Seamounts, as well as evidence of population expansion, radiation, cryptic speciation, and non-congruent patterns of gene flow among cold-water coral associates. These results, as well as ongoing work comparing the co-evolution and co-dispersal of coral associates and their hosts whose life histories are directly intertwined, underscore the importance of future decisions by managers concerned with the protection of oceanic biodiversity.

6.02

THE OCCURRENCE OF CORALLIMORPHARIANS (NAKED CORALS)

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Members of Corallimorpharia are intermediate in morphology between sea anemones (order Actiniaria) and scleractinian corals (order Scleractinia) – a corallimorpharian lacks a calcareous skeleton but its internal anatomy and nematocysts are like those of corals. Molecular data confirm that corallimorpharians are more closely related to scleractinians than to actiniarians and, in fact, may belong to order Scleractinia. Corallimorpharians of one group occur in the deep sea, sometimes being collected in the same places as scleractinians. Although most deep-sea records of them are at depths typical also of scleractinians, their lack of a calcium carbonate skeleton should allow them to occupy deeper waters. We tested the hypothesis that deep-sea corallimorpharians occur in waters less saturated with calcium carbonate than do deep-sea scleractinians.

6.03

DEEP SEA CORAL DISTRIBUTION AND HABITAT IN THE ALEUTIAN ARCHIPELAGO

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A unique feature of the benthic environment of the Aleutian Archipelago is a highly diverse and abundant coral and sponge community. Coral abundance far exceeds that reported for other high latitude areas of the world and there are many endemic species. Habitat mapping of seventeen sites covering 2,600 km^2 at depths of 30 – 3,800 m coupled with visual observations to 2,950 m were used to collect biological information and develop predictive models that relate coral and sponge distribution to environmental characteristics. Habitats dominated by bedrock and cobble supported the highest densities of corals. Diversity of corals and sponges increased from deep to shallow water. For the predictive model, explanatory variables included depth, slope, and rugosity with depth and slope being the most important factors. Models of coral and sponge presence/absence north of the Aleutian Islands Archipelago were more successful than models south of the Archipelago. The most damage and disturbance to coral and sponge communities occurred at depths < 800 m which generally corresponded to the depth limit of the majority of fisheries that use bottom contact gear. There was a consistent positive relationship between damage and disturbance levels and intensity of bottom trawling, whereas results varied for other gear types. Some commercial fish and crab species aggregate in habitats where corals are abundant, making these habitats at risk to fishing gear impacts. Protective measures implemented in the Aleutian Islands include restricting bottom trawling to historically fished areas. While this protective measure may halt the expansion of bottom trawling to areas not fished, the conservation of coral and sponge habitat in fished areas is still of primary concern.

6.04

CORAL DISTRIBUTIONS AROUND LEARMONTH BANK, NORTHERN BRITISH COLUMBIA, CANADA: INFLUENCE OF SURFICIAL GEOLOGY AND TIDAL CURRENTS

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Benthic communities living on and around Learmonth Bank, Northern British Columbia, were surveyed using ROV-based video transects in July, 2008. Learmonth Bank is a large granite massif rising to 40 m depth at the western end of Dixon Entrance, between the northern Queen Charlotte Islands and Southeast Alaska, USA. Most of the waters surrounding the bank are 250-500 m deep, and are underlain by glacial drift consisting of gravelly muddy sand with occasional large cobbles and boulders. The area has strong tidal currents, with surface velocities often exceeding 2 knots. Observed coral diversity was relatively low, being limited to the gorgonians *Primnoa* spp. and *Swiftia* spp., *Stylaster*, the solitary cup corals *Caryophyllia alaskensis* and *Desmophyllum dianthus*, and several species of pennatulaceans. In deeper water areas surrounding Learmonth bank, *Stylaster spp.* were common on cobbles and small boulders, but *Primnoa* were limited to large glacial erratic boulders, mostly greater than 1 m diameter. In glacial till areas, virtually all *Primnoa* observed were large colonies. The lower flanks of the bank were covered with glacial drift with fauna similar to that in the deep water areas, while on the upper flanks of the bank, talus supported highly abundant crinoids and wide diversity of erect sponges, with corals restricted to rocks much larger than most of the talus. The bedrock areas of the bank in waters 160-200 m depth were dominated by sponges, with abundant *Stylaster,* and a few rare areas of bedrock with *Primnoa* corals. *Primnoa* colonies in these bedrock areas included all size classes of corals. A variety of rockfish (Sebastidae) were observed resting among the branches of *Primnoa* corals, as were amphipods, small shrimp and lithoid crabs. Rockfish diversity was high; the most common rockfish species were redbanded, blackspotted, and shortraker rockfishes (*Sebastes babcocki, S. melanostictus, and S. borealis*). Mobility of pebbles and cobbles in strong currents at all depths probably limits the growth of corals, potentially explaining the restriction of large *Primnoa* colonies to large glacial erratics or bedrock. On the upper flanks of Learmonth bank, loose sponges and sponge fragments were frequently observed moving over gravelly sand plains in the strong currents, and drifted accumulations of dead sponges were observed next to talus ridges.

A preliminary evaluation of the data indicated that the coral species composition appears to be different between areas. These differences appear to be dependant on substrate type and may also be related to anthropogenic activities in the area. Coral bycatch rates in scientific surveys up to 831 kg/hr over deep-water glacial drift areas indicate that corals can reach high local abundance, despite substrate limitation. Efforts to insure sustainable utilization of the resources in the region while conserving corals and their ecosystem services will need to consider both bed rock areas composing Learmonth Bank itself and the deeper-water areas with cobble, glacial till and glacial erratics of Dixon Entrance.

6.05

RARE, PURPLE OCTOCORAL DISCOVERED IN POCKMARK LOPHELIA-REEF AT THE MORVIN FIELD, OFF MID-NORWAY

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Numerous deep-water coral reefs occur on the seafloor at the offshore hydrocarbon field, Morvin, off Mid-Norway. One of these reefs, 'MRR', occurs inside a 120 m long and 100 m wide, 10 m deep pockmark depression. The general water depth is 360 m and the ambient temperature is 7.1ºC. Upon visual inspection of this reef, a beautiful, purple, rare octocoral, suspected to be *Anthothela grandiflora* (Sverdrup), was found colonizing a dead Lophelia colony.

This reef also contains very dense accumulations of the large bivalve *Acesta excavata*, with up to 150 individuals occurring per cu m. Sediment samples were acquired from the upper 50 cm within the pockmark. The sediments contain above-background concentrations of light hydrocarbons, ranging from methane up to hexane, indicating active hydrocarbon microseepage. This may be one of the reasons for the very existence of the reef and the high biodiversity, which also includes the purple octocoral.

6.06

BIODIVERSITY OF *LOPHELIA* REEFS IN NORTHERN NORWAY

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Lophelia reefs are complex structures with a high biodiversity measured at several spatial scales. The reefs vary in shape and structure, mainly depending on environmental settings. At places where the current is mainly unidirectional, reefs tend to be elongated with a living coral zone at the up-current end with a "tail" of coral rubble with increasing age. At places where currents have a variable direction contrastingly, the reefs are more circular with a living summit. Here, the coral rubble often occurs as a basis all around the reef. The reefs as marine ecosystems are unique in presenting many different habitats within small areas. They also allow for the simultaneous presence of different stages of community succession due to the continuous growth and ageing of the carbonate substrate that the coral produces.

The three major habitats of *Lophelia* reefs (1: living coral colonies, 2: Dead coral blocks, and 3: coral rubble) can be further divided into sub-habitats related to substrate characteristics: surface structure, age, and three-dimensional aspects.

This study presents composition and distribution of macrofauna on *Lophelia* reefs based on still imagery and grab sampling. The studied reefs are located north of the arctic circle, in the Træna Deep and at Lopphavet. Observed patterns of local distribution are discussed in relation to position on reef, relative substrate age and coral sample descriptors (e.g. size of fragments, proportion live/dead, open space in fragment, and degree of sediment infill). The results are also compared with results from similar studies off mid-Norway and the Faroe Islands.

Still imagery is not an adequate method for macro fauna species inventory since only a small fraction of the fauna is large enough to be identified on images. In addition, infauna and cryptic fauna is not visible on the substrate surface. However, images of the habitat provide information about species associations with other species and the habitat that are not documented in bottom samples where mobile animals often are dislocated from their substrate.

6.07

PREDICTING SUITABLE HABITAT FOR THE COLD-WATER CORAL *LOPHELIA PERTUSA* (SCLERACTINIA)

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Ecological-niche factor analysis (ENFA) was applied to the reef framework-forming cold-water coral *Lophelia pertusa*. The environmental tolerances of this species were assessed using readily available oceanographic data, including physical, chemical, and biological variables. *Lophelia pertusa* was found at mean depths of 468 and 480 m on the regional and global scales and occupied a niche that included higher than average current speed and productivity, supporting the theory that their limited food supply is locally enhanced by currents. Most records occurred in areas with a salinity of 35, mean temperatures of 6.2-6.7°C and dissolved oxygen levels of 6.0-6.2 ml l^{-1}. The majority of records were found in areas that were saturated with aragonite but had low concentration of nutrients (silicate, phosphate and nitrate). Suitable habitat for *L. pertusa* was predicted using ENFA on a global and a regional scale that incorporated the northeast Atlantic Ocean. Regional prediction was reliable due to numerous presence points throughout the area, whereas global prediction was less reliable due to the paucity of presence data outside of the northeast Atlantic. However, the species niche was supported at each spatial scale. Predicted maps at the global scale reinforced the general consensus that the North Atlantic Ocean is a key region in the worldwide distribution of *L. pertusa*. Predictive modelling is an approach that can be applied to cold-water coral species to locate areas of suitable habitat for further study. It may also prove a useful tool to assist spatial planning of offshore marine protected areas. However, issues with eco-geographical datasets, including their coarse resolution and limited geographical coverage, currently restrict the scope of this approach.

6.08

FJORD REGIONS: WHERE THE DEEP SEA COMES WITHIN REACH

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Deep-water emergence (DWE) is a phenomenon known mainly from fjords and fjord regions. It describes the fact that part of a population or separated subpopulations of organisms that are typically found in deeper waters extend to significantly shallower depths than their average bathymetric distribution range would indicate. Examples are the *Lophelia* reefs in the Trondheim fjord, Norway, or the hexactinellid sponge reefs in British Columbia. DWE can be observed in practically all taxa but cnidarians, and in particular anthozoans, are frequent members of DWE assemblages. Most studies on this phenomenon have been carried out in fiordland, New Zealand. But despite the close relationship between the New Zealand marine fauna and the Chilean Patagonian fauna, most given explanations for DWE in New Zealand cannot, or unsatisfactorily, be applied for Chile. We herein describe the common elements of the fiordland and Patagonian DWE fauna with special focus on coral communities, and summarize the existing hypotheses and theses. Based on the hydrographic conditions and patterns of DWE in Chile, we discuss alternative hypotheses.

6.09

THE MINGULAY REEF COMPLEX, NORTHEAST ATLANTIC: AN INTERDISCIPLINARY STUDY OF COLD-WATER CORAL HABITAT, HYDROGRAPHY AND BETA DIVERSITY

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

6.10

ECOLOGICAL INTERACTIONS BETWEEN *LOPHELIA PERTUSA* AND MICRO-ORGANISMS

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Coral-microbe interactions have attracted much attention recently, however, little has been published about deep sea corals. Here we present data from the BIOSYS project conducted in the Eastern North Atlantic and North Sea. The mucus of *Lophelia pertusa* harbors ca. 10^8 viruses and bacteria per ml. We also found evidence that corals release some viruses and prokaryotes probably together with mucus. The release of mucus and inorganic and organic nitrogen and phosphorus by *L. pertusa* (and *Madrepora oculata*) stimulated the production of viruses and prokaryotes in surrounding water. Experimental enrichment of viruses and prokaryotes by ca. one order of magnitude suggest that microbial abundances are tightly controlled in coral mucus. In contrast, the increase of ambient micro-organims was reflected in the coelenteron thus, supporting the idea that corals farm micro-organisms as food source. It could also be confirmed using fluorescently labelled bacteria that *L. pertusa* uses bacteria as food. Our findings suggest that cold-water corals farm micro-organisms as food-source; the stimulation of viral and prokaryotic abundance could also indicate that cold-water corals produce a microbial shield against pathogens.

6.11

MACROFAUNAL COMMUNITY STRUCTURE AND TROPHIC FUNCTION IN DEEP-SEA CORAL ECOSYSTEMS OF THE GULF OF MEXICO

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Deep-sea coral ecosystems are highly complex, over both local and landscape scales of biodiversity. While these systems may harbor significant levels of biodiversity, details of their community structure and function remain a mystery. The work presented here represents an ongoing study of the benthic ecology of deep-coral ecosystems in the Gulf of Mexico. Study areas were located in the northern Gulf of Mexico on the continental slope off Louisiana, Mississippi, and Alabama. Specific coral locations represented two geological mound features identified as MMS Lease Blocks Viosca Knoll 826 and Viosca Knoll 862/906. Collections were made on 11 submersible dives during two research cruises in 2004 and 2005. Sediment cores were collected to assess species diversity, composition, and numerical abundance of sediment macrofauna residing in deep-coral ecosystems. In addition, samples of consumers and primary producers were collected for stable carbon and nitrogen isotope analysis in order to examine deep-sea coral food webs. Sediment collections revealed a predominance of polychaetes, amphipod, isopod, and tanaid crustaceans, nematodes, bivalves, and sponges. Specific polychaetes found represented a broad range of functional groups, including suspension and deposit feeders, and predatory forms. Stable carbon and nitrogen isotope analyses revealed a complex food web, encompassing multiple trophic levels; results indicated that a variety of food sources may fuel these communities. Specifically, sedentary fauna, including corals and associates, exhibited stable carbon isotopes indicative of nutrition derived from plankton. In contrast, certain sponges and urchins had distinct stable carbon isotope values, indicating they were feeding on a unique, yet unidentified food source. In conclusion, benthos residing in deep-sea coral ecosystems in the Gulf of Mexico represent complex communities both in terms of biodiversity and trophic structure.

6.12

DEEP-WATER GORGONIANS: CRITICAL NURSERY HABITAT FOR CATSHARKS?

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Catsharks are a speciose group of small benthic oviparous elasmobranchs [Carcharhiniformes: Scyliorhinidae] that range throughout the deep-sea. Their egg cases are distinctive, with long tendrils, and a bulging fusiform shape. Catshark egg cases have been found attached to soft coral, derelict fishing gear, and hydroids, but to date, the nature and extent of the relationship between catsharks and their choice of nursery habitat remains unclear. A 2003 expedition to the Mississippi Canyon in the Gulf of Mexico documented >1000 individual catshark egg cases in a large monotypic field of the primnoid *Callogorgia americana delta* at 560 m depth. Egg cases were vacant, and the species unidentified. Some questions posed by the discovery asked whether the choice of nursery substrate was site specific, substrate specific, or species specific. Three years later, surveys of deep-water corals in the Olympic Coast National Marine Sanctuary (OCNMS) 100-600 m found a large field of deep gorgonians with catshark egg cases using the ROPOS remotely operated vehicle. Egg cases were attached to *Paragorgia arborea pacifica, Plumarella longispina,* and *Primnoa pacifica* colonies, but not surrounding substrates. Three egg cases were collected. A juvenile brown catshark *Apristurus brunneus* hatched in the chamber during ascent, and was maintained alive for 48 hours. The filetail catshark *Parmaturus xaniurus* also lays eggs on deep-water gorgonians in OCNMS. In summary, the relationship between catsharks and deep gorgonians appears to be widespread. At least two species of catsharks are laying eggs on multiple species of gorgonians at multiple sites in the Northeast Pacific and West Atlantic.

6.13

A POSSIBLE ROLE FOR AGGLUTINATED FORAMINIFERANS IN THE GROWTH OF DEEP-WATER CORAL BIOHERMS

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Exploration of deep-water bioherms dominated by the scleractinian corals *Lophelia pertusa* and *Enallopsammia profunda* along the east coast of Florida in ~400-800 m depth reveals an often dense and rich assemblage of small (~1-20 mm) epifauna on dead coral branches dominated by sediment-agglutinating astrorhizacean foraminiferans and accompanied by thecate and athecate hydroids, sponges, stylasterids, anemones and barnacles. Three species of agglutinated foraminiferans have been identified from coral substrates. The dominant taxon is a tree-like form up to 15 mm tall, similar to *Dendrophrya* T.S. Wright, consisting of a basal tube that gives rise to branches of successively decreasing diameter and thickly coated with fine-grained material including coccoliths and diatom frustules. The other two are rare by comparison. *Halyphysema* aff. *H. ramulosa* Bowerbank constructs a cylindrical trunk that successively bifurcates into smaller branches terminating in clots of sponge spicules radiating from the open apertures. A third appears to be a smaller highly-branched version of *Spiculidendron corallicolum* Ruetzler & Richardson that constructs its test from longitudinally-oriented sponge spicules. The pseudopodial web suspended among the branches of the large numbers of the dominant taxon produces an enormous adhesive, sediment-trapping surface. These foraminiferans may thus represent an important accelerated route for sediment deposition and bioherm growth relative to baffling of suspended sediment particles by the coral branches themselves. At least the first taxon also occurs on still living coral, suggesting that it may either contribute to coral death or invade stressed colonies. It may thus be responsible for or contribute to the small percent of living corals observed in many of these habitats. Other epifauna appear to colonize after the coral has died.

Thursday 4 Dec

Sampling Methods and Mapping

7.01

THE COLD-WATER CORAL COMMUNITY OF HATTON BANK, NE ATLANTIC

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Hatton Bank is situated in the NE Atlantic northwest of Rockall Bank, halfway between Iceland and Ireland. Because of its distance to land the distribution of the benthic fauna is not well known, with only scarce information about the presence of cold-water corals (CWC). Within the frame work of the EU-projects HERMES and CoralFISH a multi-disciplinary expedition with the RV *Pelagia* was carried out during June-July 2008. A summary of the first results of the different activities will be given. This includes the mapping of the area and its CWC community with multibeam and video-cameras. Almost every mound was covered with *Lophelia pertusa* and *Madrepora oculata.* However, in comparison to the CWC communities at Rockall Bank and the Porcupine Bight, the living colonies were much smaller and with the ratio of living coral to coral rubble much lower. The CWC community was sampled quantitatively for analyses of biodiversity, density and biomass of macrofauna, and the first results will be presented here and put into perspective by comparison with those of Rockall Bank. To assess the importance of the demersal fish fauna within the CWC community near-bottom video surveys were used, together with a lander equipped with a baited HD-Video camera and infra-red video camera. Multiple deployments of 2 to 10 days were made using landers and moorings, all equipped with currentmeters, OBS(turbidity) and fluorometers, to study the hydrography and to record transport mechanisms of particles, nepheloid layers and food availability. These data, together with those of CTD transects and CTD jojo's of more than 12 hours, provide information about why these biodiverse and biomass rich coral communities can survive here.

DISTRIBUTION AND AREAL EXTENT OF DEEP-WATER CORAL REEFS OFF FLORIDA, USA

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Deep-sea coral ecosystems (DSCE) are abundant off the southeastern United States and may exceed the aerial extent of shallow-water reefs in all U.S. waters. Expeditions with submersibles and ROVs from 1999 to present have documented the habitat, benthic fauna and demersal fish diversity on many of these deep-water reefs (Reed et al. 2005, 2006; Ross and Quattrini 2007). Recently, the South Atlantic Fishery Management Council has proposed a 59,570 km^2 (23,000 mi^2) Deep-water Coral Habitat Area of Particular Concern from North Carolina through south Florida based the best available scientific data from numerous sources (scientific publications, museum records, submersible and ROV dives, and bathymetric surveys).

We have mapped over 400 potential targets off Florida that indicate high-relief bathymetry and of these we have ground-truthed 72 reef sites most of which have proved to be *Lophelia* coral reefs. This region off Florida includes a variety of high-relief (15->150 m), hard-bottom habitats including: deep-water *Oculina* reefs (70-100 m) at the shelf-edge off central eastern Florida; east Florida *Lophelia* pinnacles (400-860 m) along the base of the Florida-Hatteras Slope; Miami Terrace (330-570 m) and Pourtalès Terrace (200-460 m) off southeastern Florida; and west Florida lithoherms in the Gulf of Mexico (450-560 m). The dominant corals on these reefs are the azooxanthellate, colonial scleractinians *Oculina varicosa*, *Lophelia pertusa*, *Madrepora oculata*, and *Enallopsammia profunda*; other dominant sessile invertebrates include stylasterid hydrocorals, gorgonians, black corals, demosponges and hexactinellid sponges. In addition, museum data indicate over 350 records of deep-water scleractinian corals from historical dredge and trawls in this region. We estimate a total of 44,046 km^2 of potential deep reef habitat (>200 m depth) off Florida based on high-relief bathymetry from NOAA nautical charts. This exceeds the total aerial extent of potential shallow-water coral ecosystem habitat estimated for all U.S. waters including territories to the U.S. EEZ (36,813 km^2, Rohmann et al. 2005). These recent data for Florida are plotted in GIS and presented herein.

Protection and conservation of these deep reefs is critical to prevent long-term (perhaps permanent) damage from bottom trawling, such as has occurred on *Oculina* reefs off Florida and *Lophelia* banks worldwide. After shrimp trawlers were banned from the *Oculina* HAPC, concern developed that commercial fisheries fishers have moved to deep-water habitats in search of valuable royal red shrimp, golden crab or benthic finfish. Although these *Lophelia* reef habitats are not currently designated as MPAs or HAPCs, they are incredibly diverse and irreplaceable resources. Activities involving bottom trawling, pipelines, or oil/gas production could negatively impact these reefs.

7.03

A REVIEW OF DEEP-SEA CORAL RESEARCH CONDUCTED IN THE NEWFOUNDLAND LABRADOR AND ARCTIC REGIONS BY THE DEPARTMENT OF FISHERIES AND OCEANS CANADA

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Prior to 2004, information on deep-sea corals off eastern Canada was infrequent and sporadic with the majority of distributions documented from the Scotian Shelf (2001-2003). Recently, a systematic sampling and archiving approach has been adopted in Newfoundland Labrador (NL) region focusing on the continental shelf, edge, and slope extending from Grand Banks (2003-2008) to Baffin Basin in the Canadian Arctic (2005-2008). Initial research, focusing on distribution and diversity of deep-sea corals, was expanded in order to improve our knowledge of the biology and ecology of deep-sea corals including: trophic relationships, growth rates, longevity, taphonomy, reproduction, and recruitment. In 2007 a remotely operated vehicle (e.g. ROPOS) was used to observe and study *in situ* corals on the Grand Banks. The expedition was jointly funded by Department of Fisheries and Oceans Canada (DFO) and National Sciences and Engineering Research Council (NSERC) to help increase "At Sea Research on Sensitive Areas and Species". Preliminary results are presented here along with a review of deep-sea coral research conducted in NL and Arctic regions. DFO deep-sea coral research has extended sampling coverage into the Arctic (e.g. Baffin Bay, Davis Strait, Hudson Strait, and Ungava Bay). *In situ* observations, from the ROPOS expedition, documented five new coral species for NL region (*Umbellula encrinus* [Linnaeus, 1758], *Protoptilum carpenteri* [Kölliker, 1872], *Chrysogorgia agassizii* [Verrill, 1883], *Flabellum macandrewi* [Gray, 1849], and *Javania cailleti* [Duchassaing and Michelotti, 1864]), identified important habitats on the southwest Grand Banks (i.e. low-current *Keratoisis ornata* [Verrill, 1878] thickets, *Acanella-Acanthogorgia* fields, and sea pen meadows), and observed evidence of fishing impacts in the deep sea. Corals were primarily found along continental edge and slope, with only neptheids found on bank tops. Analysis of stable C and N isotopic composition indicated different trophic feeding levels for different coral species, and showed that most taxa fed on fresh to slightly degraded zooplankton. Radiocarbon-validated and ring-count growth rate measurements found the majority of gorgonian and antipatharian corals species to be living 40-80 years, with two gorgonian species demonstrating lifespans > 150 years. Taphonomy experiments found that post-mortem *Paragorgia arborea* (L.) skeletons are quite fragile and quickly degrade, explaining the absence of dead *P. arborea* bases in areas impacted by bottom-contact fishing. Current meters placed within beds of *K. ornata* and in nearby non-coral habitat showed that corals alter boundary layer current speed and turbulence, even under low current speeds. At present, there are no permanent conservation measures in place to protect deep-sea corals in NL region, although one temporary closure and one industry-sponsored voluntary closure have been enacted. As well gear restrictions will soon be enforced on a Greenland halibut fishery in a small area north of Davis Strait Sill. Knowledge gaps still exist, and priority areas are still being identified. Ultimately, permanent protection of important and sensitive areas will be necessary in NL and Arctic regions.

7.04

SPONGE REEFS AND REEF BUILDING CORALS IN THE COASTAL WATERS OF WESTERN CANADA

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Framework reefs constructed by siliceous (glass) sponges are frequently encountered during multibeam surveys in the coastal waters of western Canada, and are particularly well developed in the Queen Charlotte Islands (Haida Gwaii) region. The reefs can attain vertical heights of 21 m and an aerial distribution measured in hundreds of square kilometres. Processes of reef formation include framework construction by Hexactinosidan sponges and baffling and trapping of suspended sediments by generations of sponges over millennia. These reefs represent important habitat for shelf rockfish and other species, and have recently been reported from the Washington state continental shelf. New multibeam results indicate that extensive reefs occur along the eastern edge of the Queen Charlotte Basin, in addition to the previously described complexes from the central basin.

A limited number of occurrences of the deep-sea coral *Lophelia pertusa* have been identified in southern British Columbia (BC) waters, including on the sills in two fiords, at Alberni and Knight Inlets, and on the flank of an isolated knoll in the Strait of Georgia (SoG), an inland sea. These discoveries, and other reported occurrences off the western USA, suggest that *Lophelia pertusa* reefs may occur along the deeper, and relatively unexplored outer BC shelf and upper slope. Radiocarbon dating of coral branches collected at the SoG site indicate that a *Lophelia pertusa* reef, covering several hectares, died about 6000 years before present, likely as a consequence of changes to the oceanographic regime driven by the changing position of the Fraser River. During this time period the main river channel migrated to the west to debouche into the central strait, from a former position at Boundary Bay to the south. Prior to this change, fresh water would have escaped more efficiently through connecting channels to Juan de Fuca Strait and to the Pacific, with relatively little fresh water retained in the SoG. A strengthened two-layer estuarine circulation with more sustained lower layer inflow of nutrient rich deep water into the deep SoG originating with the California Undercurrent and upwelled offshore slope water would have existed, nourishing these coral colonies. The distribution, character and radiocarbon ages of unburied coral branches indicate that the SoG reef died in place and that sedimentation rates remained negligible during and since the death of the reef.

7.05

HIGH-RESOLUTION HABITAT MAPPING OF ITALIAN CWC REEFS: RESULTS FROM ROV'S OPTICAL AND ACOUSTIC SURVEY COUPLING.

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Habitat mapping is of increasing concern for the deep-sea scientist community to comply with off-shore protected area issues. The distribution of cold-water coral (CWC) reefs is frequently overlapping with areas of deep-sea fishing activities. In 2001, based on local fishery information, a scientific trawl survey carried out a few nautical miles off Santa Maria di Leuca cape (Apulian margin, Italy) revealed the presence of the two frame builders corals *Madrepora occulata* and *Lophelia pertusa* from 425 to 1100 m depth. Then begun an intense geo-biological investigation fostered by international (ESF Eurocores 'Moundforce') and national (Italian FIRB 'Aplabes') programs dedicated to CWC.

Within the frame of the EU project HERMES, VICTOR 6000 ROV on board of R/V "Pourquoi pas ?" was deployed on Santa Maria di Leuca reefs during autumn 2007. One of the objectives was to carry out a high resolution mapping survey of single mound-like structures identified as coral colonised structures during previous cruises (HERMES M70-1 and APLABES cruises). A survey module mounted on VICTOR 6000 was deployed on two mounds (300*300m) at 600 m depth to achieve a complete multidisciplinary (biological, geological and hydrological) habitat mapping. Various acoustic (multibeam echosounder, fish echosounder, ADCP) and optical sensors (long range photo camera, video) were used at three different altitude (50 m, 10 m and 3 m up to the structure). Optimal resolution for each equipment and implications for monitoring will be discussed.
Bathymetrical results confirm an asymmetrical morphology of the structure with rough topography due to coral patches on the eastern flank. Multibeam backscatter was used to map coral distribution and ground truthing was obtained with synchronised photo mosaics within GIS.
Mapping of biological observations using both geo-referenced photo and video revealed a zonation of sessile megafauna at the mound scale for scleractinian, antipatharian and sponges. A new fish echosounder mounted on ROV and coupled with optical images was tested on CWC reefs environment. Coupled with optical images, these acoustic records allowed to map the distribution of biological mobile targets especially the shoals red sea bream *Pagellus bogaraveo* were produced that way. Fish density observed on Italian CWC reefs compared to the NE Atlantic counterparts are low and confirm the poverty of the Mediterranean deep-sea ichtyofauna.

The high resolution habitat mapping does not reveal any impact of bottom trawling but human impact is however detected through the presence of dense plastic wastes covering polyps of the bordering coral colonies.

Such results on coral and associated fauna distribution linked with local environmental factors bring new insight on this reef system functioning and be useful for a finest CWC habitat modelling of the Apulian margin.

7.06

BROAD-SCALE BIODIVERSITY AND HABITAT MAPPING IN THE DEEP-SEA AROUND NEW ZEALAND WITH A FOCUS ON CORALS AND ASSOCIATED FAUNA

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Evaluating spatial relationships between habitat variability and biodiversity is a key element in developing robust management policies and decisions for the sustainable use of marine resources. Since vast areas of the sea-floor are at best poorly mapped, it is important to implement standardised methods for quantifying broad-scale relationships between sea-bed habitats and biodiversity across environmental and anthropogenic disturbance gradients. Recent systematic surveys of deep sea-floor habitats around New Zealand include studies of seamounts to determine their biodiversity and evaluate the impacts of commercial fishing, and more expansive surveys of soft sediment habitats and biodiversity from shelf to abyssal depths in the New Zealand Exclusive Economic Zone (EEZ) and in the Ross Sea, Antarctica. Such work is planned to continue over the next 15 years, partly under the auspices of the ambitious New Zealand government-funded *Ocean Survey 20/20* (OS 20/20) programme. The methods adopted for the detailed seamounts work and the broad-scale OS 20/20 voyages are complementary. Surveys commence with initial detailed bathymetric mapping of the sea-floor by multi-beam echo-sounder. These data are geo-referenced within a GIS framework and used to inform the development of appropriate biological sampling designs. Depending on research aims, sampling may be targeted at specific features, such as seamounts, be defined by depth, or be allocated across strata defined by multivariate statistical classification techniques based on available oceanographic and environmental data. The initial mapping and design phase is followed by biological sampling using a variety of instruments, including towed camera systems, sleds, grabs, corers and trawls. Generally, transects are designed to cross strong environmental and/or disturbance gradients (Chatham-Challenger and Seamounts) or specific depth-related habitat zones (Ross Sea). Examples of these methods will be presented with a focus on the identification of deep-sea coral habitats and their associated biodiversity. Potential applications of such approaches in wider marine environmental classification schemes will be outlined.

7.07

THE APPLICABILITY OF MACHINE-LEARNING ALGORITHMS FOR AUTOMATED DETECTION AND CLASSIFICATION OF COLD-WATER CORAL HABITATS FROM VIDEO TRANSECT DATA.

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In recent years, Cold-Water Coral (CWC) ecosystems have been found throughout the world oceans. Reef-building corals, such as the Scleractinian *Lophelia pertusa* can build large, complex three-dimensional structures providing habitat niches for many other species. The great majority of these reef structures are found at depths exceeding 50m. Therefore, reef health assessments and community surveys cannot be carried using the same methodologies employed at shallow tropical coral reefs. Remotely operated vehicles (ROV's), submersibles and towed camera sledges are used to obtain image transects of deep CWC reefs. However, the traditional manual analysis of the transects is both time-consuming and labour-intensive.

Here, we used video transect data collected by a towed camera sledge and ROV from a selection of Norwegian CWC reefs to test the applicability of machine-learning algorithms to process image data. Individual frames extracted from the video stream were examined by a number of CWC experts and organisms labelled, using the novel Web 2.0 'Biigle' (Bielefeld Image Indexing and Graphical Labelling Environment) interface. Additional annotations were made of areas of notable substrate types, such as 'coral rubble' regions. For each image a 30-dimensional texture feature was computed based on Gabor-jet filter responses. These numerical feature vectors were used to train a hierarchically organized hyperbolic self-organizing map (H^2SOM). The unsupervised machine learning approach computes a "coral feature map" which is automatically annotated with the expert labels obtained from Biigle. The combination of expert labels and machine learning allows the detection and classification of selected organisms and substrates throughout the unlabelled remainder of the image data.

The applicability of this approach for quick location and classification of organisms and habitat types in CWC images is discussed. The usefulness of the approach in long-term environmental monitoring schemes of CWC habitats (such as those under threat from fishery activity) is also addressed.

7.08

DISTINGUISHING MARINE HABITAT CLASSIFICATION CONCEPTS FOR DATA MANAGEMENT

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Including ecology in biodiversity data systems requires classifications of habitat terms to provide standard definitions and hierarchical relationships. In addition to data systems such as the Ocean Biogeographic Information System (OBIS), a wide range of intergovernmental, conservation and fishery organizations (e.g. IUCN, WWF, TNC, UNESCO, FAO, IOC, ICES, GEOSS) require classifications of marine habitats and ecosystems to enable comparisons between areas and to organize information in maps and reports. However, all of the terms used to describe habitats are concepts whose definition is context dependant. For example, the habitat of a benthic invertebrate is very different in spatial scale to that for a parasite, plankton, tuna or whale. An ecosystem can be physiographically defined as a lagoon, seamount, estuary, abyssal plain, or entire ocean. Different sampling methods will define different regions, such as satellite images of ocean colour, acoustic maps of the seabed, in-situ sampling of water or sediment cores, and maps derived from analyses of species distributions that may define biogeographic regions. To date, biogeographic boundaries have been more defined by expert opinions than analyses of species distribution data. This presentation reviews classifications in use regionally and globally, including the European Nature Information System (EUNIS), Australian, Large Marine Ecosystems (LME), Marine Ecosystems of the World (MEOW), Longhurst's, IHO sea and oceans, Exclusive Economic Zones). It is recommended that the different types of classifications are best kept separate for data management, namely areas defined (a) for political and management purposes (e.g. EEZ, FAO and ICES fishery areas, LME, MEOW), (b) geographically (e.g. seas, oceans), (c) topographically (e.g. seamounts, abyssal, canyon, estuary), (d) by water mass (e.g. Longhurst's for offshore surface ocean), and (d) by habitat based on the species present and in situ sampling.

Friday 4 Dec

Management Decisions and Policy for Corals, Conservation and Human Impacts

8.01

MANAGEMENT OF THE GRAVEYARD "SEAMOUNTS" IN NEW ZEALAND: AN EXAMPLE OF BALANCING FISHERIES EXPLOITATION AND CONSERVATION OF BENTHIC HABITAT

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The Graveyard "seamounts" are a cluster of small volcanic peaks at 800-900m depth on the northern slopes of the Chatham Rise, east of New Zealand. Some have extensive areas of stony coral and a diverse faunal assemblage. However, the seamounts also host aggregations of orange roughy (*Hoplostethus atlanticus*) which have been the target of a commercial trawl fishery since the mid 1990s. Concerns about the impacts of fishing on seamounts and their fragile benthic fauna lead to the protection of several of the Graveyard seamounts in 2001. This included unfished features as well as a previously-fished seamount. Hence, the seamount cluster provides a setting to evaluate differences in the fauna of seamounts which have been heavily fished through to unfished, and protected through to those still open to fishing.

In this presentation we will describe some of the research that has been carried out to determine biodiversity, fishery status, and impacts of trawling, and to evaluate the effectiveness of the management actions taken. The research has shown strong differences between fished and unfished seamounts, where the latter are dominated by extensive patches of stony coral reef, which are largely absent from the fished seamounts. Comparative surveys in 2001 and 2006 show increased numbers of hydrocorals on the previously trawled seamount, which may indicate the first stages of a recolonisation process.

The management strategy applied to the Graveyard area, where some seamounts are open to fishing, while others are closed to protect biodiversity (and perhaps some fisheries production), appears to be proving a successful model to balance exploitation of the fishery resource, and conservation of the benthic habitat.

8.02

VME'S, HAPC'S, EFH'S, MPA'S, HADD'S, AND SAC'S: THE ALPHABET SOUP ASSOCIATED WITH PROTECTING DEEPSEA COLDWATER CORALS IN THE NORTH ATLANTIC

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The impacts of certain fishing practices, such as bottom tending mobile gears, on vulnerable marine ecosystems (VMEs), such as coldwater corals, have been intensely debated in a variety of fora in recent years (e.g., the United Nations General Assembly, the Food and Agriculture Organization of the United Nations and the Convention on Biological Diversity). The informal consultations on the 2006 United Nations General Assembly (UNGA) Sustainable Fisheries resolution (A/Res/61/105) reviewed domestic and international progress on protecting VMEs from destructive fishing practices and proposed further recommendations. Resolution 61/105 calls for specific actions by States, Regional Fisheries Management Organizations and Arrangements (RFMO/As), and the Food and Agricultural Organization (FAO). The resolution calls for States and RFMO/As to adopt and implement relevant measures by December 31, 2008, or to cease authorizing bottom fishing in these areas. Thus far three RFMOs have adopted comprehensive measures to implement resolution 61/105: CCAMLR for the Antarctic and the two RFMOs within the North Atlantic, the Northwest Atlantic Fishing Origination (NAFO) and the North East Atlantic Fisheries Commission (NEAFC). Further, interim measures to implement 61/105 have been adopted in ongoing negotiations to establish two new RFMO/As in the Northwest and South Pacific. Although the provisions of 61/105 apply to the high seas, the European Union, Canada and the United States, among others, have also each taken steps to protect vulnerable marine ecosystems from significant adverse impacts of certain fishing practices within areas under their national jurisdiction. In both the multilateral and domestic contexts, while management measures are an "alphabet soup" of differing terms (EFH, MPA, HADD, AND SAC) , the goals are strikingly similar: identify areas/habitats that are vulnerable to anthropogenic activities, determine the impact of fishing practices in these areas and take subsequent actions to prevent significant adverse impacts and protect the areas/habitats.

8.03

INTERAGENCY BOARD ON DEEP-SEA CORALS AND OTHER VULNERABLE MARINE ECOSYSTEMS – ENHANCING U.S. INTERAGENCY COOPERATION

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In April 2007 the U.S. Joint Subcommittee on Science and Technology approved creation of the Interagency Board on Deep-Sea Corals and Other Vulnerable Marine Ecosystems. The need for enhanced cooperation among Federal agencies reflects the increasing prominence of management and policy issues that was highlighted at the Third International Symposium on Deep-Sea Corals in 2005. Twenty-three papers from the symposium were assembled in a special publication, "Conservation and Adaptive Management of Seamount and Deep-Sea Coral Ecosystems." With increasing utilization of the deep-sea by the commercial fisheries, marine mining, and petroleum development industries in areas with known or suspected coral communities, the need for enhancing coordination of both research and the management utilization of research results has become more critical.

Creation of the Board was a direct response to the U.S. Ocean Action Plan call to research, survey, and protect deep-sea coral communities. Accomplishments of the Board during its first eighteen months are discussed. These include leading interagency coordination and cooperation in the development of a major 4-year study of deep-sea corals in the Gulf of Mexico with emphasis on *Lophelia pertusa*. The Board also leads interagency scientific reviews of major strategic documents such as NOAA's "Deep-Sea Coral and Sponge Research and Management Strategic Plan." The Board has also facilitated coordination of U.S. science to inform multilateral efforts such as the United Nations Food and Agriculture Organization's development of technical guidelines for the management of deep-sea fisheries on the high seas. Through engaging the international research community in the identification of science needs, including those recognized by the Regional Fishery Management Organizations, the Board provides a nexus for highlighting emerging issues and opportunities. Consistent with the Federal Advisory Committee Act, the Board solicits advice from non-Federal entities including academic and environmental organizations.

8.04

NEW ZEALAND IMPLEMENTATION OF PROTECTION MEASURES FOR VULNERABLE MARINE ECOSYSTEMS IN THE HIGH SEAS OF THE SOUTH PACIFIC OCEAN

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United Nations General Assembly Resolution 61/105 of 2006 has established substantial obligations for flag states and regional fisheries management organizations to prevent deep-sea fisheries from having significant adverse impacts on vulnerable marine ecosystems (VMEs), and to ensure sustainability of deep-sea resources. These obligations have been incorporated into interim conservation and management measures adopted by the ongoing negotiations for a South Pacific Regional Fisheries Management Organization (SPRFMO). As the main bottom trawling nation in the South Pacific Ocean, New Zealand is committed to implementing these measures.

This presentation will outline New Zealand's approach to implementing the SPRFMO interim measures in relation to: limitation of fishing effort to within the historic high-seas fishing 'footprint'; adequate and representative spatial protection of areas likely to include VMEs; and benthic by-catch monitoring and move-on provisions in areas with less information on presence of VMEs. New Zealand has adopted a three-tier approach, with different levels of protection in areas subject to different levels of past impact.

Most of these international instruments have hesitated to clearly define a number of the important concepts related to protection of VMEs, including the definition of VMEs themselves, definitions of significant adverse impacts and of adequate protection and mitigation measures. Details on requirements for risk assessments have also been left to flag states and RFMOs to develop. Fortunately New Zealand has a substantial quantity of historic fisheries data and information available for use in developing useful working definitions of these concepts.

8.05

INFORMATION NEEDS AND IDENTIFICATION CRITERIA FOR MANAGING VULNERABLE MARINE ECOSYSTEMS IN THE SOUTH PACIFIC OCEAN

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The United Nations General Assembly resolution 61/105 calls for States to protect vulnerable marine ecosystems (VMEs), including cold water corals, from destructive fishing practices in international waters. In response, the developing South Pacific Regional Fishery Management Organization adopted interim measures requiring Participating States to assess whether individual bottom fishing activities encounter VMEs, to prevent significant adverse impacts, and to require vessels to cease fishing and move away from such areas. We developed criteria to identify VMEs from trawl fishery bycatch data and other available scientific information. The criteria integrate information about the vulnerable taxa present, their relative abundance as bycatch, evidence from previous fishery interactions in the area, the degree of habitat isolation, and an index of taxonomic distinctness. We also analysed observer data from previous fishing by New Zealand vessels to evaluate the use of bycatch thresholds to trigger a move-on rule in the SPRFMO convention area. A focus on collecting fishery information to document the distribution of vulnerable taxa and habitat associations will facilitate identifying representative spatial closures for long-term protection of VMEs.

8.06

TOO PRECIOUS TO WEAR – CREATING A DEMAND FOR CORAL CONSERVATION

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The deep-sea coral species *Corallium* is one of the most valuable and widely traded coral species in the world. Raw *Corallium* auctions for US $150-900 kg^{-1}, with finished jewelry pieces ranging from US $20-20,000. Despite the high price point, precious coral floods into the US; 26 million pieces were imported from 2001 to 2006. Red and pink coral is commonly and consistently highlighted in the jewelry and home décor industries for its color and for raw material. *Isididae* and *Keratoisidinae* species are also traded for jewelry, often dyed red to resemble Corallium and this trend is a growing concern. These species face threats such as overfishing, trade pressure and habitat destruction.

Part of the problem is that the public has little awareness of *Corallium*'s origins, biological characteristics or its vulnerability. To increase awareness about the living nature of corals and to address the many threats facing deep-sea corals, SeaWeb launched the campaign *Too Precious to Wear* during the 2008 International Year of the Reef. The campaign highlights the unique role deep-sea organisms play in the marine ecosystem and directly targets the industries that utilize *Corallium* and other corals as a raw material – the fashion, jewelry and home décor industries – in order to promote conservation and policy advancement for the species. This presentation will show prevalence of red and pink corals in the public sphere and the need for targeted campaigns such as this to overcome the public's misconception about *Corallium* and other deep-sea species.

8.07

RATE AND EXTENT OF DECLINE IN *CORALLIUM* POPULATIONS: ARE EXISTING DATA ADEQUATE TO JUSTIFY A CITES APPENDIX II LISTING?

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In June, 2007, the United States submitted a proposal to list all species of *Corallium* (pink and red corals) on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The taxa are under considerable threat from harvest and international trade due to 1) vulnerable life history traits, such as a sessile (attached) growth form, slow growth rates, late reproductive maturity, reproductive output that increases with size, long life spans, and limited dispersal potential, 2) the occurrence of low density populations in geographically isolated and spatially confined deep water rocky bottom habitats; 3) serial depletions of western Pacific populations using non-selective trawls and dredges; 4) decreased genetic diversity, reduced colony densities, and shifts in size/age structure to a dominance by small, immature colonies in the Mediterranean and 5) increasing international demand for *Corallium* jewelry and art objects.

The CITES proposal was overturned due to perceived difficulties in implementing and enforcing a CITES listing, and uncertainties on the population status and extent of decline. According to an expert review, these species had not declined to 20-30% of the historic baseline, as required to justify a CITES Appendix II listing for low productivity taxa like *Corallium*. This review primarily considered numbers of colonies and density as surrogates of decline, both of which may be relatively high (200-1300 colonies/m^2) in the shallow coralligenous zones of the Mediterranean. Yet, changes in abundance are likely to be inadequate measures of decline for colonial (modular) organisms, as these corals exhibit a size-based exponential increase in reproductive output and their continued survival is dependent on both colony size and density to ensure successful reproduction and fertilization. In the Mediterranean, *C. rubrum* historically achieved heights of 50 cm; today, over 90% of colonies in fished areas are 3-7 cm in height, most with only rudimentary patterns of branching, and few (<20%) sexually mature colonies. Shallow *C. rubrum* populations declined by 80-90% in fished areas when considering the exponential decline in numbers of polyps (e.g., reproductive units) per colony attributed to large reductions in height, basal diameter and number of branches. Documenting population declines for Pacific species is more problematic and based largely on catch data. Fisheries have undergone “boom and bust” phases as new sites were discovered, and population trends are available for relatively few sites. Furthermore, recent radiometric aging information suggests that traditionally-determined growth rates for certain deep sea corals, including *Corallium* spp., may be underestimated, highlighting the need for a precautionary approach to management

8.08

ECOSYSTEM BASED MANAGEMENT OF CORALS, FISH AND FISHERIES IN THE DEEP WATERS OF EUROPE AND BEYOND

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In 2006, the UN General Assembly Resolution (61/105) called upon fisheries management organisations worldwide to: i) assess the impact of bottom fishing on vulnerable marine ecosystems, ii) identify/map vulnerable ecosystems through improved scientific research/data collection, and iii) close such areas to bottom fishing unless conservation and management measures were established to prevent their degradation. In European deep waters, in addition, there is now a need to establish monitoring tools to evaluate the effectiveness of closed areas for the conservation of biodiversity and fish and their impact on fisheries. Currently the tools necessary to achieve these management goals are wholly lacking.

CoralFISH is a four year, EU FP7 Integrating Project, designed to address these issues by: i) developing essential methodologies and indicators for baseline and subsequent monitoring of closed areas, ii) integrating fish into coral ecosystem models to better understand coral fish-carrying capacity, iii) evaluating the distribution of deepwater bottom fishing effort to identify areas of potential interaction and impact upon coral habitat, iv) using genetic fingerprinting to assess the potential erosion of genetic fitness of corals due to long-term exposure to fishing impacts, v) constructing bio-economic models to assess management effects on corals and fisheries to provide policy options, and vi) producing habitat suitability maps both regionally and in the High Seas to identify areas likely to contain vulnerable habitat to address the issues raised by the UNGA resolution. An overview of the project will be presented.

8.09

DISTRIBUTION AND CONSERVATION STATUS OF DEEP-SEA CORALS OFF THE BRITISH ISLES

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There are more deep-water coral records for the North Atlantic than any other area in the world, reflecting both its long history of deep-sea research and an increased focus on surveys of deep sea coral habitats over the past decade. We analysed available data on scleractinian, antipatharian, gorgonian and stylasterid coral distributions from benthic sampling expeditions from 1868 -2006 around the British Isles between 48 -60°N out to 20 °W, which include approximately 1800 records of deep -water corals (>200 m) including 26 scleractinian spp., 31 gorgonian spp., 9 antipatharian spp. and 3 stylasterid species.

We show that, 66 % of all deep -water coral records around the British Isles are scleractinians. *Lophelia pertusa* is the most common with approximately 50 % of record s found between 300 - 500 m and 10 % found > 900 m. Gorgonians are the most species -rich order, with 50 % of records from 520 - 800 m and the deepest gorgonian record being *Lepidisis longiflora* at 2989 m. Approximately 50 % of antipatharian records are from 478 - 670 m and 10% in the bathyal slope > 900 m. 75 % of all records of stylasterids are recorded between 480 - 550 m and *Pliobothrus* records dominate. Approximately 11 % of deep-water coral records around the British Isles remain unidentified.

No area of the ocean is unaffected by humans. Around the British Isles, the effects of fishing, oil and gas exploration, pollution, bioprospecting , climate change and ocean acidification have all been highlighted as major concerns for marine conservation. Bottom trawling has had the greatest documented impact on deep-water corals, which has led to increased conservation efforts and a developing network of areas that are closed to demersal fishing gear along the continental shelf-break. Some of these protected areas are up for revie w in 2009, hence assessments need to be carried out as to whether existing management is effective. We present an overview of local advances in deep-water coral management starting with closure of the Darwin Mounds in 2004 followed by High Seas, UK and Irish closures in 2007. Accurate mapping and quantitative abundance measurements are vital to marine spatial planning in order to best influence the management of vulnerable deep-sea corals. We show which deep-sea coral habitats are currently protected in the NE Atlantic between 48 -60°N, and which are not.

8.10

SEAMOUNTS OF NAZCA AND SALAS-Y-GÓMEZ: A REVIEW FOR MANAGEMENT AND CONSERVATION PURPOSES

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Due to growing international awareness of the importance of the conservation and management of vulnerable marine ecosystems – of which the seamounts and deep-sea corals of Nazca and Salas y Gomez submarine ridges are examples – and taking into account the imminent establishment of a South Pacific Regional Fisheries Management Organization, a scientific review of this area is needed as an input into decision-making processes. Considering geological, oceanographic, biological, ecological and fisheries issues associated with Nazca and Salas y Gómez, this paper aims to contribute to meeting this need and also to identify some management options. Notwithstanding the limited and fragmented studies available, the distinctiveness of the area is highlighted due to its high level of endemism and rich biodiversity, seamount density, the presence of deep-sea corals, relatively elevated primary productivity, and its potential for bottom fisheries and ocean-mining activities. Because of the remoteness of the area and the costs involved, strong international cooperation will be required to undertake future studies. A network of Marine Protected Areas comprising the high seas and Chilean jurisdictional waters is identified as the best management option for the area, which in turn will demand high coordination between international organizations and Chilean agencies.

8.11

ASSESSING THE INCIDENTAL CATCH OF CORALS IN NEW ZEALAND FISHERIES

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The Marine Conservation Service's Observer Programme seeks to identify, monitor and, where possible, quantify protected species interactions with commercial fisheries. Two groups of coral are currently protected in New Zealand's Exclusive Economic Zone: black coral ("all species in the Order Antipatharia") and "red coral". In order to assess the extent of interactions between protected corals and trawl fishing operations, Government fisheries observers are requested to record, weigh and sub-sample specimens of deep sea corals landed on trawl vessels. Sub-samples are returned to experts ashore for identification to lower taxa (families, genera, species).

The sub-samples of corals returned by observers represent a valuable data source that can be used to better describe the relationships between deep sea corals and commercial fishing activity. To date, we have little knowledge of the long-term effects of benthic impacts on protected corals in New Zealand. Protected species need to be adequately described to ensure legal obligations of the Wildlife Act 1953 are followed. The results from this project will provide important knowledge of the region's biodiversity and will improve our understanding of the ecosystem effects of fishing. In addition, data collected through this project may help to avoid, remedy or mitigate any adverse effects of fishing on biodiversity, improve our knowledge of areal and vertical distribution of protected coral taxa within and outside the EEZ, provide a measure of abundance, and help quantify protected species interactions with commercial fisheries. The data will also add to descriptions of the biodiversity of seamount / non seamount habitats and provide information useful for the consideration of potential marine protected areas.

8.12

MANAGING FISHERY IMPACTS TO DEEP-SEA CORAL ECOSYSTEMS OF THE UNITED STATES: EMERGING BEST PRACTICES

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The United States has the world's largest exclusive economic zone, containing rich and varied deep-sea coral ecosystems. In 2007, the first major assessment of these ecosystems reviewed their distribution, the threats they face, and current management measures to address these threats. Most areas have been inadequately surveyed for the presence of deep-sea coral habitats, which hinders management. However, disturbances from bottom trawls to coral communities deeper than 50 m are well documented and considered the major threat to deep-sea corals in most U.S. regions where such fishing is allowed. Other bottom-set fishing gears (e.g., gillnets and longlines) can also impact these communities. The United States, especially since 2005, has taken far-reaching action to address these threats to deep-sea habitats. In 2006, the U.S. protected over 1.45 million km^2 of vulnerable benthic habitats from bottom-trawling in the Pacific. Additional major habitat conservation efforts are underway in the Bering Sea and U.S. Atlantic. In these U.S. efforts, a number of approaches are emerging as best-practices to conserve deep-sea corals and other vulnerable marine ecosystems in the deep sea:

- Banning bottom-contact gear from seamounts and major identified deep-sea coral habitats.
- Defining the current "footprint" of bottom-trawl and dredge fisheries in partnership with the fishing community, and preventing expansion of these fisheries into deeper waters until they can be surveyed to identify potentially-vulnerable habitats.
- Using fisheries observers and vessel monitoring systems to provide key information that can inform management and enforcement.

In 2006, the nation's primary fishing law was amended to explicitly allow protection of deep-sea corals in their own right. This talk will show how these approaches are being incorporated into a national strategic plan to comprehensively study and conserve deep-sea coral and sponge ecosystems, and how they may inform ongoing international conservation efforts.

8.13

DEEP SEA CORAL MATTERS: SCIENCE AND FISHERIES MANAGEMENT DEVELOPMENT IN NEW ZEALAND

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Deep sea corals have become iconic in New Zealand not least of all because of their beauty, longevity and fragility. Their association with seamounts and other underwater topographical features that abound in our waters is well known and some have protected species status. Their vulnerability to deep sea fishing activities led to the closure of 19 seamounts in 2001. Since then, there has been a plethora of research projects in New Zealand to learn about coral in deep sea environments. Considerably more is now known about their biology and distribution, taxonomy; diversity and functional role in marine ecosystems. Recent research has also shown that the effects of climate change will extend into deep sea environments. The response of deep sea coral to fishing closures is being carefully monitored in a few locations. There have also been studies on the footprint of trawling in New Zealand, and attempts to find indicators that would be useful for ecological risk assessment of fishing and other threats to corals on seamounts. This presentation discusses the uptake of these science results and options for policy development that will progress the development of standards through the Strategy for Managing the Environmental Effects of Fishing (SMEEF) and build on the Benthic Protection Area (BPA) initiative already in place in New Zealand's EEZ.

8.14

BENTHIC PROTECTION AREAS: PROTECTING NEW ZEALAND'S DEEPWATER HABITATS

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The benthic habitats in New Zealand's EEZ include soft substrates, hydrothermal vents, seamounts and other underwater topographic features. Corals are among the diverse biota associated with these habitats.

The Ministry of Fisheries and the fishing industry recognise the importance and value of these communities and regard protecting them from adverse effects as an integral part of managing New Zealand's deepwater fisheries responsibly.

In November 2007, the Government closed 17 large areas within the New Zealand EEZ to bottom trawling and dredging. These closed areas are known as Benthic Protection Areas (BPAs) and protect the biodiversity of about 1.2 million square kilometres of seabed – about 30% of the EEZ. Associated with this initiative is a significant regulatory and monitoring regime. This is thought to be the largest single marine protection initiative in a nation's EEZ anywhere in the world; the closures are approximately 1.7 times the size of the EEZs of Spain and Iceland. Within New Zealand's EEZ, BPAs protect:

- 28 percent of Underwater Topographic Features (including seamounts);
- 52 percent of seamounts (underwater mountains over 1000 metres in height);
- 88 percent of active hydrothermal vents.

BPAs were established to set representative benthic habitats aside, in essentially pristine condition, to avoid any future adverse effects of fishing. This preserves a large portion of New Zealand's natural marine heritage whist allowing fishing to continue in other areas or in a way that does not modify benthic habitats within the BPAs. Such an approach recognises the distinction between impacts of fishing, which are acceptable under New Zealand law, and adverse effects, which are not. By setting aside large areas of the EEZ, adverse effects are avoided and other areas remain available for fishing.

The areas protected are broadly representative of the diverse marine habitats in the EEZ, and were selected based on the Marine Environment Classification 2005; the best available classification at that time. However, work will continue in the EEZ to determine the extent to which BPAs adequately represent habitat types. Additional management measures to fine tune BPAs will be considered in the future as better information becomes available.

The BPAs, and other similar protected areas, will contribute to the New Zealand Government's Marine Protected Areas Policy and other initiatives to better manage New Zealand's marine environment.

8.15

MANAGING DEEPWATER CORAL ECOSYSTEMS OFF THE SOUTHEASTERN UNITED STATES

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In response to research revealing the importance and uniqueness of deepwater coral habitats off the southeastern United States, the South Atlantic Fishery Management Council (SAFMC) initiated a process to designate these areas for protection. The SAFMC is one of 8 United States' Regional Fishery Management Councils charged with conservation and management of fisheries in their respective region's Exclusive Economic Zones (3 to 200 miles [5 – 321 km] in the southeastern U.S.). In 2004, the SAFMC received scientific reports characterizing extensive deepwater coral communities throughout the southeastern U.S. in waters deeper than 400 m. The SAFMC subsequently adopted recommendations developed by its Coral and Habitat Advisory Panels--comprised of researchers, state federal and local managers, conservation representatives, and fishing industry representatives—for the designation of five areas off the southeastern U.S. coast as Deepwater Coral Habitat Areas of Particular Concern (CHAPCs). Altogether, these areas comprise over 25,000 square miles (64,750 square km) of relatively pristine deepwater coral and rocky reef ecosystems. Over 110 species of deepwater corals occur in this region, but the major structure forming corals are *Lophelia pertusa* and *Enallopsammia profunda*. The SAFMC's intent is to prohibit bottom damaging-gear and fishing activities that could threaten the health and continued existence of these unique deepwater communities. In so doing, the SAFMC has taken a precautionary approach to managing these systems and, by engaging various stakeholders, ensured transparency in the process. Furthermore, the SAFMC has worked cooperatively with fishermen to designate "Allowable Gear Areas" within the proposed CHAPCs to ensure that traditional fisheries, such as golden crab, can continue in areas where damage to deepwater communities is not expected to occur. Once this proposal is implemented, the National Marine Fisheries Service and the SAFMC will also be able to participate in the permitting process for non-fishing activities that could potentially threaten the continued viability of these important systems.

8.16

DEVELOPMENT IN A TRAWL-DAMAGED CORAL HABITAT (TISLER REEF, NE SKAGERRAK) DURING FOUR YEARS OF TRAWL PROTECTION

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The Tisler reef is a relatively large (c. 0.25 km^{-2} live reef, c. 0.5 km^{-2} total) inshore reef dominated by the hermatypic scleractinian cold-water coral *Lophelia pertusa*. The reef was first documented by ROV in 2002 and has later been mapped in detail. The mapping revealed that large parts of the reef had been damaged by trawling. The Tisler reef and a small buffer zone around it was protected from fishery with bottom-impacting fishing gear in late 2003.

Quite a number of Scandinavian cold-water coral reefs have been protected against bottom-impact fisheries during the last decade. To our knowledge, however, there have been no previous studies to demonstrate the effectiveness of such protection or the rate of recovery in damaged coral habitats after protection. To study these issues, a bottom transect (weighted line with markers) was established through a trawl-damaged part of the Tisler reef in 2005. The development in the coral habitat surrounding the transect was then documented regularly by ROV (video, still photography and video mosaics) over a period of 3 years. Great care was taken to prevent impact of the ROV used on the coral habitat studied.

The studies have revealed frequent re-location of smaller coral colonies and fragments. In part of the transect, smashing and re-location of larger colonies was also observed. In a few larger and stable colonies growth rates (increase in polyp length) of c. 6-7 mm^{-year} were measured from time-lapse photographs with laser markers.

Our findings indicate that during the study period there was no net recovery in the coral population studied, but instead a net loss and further fragmentation of live coral tissue. It seems likely that part of the negative development was related to continued illegal fishery with bottom-impacting gear, which was further indicated by loss or displacement of bottom-mounted recording instruments deployed withinin the protected area. Also natural factors, such as occasional occurrence of very strong bottom currents (as measured in the area by recording instruments), might contribute to hinder re-establishment of smaller coral fragments created by physical disturbance, due to frequent re-location of the fragments.

8.17

THE STEPS TAKEN TOWARDS CORAL CONSERVATION ON THE WEST COAST OF CANADA

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Fisheries and Oceans Canada (DFO) – Pacific is in the early stages of drafting, consulting upon and implementing a Coldwater Coral and Sponge Conservation Strategy for the West Coast of Canada. This strategy describes the international, national and regional drivers that have precipitated the development of the strategy. It will be a living document that will outline the management and research actions required to implement a knowledge-based risk-assessment framework for a management system to control the activities that are putting more than 80 coral species and 250 sponge species at risk.

It is hard to say where the pathway leading to development of a strategy started but it seems to be the culmination of international efforts to have nations subscribe to the FAO precautionary approach to fisheries management and recognition of the value of biodiversity with ratification of the Convention on Biodiversity. The list of pressures continues to grow with the latest UN General Assembly fisheries resolution and the draft FAO guidelines for the management of Deep Sea fisheries. In addition, there is growing marketplace pressure to demonstrate, through certification, that fisheries are sustainable and managed and assessed on an ecosystem basis, taking into account the impacts on not only target species but other species and marine habitat.. From a national perspective it was the implementation of two regulatory enablers, Canada's *Oceans Act (1997)* and the *Species at Risk Act (2002)* that started managers and scientists thinking about managing human activities so that the impacts were understood across the entire ecosystem. As a result it was recognized that there was a need to extend protection for all species not just the commercially important ones. More recently this has been augmented by draft national fisheries policies for management of sensitive benthic habitat and management of impacts on forage species. On the Pacific Coast of Canada, the discovery of unique ecosystems and new species and the actions of environmental non-governmental organizations (ENGOs) have resulted in increased understanding of the importance of these animals and growing concerns about the threats posed by human activities has led to demands for the development of a conservation and management strategy.

The draft conservation strategy is designed in such a way that it provides a glimpse of the extent of the problem by trying to step our way through a series of questions: What do we have? Where are they? What value is there in protecting them? What makes them vulnerable and sensitive to various threats? What and where are the threats?

By following these steps we propose a suite of Conservation and Management Goals which in turn drives the questions on which science needs to provide advice.

8.18

SCIENCE-BASED ADVOCACY AS A TOOL TO OVERCOME INSTITUTIONAL OBSTACLES TO DEEP SEA CONSERVATION

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In marine policy, the burden of proof is often on conservationists to demonstrate that fishing practices are having a significant and lasting impact on marine ecosystems. As a result, the fishing industry is able to exploit the paucity of data and the inherent uncertainties associated with research findings to successfully oppose regulations that would limit their activities. This is particularly true of the deep sea, where data sets are even more limited and baseline studies pre-dating fishing impacts are rare. Further, marine policy is often heavily influenced by fishing industry representatives, adding additional challenges for conservationists. However, most management regimes do purport to be grounded in the best available science, so research can, in theory, play an important role in protecting vulnerable habitats.

Despite several appeals from environmental organizations, native leaders, and some small-scale fishermen, policy makers responsible for managing Bering Sea fisheries rejected proposals in 2006 to protect several large canyons along the shelf break, citing a lack of sufficient data. In 2007, Greenpeace responded by organizing a research expedition employing an ROV and two manned submersibles to conduct video surveys of the seafloor habitats of two canyons. Zhemchug Canyon, the world's largest underwater canyon, had never been explored *in situ*. Thirty-one transects were spread approximately equidistantly apart; transects were perpendicular to depth contours and surveyed depths between 1000 and 150 meters. Specimens of corals, sponges, and benthic invertebrates were collected for taxonomic identification.

Despite repeated assertions from the fishing industry that the canyons consisted of just mud and silt and were therefore suitable areas for trawling, 14 species of coral and at least 20 species of sponge were identified, including a species of *Aaptos* that was previously undescribed. Numerous associations between commercially important fishes and habitat-forming corals and sponges were documented as well, demonstrating the value of large sessile invertebrates for fisheries. Contrary to claims that no damage was occurring, evidence of fishing impacts was documented, including large swathes of broken and overturned corals.

These results strengthen the case for protecting deep sea coral habitats in general, and Bering Sea canyons in particular. Given the considerable obstacles to limiting fishing in areas currently utilized by lucrative commercial fisheries, it is too early to tell whether new management measures will be implemented in these canyons, or if they will be sufficient to protect the vulnerable coral habitats identified in this study. However, it is clear that these new findings underscore the need to adopt a precautionary approach in areas where vulnerable marine ecosystems may occur and provide new hope for conservation in a management regime that had previously opted to allow continued fishing in a data-poor environment.

Poster Session

Systematics and Biogeography (Abstracts 10.01–10.19)

Sampling Methods and Mapping (Abstracts 11.01–11.15)

Coral Ecosystems and Habitats associated with Seamounts (Abstracts 12.01–12.04)

Geology, Palaeontology and Palaeoclimate incl. Ocean Acidification (Abstracts 13.01–13.18)

Biology: Feeding, Growth and Reproduction (Abstracts 14.01–14.08)

Ecology and Species Associations (Abstracts 15.01–15.15)

Management Decisions and Policy for Corals, Conservation and Human Impacts (Abstracts 16.01–16.15)

10.01

DEEP-WATER CORAL DNA REPOSITORY FOR THE NE PACIFIC

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We are developing an initial species inventory of deep-sea corals off the NE Pacific coastline as a necessary first step to understanding more about the ecology and distribution of deep-water corals. To facilitate species identification we are creating a DNA sequence repository in collaboration with Fisheries and Oceans Canada and NOAA's Alaska Fisheries Science Center. All DNA sequences will be linked to verified morphological identifications to create a West Coast repository of coral species found in this area. This repository will serve not only as an essential resource for coral researchers and other stakeholders, but also as a foundation for future research efforts at the NWFSC aimed at understanding the biogeography and ecology of coral species in these deep-sea communities. We currently have specimens from California, Oregon, Washington, and Alaska, from a number of sources: MBARI, Los Angeles County Museum, Olympic Coast National Marine Sanctuary, the 2006 and 2007 NOAA Fisheries Groundfish Survey, and the 2007 NOAA Fisheries Alaska Groundfish Assessment. Two genes from each specimen will be sequenced: COI for submission to the DNA Barcode of Life, and mitochondrial MutS. This sequence information will allow us to make a preliminary ID based on genetics, and thereby group like individuals to reduce the number of individuals needed to send to morphological taxonomists already overwhelmed with their workloads.

Our preliminary results indicate that specimens recovered opportunistically from these trawl surveys are of sufficient quality to give clean genetic sequences. Initial shipboard identifications are made by volunteers given minimal training in identification of corals, so it is critically important that reference material supplied to them be clear and accurate. Our sequencing and identification efforts will help provide the most up-to-date information regarding the genera and species likely to be found off the NE Pacific coastline. We have already demonstrated instances where initial shipboard identifications were accurate, as well as those where initial species designations were inaccurate or of insufficient detail. The combination of MutS sequences, which are species-specific for many octocorals but is not found in hexacorals, plus COI which is found in all coral species, should yield sufficient power for identifying all taxa present in our regional waters.

Poster

10.02

COLD-WATER CORALS OF THE AZORES: PRELIMINARY ASSESSMENT OF DISTRIBUTION, DIVERSITY AND ASSOCIATED FAUNA

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A wide variety of sources, such as historical records, longline bycatch data and direct observations, indicate that the Azores Archipelago lies within a geographic area which harbours highly diverse and extensive cold-water coral communities. During the last 4 years, 81 species were recorded in the region. The most represented taxa, Alcyonacea, include corals from the families Plexauridae (14 species), Primnoidae (7 species) and Acanthogorgiidae (3 of species). The majority of the antipatharians recorded belongs to the families Leiopathidae and Myriopathidae, with *Antipathella wollastonii* and *Leiopathes* spp. being dominant species and occuring at considerably different depth ranges. Hydrocorals (4 Stylasteridae species) and stony corals (13 Caryophyllidae species and 6 Dendrophyllidae species) were also very abundant. This communication provides a reviewed list of cold-water corals that occur in the Azores region, with a few notes on its associated fauna and habitat. Additionally, we will provide a description of coral distribution with depth and spatial location. With only a fraction of the habitat explored so far, the number of coral species known to occur in the Azores will most likely increase. Given the isolated nature of the Azores, which possibly imposes restrictions to gene flow, the level of endemism reported for the region may have been under-estimated. Current research being developed in the region will contribute to a better understanding of cold-water coral communities, in terms of species composition, ecology and connectivity.

Poster

10.03

HEXACORAL AND OCTOCORAL COMMUNITIES ON THE UNEXPLORED GREAT BARRIER REEF SHELF-EDGE

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Drowned reefs have been identified on continental shelves and around oceanic islands in many parts of the world, including Barbados, Papua New Guinea, Hawaii and Tahiti. In 2007, an expedition on board the RV southern surveyor explored shelfedge reef and terrace features at 4 different sites along the GBR margin in depths of 40-160m. Multibeam swath mapping and dredge sampling was combined with high-resolution images obtained by autonomous underwater vehicle (AUV) to provide the most complete study ever undertaken of the GBR shelf edge. Data from these virtually unstudied ecosystems reveals a diverse range of habitats and communities. Limestone reef and terrace features provide hard substrates for a diverse range of hard coral, soft coral and gorgonian communities. 24 dredges across the 4 sites yielded a large number of specimens which are currently being studied for taxonomic identification. Initial examinations show many specimens to be different from those found on the modern, shallow water reef, and probably new to science. Detailed multibeam bathymetry and acoustic backscatter combined with AUV data has identified several discrete habitats and taxonomic on the GBR shelf edge. Macrobenthic communities are dominated by calcareous algae, sponges, and a diverse range of both hard and soft corals. Live scleractinian corals representing 7 families (acroporidae, pocilloporidae, agariciidae, fungiidae, poritidae, faviidae and oculinidae) have been identified so far at depths to 103m. Commonly the hard substrates also exhibit lush growth of octocorals, including many gorgonians which bear little similarity to those recovered from the shallow-water reef.

Poster

10.04

GEOGRAPHIC DISTRIBUTION AND BIODIVERSITY OF DEEP-SEA AZOOXANTHELLATE CORALS (HEXACORALIA, ANTHOZOA, CNIDARIA) IN TAIWAN

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Scleractinian corals are divided into two major groups based on the status of algal symbiosis. The zooxanthellate corals, composed of a group of scleractinians that are associated with symbiotic algae (also known as zooxanthellae), live in the shallow water of tropical and subtropical sea and play an important role in the formation of modern coral reef ecosystem. In contrast, the azooxanthellate corals which are free of zooxanthellae association and mostly live in the deep sea, are less known in their geographic distribution and biodiversity in Taiwan. In this study, the collection of azooxanthellate corals were conducted island-wide between 1999 and 2007 in Taiwan, ranging from the deepsea trench of northeastern coast, the slope along the east coast of Taiwan, and valley between Hsioliuchiao and Tungsha Atoll. The depth zone was between 200 to 4455 m. Over 430 specimens deposited in the National Museum of Natural Science (NMNS), Taichung and Biodiversity Research Centre, Academia Sinica (BRCAS) were examined. Six families, including Fungiacyathidae, Anthemiphylliidae, Caryophylliidae, Turbinoliidae, Flabellidae, and Dendrophylliidae, 11 genera, and approximately 25 species are identified from this collection. Most of these species are free-living and have discoidal coralla, which are adapted to soft substrate environment. These include at least 2 undescribed species and 22 new records from Taiwan. The geographic distribution of azooxanthellate corals and their relationships to the adjacent fauna in Japan, Philippine, and West Pacific are highlighted.

Poster

10.05

BIOGEOGRAPHY AND COMMUNITY STRUCTURE OF THE NEW ENGLAND AND CORNER RISE SEAMOUNTS

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In an effort to elucidate the role seamounts play in structuring marine biodiversity and biogeography, the composition and distribution of on North Atlantic seamounts, including the New England Seamount chain, the Corner Rise Seamounts, and Muir Seamount were assessed. Videographic surveys using high-definition recordings revealed striking differences in the composition between these seamount regions. To date, a total of 61,625 recorded observations reveal: 1) 270 morphospecies from 13 Phyla; 2) constituent fauna dominated by sponges, corals, and echinoderms; 3) that 27% of the morphospecies were unique to Corner Rise seamounts; 4) 22% of the morphospecies were unique to New England seamounts; and 5) that significant host-associate relationships were observed in 7 taxa. Specifically, a high degree of invertebrate associate specificity with particular cold-water coral host substrate. For example, the chirostylid crab (*Uroptychus* sp.) was observed only on the antipatharian *Parantipathes sp.*, the ophiuroid *Asteroschema clavigera* was observed on the corals *Paragorgia spp.* and *Paramuricea spp.*, and the ophiuroid *Ophiocreas oedipus* was observed only on the coral *Metallogorgia melanotrichos*. Multidimensional scaling and cluster analysis revealed several patterns in the faunal assemblages of the seamount fauna. Distinct faunal assemblages were observed on different types of substrate, including natural abiotic substrate (soft sediment, hard substrate, and open water), and were distinct from each other, from anthropogenic abiotic substrates and biotic substrates. Significant differences were also observed in the composition of faunal assemblages between the Corner Rise and New England seamount chain regions as well as between depth regions with breaks detected at 1300 m, 2300 m, and 2600 m. We discuss the importance of various factors of geographic region, depth, and host-associate relationships in structuring seamount populations, and their implications for recent conservation and management strategies of the New England and Corner Rise Seamount cold-water coral communities.

Poster

10.06

REVISION OF THE OCCURRENCE AND DISTRIBUITION OF *LEIOPATHES* SPP. (ANTHOZOA: ANTIPATHARIA) FROM THE NE ATLANTIC.

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Leiopathidae is the only Family of Antipatharia in which the polyps have an extra pair of secondary chambers (presenting 12 mesenteries). There are 6 known species, 3 of which are though to occur in the N Atlantic (the last records of 2 of these species date almost 100 years back) (Johnson, 1899; Roule, 1902). *Leiopathes glaberrima* (Esper 1792) was the first species established for this genus. The type specimen -collected in the Mediterranean, still exists in the Erlangen Museum in Germany but since it has no polyp tissue, the specimen described by Brook (1889) -collected in Naples at approximately 200m depth, should be considered the substitute type specimen (Opresko, 1998).

In the end of the 19th century, records of *L. glaberrima* and the new species *L. expansa* Johnson, 1899 where produced in the Madeira Archipelago. Unfortunately the description of the new species was based on a single specimen and is a bit vague (the spines are only illustrated and the polyps weren't mentioned at all), for the author considered that "the flabellate form and delicate habit" where enough to distinguish it from known species of Lei*opathes*. The type specimen was deposited in the Funchal Museum but the depth and exact location where it was collected isn't known. The study of specimens gathered during the Prince Albert of Monaco campaigns, allowed to establish records of *L. glaberrima* in the proximity of the Azorean Archipelago (Gravier, 1921) and the new species *Leiopathes grimaldi* Roule, 1902. The type specimen was collected in the Azores and deposited in the Museum in Monaco.

While Roule (1905) suggested that *L. expansa* was very likely to be a ecotype of *L. glaberrima* or *L. grimaldi*, van Pesch (1914) went even further by suggesting that both *L. expansa* and *L. grimaldi* where in fact ecotypes of *L. glaberrima*. In 1974 Opresko provided a redescription of *L. glaberrima* (based solely on bibliography and samples collected in the W Atlantic) and in 1998 stated the hypothesis that *L. grimaldii* and *L. expansa* where in fact ecotypes of the same species that was not *L. glaberrima*.

This current study is based on a bibliographic review and examination of over 30, live and preserved, colonies from the E Atlantic (including the type specimen of *L. expansa*). It updates the taxonomic value of the species known for the NE Atlantic, providing a comprehensive redescription of the species and an occurrence map for the N Atlantic (based on corrected previous records and material gathered by the Department of Oceanography and Fisheries of the University of the Azores).

Poster

10.07

COLD-WATER CORAL GROWTH IN RELATION TO THE HYDROGRAPHY OF THE CELTIC AND NORDIC EUROPEAN CONTINENTAL MARGIN

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Along the Atlantic European continental margin, living cold-water coral reefs occur over a wide bathymetric and hydrographical range. Focussing on two regions, the Celtic and the Norwegian shelves we found that they are bound to different intermediate water masses. Measurements of the physical and geological properties indicate that parameters such as temperature, salinity, dissolved oxygen content, current intensities, and different substrates do vary in a wide range without impacting the distribution of living cold-water coral reefs to a first degree.

Our study shows that cold-water corals in the North Atlantic tolerate a wide range of environmental conditions. The habitat of living reefs comprises a temperature-salinity field with its lower boundary being equivalent to the Intermediate Salinity Maximum (ISM). The ISM on the Celtic margin is represented by Mediterranean Outflow Water, while it is replaced by Atlantic Water on the Norwegian margin. The upper limit corresponds to water mass boundaries of Eastern North Atlantic Water / Mediterranean Outflow Water on the Celtic margin and Norwegian Coastal Water / Atlantic Water on the Norwegian margin.

The density of seawater is a frequently used parameter by oceanographers to describe and understand ocean-mixing processes, as it is easier to mix water along a surface of constant density (an 'isopycnal') rather than across it. The potential density anomaly sigma-theta is a function of salinity, potential temperature, and pressure at the sea surface. This parameter indicates values of sigma-theta = 27.35 - 27.65 kg m^{-3} for all living cold-water coral reefs of the Porcupine Seabight, the Rockall Bank, and the Norwegian margin highlighting the importance of physical boundary conditions on cold-water coral growth and distribution. Additional information from literature shows that this value is also valid for reef sites along the Western Atlantic (Nova Scotia, Florida Strait, Brazilian margin) suggesting that this observation is an Atlantic-wide phenomenon. In areas where coral growth is restricted to some small patches and reefs, or recent mound growth is limited, like in the Gulf of Cadiz or off Mauritania, recent sigma theta values lay outside the envelope of 27.5 ± 0.15 kg m^{-3}. However, it has to be mentioned that corals do not occur everywhere along the European continental margins where sigma theta values are around 27.5 kg m^{-3}. In this case, second order parameters like sedimentation rates, currents, the lack or presence of good settlement substrates, nutrient concentrations, etc. are controlling the coral growth and settlement.

Dullo, W.-Chr., Flögel, S., Rüggeberg, A. (in press) Cold-water coral growth in relation to the hydrography of the Celtic and Nordic European Continental Margin. Marine Ecology Progress Series.

Poster

10.08

COLD-WATER CORALS AND THE HYDROCHEMSITRY OF AMBIENT BOTTOM WATER MASSES – RESULTS FROM THE NE-ATLANTIC AND THE MEDITERRANEAN

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Physical and chemical parameters were measured in five different regions of the Northeast Atlantic and the Mediterranean with known occurrences of cold water coral reefs and mounds. In this study we analyzed 284 bottom water samples regarding $\delta^{13}C_{DIC}$, $\delta^{18}O$, and DIC. The hydrochemical data reveal characteristic patterns and differences for cold-water coral sites with living coral communities and ongoing reef and mound growth at the Irish and Norwegian sites while the Mediterranean, Gulf of Cadiz, and locations off Mauritania show only patchy coral growth on mounds and various substrates.

The analysis of $\delta^{13}C/\delta^{18}O$ reveals distinct clusters for the various regions and the respective bottom water masses bathing the corals. The analysis of relationships between salinity, temperature, $\delta^{18}O$, and especially between $\delta^{13}C_{DIC}$ and DIC shows that DIC is a parameter with high sensitivity to the mixing of bottom water masses and varies distinctively between sites with dead and living reefs/mounds. Preliminary results suggest that DIC and $\delta^{13}C_{DIC}$ can provide additional insights into the mixing of bottom water masses.

Additionally, we are currently analyzing pH- and alkalinity data sets, as well as the amount of turbidity and its relationship to cold-water coral mounds at the Rockall and Porcupine Bank, West off Ireland.

Poster

10.09

DEEP-SEA CORALS SHOW NO EVIDENCE OF ENDEMISM ON NORTHWESTERN ATLANTIC SEAMOUNTS

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Past work suggests that the isolation of seamounts may lead to endemicity of benthic fauna, or, alternatively, that these small areas of hard substrate may be hotspots of biodiversity in a well-connected system. To evaluate these hypotheses on seamounts in the northwestern Atlantic, we studied patterns of genetic variation in deep-sea corals of the Corner Rise and New England seamounts (2200 km span, 800-3860 m depth). We sequenced mitochondrial (mt) DNA for 164 octocoral colonies (Chrysogorgiidae: 26 *Chrysogorgia*, 15 *Iridogorgia*, 36 *Metallogorgia*; Plexauridae: 89 *Paramuricea*) at the *msh1* gene (750 base pairs) and 50 black coral colonies (Schizopathidae: 18 *Bathypathes* and 32 *Parantipathes*) at *cox1* (658 bp) and two intergenic regions (407 bp and 448 bp, respectively). Though anthozoans are known to have a low level of variation in the mtDNA, we were able to distinguish multiple haplotypes that correspond to species for all genera except *Metallogorgia*, which is monospecific.

Species are not geographically isolated on individual seamounts, and thus our results do not support endemism at this scale in the northwestern Atlantic. For example, two species of *Paramuricea* (*n*=33 and 29 colonies collected, respectively) are co-distributed across a subset (*n*=10 and 8) of the 12 seamounts sampled. There were also examples of rare haplotypes, but these may be incidences of under-sampling rather than endemism, e.g., only four colonies of a third species of *Paramuricea* were collected, but each was found on a different seamount. *Metallogorgia* (*n*=36) is the most geographically widespread, with a single haplotype spanning the entire range of seamounts sampled and into the Pacific. Addressing the question of regional endemicity would require additional samples of the other taxa from outside the northwestern Atlantic. Our results do not preclude that cryptic variation and endemism not revealed by mtDNA may become evident should more variable nuclear markers be discovered.

Poster

10.10

MITOCHONDRIAL GENOME STUDIES OF THE BLACK CORAL FAMILY LEIOPATHIDAE HAECKEL, 1896

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Antipatharians (black corals) of the monogeneric family Leiopathidae are abundant at 175-1700 meters depth world-wide. *Leiopathes* are conspicuous in bottom surveys due to their coloration and large, irregularly branching, bushy form. There are currently six described species, but the lack – or extreme reduction – of axial spines and highly variable polyp sizes, characters typically used to delineate antipatharian species, render taxonomy in this group particularly difficult. Opresko (1998) suggested the Leiopathidae might merit higher taxonomic status based on the unusual skeleton and the possession of 12 mesenteries (six primary and six secondary; all other black corals possess six primary and either zero or four secondary mesenteries).
In this study, we examined genetic characters to evaluate the relationship of the Leiopathidae to other antipatharians, and to create a phylogeny of the Leiopathidae to help identify morphological characters that may delineate species. Since anthozoans are characterized by slow mitochondrial (mt) molecular evolution, we elected to sequence the entire mt genome rather than simply one or two gene regions. In addition, because of the unusual morphological characteristics of the Leiopathidae, we predicted mt genome structure (gene order and content) might show significant differences to that of a previously published antipatharian mt genome (*Chrysopathes formosa*).

We sequenced complete mtDNAs of six individuals (three from the New England Seamounts (western North Atlantic), and one individual each from the Gulf of Mexico, Mediterranean Sea, and Hawaii) that our earlier genetic data indicated were divergent. Our data show that gene order is the same as that of *C. formosa*; however, there is evidence that the *Leiopathes* genome may not be circular. In addition, we discovered a large (1588 bp) group I intron within the *cox1* gene. We have also observed *cox1* introns in the black coral families Myriopathidae and Stylopathidae, and the genus *Elatopathes*, but they are significantly smaller (600-900 bp). *cox1* introns (854-1239 bp) have also been reported in the same position in other hexacorallian mt genomes (Actiniaria, Corallimorpharia, Zoanthidea and Scleractinia), but there does not appear to be a phylogenetic pattern to its occurrence. Analysis of the *cox1* intron for five western North Atlantic *Leiopathes* revealed a maximum variation of 0.63%, which is more variable than the two longest intergenic regions (*trnW-nad2* (972 bp): 0.41%; *nad5*(5')-*nad1* (572 bp): 0.17%) and the *cox1* "barcode" region (658 bp; 0.30%).

Poster

10.11

THE FIRST MOLECULAR PHYLOGENETIC RECONSTRUCTION OF THE CHRYSOGORGIIDAE (ANTHOZOA: OCTOCORALLIA) QUESTIONS ITS MONOPHYLY

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Chrysogorgiids are among the most commonly encountered octocorals in the deep-sea. Despite their diversity, ubiquity and relative abundance, chrysogorgiids lack systematic treatment. We present the first phylogenetic reconstruction of the family, based on taxa from 8 of 13 recognized genera, using both nuclear (18S) and mitochondrial (*cox1* and *msh1*) markers (5265 bp). The deep-sea genera *Metallogorgia*, *Iridogorgia*, *Rhodaniridogorgia*, *Radicipes* and *Chrysogorgia* form a monophyletic clade. The newly described *Rhodaniridogorgia* is polyphyletic within the *Iridogorgia* clade. Genetic variability was low (18S) to nonexistent (*cox1*, *msh1*) in *Metallogorgia*, across a wide geographic scale (NW Atlantic, N and S Pacific), suggesting a relatively recent origin of the genus (insufficient time to accumulate mutations at the target markers), or high dispersal capability relative to confamilial species. As multiple *Chrysogorgia* and *Iridogorgia msh1* haplotypes had similar geographic distributions (NW Atlantic and S Pacific), we propose that the later explanation is not likely. The relationship between *Radicipes* (monophyletic) and *Chrysogorgia* is poorly resolved, and preliminary data suggest a rapid diversification of the latter. The phylogenetic position of two specimens (sister to *Metallogorgia*), collected in New Caledonia, suggests the establishment of a new genus. Preliminary analyses suggest either that the family is paraphyletic, or that *Stephanogorgia* and *Trichogorgia*, and *Isidoides* do not belong to the Chrysogorgiidae, as they cluster with ifalukellid and isidid taxa (respectively). This result has strong implications for the phylogeography of the family, as *Stephanogorgia* and *Trichogorgia* are primarily tropical, shallow-water genera.

Poster

10.12

EVOLUTION IN THE BUBBLEGUM OCTOCORALS: DNA VS. MORPHOLOGY

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The bubblegum octocorals (Paragorgiidae: Octocorallia) are one of the most important habitat-builders in deep-sea ecosystems (e.g., seamounts, bioherms, canyons, continental shelves, etc.). Some colonies have been reported to grow up to 10 meters in height, being among the largest benthic organisms in the planet. They provide refuge to many individuals of a variety of fish and several invertebrate species. These animals have slow growth rates, studies have indicated a value of ~1 cm in height per year. Unfortunately the bubblegum corals and the deep-sea fauna in general are being rapidly threatened by human activities. As a product of the depletion of mid-water fisheries around the world, alternative destructive fishing techniques (e.g., bottom trawling) are being implemented in deeper waters.

The lack of knowledge on the biology, ecology, evolutionary history and taxonomy of the deep-sea fauna has prevented the creation of efficient ecosystem preservation policies based on a solid ground of scientific information and evidence. Some of the most important questions that need to be addressed in order to provide accurate and efficient actions are: How many species there are? Where they are? Which have the most important roles in the ecosystems? How are their populations interconnected? How was their evolutionary history? In order to answer some of these questions for the case of the bubblegum corals, we developed molecular-DNA data for most of the currently recognized species of the *Paragorgia* and *Sibogagorgia* genera. The set of specimens used in this study is a good representative of the known geographical distribution of this group. Phylogenetic relationships were reconstructed and compared with previous studies based on morphological data. A more detailed phylogeographic analysis was also implemented for *P. arborea*, which is the most conspicuous, abundant and widespread species of the family.

Our data suggested that there was a conflict between the phylogenetic relationships inferred with molecular and morphological data. The morphospecies do not match in all cases with the phylogenetic species. This constitutes evidence supporting the increasingly widespread idea that conventional morphological characters used in traditional taxonomy for coral species recognition need to be reviewed. We also present evidence indicating that *P. arborea* is in fact a unique taxonomic unit with a cosmopolitan distribution, which suggests the existence of worldwide metapopulations. This information can provide the basis for understanding connectivity patterns in the deep-sea, and therefore help to create appropriated management policies for deep-sea fauna conservation.

Poster

10.13

PHYLOGENETIC RELATIONSHIPS AMONG THE SCLERACTINIA (CNIDARIA, ANTHOZOA) INFERRED FROM MITOCHONDRIAL COI SEQUENCE DATA

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Traditionally evolutionary relationships between scleractinian corals have been inferred largely from micro- and macromorphological skeletal characteristics of extant and fossil material. During the last decade, however, molecular sequence data for ribosomal genes (12S, 16S, and 28S rRNA) have enabled phylogenetic analyses that are independent of the skeletal data, and these imply quite different evolutionary scenarios for scleractinians. Here we present new phylogenetic analysis of Scleractinia based on partial sequence (611 bp) of the mitochondrial cytochrome oxidase subunit 1 (COI) gene. COI sequence data were determined for 19 deep-sea corals from New Caledonia and adjacent waters and these were aligned with 115 homologes of previously published sequences from scleractinians, 3 corallimorpharians, and 3 octocorallians used as an out-group. Twenty of the 24 currently recognized scleractinian families were represented in the analyses.

Even not presenting differences between amplification size (present in the 16S and 12S sequences), and being very conserved among the scleractinians examined, our Bayesian analyses of the COI sequences supported the distinction of two major clades within the Scleractinia ("complex" and "robust" corals) previously implied by molecular phylogenetics of mitochondrial 16S and 12S rRNAs, and nuclear 28S rRNA. This division had high posterior probability, and was not significantly affected by weighting the analyses for codon position. The complex clade consisted of representatives of the following morphological families (P indicates the paraphyletic status of some families): Flabellidae, Turbinoliidae, Fungiacyathidae, Dendrophylliidae, Poritidae, Agariciidae, Acroporidae, Astrocoeniidae, and Anthemiphylliidae. Representatives of the Faviidae (P), Merulinidae, Pectiniidae, Mussidae (P), Pocilloporidae, Meandrinidae, Fungiidae, Siderastreidae, Rhizangiidae, and Oculinidae (P) are grouped in the robust clade. Some representatives of the family Caryophylliidae cluster with complex corals (*Deltocyathus suluensis*, *D. inusitatus*, *Rhizosmilia maculata* and *Trochocyathus rhombcolumna*) whereas others cluster with robust corals (*Trochocyathus efateensis* and *Stephanocyathus spiniger*).

Our analyses grouped corallimorpharians within the complex clade of the Scleractinia, and are therefore consistent with the "naked coral" hypothesis, which implies that corallimorphs are corals that have undergone skeleton loss.

Poster

10.14

THE NEPHTHEID SOFT CORAL GENUS *GERSEMIA,* MARENZELLER, 1878 WITH THE DESCRIPTION OF A NEW SPECIES FROM THE NORTHEASTERN PACIFIC OCEAN (OCTOCORALLIA, ALCYONACEA)

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A new species of nephtheid soft coral inhabiting the northeast Pacific Ocean is described from samples collected using remotely operated vehicles (ROVs) and a benthic trawl. Two hundred thirty ROV video observations provide additional information about the biogeographical distribution and habitat characteristics of this new species and are used to supplement the information ascertained from collected specimens. The species described herein is found through a broad range of depths, has been observed through a latitudinal range of approximately 1200 km, and has primarily been observed living upon hard-rock substrate. The nephtheid soft coral genus *Gersemia* is also reviewed.

Poster

10.15

BLACK CORALS OF EUROPEAN CONTINENTAL MARGIN: ALPHA DIVERSITY AND RELIABILITY OF HISTORICAL DATA FOR BIOGEOGRAPHIC SPECULATIONS

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Until quite recently black corals (Antipatharia: Anthozoa) were only sporadically reported from higher latitudes of the North Atlantic. However, after introducing methods of observations using remotely operated vehicles and manned submersibles it became obvious that black corals are important and rich components of suspension feeding fauna of the North-East Atlantic continental margin including banks and carbonate mounds (Weinberg et al., 2008; Roberts et al., 2008).

Purpose of the present work was to study existing materials on black corals from the European continental margin and adjacent seamounts and banks, including historical collections and recently collected samples: both fisheries bycatch and materials obtained in scientific cruises. Main attention was devoted to antipatharian fauna of the Bay of Biscay (with 9 species known so far) and almost unknown fauna of Porcupine Seabight. We have found that number of species reported from the European continental margin is underestimated and requires a revision. In the material studied we recorded 19 species. Several species obtained from fisheries bycatch were not found in scientific collections including samples from adjacent areas. Some colonies from fishery bycatches were of considerable size 1.5-2 m.

Re-examination of specimens from published records showed that many antipatharian species published in the literature are not reliable and many identifications need to be verified. Several species (*Parantipathes larix*, *Bathypathes patula*, *Leiopathes glaberrima*) reported previously as having wide or cosmopolitan distribution in fact appeared to include several species, sometimes even from different genera. It follows from these results that most of historical data on black corals cannot be recommended as it is for biogeographical constructions.

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Poster

10.16

SYSTEMATICS AND DISTRIBUTION OF DEEP-SEA BAMBOO CORALS (OCTOCORALLIA: ISIDIDAE) IN NEW ZEALAND WATERS.

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Bamboo corals (Isididae) are highly calcified octocorals with characteristic gorgonin nodes interchanged with longer calcite internodes. Bamboo corals are among the oldest and largest coral colonies found in deep-sea habitats. Even so small forms are one the most dense and abundant suspension-feeders at benthic habitats in the southern Pacific and Antarctica. As most deep-sea corals with slow growth rates, bamboo corals are very susceptible to destructive fishing activities such as bottom trawling. New Zealand has remarkable underwater features including extensive continental shelves, about 800 seamounts, canyons, trenches and slopes among others, offering hard ground habitats for octocorals species. Extensive collections of bamboo corals made in the last three decades around New Zealand and the Ross sea (Antarctica) provide one of the most complete sampling of deep-sea bamboo corals. The fauna of New Zealand is particularly diverse on large long-lived species of the subfamily Keratoisidinae, including numerous undescribed species of *Keratoisis*. The small species of the subfamily Mopseinae were among the most abundant corals in several deep-sea habitats specially members of *Minuisis, Sclerisis* and *Echinisis*. Preliminary identifications suggest a large portion of the fauna is likely endemic to New Zealand.

Former bamboo coral descriptions used the general morphology of the colony, polyps and sclerites for their taxonomic classification, but none of them has considered skeletal details such as the architecture of sclerite tips, textures, and the ratio node/internode. These elements were considered in order to suggest new microstructural characters for the taxonomic classification in these octocorals. By means of SEM, sclerite details (architecture of the sclerite tips, textures, and sizes) from New Zealand samples from were examined. Considering sclerite microstructure we found a very high diversity of bamboo coral morphospecies. However, there was no concordance with the low molecular divergence using mitochondrial DNA of these morphospecies, which in addition presented a great deal of polyphyly at the genus level. Ongoing research using more variable sequences (ITS2, rDNA) will be fundamental to determine if the high diversity of bamboo corals in New Zealand correspond to a rapid radiation.

Poster

10.17

MOLECULAR AND MORPHOLOGICAL DIVERSITY OF STYLASTER CORALS IN THE CENTRAL ALEUTIAN ISLANDS, ALASKA

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Identification of Alaskan *Stylasters* is maddeningly difficult. A genetic analysis using 16S mtDNA was performed to resolve the problems in placing morphological features with various species. Thus far it seems that fewer species have been identified than are reported in the literature. Certain morphological characters appear to be homoplasic, and some characters may only appear in specimens of advanced age, further confusing attempts at identification. Grouping of genetically identical specimens does reveal a set of characters not previously reported that may allow for accurate field identification. Half of all specimens sampled for this study are of a single species that is never listed in field identifications from NOAA cruise reports. The dominant species forms a single well mixed population with genetically identical specimens occurring on the Pacific and Bering Sea sides of the Aleutians.

Poster

10.18

HIDDEN DIVERSITY IN THE ORDER ZOANTHARIA (CNIDARIA: ANTHOZOA) REVEALED BY MOLECULAR ANALYSES: TAXONOMIC IMPLICATIONS FOR PARAZOANTHIDAE (HEXACORALLIA: ZOANTHARIA)

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The problematic taxonomy of the hexacorallian order Zoantharia is due to the lack of easily accessible and informative morphological taxonomic characters. Therefore, zoanthids are seldom included in biodiversity studies despite their presence in the benthos of almost every marine area. In deep-sea environments, zoanthids are usually associated to different organisms used as substrates, such as gastropod shells, often inhabited by hermit crabs, gorgonians or hexactinellid sponges. Recently, DNA-based studies have proven to be of great use in clarifying relationships among Zoantharia and suggested that the type of organism used as substrate may be used for identification. NIWA collections contain many undetermined and undescribed zoanthids from the deep seas around New Zealand. A preliminary examination of this collection presenting some unreported associations (i.e. between zoanthids and Isidid gorgonians) suggested unknown but important and high levels of diversity among deep-sea zoanthids. However, due to the still chaotic taxonomic situation this diversity and its taxonomic level (genus, family, etc.) remain to be confirmed. Here we present preliminary results obtained using molecular markers and their implication for zoanthid systematics.

Poster

10.19

CORAL ID – NO LONGER 'ALL AT SEA': MARRYING TAXONOMIC DESCRIPTIONS OF DEEPSEA CORALS WITH AT-SEA ID GUIDES

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Identification and recording of the invertebrate catch while at sea can be difficult. In New Zealand, invertebrates caught on or close to the seabed are identified and weighed by observers or researchers on board commercial and research vessels. Specimens of many species in the past have had to be retained for later examination by experts ashore because of the lack of information available at sea.

To enable observers and researchers to identify these organisms more easily, and to improve the standard of catch records, two invertebrate identification guides for New Zealand fisheries were produced: A Guide to Common Deepsea Invertebrates in New Zealand Waters funded by the Ministry of Fisheries (Tracey et al 2007), and a Coral Identification Guide funded by the Department of Conservation (Tracey et al 2008). Many taxonomic experts had direct input in preparing these guides.

Building on the identification guides, specific on-deck, rapid Vulnerable Marine Ecosystem (VME) ID guides are currently being produced for use by observers in international waters of the South Pacific and Ross Sea. These guides are designed to be used on deck, and use a comparison table format arranged by distinguishing features to allow observers to identify a particular group, and to contrast other similar groups.

Funding to support the production of pictorial guides on deepsea corals is enabling fisheries and conservation managers to obtain more accurate identification of invertebrates, to better monitor trends in the occurrence and distribution of bycatch, and address concerns about the effects of fishing on corals. The development of accessible identification guides is an important step towards the goal of a healthy aquatic environment.

Poster

11.01

GLORIA KNOLLS: A NEW COLDWATER CORAL HABITAT ON THE GREAT BARRIER REEF MARGIN, AUSTRALIA

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Coldwater coral habitats are usually associated with large geological features, such as deepwater seamounts and guyots, or found as smaller mounds on relatively steep continental slope and basin areas. Although seamounts are typically of volcanic origin, which explains their complex topography and hard substrates, the genesis and initial control of the smaller mound settings on soft sediment is currently a point of debate. For example various seabed features, such as hydrocarbon seeps, slumps and mud volcanoes, may provide the initial topographic relief, then is followed by phases of mound development due to favourable oceanographic conditions and the successive build-up of coldwater coral communities. Here we present new high-resolution multibeam bathymetry datasets from the Great Barrier Reef (GBR) margin. Combined with sub-bottom profiles and rock dredge samples, these data provides a fresh insight into the origin and spatial distribution of a new coldwater coral habitat discovered in the adjacent Queensland Trough. These findings suggest that large blocks may have broken off the GBR margin as catastrophic landslides, moving down the lower slope and coming to rest in the basin where they now form a preferential habitat for a deep, coldwater coral community.

The multibeam and sub-bottom data reveal a spectacular network of submarine canyons, slump scars and landslide deposits on the continental slope and upper basin. The canyons often terminate in the Queensland Trough as slide scarps and debris fields where progressive upslope erosion has reduced the stability of the parent margin sediments. Lying downslope of the canyons and slump scars, the multibeam maps show a cluster of eight knolls up to two km long and over 100 m high in depths of about 1100 m. Moats or scours are prominent around the larger knolls and are indicative of impinging bottom currents. Sub-bottom profiles across the knolls show they are discrete, seismically-opaque blocks capped by a ~15 m of soft sediment. The blocks protrude through multiple, parallel sub-surface reflectors from the adjacent basin sediments. A rock dredge taken across the top of the largest knoll recovered evidence of a coldwater coral community, including live gorgonian and dead scleractinian corals, barnacle plates, gastropods, serpulid worms, and manganese-covered concretions within a matrix of carbonate mud. We named these fascinating features the Gloria Knolls, and they represent the first documented case of a coldwater coral habitat adjacent to the GBR World Heritage Area (GBRWHA). Significantly, the multibeam maps show the potential for other geomorphic features with similar origins to be used as proxies for deep seabed biodiversity distribution along the GBR margin.

Poster

11.03

QUANTITATIVE HABITAT CHARACTERIZATION AND BENTHIC ASSEMBLAGE STRUCTURE OF DEEP-WATER SCLERACTINIAN REEFS OFF EASTERN FLORIDA

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Eight deep-water coral sites were surveyed in November 2005 during 11 dives with the *Johnson-Sea-Link* submersible along the eastern continental margin of Florida from St. Augustine to Miami. Sites included unconsolidated sediment/coral bioherms, rocky lithoherms and the Miami Terrace escarpment. Photographic transects using high-resolution video and digital still images documented each site. Observations were made over a depth range of 282-871 m. *In situ* temperatures ranged from 6 to 9ºC. We examined 31 video transects and extracted over 2500 images for habitat characterization and quantitative analyses of percent coverage by substrate type using the Coral Point Count software (CPCe). Densities of major macrobenthic assemblage components were also quantified. The percentage of live coral varied among sites, regardless of the dominant species in that area. PRIMER-E was used to compare distributions of percent cover, and relative abundances and densities of organisms within and among sites. Distributions of some taxa were depth-related, while multiple factors appeared to be responsible for the distributions of others. Sites with relatively few dead standing coral colonies and high percentages of coral rubble, sediment and rocky substrates appeared to harbor similar assemblages. Overall organism densities correlated significantly with availability of hard substrates. Dead standing coral colonies did not affect organism density, but had a significant effect on assemblage composition at different sites.

Poster

11.04

DEEP-SEA CORALS OF CAMPOS BASIN (BRAZIL): RESULTS AND PERSPECTIVES

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Knowledge of deep-sea coral communities is still scarce in SW Atlantic Ocean despite recent contributions in the last few years off the Brazilian coast. Since the oil and gas activities have been considered as a potential threat to these ecosystems, the Research and Development Center of the Brazilian Energy Company - PETROBRAS, with the partnership of some national universities, has implemented, since 2004, a detailed deep-sea coral assessment project in Campos Basin (SE Brazil) to subside its environmental management in deep waters.

The main goals of the project were to confirm, using remotely operated vehicles (ROV), the existence of coral banks that were previously indicated by acoustic methods (mainly side scan sonar-SSS) in selected sites and, after their ground-truthing, to characterize these ecosystems, considering their biological and physical aspects. This paper consolidates and discusses the results obtained by the project after four surveys carried out between 700 and 1200 m depth in 39 sites until 2007 and presents the scope and perspectives for a next three-year study.

Although estimates in coral banks cover after SSS information were much greater than ground-truth with ROV surveys, this acoustic method can be considered as a useful first screening tool for indicating the presence of deep-sea corals communities in a determined region. The coral banks covered less than 6 % of the total investigated area and varied in shape, size and height: while the smallest ones (< 1 m) had rounded shapes, the biggest ones (> 100 m) were elongated, showing some current orientation. In terms of heights, the banks had a mean value of 1.54 ± 0.08 m (mean ± SE). More than 90 taxa were identified by taxonomists using video footages and collected samples. Porifera (mainly Farreidae) was the most frequent group jointly with stony (mainly Caryiophylliidae) and soft corals (mainly Primnoidae). Among stony corals, *Solenosmilia variabilis* was the dominant species. Echinoderms and crustaceans were also registered, usually associated to the sponges and corals. Towards the margin of the banks, the faunal density diminished and non-sessile organisms such as bony fish (mainly Macrouridae) and cartilaginous fish were frequently observed swimming by.

At the beginning of 2008 the project started a new phase, now giving focus on some processes that control distribution of deep-sea corals in the region. A total of 13 monthly ROV surveys, have already been planned to collect four of the main deep-sea scleractinian reef-building species (*S. variabilis*, *Lophelia pertusa*, *Enallopsammia rostrata* and *Madrepora oculata*) for a reproductive biology study. Moreover, two other cruises will compare coral bank community structure in areas with differences in bathymetry and latitude.

Poster

11.05

ADVANCING MARINE HABITAT CLASSIFICATIONS THROUGH A NEW GLOBAL TERRAIN MAP TO INTEGRATE ECOLOGY IN BIODIVERSITY DATA SYSTEMS

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The scientific literature has frequent mention of ocean features such as seamounts, abyssal plains, and continental shelf and slope. However, no world map using a standardised definitions of the features and produced using a standard method exists in a form amenable to use for analysis; for example to compare against species distributions. Often, studies say their country or sea area is the n^{th} largest in the world, but cite no primary sources for such statistics. Using a Geographical Information System, we produced a seabed terrain map using the best available world bathymetry derived from gravitational anomaly, and updated by Smith and Sandwell in 2008. We calculated statistics for the each country's marine limits defined as their Exclusive Economic Zones (EEZ), and seas and oceans as defined by the International Hydrographic Office, namely: seabed and sea surface areas; average, maximum and standard deviation of depth; average, maximum and standard deviation of seabed slope. Further work will predict the locations of topographic features so it will be possible to overlay them against species distribution data, for example as are in the Ocean Biogeographic Information System.

Poster

11.06

GIS STRATEGY FOR MAPPING COLD-WATER CORAL HABITATS IN THE WESTERN MEDITERRANEAN SEA, SPAIN

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Cruises performed in the Western Mediterranean within the EC-funded HERMES project have provided geographically well distributed data like multibeam bathymetry and acoustic backscatter, which have been used in a GIS project to guide more focused activities, like ROV observations and sampling. Acoustic maps have been analyzed with means of GIS to extract different acoustic classes, which in their turn have been applied to the identification of seafloor habitats. This method is based on the morphology, substratum characteristics and long-term oceanographic requirements of the organisms in the habitats under consideration. Groundthruting through ROVs, video inspection and sampling has been performed at well-selected locations and transects. Unfortunately, the groundthruting strategy cannot be applied for general mapping purposes as it involves high economic and temporal costs.

To evaluate the occurrences of cold-water coral location, a multicriteria approach has been used to mark the cold-water coral environment based on present knowledge. Coral distribution in the Western Mediterranean Sea shows that this benthic community occurs within areas characterized by rather abrupt morphological changes, hard substratum, low sedimentation rates and relatively shallow depths, under the influence of episodic or continues cold waters. The Benthic Terrain Model (BTM) generated is a basic acoustic-sampling model for habitat mapping, which has been developed and implemented within a GIS context. This model is basically based on bathymetric data and derivate multibeam data products such as slope and rugosity, and the Bathymetric Position Index (BPI), which is a measurement related to a referenced location. The application of the GIS based technology to onboard pre-processed data and to data processed after the cruises allowed us to guide better-focused observations and to map quickly the coral habitat distribution.

In general, living framework forming corals are limited to upper flanks of seamounts and canyon heads where a rough and hard substratum is available. New coral settlements have been found on top of fossil oyster shells at the seamounts of the Alboran Sea. Though all investigated areas show a certain disturbance by fishing, which makes it difficult to estimate the original environment, it seems that cold-water corals take advantage of the flow of cold and fresh waters easing them to occur generally in relatively shallow waters. However, environmental conditions limit reef building, which is restricted to patch or thicket stages.

Poster

11.07

PREDICTIVE MODELING OF CORAL AND SPONGE DISTRIBUTION IN THE CENTRAL ALEUTIAN ISLANDS (ALASKA, U.S.A.)

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Alternative models for predicting the probability of abundance or presence/absence for deep-sea corals and sponges in the central Aleutian Islands (Alaska, U.S.A.) from 50 to 3000 m depth were considered. We focused particularly on two modeling approaches, logistic regression and generalized estimati ng equations (GEE). Explanatory variables included depth, slope, and rugosity. Models were evaluated based on a cross validation procedure. Using logistic regression, models of occurrence north of the Aleutian chain were more successful than models for ar eas to the south of the chain. Model success was related to prevalence of the taxonomic group. Based on the predictive model, there are large swaths of sea floor below 200 m with potential coral garden habitat (highly diverse coral and sponge communities), particularly north of the Aleutian Islands arc and in Amchitka Pass. The merits of alternative models as well as sampling and modeling considerations and constraints are discussed.

Poster

11.08

CONSISTENT QUALITY LONG-TERM HABITAT MAPPING AND MONITORING – SIDESCAN VERSUS MULTIBEAM

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During a cruise in 2006, a cold-water coral reef complex of several square kilometres in size has been mapped with high-resolution deep-towed sidescan sonar (325 kHz) and shipboard multibeam (30 kHz). These reefs of *Lophelia pertusa* are located in the Minch (NW Scotland), in about. 260 m water depth. During the cruise, an experiment was carried out by repeatedly running identical survey lines over the same patch of coral with the aim to compare the backscatter data of both systems and to test the repeatability of each system. The data were processed, using radiometric and geometric corrections, with the in-house NOCS software suite *PRISM*. Processing both data sets with the same software suite guarantees consistency and allows highly detailed comparison of the image textures.

Texture analysis methods have previously been proven to enhance the quality and consistency of the sonar image interpretation by revealing texture patterns 'invisible' to the human eye. The texture analysis software used for the coral datasets was the University of Bath package *TexAn.* It uses Grey Level Co-occurrence Matrices (GLCMs) to calculate entropy and homogeneity indices in moving windows across the imagery. Entropy quantifies the amount of local chaos or organisation within an image, whereas homogeneity describes the amount of similarities/dissimilarities in a chosen neighbourhood around each pixel. This method has been used successfully to distinguish different types of coral facies (live, dead, sponge covered rubble) within a reef complex from sidescan sonar data. An intense ground-truthing was a pre-requisite for the interpretation, and was carried out during the cruise using a camera system.

From the repeatability test on the sidescan data it became clear that the image texture is very sensitive to changes in angle of incidence of the towed system (i.e. the towing height above the seabed, which is difficult to control). The texture analysis algorithm identifies the same large-scale patterns in the repeated survey lines, but mapped considerable differences in the fine details. The multibeam data does not suffer from this effect but shows water column artefacts that could mislead the interpretation.

This study is the first step towards the development of a long-term monitoring strategy for cold-water coral reefs that are protected against economic (e.g. fishing) and environmental (e.g. pollution) impacts and where quick assessments are vital for stakeholders.

Poster

11.09

DEEP-WATER ALCYONACEA OF FLOWER GARDEN BANKS, NORTHWESTERN GULF OF MEXICO

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Flower Garden Banks National Marine Sanctuary (FGBNMS) boundaries encompass two large salt dome uplifted banks and a third location, Stetson Bank, on the continental shelf break in the northwestern Gulf of Mexico. The shallow reef cap has been called the “healthiest coral reef in the West Atlantic” because of its high coral cover and low incidence of disease. Gorgonian octocorals are absent from the reef cap, and were presumed absent from the banks until submersible surveys in the 1980’s revealed a mesophotic zone at 100 m depth characterized by sea fan colonies. Since that time, ~150 remotely operated vehicle transects have been conducted in deep-water during 10 cruises from 2002-2008. A photo-database of ~8000 *in-situ* images was assembled and cross-referenced to gorgonian voucher specimens and imported to a Geographic Information System. Gorgonian species were identified using scanning electron microscopy (SEM) of the diagnostic sclerite morphology. A comprehensive checklist of 20 deep-water octocoral species in families Anthothelidae, Ellisellidae, Gorgoniidae, Keroeididae, Paramuricidae, Plexauridae, and Primnoidae is provided, including SEM plates, depths of occurrence, *in-situ* photos, and generic maps of their distribution within FGBNMS.

Poster

11.10

SEASCAPE DESCRIPTION OF AN UNUSUAL CORAL REEF AREA OFF VESTERÅLEN, NORTHERN NORWAY

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Several studies have indicated that the distribution of cold-water coral reefs is correlated with rough topography and slopes exceeding a certain critical angle. In this study, based on results from multibeam and videos (obtained by the Norwegian seabed mapping program MAREANO), we show that this is not always the case. The study area is situated in the Hola glacial trench off Vesterålen. Here, *Lophelia*-reefs occur in the deep parts of the trench at the northern side where the currents flow from the coast towards the shelfbreak. The seabed is relatively level with small gravelly patches within a mainly sandy environment. One active gas seep was discovered in the outer part of the reef area, but no signs of seepage or carbonate crusts were found within the central and denser reef area. In total, there were 330 reefs in the area. These were 31 - 334 m long, 27 - 114 m wide, and 4 – 17 m high. Most (132) of the reefs were smaller than 100 m in longest direction, whereas only 81 reefs were longer than 200 m. The shape of the reefs changes from circular to elongate with increasing size. They normally consist of a relatively small (20x20 m) living up-current front and a longer “tail” of coral debris. Signs of erosion were common around the reef front. Seabed topography has no direct influence on the coral distribution, but influences the environment by modifying the hydrodynamic setting. Local topographic features such as peaks and ridges induce accelerated currents and are favorable locations for reef growth. The Hola trench is a landscape feature which also seems to induce strong currents, bringing nutrient rich water from local production at the shelf. Within the range of the coral’s temperature and salinity tolerance the combination of hard bottom substrate for coral larvae settlement and relevant food transport rates are probably more important than the local topography of the seabed.

Poster

11.11

SÙIL NA MARA, THE 'EYE OF THE SEA', A MICROLANDER SYSTEM FOR MONITORING COLD-WATER CORAL HABITATS

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Monitoring variability and temporal patterns in environmental parameters is a vital part of understanding how cold-water corals function ecologically. Here we describe a small benthic lander designed to be deployed by manned submersible or remotely operated vehicle in a precise way within structurally complex coral habitat. In addition to standard oceanographic sensors (current meter, optode, fluorometer, light-scattering sensor, transmissometer) we use one of two camera systems: (1) a conventional digital stills camera with strobe illumination and (2) a novel time-lapse digital video camera with infra red illumination to avoid confounding effects of white lights in an aphotic environment. We believe this approach has great potential to make observations as unobtrusively as possible allowing us to build a better picture of species interactions and responses to environmental changes.

Poster

11.12

CLASSIFICATION OF BENTHIC HABITATS FROM VIDEO AND STILL PHOTOGRAPHS

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There is a need to develop standard methods to classify habitats to enable comparison within and across studies, provide a structured method for describing habitats, and facilitate data management in databases by using standard fields and vocabularies. Typically, habitats are classified using a range of observations and in situ samples. Increasingly video and still photography surveys are being employed to explore deep-sea marine habitats. Unlike data collected from sampling seashores, scuba diving observations, ROV, or manned submersibles, it is often impractical to make direct in situ observations or collect physical samples from deep-sea habitats. Thus the habitats and species present must be identified from the image alone. Previous studies have classified benthic habitats using a variety of terminology and hierarchical relationships representing the environmental features that help classify the habitats. Some place the emphasis on the geological and other the species present, and most were developed in a regional context. Some classify habitats at different spatial scales. Here we describe a method to classify seabed habitats from images that has been tested (a) against previously classified images from shallow-water habitats in Europe, (b) in coastal water below 50m depth off the north-east coast of New Zealand, and (c) in the Ross Sea, Antarctica, at >600 m depth. Our aim was to provide an ecological relevant classification, by defining the habitat based on its species present, or our expectation based on current knowledge of shallow water species ecology, that the different habitats were likely to harbour different assemblages of species. Our approach was constrained by the field of view of video and still photograph. Typically this is less than 2 m^2. Data was captured using a standard template that recorded the area covered by features visible on the seabed. We propose three primary categories of information: slope; substratum; relief. Relief estimates the extent of 3-D habitat that is known to be important for many fish species. It was subdivided into that of geological and biological origin. This methodology was tested using images previously classified by other researchers, and with new coastal and deep sea data from New Zealand and the Ross Sea. The resulting tables used to capture the habitat parameters, and associated vocabulary, may provide a parsimonious approach to classifying benthic habitats in other studies and databases.

Poster

11.13

USING MUSEUM RECORDS TO INVESTIGATE DISTRIBUTIONS OF DEEP-SEA CORALS: HOW VALUABLE ARE THEY?

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Since distributions of deep-sea corals are poorly known and detailed maps are generally lacking, many researchers have used museum records to enhance distribution maps. Deep-sea coral museum data are usually acquired from online museum catalogues. However, lack of interaction with the specimens or museum personnel raises questions about the quality of the data, including the reliability of identifications, accuracy of positions, and completeness of data. Also, it is common that many museum specimens are unavailable through online sources because they are either uncatalogued or because catalogued specimens were not yet entered into electronic databases. During our investigations of deep-sea coral communities off the southeastern US, we evaluated holdings of four dominant deep-sea coral species (*Lophelia pertusa*, *Madrepora oculata*, *Enallopsammia profunda, Enallopsammia rostrata*) in the US National Museum (USNM) and the Harvard Museum of Comparative Zoology (MCZ). First, we gathered all possible data via online sources and from publication listings for the above species. The resulting database was imported into ArcGIS in order to query, plot, and map the data. We examined the museum records and cross referenced these to published sources to find data discrepancies. For example, different publications may reference the same museum number but provide contradictory data. Finally, we visited the two museums and attempted to physically locate each identified record as well as any other records. We photographed each sample and obtained as much additional data about the record as possible. For all four coral species we located 256 records at the USNM and 11 records at the MCZ, and 52 and 6 of these, respectively, were new (i.e., unavailable from electronic databases). Although errors were not extensive, the problems we encountered included lost specimens, museum numbers not explicitly associated with a distinct station, same museum number for different taxa, and missing station data. Missing station data was the most pervasive and serious problem. Museum collections are quite useful for investigating deep-sea coral distributions; however, these data require more scrutiny than they usually receive in order to achieve this utility. The available electronic data, in contrast, seem to be less valuable and may even be misleading. We encourage and recommend improvements to online databases, including more complete data entry, better metadata, and more complete cataloguing.

Poster

11.14

NEW ZEALAND DEEP-SEA CNIDARIA: PAST, PRESENT AND FUTURE

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Records of New Zealand Cnidaria date back as far as the early 19th century with the first records reported following the *Astrolabe* Expedition. Since then, New Zealand cnidariological research has steadily been advanced, by New Zealand and international scientists alike. At present, the entire Cnidarians fauna of New Zealand is recorded as over 1,100 species including all orders, with a high proportion of endemism across most taxa. Of all known species, approximately a third are either new to science or not yet identified and estimates of the total Cnidarian fauna exceed 2300 species. It is apparent, that for some groups such as the Antipatharia or Gorgonacea, New Zealand is a biodiversity hotspot. The NIWA Invertebrate Collection (NIC) in Wellington holds one of the largest and most diverse New Zealand collections of marine Cnidaria with nearly 7500 registered specimen lots covering 106 identified families (302 genera) so far. These samples were collected over five decades of research in the New Zealand region, the southwestern Pacific and the Ross Sea. Our collection is constantly augmented through a very active collection program including fisheries bycatch studies and sampling on seamounts, hydrothermal vents, cold seeps and in the Southern Ocean. Although this material already provides a critical resource for a diverse range of studies ranging from taxonomy to long-term ecological research, biosecurity monitoring, bioinformatics and marine conservation, the potential for new questions and approaches remains large.

Poster

11.15

HABITAT MAPPING AND FACIES DISTRIBUTION THROUGH TIME AT S. MARIA DI LEUCA CORAL MOUND PROVINCE: MAIN RESULTS FROM THE APLABES PROJECT

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Selected areas within the Santa Maria di Leuca Coral Mound Province were investigated on the Apulian margin between 350 and 1200 m water depth, within the National Italian Project APLABES (Apulian Plateau Bank Ecosystem Study). The aim of this study was to define (1) the distribution of habitats, living organisms and their remains within sediments which contribute to local carbonate production and (2) the sea bottom sedimentary context on which coral mounds are developed (Malinverno *et. al*.; Mastrototaro *et. al*.; Rosso *et. al*.; Savini *et. al*.; Vertino *et. al*., all in press on Deep Sea Research II).

Local topography and near surface sediment stratigraphy are strongly forced by tectonics and geomorphology which cause submarine scarps and overhanging, large scale erosional features, sediment failure along slopes, local accumulation through gravity and/or the action of strong bottom currents. A complex topographic and habitat distribution pattern results with patches of mound-like structures and elongated ridges including two main mesohabitats (mound and intermound) and several coral-bearing and -barren macrohabitats. The coral-rich macrohabitats, characterized by densely-packed colonies of scleractinians (mainly *Madrepora oculata*) are typically restricted to the mound areas whereas the mud-dominated ones, almost devoid of coral colonies, are more common within the intermound mesohabitat. Along the opposite flanks of the same relief there is a clear differentiation: *Madrepora* colonies are located on top and along the NE mound flank; solitary corals and antipatharian colonies dominate the fragmentary exposed scarps and heterometric boulders located on the mud-dominated SW flank. Typically, fan-shaped corals and sponges show a NNW-SSE preferential orientation seemingly caused by a main south-westerly current flow. Skeletal remains, or thanatofacies, of colonial frame-building corals and other bottom-dwelling faunas from different habitats have proven to posses a high fidelity in recording living facies and largely supply coarse bioclastic fractions to sediments, mostly consisting of hemipelagic silty clay, enhancing to delineate different sedimentary facies.

Sedimentary successions show (1) strong lateral variability in sediment type and age including areas where mid-Pleistocene sediments are brought very close to the bottom surface due to broad erosional features, (2) sites with relatively thick late Pleistocene to Holocene series, falling within the *E. huxleyi* acme nannofossil zone and (3) areas of periodic accumulation and local re-deposition of coarse biogenic sand from the surrounding areas and from shallower depths. Coral growth seems to begin on hardened bottoms and shell lags, sometimes with subsequent phases of colonization, with active mound construction during the last postglacial, at least in some areas.

Poster

12.01

MEADOWS OF *ANTIPATHELLA SUBPINNATA* (MYRIOPATHIDAE, ANTIPATHARIA) IN THE CALABRIAN TWILIGHT ZONE (SOUTHERN TYRRHENIAN SEA, ITALY)

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The hard substrata of the Mediterranean twilight zone commonly host the black coral *Antipathella subpinnata*, a large, white, branched antipatharian coral. The colonies of this species are generally single or grouped in small patches of around 10 specimens. The discovery of the widest populations of this species ever recorded in the Mediterranean Sea, and forming meadows of thousands of colonies in the deep waters off the Calabrian coast (South Italy, Tyrrhenian Sea), is herein reported. The specimens have been photographed and filmed with the aid of a ROV during an oceanographic campaign on board of the R/V *Astrea* of ICRAM. Detailed georeferenced bottom profile 3D maps were obtained by means of multibeam data, pointing out that the surveyed area was formed by several rocky shoals ending on a detritic bottom.

Two dense meadows have been monitored in the site of Favazzina in the northern border of the Messina Strait and several ecological data have been collected concerning the bathymetric distribution of the species, its habitat and the population structure. The colonies are located only on the western side of the explored shoals between 55 and 100 m depth, with higher densities on the most inclined substrata. In the upper part of the slope, until 65 m depth, the meadow is mixed, being composed of both *A. subpinnata* and the gorgonian *Paramuricea clavata*. Around 70-80 m depth the seascape is completely dominated by the arborescent colonies of the black coral (densities of 1-5 colonies/m^2). The population is made of both adult colonies of big size (more than 1 m high) and small juveniles (around 20-30 cm high). Pink coloured patches of fertile polyps are randomly distributed on the branches of mature colonies. Sizes and density of adult specimens tend to decrease with depth, and around 100 m only small, sparse colonies have been reported.
A. subpinnata creates an important three-dimensional habitat and represents the most characteristic component of the lower fringe of the circalittoral twilight environment in the Mediterranean Sea.

This study has been conducted by ISPRA (ex ICRAM), within the project n°327 MoBioMarCal, and financed by the Calabrian Regional Council for Environment.
This work undertaken through MoBioMarCal is affiliated to the European Census Of Marine Life.

Poster

12.02

THE IMPORTANCE OF PARTICLE-RICH DOWNWARD WATER MOTION AND BOTTOM WATER ADVECTION AS FOOD SUPPLY MECHANISMS TO THE COLD-WATER CORAL *LOPHELIA PERTUSA* (SCLERACTINIA) AT THE MINGULAY REEF COMPLEX.

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The colonial cold-water coral *Lophelia pertusa* forms large biogenic reefs in the North Atlantic Ocean. The food supply mechanisms to these reefs have been largely conjectural with a general consensus that topographical focussing of currents and breaking internal waves on critical slopes play important roles. Several *L. pertusa* reef areas form the Mingulay Reef complex in the Sea of Hebrides at 140 m water depth west of Scotland. In 2006 and 2007, multiple deployments of current meters and optical sensors were made in the first detailed *in situ* study of the particle supply to the coral community in the area. Two distinct and predictable particle supply mechanisms were resolved. One mechanism consisted of the rapid downwelling of surface water caused by hydraulic control of tidal flow that transports particles from the surface to the corals in less than an hour. The rapid downwelling was recorded on the reef top as a pulse of warm, fluorescent and relatively clear water at the onset of the flood and ebb tides. The pulse was strongest after flood tide and lasted for up to three hours. The second mechanism consisted of advection onto the reef of deep bottom water with a high suspended matter load. This advection occurred during peak tides and was combined with topographical current acceleration on the reef top enhancing delivery of particles to the corals. Particle quality in the latter case may have been lower given reduced fluorescence levels of the advected bottom water.

Poster

12.03

DISTRIBUTION PATTERNS OF DEEP CORALS AND OTHER MEGAFAUNA ON A RIDGE AND SEAMOUNT IN THE NORTHWESTERN HAWAIIAN ISLANDS

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In November, 2007, the *Pisces V* submersible was used to survey benthic megafaunal distribution patterns on two sites within the Papahanaumokuakea Marine National Monument in the Northwestern Hawaiian Islands. Three dives were conducted on the top and each side of a rift zone ridge extending south from West Twin Bank. Four additional dives (3 biological and 1 geological) were conducted on the north and south flanks of an un-named seamount located near French Frigate Shoals. A single upslope belt transect was conducted on each of the six biological survey dives, with depths ranging between 1755 m to 1153 m, and 1330 m to 683 m for the ridge and seamount sites, respectively. The width of each transect was defined by the submersible light field which varied according to orientation to the slope and terrain but averaged 20 m based on measurements obtained during previously conducted two-sub dives. A trained observer on each side of the sub counted and identified invertebrates and fishes to the highest possible taxonomic resolution, which ranged from species (i.e. *Metallogorgia melanotrichos*) to a general description of color and shape (i.e., cnidarian small two fingers). The types of substrates were also noted during the dives, which on the deeper ridge consisted of manganese-crusted volcanic bedrock, pillows, boulders, dikes, and talus with intermittent sediment patches. On the seamount, manganese-crusted basalt bedrock and boulders mixed with sediment patches were dominant from 1330 m to 1050 m. At 1050 m, both exposed and manganese coated carbonate appeared that continued up the flanks to the flat crescent shaped summit at 683 m.

A total of 7015 animal counts (77 identifiable families) were recorded on the deeper ridge (site 1), 80% of which were cnidarians (5584 counts, 25 families). Sponges were the next most abundant group (837 counts, 9 families), followed by arthropods (219 counts, 11 families), fishes (193 counts, 12 families), and echinoderms (182 counts, 19 families). On the seamount (site 2), a total of 36741 animal counts (100 identifiable families) were recorded, 80% of which were cnidarians (29463, 32 families), followed by sponges (6397 counts, 9 families), fishes (337 counts, 20 families), arthropods (307 counts, 13 families), and echinoderms (237 counts, 26 families). Echinoderms and arthropods were under-surveyed on both sites due to the inability of the observers to count commensal ophiuroids and crabs living on gorgonians and sponges. Distribution patterns varied widely between and within groups in relationship to the location on the feature (i.e., flank vs crest/summit), depth, and substrate type. For example, shrimp and fishes were more abundant on the apparent “lee flank” of both sites where sedimentation was higher, while gorgonians and sponges showed the opposite pattern. Corallids were found in high abundance at the deep north side of the seamount whereas chrysogorgiids were more abundant close to the summit on either side of the seamount. Surprisingly few gorgonians were observed on the crest of the ridge where the substrate was dominated by manganese-cemented talus. These and other megafaunal distribution patterns on these sites will be discussed in this presentation.

Poster

12.04

DEEP-WATER CORALS IN THE SOUTHERN OCEAN - THE NBP08-05 EXPEDITION

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In May 2008 the R/V Nathaniel B. Palmer 08-05 expedition set out to locate and sample live and fossil deep-water corals in the Drake Passage, between South America and the Antarctic Peninsula. Prior to this project there had been no cruises specifically directed to imaging or sampling deep-water corals from the Drake Passage; the species composition, densities, and ranges are therefore likely to be vastly underestimated in this region. During this expedition a combination of multibeam bathymetry, WHOI TowCam seafloor photographs, environmental water chemistry, dredges and trawls were used to map, characterize and sample, cold-water coral populations.

Five main areas were explored during this cruise: Burdwood Bank, the slope north of Elephant Island, the southern Shackleton Fracture Zone, an unnamed seamount we called Interim Seamount, and Sars Seamount in the western Drake Passage. Water depths ranged from ~200m to ~4000m. This survey strategy created a transect across the Drake Passage from the Argentine to the Antarctic Continental Shelf. In each area we collected multibeam bathymetry data to create the first detailed bathymetric maps (Burdwood, Interim and Sars sites) or added to existing maps (Elephant and Shackleton sites). Water depths in the areas mapped ranged from about 200m to about 4,000 m. Biological sampling was carried out at each of the five sites at a wide range of water depths up to 2,700 m. Seafloor photographs and water samples were collected from all sites except Burdwood. Three CTD deployments were completed near Burdwood, Elephant, and north of Interim Seamount.

In total, 36 species of coral were collected (including Stylasterid, Octocorallia and Scleractinia) and over 8,000 images along a total of 16 km of trackline were taken with the WHOI Towed Camera covering a wide range of seafloor types, including bare basalt, silty sand, coarse coral sand, ferromanganese nodules and drop stones.. These images were analyzed for biota and bottom type, allowing characterization of areas where deep-water corals live in this extreme environment. All newly collected data were entered into an ArcGIS database to allow synthesis with existing environmental datasets and for analysis of habitats.

A website, created by the Census of Marine Life for Seamounts (URL: http://censeam.niwa.co.nz/outreach/nathaniel_b._palmer), made daily updates from the ship and other related educational material available to the public.

Poster

13.01

THE P/Ca, Ba/Ca, AND B/Ca PROXIES IN THE SOLITARY DEEP SEA CORAL *D. DIANTHUS*: SAMPLING AND ANALYTICAL STRATEGIES

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We have developed and are refining skeletal proxies for seawater nutrients and pH. These fundamental variables have been difficult to reconstruct using traditional paleoceanographic proxies, but are critical to reconstructions of water mass mixing and biogeochemical cycles in the past ocean. Using 193nm laser ablation (LA) HR-ICPMS, we measure elemental ratios in globally distributed modern samples of *D. dianthus*. Mean P/Ca, Ba/Ca, and B/Ca ratios for each coral, along exterior surfaces and transverse longitudinal sections of septa, are regressed against hydrographic data from nearby stations, integrating multiple years of growth. P/Ca is strongly correlated with seawater phosphate (D_{PO4}~0.7, where D=element/Ca in coral divided by element/Ca in seawater; R^2~0.7), and Ba/Ca with the nutrient-type seawater trace metal barium (D_{Ba}~1.8, R^2~0.96), while B/Ca is positively correlated with seawater pH (slope D_B~1.6, R^2~0.8). Additionally, we present spatial 3-D maps of P/Ca, Ba/Ca, and B/Ca across different skeletal micro-features, including the central band and surrounding fibrous aragonite, to identify possible non-environmental factors influencing skeletal elemental ratios. We are using micromilling and solution phase ICPMS to complement LA-ICPMS and address cleaning protocols and proxy element associations with intra-skeletal contaminant phases that contribute to compositional variations. We are also examining the reproducibility of elemental ratios within individuals and among different corals of the same age and location. Finally, we draw from these results a protocol for sample handling and analysis that optimizes precision and accuracy of these proxies, so that we can apply them to critical questions of past ocean circulation and biogeochemistry.

Poster

13.02

A NEW PALEOCLIMATE ARCHIVE FROM INTERMEDIATE WATER DEPTHS

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A limitation of many paleoclimate records is that they only provide temperature and productivity information for the surface ocean, often at annual or decadal scale. Higher resolution, seasonal paleoclimate reconstructions are important to determine the role of particular seasons in climate change. Many seasonal resolution records come from surface corals, where the high growth rates enable monthly to weekly sampling, but these archives are latitudinally restricted to the tropics and sub-tropics. Mid and high latitudes have larger seasonal ranges, making them of particular interest for paleoclimate reconstructions. Deep-water coral assemblages and their associated fauna occur in all ocean basins and over a broad range of depths and offer potential for such mid and high latitude paleo reconstruction. Various species of barnacle are commonly found in such assemblages, but have not been extensively investigated as a paleoclimate archive despite their sometimes large size and long growth period.

This study evaluates the potential of the deep-water barnacle Bathylasma corolliforme to reconstruct past oceanic conditions and particularly past seasonality. The barnacle secretes a robust low-Mg calcite shell with distinct growth increments on the external surface with estimated life spans of 30-50 years. The Bathylasma samples used in this study grew in the Ross Sea and became entrained by the grounding line of coastal ice shelves, indicating they should be a sensitive archive not only to changes in ice shelf dynamics, but also to changes in temperature and salinity.

Barnacle samples as old as 7000 years B.P. were collected from the McMurdo Ice Shelf. Barnacles and solitary corals are found in discrete debris piles on the surface of the ice shelf and chronology is determined through a combination of Δ14C and U/Th dating. One barnacle sample which was dated at > 200 ka recorded similar $\delta^{18}O$ and $\delta^{13}C$ values as Holocene samples suggesting no significant diagenesis. High resolution stable-isotope ($\delta^{18}O$ and $\delta^{13}C$) and trace-element analyses were obtained from nine shells by micro-milling. Average $\delta^{18}O$ values indicate that Bathylasma calcifies close to equilibrium with ambient seawater. Cycles of $\delta^{18}O$ and Mg/Ca correlate with annual growth bands. The amplitude of this seasonal $\delta^{18}O$ signal is significantly larger than the local seawater temperature range (~ 1°C) indicating an additional salinity effect from ice volume. Changes in the mean $\delta^{18}O$ value occur between 6 ka and 3 ka suggesting fluctuations in salinity and/or local ice balance during this period. These data indicate that Bathylasma can provide valuable paleoclimate information at seasonal resolution for intermediate water depths and regions such as Antarctica that play an important role in the climate system.

Poster

13.03

DEEP-SEA BAMBOO CORALS FROM THE TASMANIAN SEAMOUNTS: ISOTOPIC EVIDENCE FOR BENTHIC-PELAGIC COUPLING AND CENTENNIAL CONSTANCY OF OCEANOGRAPHIC CONDITIONS.

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Bamboo corals (Family Isididae) are an important component of seamount benthos in the Tasman Sea. Besides a lifespan of nearly 400 years, little is known about their basic ecology nor how to decode potential climate signals contained in their skeletons. We explored the stable N isotope and radiocarbon composition of the organic fraction of bamboo coral skeletons colleted from 3 seamounts southeast of Tasmania: Cascade Plateau (43.58°S/150.22°E; 900-1100 m water depth) Dory Hill (44.33°N/147.14°E, 1075-1656 m) and an unnamed seamount (44.19°S/146.20°E, 1050-1230 m). Analyses were performed on tissues and organic node growth rings sampled at a temporal resolution of 1-4 years. Radiocarbon chronologies exhibited bomb signals characteristic of surface waters, reconfirming that the skeletal organics are derived from recently fixed and exported organic matter. Radiocarbon chronologies constrained radial growth rates to ~0.035±0.010mm/yr for specimens of the genus *Lepidisis* and 0.113±0.017mm/yr for a colony of *Isidella*. δ^{15}N values of the living tissue and underlying gorgonin were similar and averaged 9-12 ‰. Compared with previously published values for suspended and sinking particulate organic matter collected in nearby waters the corals do not appear to feed directly on these food sources, but rather on higher trophic level intermediaries. Records of δ^{15}N showed subtle, quasi-decadal patterns over the last ~100 years, although the amplitude of these features (~1‰) was similar to the average intra and inter-colony reproducibility. These results demonstrate the utility of deep-sea corals to track seamount biogeochemical processes over long time-scales, and suggest that the extent of nutrient depletion of surface waters and associated trophodynamics have remained relatively constant in this region over centennial timescales. This provides an important baseline for the evaluation of the impacts of anthropogenic climate change.

Poster

13.04

ENVIRONMENTAL SETTING OF COLD-WATER CORAL LOCATIONS IN THE STRAIT OF GIBRALTAR AND ALBORAN SEA, SPAIN.

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This study reports on the spatial distribution and general environmental parameters of cold-water coral species in the Strait of Gibraltar. The results are based on data of SECEGSA (Sociedad Española de Estudios para la Comunicación Fija Europa-Africa a través del Estrecho de Gibraltar). This particular geological and oceanographic setting demonstrates coral colonisation in the deepest part of the Strait of Gibraltar in water depths between 250-300m (Álvarez-Pérez et al., 2005).

The cold water coral diversity in the western Mediterranean Sea is highest in the area of the Strait of Gibraltar, at the gateway between the Atlantic Ocean and the Mediterranean Sea. The dominant living cold-water corals in the present setting are the framework builders *Lophelia pertusa* and *Madrepora oculata*. The coral occurrences are situated at positive, local seafloor irregularities. The highest concentration of living corals is associated with underlying palaeo-channel. At the flanks of the palaeo-channels bio-constructions of up to 40m and between 100-800m in width are observed. The mounded structures demonstrate a certain elongation parallel to the structural lineation in the area and current patterns in a E-W direction. Short cores of these topographic features revealed a cemented boundstone.The fossil fauna observed in the cores is similar to the present living and dead fauna assemblage, including corals, Barnacles (crustacean) and bryozoans. The top of the fossil lithified coralbanks is dated back to 20-35Ky (Last Glacial Maximum) and the base of the mounds is estimated to be of Early Pleistocene age. The present day coral-ecosystem occurs in water temperature and salinity interval between 12-13 degrees Celsius and 38-38.5 PSU salinity that reflects a dominance of Mediterranean watermasses. The Strait of Gibraltar has a peculiar oceanographic setting and acts as the bottleneck between the exchange of Atlantic and Mediterranean water, which is strongly influenced by tidal currents as well as by wind and atmospheric pressure variations. The upwelling and mixing of the water masses results in a higher nutrient availability in suspension to the coral fauna, in combination with the seafloor morphology local turbulence safeguard the corals against sediment burial. During periods of low-stand (glacial periods), the corals seems partly extinct in the area, this might be due to the changing sedimentation and current pattern, that are more focused in the deepest parts of the sill. High-stand periods are characterised by strong currents and abrasion, the corals develop rather patches, which accumulates in protected areas to coral layers. In the Alboran Sea corals are commonly found at the flanks and the deeper tops of seamounts. Most of the corals are fossil, although little juvenile corals have been observed, indicating a recolonisation of the corals in the area. Dating of the corals indicate that the corals flourished in the colder periods in this area, in contrary to the Strait of Gibraltar.

Poster

13.05

COMPOUND SPECIFIC $\delta^{13}C$ AND $\delta^{15}N$ IN GOLD CORAL GORGONIN

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Recent evidence using radiocarbon has documented a rapid incorporation of recently exported particulate organic carbon in live polyps and the underlying hard horny protein skeleton of Gerardia, colloquially known as gold coral. Stable isotope analysis of (bulk) live polyps from subtropical North Pacific Gerardia are consistent with the interpretation provided by radiocarbon. Polyps show trophic level enrichment indicative of low level consumers: polyp $\delta^{13}C$: -19.3‰, $\delta^{15}N$: ~+8.3‰ relative to surface particulate organic carbon of -20 to -23‰ and from -1 to +1‰ respectively.

The close coupling between surface primary productivity export and Gerardia as inferred from the radiocarbon in the polyp and skeletal material, begs the question as to whether or not locked in the skeleton is a detailed record of past changes in surface water carbon signatures (sources) and nutrient cycling of unsurpassed fidelity. Potentially, an ideal tracer of nutrient cycling is the isotopic signature of essential and enriched amino acids. Essential amino acids are less likely to undergo trophic level modification and are thought to be 'superior' to bulk skeletal isotope analyses. We explore the isotopic differences between bulk and essential and enriched amino acids from a branch of a ~300 year old Gerardia. The time period provides an obvious first order check on the respective $\delta^{13}C$ time-series' anticipated 'Suess Effect.'

Poster

13.06

HIGH-RESOLUTION U-SERIES DATINGS OF *LOPHELIA PERTUSA* FROM A CARBONATE MOUND IN THE BANDA MOUND PROVINCE OFF MAURITANIA

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Cold-water coral-covered carbonate mounds are a well-known phenomenon of the Irish Margin. Newly discovered mounds off Mauritania – the Banda-Mounds – in 440 m water depth are similar in shape and size to their Irish counterpart. They have been sampled in January 2007 by the German R/V Poseidon, cruise POS-346. Cold-water coral mounds are known to have discontinuous growth, which is very likely dependant on climatic boundary conditions. The Mauritanian mounds now provide the opportunity to compare the growth dynamics of these low latitude structures under different climatic and oceanographic settings. For this purpose more than 25 samples of *Lophelia pertusa* were taken from one of the gravity cores retrieved from the Banda Mound province to obtain a high-resolution age record of this ecosystem. The U-series ages revealed a stunning pattern: while solitary corals are known to develop in the temperate NE-Atlantic almost continuously during the past 120ka, the coral samples from the Banda Mounds can be divided into three different age groups. At the core base, corals show ages of ~60 ka with healthy coral growth for some thousands of years. Then the corals seem to disappear for some successive warmer episodes, namely the Dansgaard-Oeschger cycles 17-12. About 45 ka ago, corals re-appear again, albeit sediment accumulation is disturbed. Over the whole sediment core, coral ages group at around 60 ka, 45-32 ka and 15 ka. Nowadays living corals are extremely rare in this region. This temporal growth pattern coincides with major fresh water releases into the N-Atlantic the so-called Heinrich events 6, 5-3 and 1. Now the following questions arise: (1) why would cold-water coral growth be most favourable during times of major climate cooling or climate deterioration on the slopes of NW-Africa? (2) Are changes in water temperature, upwelling dynamics or dust input responsible for the observed patterns?

Poster

13.07

PATTERNS OF TRACE ELEMENTAL AND C AND O STABLE ISOTOPIC VARIABILITY IN DEEP-SEA BAMBOO CORALS OF NEWFOUNDLAND AND LABRADOR

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Deep-sea gorgonian octocorals of the families *Primnoidae* and *Isididae* exhibit centennial-scale lifespans and, in some species, annually-secreted growth rings. Because of these attributes they have outstanding potential as long term paleoceanographic archives. Previous work has focused on characterization of growth rates and isotopic/trace elemental composition of skeletal calcite and organic fractions. However, imprecise skeletal chronologies and scarcity of long-term oceanographic data for calibration purposes have presented major impediments to the development of reliable environmental proxies from gorgonian corals. We examined trace element and stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope variability in a live-collected, 140 year old specimen of *Keratoisis ornata* (Isididae) from the southern Grand Banks of Newfoundland (700 m water depth). Hydrographic records from this region extend back to the early 20th century, overlapping with the coral record almost continuously over a period of 96 years. Skeletal chronology was established through a combination of ^{210}Pb and bomb-^{14}C dating. Focusing on the skeletal calcite fraction, trace elements were measured along parallel radii of an axial section using laser ablation ICP-MS, while $\delta^{13}C$ and $\delta^{18}O$ were measured on milled samples acquired at a spatial resolution of 100 µm. Annually-averaged trace element profiles were aligned using peaks and troughs in Ba/Ca, which correlated remarkably well along parallel radii (r = 0.62 to 0.85). Reproducibility of other elements ranged from medium (B/Ca, r = 0.49 to 0.65; Mg/Ca, r = 0.21 to 0.39) to poor or inconsistent (Sr/Ca, r = 0.06 to 0.31; U/Ca, r = -0.01 to 0.79). For all elements, temperature and salinity explained < 10% of the interannual variability. Stable isotope data exhibited classic kinetic isotope effects (KIE), with $\delta^{13}C$ and $\delta^{18}O$ correlated (slope = 0.33, r^2 = 0.4) along a line extending from equilibrium with seawater ($\delta^{13}C$ = 1.7 ‰ PDB, $\delta^{18}O$ = 2.66 ‰ PDB) to more depleted values. Temperature reconstructions using the 'lines technique' (Smith et al. 2000) may be feasible using deep-sea gorgonians. Similar patterns of elemental and isotopic variability were replicated with a ~1000 year old specimen of *K. ornata* from the Northern Labrador Sea. Overall, our results demonstrate that further development is required to interpret geochemical patterns in gorgonian calcites as reliable environmental proxies.

Smith JE, Schwarcz HP, Risk MJ (2000) Paleotemperatures from deep-sea corals: Overcoming 'vital effects'. Palaois 15: 25-32.

Poster

13.08

TRACE ELEMENTS AND STABLE ISOTOPES IN RECENT NORTH ATLANTIC *LOPHELIA PERTUSA* ALONG A LATITUDINAL GRADIENT AND FROM FOSSIL MEDITERRANEAN SITES

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Along a latitudinal transect recent cold-water corals (*Lophelia pertusa*) from the North Atlantic and the Mediterranean were sampled for trace element (LA-ICP-MS) and stable isotope composition (Micromill). Bathyal sites from boreal (72°N) to tropical (7°S) latitudes span a wide range of environmental settings: from eutrophic to oligotrophic, temperatures of 5.5 to 14°C and different seasonality. Boreal corals exhibit annual theca-banding. Trace element levels are often microstructure-linked (B, Mg, Ba, U, P and Li/Ca), but Sr/Ca less so. Stable isotopes show strong vital effects, with strict $\delta^{18}O$/ $\delta^{13}C$-correlation and regression lines form three clusters (Norwegian Sea, Mid-Atlantic and Mediterranean with deep-outflow), reflecting watermasses. Lines-technique temperature-reconstructions are difficult, due to varying metabolic carbon. Mg/Ca and U/Ca ratios are also highly correlated ($Y=X^{-1}$) and equal for all sites, reflecting dominant geochemical/ biological control independent of temperature. Mg/Ca and U/Ca exhibit respectively negative and positive linear correlation with $\delta^{18}O$. Their regression intercept is always at 2.18 ± 0.05 mmol/mol and the corresponding $\delta^{18}O$-value coincides with the expected aragonite equilibrium, calculated from ambient seawater-temperature and oxygen isotope composition. This relationship yields good paleotemperatures for Glacial to Holocene Mediterranean corals.

Poster

13.09

BENTHIC AND PLANKTONIC FORAMINIFERA AND OTHER PROXIES FOR DETERMINING ENVIRONMENTAL PARAMETERS IN COLD-WATER CORAL ECOSYSTEMS ALONG THE EUROPEAN MARGIN

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Cold-water coral ecosystems were discovered in the last century. They occur worldwide but especially along the European margin from northern Norway to the Gulf of Cadiz. In this area in particular, scleractinian corals (e.g., *Lophelia pertusa* and *Madrepora oculata*) are present as living reefs in the north and build-up coral mounds in the south. Along the Rockall Bank and the Porcupine Seabight living scleractinian corals grow on fossil coral debris and can build up mounds of a few hundred meters in height. Extensive investigation of cold-water coral ecosystems started only 15 years ago. Since then, new mound fields with cold-water corals have been discovered and studies have primarily concentrated on macrofauna, sedimentology, oceanography, and microbial communities.
Only a few studies have focused on foraminiferal assemblages and phosphorus concentration in these ecosystems and in the surrounding pelagic sediments. Foraminiferal assemblages and phosphorus can be used as proxies providing important information about productivity and oceanographic conditions.

Surface sediments (box- or grab corer) recovered during different cruises, were investigated for their quantitative planktonic and benthic foraminiferal assemblages, organic-bound phosphorus (P_{org}), and total organic carbon (TOC). Quantitative data of foraminifera were statistically evaluated using software PRIMER5. In particular, Bray-Curtis similarity and nonmetric Multi-Dimensional Scaling (nMDS) was used to obtain clustering.

Planktonic foraminifera nMDS results imply different surface water mass conditions. Warm surface water is indicated in the Gulf of Cadiz, cold and upwelled nutrient rich water on the Rockall Bank, and cold water but with reduced upwelling in the Porcupine Seabight. The nMDS based on benthic foraminiferal assemblages shows a clear separation among areas characterized by living coral reefs and/or mounds, dead coral assemblages, and pelagic sediments. The correlation between the foraminiferal data from surface and sea floor in addition to concentrations of P_{org} and TOC allows the establishment of a preliminary model. This enables the relating of productivity at the surface, labile and refractory organic matter fluxes from the surface to the sea floor, possible availability of nutrients for cold-water corals and benthic foraminifera in the sediments to each other.

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Poster

13.10

COLD-WATER OCTOCORAL'S CONTRIBUTION TO CARBONATE PRODUCTION ON THE NW-PACIFIC SEAMOUNT.

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Since Nelson (1988) suggested the importance of non-tropical carbonate sedimentation, several works on cold water corals, especially those on ahermatypic scleractinian coral have been shown their importance as their cold-water bioherms and contribution to marine carbonate production. However, there is no work has been done about the probability of contribution for carbonate production by cold-water octocorals (Primnoid corals, gorgonian) which is the major element of cold-water coral fauna in NW-Pacific Seamounts.

To make clear the contribution of the carbonate production of octocorals as constructor of bioherms, it was calculated and estimated the carbonate standing stock and carbonate production of cold-water octocorals on Shiribeshi seamount, NW-Pacific, by analysing video recordings of submersibles.

The amount of carbonate sclerites of Primnoid coral colonies would be over 0.6 ton in total at all dive lines (23292 m^2) at Shiribeshi seamount. Maximum carbonate standing stocks of Primnoid corals was calculated to be 2 g/m^2 and estimated their carbonate production at 87 $g/m^2/y$. The results of this study show that octocorals could have potential to contribute the carbonate production at cold and deep water environment.

Poster

13.11

GROWTH RATE, TRACE ELEMENTS AND STABLE ISOTOPES IN *CORALLIUM RUBRUM* FROM SHALLOW AND BATHYAL SETTINGS IN THE MEDITERRANEAN SEA

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The precious long-lived gorgonian coral *Corallium rubrum* has been exploited for jewellery production over decades, forcing a strong decline of this species in shallow waters of the Mediterranean. This calcitic gorgonian inhabits semi-sciaphilic to dark environments from a few meters down to upper bathyal depths in the E Atlantic and the Mediterranean. Recent research carried out in the frame of the EU "Hermes" project, has documented living *C. rubrum* as deep as 650 m in the Strait of Sicily (Linosa Island and Malta) in close association with living colonial and solitary scleractinians (e.g. *Lophelia pertusa*, *Madrepora oculata* and *Desmophyllum dianthus*).

Our research aims to assess the growth rates of *C. rubrum* and the environmental parameters recorded in its skeleton as geochemical signals, considering the possible complications of the biological activity of the organism during the skeletogenetic processes. For this purpose specimens from shallow water off Marseille, Corsica and the Medes Islands have been collected at various depths. This shallow-water growth-rate experiment is accompanied by high resolution temperature probes, providing an excellent control on the environmental boundary conditions determining the geochemical signals in the corals and a solid base for the calibration work of potential climate proxies. Microstructural investigations show distinct increments of annual character in shallow water settings, with growth-rates ranging between 0.1 and 0.6 mm/yr. Currently, deep-water specimens from the Strait of Sicily are being analysed for their microstructure, trace elements and stable isotope composition. Bathyal environmental conditions are quite stable at around 13.9°C and 38.77 PSU throughout different seasons and the amplitude of the geochemical tracers should be minimal. However, first LA-ICP-MS transects across the solid axial calcareous skeleton from a live specimen reveal large geochemical variability (25% for Mg/Ca, 57% for B/Ca, 20% for Sr/Ca, 200% for U/Ca, 17% for Ba/Ca, 75% for P/Ca and 80% for Li/Ca), indicating that vital effects might be involved. The concentration of these elements is highly variable across the axis, being clearly microstructure-related, with most of the elements significantly enriched in the medullar region. The role of the biological activity in obliterating the environmental signals recorded in the geochemical pattern can be best assessed at the bathyal sites and might have also implications for shallow water specimens. The multi-proxy approach will also help to test the likely annual nature of the thin banding in bathyal specimens and the use of high-resolution microanalytical techniques will potentially provide monthly records of temperature and other important environmental parameters (e.g. nutrient content).

Poster

13.12

PALEO-RECONSTRUCTION OF EAST AUSTRALIAN CURRENT VARIABILITY OVER THE LAST CENTURY USING DEEP-SEA CORAL PROXIES

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The East Australian Current (EAC) is the major western boundary current in the SW Pacific. The EAC is derived from large-scale wind forcing across the South Pacific, and transports heat polewards along the eastern seaboard of Australia before reflecting eastwards as part of the Southern Hemisphere (SH) super-gyre. As a warm polewards-flowing current, it also has major impacts on local climate and ecosystems in SE Australia and northern New Zealand.

Models suggest that the strength of the EAC will increase as a result of global warming, with substantial impacts regionally and across the Southern Hemisphere. We reconstruct changes in the strength of the EAC and associated gyre flow over the last century from Mg/Ca variability in deep-water corals collected off Tasmania in the south Tasman Sea, from the north Tasman Sea and from north Chatham Rise, all areas directly influenced by the modern polewards-flowing current system. The proxy is validated by comparison of the coral records with 50 years of water temperature data off eastern Tasmania.

The coral record suggests that during the last century the strength of the EAC has shifted relatively quickly between two phases – a low phase early in the time-series and since about 1940, and a stronger phase from approximately 1900 to 1940. The difference between phases suggests that the SH super-gyre, and consequently transport between ocean basins across the southern mid-low latitudes, was stronger prior to the onset of modern data collection. In addition, warmer conditions in the SW Pacific due to a strong EAC are not unprecedented, and a strengthening EAC due to climate change may effectively be a return to conditions similar to those that prevailed earlier in the 20th century.

Poster

13.13

GROUND-TRUTHING AN OCEAN CIRCULATION MODEL FOR THE STRAITS OF FLORIDA: AN APPLICATION OF DEEP-SEA CORAL GEOCHEMICAL PROXIES

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Deep-sea corals (*Lophelia pertusa, Enallopsammia profunda,* and *Madrepora oculata*) were collected from three sites (Miami Terrace, center of the Straits, and Great Bahama Bank) in the Straits of Florida at depths between 700m and 865m. Using a mass spectrometer and ICP-OES, stable isotope and trace/minor element analyses were conducted on material micro-milled from coral skeletons from all sites. Preliminary analysis of bulk *Lophelia* samples yielded $\delta^{18}O$ values between +1.99$^{o}/_{oo}$ and +3.35$^{o}/_{oo}$ and Sr/Ca values between 10.12mM/M and 10.81mM/M suggesting a 3^{o}C temperature range and 0.25psu salinity range in the Straits based on modern calibration equations. Further geochemical results at high-resolution can be used to constrain temperature and salinity variations across the Straits for comparison to the East Florida Shelf – Princeton Ocean Model (EFS-POM).

This model is implemented with mesoscale-eddy resolution and realistic bottom topography for the Straits of Florida. Realistic synoptic (3-hourly) numerical weather prediction winds, four diurnal and four semi-diurnal tidal constituents, and open boundary conditions from an operational global ocean model were used to force EFS-POM for a year. The bottom temperatures were extracted from the model output at the deep coral sampling sites. Through the comparison of model and geochemical data, it is possible to advance our understanding of water mass movement and circulation within the Straits of Florida.

Poster

13.14

MEDITERRANEAN COLD-WATER CORAL *LOPHELIA PERTUSA* AS A HIGH-RESOLUTION ARCHIVE OF PALEO-ENVIRONMENTAL CONDITIONS

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Cold-water corals are one of the most promising paleo-environmental archives in paleo-climate research that contain high-resolution records of long-term climate change (Roberts et al. 2006). This study focuses on several examples of the cold-water coral *Lophelia pertusa* as well as water samples from different locations in the central Mediterranean Sea collected during Meteor cruise M70/1 in October 2006. The intention is to compare present-day with paleo-environmental conditions during the Last Glacial Maximum (LGM) and the Younger Dryas.

We used ion-microprobe imaging to map elemental distributions of Mg, Ca, Sr, S and P across the thecal wall of the coralline aragonite. On same sections LA-MC-ICP-MS measurements were performed to determine stable strontium isotopes ($\delta^{88/86}$Sr) as a proxy for the reconstruction of intermediate water temperatures following the approach of Fietake et al. (2008). Water samples were collected together with the coral species and were analysed using ICP-MS and ICP-OES techniques for concentrations of Mg, Ca, Sr, Ba, B, Li and P. Fossil coral samples were AMS ^{14}C-dated after having been checked for alteration.

The geochemistry of recent coral skeletons will be compared and calibrated to the analysed water samples. The focus will be on environmental parameters like temperature, salinity and nutrient concentration using Mg/Ca, Ba/Ca, and Sr/Ca ratios, as well as P/Ca and dissolved inorganic phosphorous (DIP). Stable strontium isotopes ($\delta^{88/86}$Sr) will be used to complete the temperature calibration published earlier by Rüggeberg et al. (2008). On the basis of this comparison it should be possible to reconstruct the environmental conditions of the LGM and the Younger Dryas, especially the nutrient content and the temperature of intermediate water masses in the central Mediterranean Sea.

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Poster

13.15

X-RAY VISION - A FIRST LOOK INSIDE THE MINGULAY *LOPHELIA* REEF

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In October 2007, a team from the British Geological Survey recovered a series of vibrocores from the Mingulay Lophelia reef complex in the outer Hebrides, Scotland. These cores consist of a matrix of fine mud and densely packed fragments of *Lophelia*, and potentially contain information about the internal structure and growth of the reef complex, as well as representing a chronological archive from which palaeoceanographic information can be derived.

As the first phase of a larger project to study reef structure and the potential for palaeoceanographic reconstruction from the cores, we have used the Oban Hospital's new CT Scanner to take 3 Dimensional X-ray images of the of the unopened vibrocore sections. From these we are able to study the in-situ distribution of coral clasts which are clearly resolved from their mud matrix. We discuss quantitative methods for characterizing clast morphology, degree of preservation and size distribution from the CT data.

Preliminary observations reveal that the clasts are very unevenly distributed. There are large (centimeters thick) zones within the cores which contain almost no clasts. We hypothesise that these may represent periods where high sedimentation rates inhibited reef growth, and this will be tested in later phases of the project. The size distribution of clasts, and degree of microboring (which can be readily determined from the CT images) are also very variable down the core indicating that coral clast preservation is complex and not a simple function of time/stratigraphy. This confirms surprising field-observations that coral fragments from deep within the core (presumed to be the oldest material) appeared to be pristine. At present we do not know if there is a relationship between clast preservation and the hypothesized rapid sedimentation events: this will be the subject of further analysis.

Poster

13.16

UNRAVELLING THE 2.7 MA DEPOSITIONAL SEQUENCE FROM THE CHALLENGER COLD-WATER CORAL MOUND (IODP EXP. 307): SEDIMENT CONTRIBUTORS AND PALAEO- ENVIRONMENTS.

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During IODP Expedition 307, *Challenger Mound*, one of the large (~155 m high) cold-water coral mounds along the NE Atlantic continental margin (Porcupine Seabight), was successfully drilled. The complete recovery of this carbonate mound's sedimentary sequence provides us for the first time with material documenting the entire mound development process and is therefore crucial in unravelling the mechanisms driving and maintaining the build-up of these bio-geological systems.

Changes in the hydrodynamic and sedimentary regime are suggested as the main controls on cold-water coral mound evolution (e.g. Rüggeberg *et al.*, 2007). Therefore, in this study high-resolution (siliciclastic) particle size analyses and their end-member modelling (Weltje, 1997), in conjunction with additional data (XRD, foraminiferal assemblages, grain surface textures), are chosen as primary tools for disentangling the different sedimentary contributors to the Challenger Mound system and their palaeo-environmental implications.

The results, so far, enable the differentiation and identification of 4 sets of sediment producing and transporting mechanisms. Based on the presence and intensity of these mechanisms distinct variations in the hydrodynamic environment can be observed throughout the entire mound sequence, which are inferred to be (predominantly) climatically steered. A clear and significant shift in sedimentation and/or preservation style can be noted around 22-23 mbsf, supporting and refining the two-phase mound development model proposed by Kano *et al*. (2007), who located a significant (~1 Ma) "mound crisis" around this depth. A higher resolution palaeo-record appears to be located below this "mound crisis", in the lower part of the mound (23- 155 mbsf), rather than above, revealing the potential of cold-water coral mounds as intermediate water depth, continental margin, Early-Mid Pleistocene palaeo-archives. Furthermore it seems that the specific role of cold-water corals in these sedimentary systems may be primarily in stabilisation and preservation of the matrix records.

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Poster

13.17

DEVELOPMENT AND STRUCTURE OF COLD WATER CORAL CARBONATE MOUNDS AT THE ROCKALL TROUGH MARGINS, NE ATLANTIC OCEAN.

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Kilometres long and wide, single as well as clustered carbonate mounds occur on the SE (Porcupine) and SW Rockall Trough margin in distinct depth zones between 600 and 1000 m water depth and characterised by bottom water temperatures between 6.2 and 9.8 °C and a salinity range of 35.13-35.4. Hardgrounds of various dimensions are found within the mounds.

The SERT margin mounds usually occur as isolated single mounds with a maximum diameter at the sea bed of 1-2 km and a maximum height of 50-100 m and are covered with isolated colonies of cold water corals.

The SWRT margin mounds are several km in diameter, can be up to 380 m high and occur mostly as elongated clusters up to 10 km in length high and are covered on their tops and upper flanks with living colonies of the framework building corals *Lophelia pertusa* and *Madrepora oculata* and to a lesser extent Stylaster sp. Recently a range of other coral covered mound structures of various shapes and sizes were noticed on the western Rockall Bank margins.

Mound development shows strong contrasts between and within SE and SWRT regions, however a number of cores from both regions reflect continuous sediment accumulation over the last ~11000 years, following a regional erosional event and locally, initial hardground formation. Before 11 kyrs BP several hiatuses disturb the sediment record.

Poster

13.18

DRILLING COMPLETE SEQUENCES THROUGH COLD-WATER CORAL CARBONATE MOUNDS (ESF-CARBONATE): DRILLING EXPEDITION RESULTS AND CORE ANALYSIS

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Cold-water coral carbonate mounds form common features at intermediate water depth on the European, African and American continental margins. They can be several hundred metres tall and more than a kilometre across. Features are both exposed at the seabed and buried within upper seismic sequences. A significant concentration of large carbonate mounds exist on the Irish margin. Exposures on land are rare with most information on internal properties coming from shallow cores and one long borehole (155m) through one mound (the Challenger Mound - IODP Exp. 307).

The ESF-CARBONATE project aims to recover complete mound sequences through a range of carbonate mounds in different settings and elucidate the timing and factors controlling carbonate mound genesis, generate a robust carbonate mound development model for different environmental setting and estimate the influence of climate change in carbonate mound development. In addition, CARBONATE will derive palaeoenvironmental signals from carbonate mound sequences and assess the role of cold-water coral carbonate mounds in the global carbon cycle.

Detailed analysis of 525,000 km^2 multibeam echosounder coverages and existing information identified a range of carbonate mound provinces and potential drill targets. A pre-drilling site survey was conducted in October 2007 (RV Pelagia) with the acquisition of high resolution seismics, box-cores, piston cores, video tows and monitoring of seabed environmental dynamics using the BoBo lander platform. A number of drill targets were then selected.

Deep-sea drilling of cold-water coral carbonate mounds was undertaken at various sites on the Irish continental margin (Aug. to Sept. 2008) on board the RV Celtic Explorer (INS_DeepDrill) using the remotely operated, seafloor mounted drilling platform MeBo in addition to CTD and sediment samples. Complete core sequences through carbonate mounds down to a maximum depth of 70m were collected with preliminary results presented here.

Initial post cruise analysis occurred at a sampling workshop in at the IODP Core repository in Bremen where non-destructive logging and sampling was undertaken. Further detailed analysis to meet project aims will proceed over the coming years.

See http://www.esf-carbonate.org

Poster

14.01

AQUARIUM CULTURE AND ECOPHYSIOLOGY OF THE COLD-WATER CORAL *LOPHELIA PERTUSA*

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Lophelia pertusa is the world's most widespread reef framework-forming, cold-water coral. This azooxanthellate scleractinian is generally found at depths of 200-1000 m on offshore banks, oceanic ridges and seamounts where coral growth over many years can form significant reefs and coral carbonate mounds. *Lophelia pertusa* is typically associated with water motion and oceanic water conditions (temperatures of 4-12°C, salinities of 35-37, dissolved oxygen levels of 3-5 ml l^{-1}). Recent ecological niche factor modelling suggests that *L. pertusa* may not tolerate high levels of nutrients. Therefore, maintaining *L. pertusa* in the laboratory must take into account the species environmental requirements if experimental manipulation is to take place. Here, we present a new aquarium system using salinity mixing components and chillers to maintain oceanic seawater conditions in a coastal laboratory setting.

Poster

14.02

AGE DETERMINATION AND ECOLOGICAL AND COMPOSITIONAL CORRELATES OF GROWTH RATES IN DEEP-WATER BAMBOO CORALS (ISIDIDAE)

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Gorgonians are a major element of the fauna of deep-water coral reefs and very long-lived recorders of deep-water paleo-oceanography. Both ecological studies and paleo-analyses require accurate age determination and dating of colony formation, but because of the depths at which they occur (typically 1-3 km), direct validation by tagging of aging methods is logistically difficult. We applied and compared the results of three different methods to age and date recent and sub-fossil isidids collected from deep-reefs in the Southern Ocean: “wiggle-mapping” compositional time-series across corals to generate composite long-term series, ^{14}C analysis of nodes and internodes, and U-Th analysis of internode calcite. Radiocarbon analysis of both the node organic tissue and internode calcite provided apparently robust age and date information that broadly matched inferences drawn from wiggle-mapping larger coral colonies. U-series analysis robustly identified very old material (>10 Kyr), but struggled with the younger samples due to absolutely very low U concentrations and evidence of a growth rate-dependent concentration of Th that is taken up from seawater and subsequently lost through diffusion in a time-dependent process in progressively older samples.

Following these analyses, we compiled the robust growth-rate data for recent material, and report on a first-pass analysis of ecological and regional effects on isidid growth rates, and test hypothesized compositional proxies for growth rate that have been suggested in the literature.

Poster

14.03

A PILOT EXPERIMENT OF RESTORATION OF *LOPHELIA PERTUSA* REEFS USING TRANSPLANTS

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During the three last decades rehabilitation of damaged tropical coral reefs have been accelerated by two methods: deployment of artificial structures as settlement substrate for coral larvae and transplantation of coral colony fragments. During the 1970s it was proven for the first time that tropical coral fragments could be transplanted and used to rehabilitate damaged reefs. Coral fragment transplantation has since then been recognized as the prime management tool for tropical reef restoration. The primary objectives of coral transplantation are to improve reef quality measured in amount of live coral, and enhance topographic complexity thereby increasing biodiversity.

One of the most important species of hermatypic cold-water corals is *Lophelia pertusa*. Many *L. pertusa* reefs have been severely damaged due to commercial trawling during the last decades. By using transplantation techniques the time-span needed for restoration or introduction of new reefs in suitable areas, may be shortened considerable.

The larva of *L. pertusa* still remains undescribed and the importance of sexual selection unknown. To our knowledge field experiments with settling panels have failed to produce any corals. For rehabilitation of *L. pertusa* reefs thus transplantation of coral fragments seems to be the only option for now.

The pilot experiment is taking place in the Kosterfjord area off the Swedish westcoast. In this area one live *L. pertusa* reef exists but the remains (coral rubble and larger pieces) from at least five more reefs that are known to have existed some decades ago have been found. The main reason for their disappearance is believed to be trawling. Today the sites of all six reefs are protected against bottom-impact fisheries.

Coral fragments have been selectively picked up with ROV from nearby Norwegian large reefs and transported to lab where the fragments were tested with microsatellites. Genetic individuals were identified to test the hypothesis of varying growth rate among and within genotypes/clones, and also to test the survival percentage/growth rate of fragments from different source reefs. The fragments were then attached to plastic constructions at the lab. On each construction eight plastic plates have been used as substrates for the coral fragments, four on each plate, altogether 32 fragments on each construction. The constructions have been deployed in three of the sites with dead coral reefs.

By taking photos and video films with ROV of the coral fragments on the constructions at regular time intervals the development of the fragments will be closely followed without disturbing the corals. The fauna adjacent to the constructions are also studied with the ROV in order to investigate if even very small coral patches is able to influence the fauna.

Poster

14.04

AGE AND GROWTH OF THREE BAMBOO CORAL SPECIES FROM THE NORTHEASTERN PACIFIC OCEAN

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Bamboo corals (Family: Isididae, Subfamily: Keratoisidinae) are common deep-water inhabitants of continental slopes and seamounts of the Northeastern Pacific Ocean. They are extremely fragile, relatively large, and have a patchy distribution; three attributes that make them particularly vulnerable to disturbance from fishing gear. The goal of this study was to determine the age and growth of bamboo corals from two regions of the Northeastern Pacific with the intention that recovery times from disturbance could be estimated. Age and growth was determined using lead-210 dating for colonies collected from Davidson Seamount off California and the Gulf of Alaska. Radiometric results for both of the Davidson Seamount corals (*Keratoisis* sp. D group) converged on a radial growth rate of approximately 0.055 mm yr^{-1}. For the smaller of the two colonies (~70 cm tall), the age was 98 ± 3 years with an average axial growth rate of approximately 0.7 cm yr^{-1}. A minimum age of 145 years (upper limit of 450 years) was determined for the largest colony; an irregular shape and height precluded use of the full colony to calculate an axial growth rate, but based on one major branch length the axial growth rate was lower than expected and ranged between 0.09 and 0.24 cm yr^{-1}. Differences in the axial growth rates between the two colonies may indicate nonlinear growth with increasing colony height. From the Gulf of Alaska, a *Keratoisis* sp. (B group) colony (120 cm tall) was aged at 116 ± 13 years with an average axial growth rate of 1.03 cm yr^{-1} (0.93-1.16 cm yr^{-1}, 2SE). The radial growth rate was similar to the Davidson Seamount *Keratoisis* sp. (D group) at 0.056 mm yr^{-1}. An *Isidella* n. sp. colony (72 cm tall) was aged at 53 ± 4 years. Of the corals studied here, this colony grew most rapidly with a radial growth rate of 0.099 mm yr^{-1} and an average axial growth rate of 1.32 cm yr^{-1} (1.23-1.46 cm yr^{-1}, 2SE). Our findings of slow growth rates and high longevity compare favorably to those determined for bamboo corals from other regions of the Pacific Ocean and highlight the need for immediate conservation measures to protect these important members of deep-sea ecosystems.

Poster

14.05

SPATIAL DISTRIBUTION OF THE GORGONIAN OCTOCORAL *BAYERGORGIA VERMIDOMA* (ANTHOZOA: PLEXAURIDAE) IN THE DRAKE PASSAGE

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The fauna of the Antarctic shelf is dominated by sessile invertebrates. Anthozoans, mostly gorgonians, are the second most dominant macrobenthic taxon in the Weddell Sea. However, despite the importance of gorgonians in Antarctic regions, there have been very few studies on their basic ecology, with most published work centering on taxonomic descriptions of different species. The spatial distribution of many octocoral species is related to their environmental limits as well as their reproduction biology, and therefore serves as a first step approach to understanding their ecology. Data on the distribution patterns of the gorgonian octocoral *Bayergorgia vermidoma* (Anthozoa: Plexauridae) were collected in the Drake Passage between the southern tip of South America and the northern part of the Antarctic Peninsula using a deep-towed digital imaging system (WHOI TowCam), as well as deep sea collections performed using bottom trawls. *B. vermidoma* was recorded from Burdwood Bank to Elephant Island in 300-1800m with a patchy and clumped distribution, thus extending both the previously known geographic and depth range of this species. The abundance was mostly low (<1 colony/100m^2) with few patches of densities of up to 25colonies/100m^2. The results are discussed in the context of the reproduction biology of *B. vermidoma* and environmental factors.

Poster

14.06

OXYGEN MEASUREMENTS AT THE TISLER COLD-WATER CORAL REEF

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As part of the multi-disciplinary study conducted at the shallow Tisler cold water coral reef within the EU HERMES project, oxygen measurements have been made close (~1 m above) to the seabed to estimate changes in oxygen composition and community respiration at the reef. Measurements have largely been made with Aanderaa Optodes mounted onto RCM 9 recording current meters, with an additional turbidity sensor on the instrument, for a number of deployments during the spring and summer of 2 consecutive years. The reef itself is a little over 1 km long by 400 m wide and occurs over the depth range 60-120 m. The flow over the reef is variable, with weak tidal currents (5-10 cm s^{-1} amplitude) and relatively strong density or wind driven residual flows up to 30 cm s^{-1}.

Long term oxygen values vary seasonally at the reef, partly in response to the changing water masses at the sill, due to advection from the inner Kosterfjord and the outer Skagerrak and by seasonal effects such as springtime freshwater runoff (snow/ice melt). Other biologically associated seasonality is also obvious in the long term O_2 records resulting in periods of low O_2 at the spring bloom fall and general summertime lower O_2 values. Oxygen records also show a reduction in oxygen at lower flow rates, as might be expected, but this reduction is enhanced during periods of low residual flow. For a low residual flow regime, the weak tidal currents are insufficient to advect water through the complete reef system and hence residence times for the water over the reef increases. At these times the inferred O_2 respiration is increased relative the normal background levels when the reef is continually 'flushed'. Estimation of the Carbon drawdown associated with this increased respiration has been estimated at 41 gC m^{-2} $year^{-1}$, a high value compared to typical shelf sea benthic ecosystems. The results highlight the possible importance of the ecosystem associated with cold water coral reefs to Carbon cycling in the ocean.

A new technique to estimate O_2 respiration, through an eddy correlation technique, has been recently attempted at the Tisler reef, utilizing the correlation in vertical velocity and O_2 fluctuations. The results, from a short test deployment, suggest a way forward for future respiration measurements at benthic ecosystems.

Poster

14.07

THE IMPORTANCE OF THE PERMANENT THERMOCLINE TO THE DEPTH DISTRIBUTION OF CARBONATE MOUNDS IN THE NE ATLANTIC.

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A prominent feature of the continental margin of the NE Atlantic is the occurrence of numerous carbonate mounds located at the continental slopes of the Rockall and Porcupine Banks and the Porcupine Sea Bight. These mounds occur as clusters within a narrow depth range along the margin with the majority of the mound bases found between 700-900 m. This range coincides with the depth of the permanent thermocline and which marks the base of the winter mixed layer, and there is an obvious correlation between the thermocline and mound base depth. Analysis of historical current meter data sets indicate that the permanent thermocline is also associated with relatively strong residual and periodic (tidal) baroclinic currents close to the seabed. These currents play a major role in setting appropriate environmental conditions for the settlement and growth of cold water coral and carbonate mounds. Strong residual currents provide long term stable organic matter fluxes along the margin, whilst diurnal currents and internal waves provide periodic currents which promote re-suspension of material in the bottom boundary layer region as well as high periodic transport of material across the slope.

The permanent thermocline is a region of relatively strong vertical density gradients, characterised by the vertical buoyancy frequency, N, where $N^2 = (g/\rho_o)*(d\rho/dz)$. Here ρ is the density and ρ_o a reference (mean) density value of a depth range dz. This fact, coupled with the steepness of the seabed bottom (α) at these depths, allow the development of enhanced baroclinic motions such as bottom intensified diurnal tidal currents and internal waves. Where the product of $N.\sin(\alpha)$ is a maximum, such as at the thermocline depth, strong baroclinic diurnal period currents might be expected, especially when resonance conditions might be met related to the value of $N\sin(\alpha)$. Such resonant conditions occur at the Belgica and Logachev mound provinces, where enhanced diurnal tidal currents have been measured.

The strong vertical density gradients and steep slopes at the mid continental slope depth ranges (600-1000 m) also encourage a higher flux of internal wave energy at these depths which also contribute to the dynamic environment suitable for carbonate mound growth. Evidence of this has been observed at the Pelagia mound province. Generally, long term mound development is likely facilitated by the relatively temporal stability in the depth of the permanent thermocline, which provides stable environmental conditions and a persistent dynamic environment.

Poster

14.08

SKELETAL REORGANISATION AND STABLE ISOTOPE SIGNATURE OF THE STYLASTERID *ERRINA DABNEYI* (AZORES ARCHIPELAGO)

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Along the slope of the Azores Archipelago, colonies of the stylasterid species *Errina dabneyi* (Pourtalès, 1871) are a conspicuous feature among the upper bathyal calcified epibenthos and were documented and recovered alive with the aid of a submersible at ca. 500 m water depth in the southern Faial Channel. These colonies grow as pure white, uniplanar fans up to 40 cm wide. The dactylo- and gastropores are crowded on (sub-)terminal branches, whereas the more basal stems bear scarce coenostreal pores.

Etched vacuum-epoxy-casts of the skeleton, studied by SEM, reveal the three-dimensional internal architecture of the coenosarcs canal meshwork, dactylopores, gastropores and ampullae. Near the surface, the canals are thin and branched in regular dendritic patterns. They are connected to irregularly thicker canals in the centre of the branches. This pattern implies that the skeletal architecture is modified during growth, with the central canals being enlarged by dissolution of skeletal material and tunnels in the inner periphery being filled with aragonite re-precipitates. The aragonitic skeleton is primarily composed of irregular full-spherulitic aggregates and is overprinted during growth, as witnessed by ghost structures in form of successive semi-spherulitic infill of former tunnels.

This internal rebuild process involves an alteration of initial stable isotope ratios ($\delta^{18}O$ and $\delta^{13}C$), due to differential dissolution and re-precipitation. This has to be taken into account when attempting to use stylasterids as a geochemical archives. The stable isotope signature was investigated by a high-resolution transect (~100 µm spacing) across the main trunk of a colony. The $\delta^{18}O$ shows a mean of 1.6 ± 0.3‰ V-PDB with short term fluctuations of 0.5‰ and an overall spread of close to 1‰, the highest values being closest to equilibrium with sea-water. On both sides from the centre, there is a slight decrease in $\delta^{18}O$ during lifetime but no high resolution symmetry. Hence, as implied already by the microstructure analysis, the internal reorganisation prohibits a detailed stable isotope sclerochronology. The $\delta^{13}C$ values exhibit a mean of 1.6 ± 0.2‰ V-PDB with maximum values clustering below 2‰ and an overall spread of close to 1.5‰. This range is largely due to a distinct ontogenetic decrease in $\delta^{13}C$.

Long-term *in-situ* measurements of temperature and salinity *via* data loggers as well as stable isotope analyses of the ambient sea-water are underway, allowing for a proper evaluation of the potential biological fractionation involved and paving the road for a final recommendation concerning the potential value of these stylasterids as palaeoenvironmental archive.

Poster

15.01

DEEP-SEA CORALS (OCTOCORALLIA AND SCLERACTINIA) ASSOCIATED WITH OCEANIC WATER MASSES: A CASE STUDY IN BRAZIL

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Recent sampling increased the knowledge on the coral fauna of the Brazilian continental slope. The Project OceanProf (Campos Basin Deep-sea Environmental Project), coordinated by CENPES/PETROBRAS, and the Project REVIZEE (Assessment of the Sustainable Yield of the Living Resources in the Exclusive Economic Zone) sampled the Campos Basin area, between latitudes 21° and 23° S. The continental shelf of this area is some 100 Km wide, with the slope starting between 80 and 130 m deep. The slope is about 40 Km wide, being deeper in the South (2000 m) than in the North (1500 m). Its average inclination is 2.5°. The area is under the influence of several water masses, including: a) Superficial Tropical Water (STW), a mixture of coastal, tropical waters with an upwelling of the South Atlantic Central Water (SACW), which flows to the South and it is well represented at 250-300 m depths; b) SACW, flows to the North below the STW (300-550 m); c) Antarctic Intermediate Water (AIW), which is formed at 45° S and flows to the North, contouring the continental slope between 550 and 1200 m depths; d) North Atlantic Deep Water (NADW), flowing to the South at depths between 1200 and 3500 m. We analyzed the distribution of octocorals (15 families, 25 genera, and 32 species/morphotypes) and scleractinian corals (2 families, 7 genera, 11 species/morphotypes), their association among taxa and with water masses. Our analyses showed different coral communities in three depth ranges. MDS and cluster analysis showed a complete dissimilarity between the continental shelf margin/upper slope and the mid and lower slope. This shallower range (52-760 m) is under the influence of STW, SACW and upper limit of the AIW. It presented a complete separation of species assemblages. Sampling in this range was limited and further material may show a better resolution regarding the influence of the water masses. The mid range (1000-1200 m deep) was under the sole influence of the AIW and presented the exclusive occurrence of 11 species/morphotypes. The third range (1200-1605 m) was bathed by the NADW, which did not present any exclusive occurrence of species. MDS graphs indicated that mid slope areas were distinct from one another, while lower slope areas were more homogeneous. As expected, co-occurrences of species indicated the type of environment they live in, as unconsolidated or hard bottoms. Especially one group of species indicated the occurrence of deep-sea coral communities, including the species *Lophelia pertusa*, *Enallopsammia* sp., *Corallium niobe*, and *Paragorgia johnsonii*.

Poster

15.02

IN-SITU OBSERVATIONS OF DEEP-SEA CORAL COMMUNITIES ON THE SOUTHWEST GRAND BANKS, NEWFOUNDLAND

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The physical and biological features that cause species to create patchy distributions versus relatively uniform or random distributions, and the features that cause species to become common versus rare are still unknown for most deep-sea coral communities. Nevertheless, diverse trends in distributions and abundances have been adopted by the various deep-sea fauna. A research cruise in the Haddock Channel and Desbarres Canyon on the Southwest Grand Banks during 2007 offered the first glimpse of small-scale community trends in coral ecosystems for this area. We used the remotely-operated vehicle *ROPOS* (Remotely Operated Platform for Ocean Science) to collect specimens and conduct transects through areas thought to be coral habitat. Transects were carried out along depth contours during 6 dives that covered depth ranges greater than 2000 m to less than 500 m. In total, more than 165 hours of video were collected over 9 days.

The region is characterized by weak bottom currents and extensive sand and mud derived from continental shelf sediments, with scattered glacially-derived boulder fields in waters shallower than 700 m. *Keratoisis ornata* thickets, *Chrysogorgia agassizii*, large sea pen meadows, and fields of *Acanella arbuscula* and *Acanthogorgia armata* highlighted the distinct community assemblages observed in this region. *Pennatula* colonies were patchily distributed and created sea pen meadows over 1 km in length in sandy mud and muddy sand sediments, while other sea pens (such as *Anthoptilum grandiflorum*) appeared to be randomly distributed throughout the study area. Patches of *K. ornata* thickets were common in the Haddock Channel and colonies over 1 m were often observed. These large gorgonians occurred on cobbles and boulders in a muddy sand matrix and may create unique community assemblages. A variety of other corals (such as *A. armata*) were often co-occurring with *K. ornata* in these rocky areas. Antipatharians, represented by *Stauropathes arctica* were rare. *C. agassizii* and a variety of small sea pens created distinct community assemblages in deep-water. Redfish (*Sebastes sp.*) were sighted in large schools near several rocky areas and wolffish (*Anarhichas sp.*) were occasionally found near the base of *K. ornata* colonies. Other deep-sea fishes frequently observed throughout the study area included *Synaphobranchus sp.*, macrourids, *Antimora rostrata*, and Pleuronectidae.

Poster

15.03

OBSERVATIONS OF DEEP CORAL AND SPONGE ASSEMBLAGES IN OLYMPIC COAST NATIONAL MARINE SANCTUARY USA, AND A COMPARISON OF COMMUNITY STRUCTURE IN CLUSTERS OF BIOGENIC STRUCTURE VERSUS NON-BIOGENIC STRUCTURE

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In 2006 and 2008, NOAA scientists led research cruises using the Canadian Scientific Submersible ROPOS Remotely Operated Vehicle (ROV) to conduct a series of dives at targeted sites in the Olympic Coast National Marine Sanctuary (OCNMS) in Washington state, USA, with the goal of documenting deep coral and sponge communities. Dive sites were selected from areas with available side scan sonar data indicating the presence of hard or complex substrate suitable for coral growth. The team completed 17 dives from six to 52 hours in length and at depths of 100 to 650 meters. The dives were conducted along transects at 22 pre-selected sites (delineated by polygons surrounding suspected hard-bottom habitat) with additional observations made at six other sites. The survey locations included sites both inside and outside the Essential Fish Habitat (EFH) Conservation Area, known as Olympic 2, established by the Pacific Fishery Management Council, enacted on June 12, 2006. Bottom trawling is prohibited in the Olympic 2 Conservation Area for non-tribal fishermen but other bottom contact gear is allowed. The Conservation Area covers 159.4 nm^2 or about 15% of the sanctuary. Several species of corals and sponges were documented at 21 of the 22 sites surveyed, at sites both inside and outside the Conservation Area, including numerous gorgonians and the stony corals *Lophelia pertusa* and *Desmophyllum dianthus,* as well as small patches of the reef building sponges *Farrea occa*, *Aphrocallistest vastus and Hterochone calyx.* Several species represented first-ever records for the sanctuary and region. The team also documented *Lophelia* sp. and *Desmophyllum* sp. coral rubble, dead gorgonians, trawl tracks, lost fishing gear, and other anthropogenic debris, supporting concerns over potential risks of anthropogenic disturbances to coral health. Numerous demersal fishes and invertebrates, including commercial species, also were observed in association with the coral and sponge habitat. Potential differences in community structure and composition between coral vs. non-coral areas are being assessed through a combination of cluster analysis and paired t-tests and will be discussed at the symposium.

Poster

15.04

COLD-WATER CORAL ASSOCIATIONS ON THE GRAVEYARD SEAMOUNT COMPLEX (CHATHAM RISE, NEW ZEALAND REGION)

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Cold-water corals in the deep-sea can provide three-dimensional habitat for a variety of fish and invertebrates. These potentially important habitats are increasingly threatened as human activities such as fishing and mineral exploration move into the deep sea to an ever-increasing extent. As a result there is a need for greater knowledge and understanding of the relationship between corals and their associated fauna. Previous attempts to study the nature of the associations have not been particularly successful because of problems with poor quality data, and/or analytical techniques. The examination of high quality still and video images taken on the Graveyard seamount complex, acquired using DTIS (NIWA's Deep Towed Imaging System), provides us with a good opportunity to identify and quantify robustly the type and number of associations between coral and other invertebrates and fish, and how these associations might vary with depth and position on a seamount, local seabed morphology and substrate composition, and coral identity and abundance.

Poster

15.05

CORAL COMMUNITIES OF THE LOWER CONTINENTAL SLOPE OF THE GULF OF MEXICO

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A number of recent studies in the Gulf of Mexico have greatly increased our knowledge of cold-water coral distribution, biology, and ecology. However, these studies have focused on the corals of the upper slope (primarily *Lophelia pertusa*), in less than 1000 m water depth. On a recent expedition to the lower slope of the Gulf of Mexico, a thriving coral community was discovered at approximately 1400 m depth. The site was discovered using remote sensing and geophysical data filtered to target deep-water hydrocarbon seep sites, and this process is being adapted for application to deep-water coral sites. The coral community was comprised of the framework-building scleractinian corals *Madrepora oculata*, *Enallopsammia profunda*, and *Solenosmilia variabilis* along with numerous species of gorgonians and antipatharians. Photomosaics were compiled of the main coral area at this site and several inter-specific associations were detected. The community composition of the corals and their associates differed greatly from the coral communities of the upper slope. Isotopic composition of coral skeleton and tissues were similar between upper and lower slope corals, showing no detectable shift in food source with depth. These bathymetric trends mirror those of the seep and soft-bottom communities of the Gulf of Mexico, which suggests that there are common factors that control the distribution of fauna across all of these types of communities.

Poster

15.06

DIVERSITY AND SEASONAL DISTRIBUTION OF NEAR-BED ASSOCIATED ZOOPLANKTON TO COLD-WATER CORALS IN THE CAP DE CREUS CANYON (NORTH WESTERN MEDITERRANEAN)

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Deep-water corals found in submarine canyons are considered an important habitat for fish larvae, some of them commercially important, as well as crustacean species, such as a nursery effect, and in promoting a high associated diversity. This fauna is, however, difficult to sample and therefore very little is known about the zooplankton communities associated with deepsea coral habitats and in general with deep macrobenthic communities. Nearbed zooplankton was sampled in four different seasons (from April 2006 to September 2007) over the deep-coral area (i.e. *Madrepora oculata*) in the southern wall of the Cap de Creus submarine Canyon (western Mediterranean) at depths ranging from 200 to 300m. Preliminary results show seasonal differences in the species composition and abundance of dominant groups (i.e. chaetognatha, cnidaria, crustacea and chordata). Spring samples are characterized by high abundance of copepods, euphausiids larvae, decapods larvae and fish larvae, whereas summer and autumn samples show a more homogeneous composition and lower abundances, except for gelatinous groups. The aim of this work is to evaluate the coral-associated zooplankton community diversity and their seasonal variation. Seasonal trends of most abundant species will also be described in accordance with environmental features inner canyon habitat.

Poster

15.07

ICHTYOFAUNA DIVERSITY AND DISTRIBUTION IN THE CAP DE CREUS CANYON (NORTHWESTERN MEDITERRANEAN) FROM VIDEO TRANSECTS

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The Cap de Creus canyon is characterized by a rich benthic fauna with presence of communities dominated by *Madrepora oculata*. The study of the associated ichtyofauna contribute to improve the knowledge on the ecosystem biodiversity and reinforce the evidence that canyons are relevant diversity hot spots in the Mediterranean. The ichtyofauna of the Cap de Creus canyon (Northwestern Mediterranean) was assessed by means of 28 underwater video transects (more than 45 hours of video records), performed during three oceanographic cruises carried out in October 2005, July 2006 and September 2007 on board of the RV García del Cid (CSIC). Video transects were conducted by using the Remotely Operated Vehicles (ROVs) Falcon and Phantom 4, and the man submersible JAGO (IFM-GEOMAR). Dives were performed from 115 to 350 m depth in both canyon walls (North and South).

The use of video transects in order to characterise the ichtyofauna of deep areas represent an innovative method in the study area. The quality of images allows to easily recognise from distinctive characters the fish species, and it is a non-destructive method to carry out ichtyofauna census. A total of 23 fish species were observed in the canyon. *Helicolenus dactylopterus* (Scorpaenidae), *Trisopterus luscus* (Gadidae) and *Trachurus mediterraneus* (Carangidae) were the more abundant species observed. Fish richness and diversity varies among areas and depths throughout the canyon, according with the bathymetric distribution and substrate preferences of each species. A clustering of species was observed depending on the area and the main bottom type and related to the presence of the communities dominated by corals. A join study of benthic communities and associated fish assemblages is crucial in order to establish adequate management plans in order to implement protection measurements.

Poster

15.08

COLD WATER CORAL DISEASE

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The first recorded incidence of cold-water coral disease was noted in a marine protected area in 2002 where *Eunicella verrucosa*, which occurs to 400 m depth from the Canaries to the British Isles, exhibited coenchyme necrosis, leading to tissue sloughing and exposing skeletal gorgonin to settlement by fouling organisms. Surveys of more than 600 colonies at 13 sites revealed that disease outbreaks were widespread in SW England from 2003-2008 and that sites where necrosis was found had significantly higher incidences of fouling. No fungi were isolated from diseased or healthy tissue, but significantly higher concentrations of bacteria occurred in diseased specimens. Of 21 distinct bacteria isolated from diseased tissues, 15 were strains of *Vibrio splendidus.* Vibrios isolated from the corals did not induce disease at low temperatures but at 20°C controls remained healthy and test gorgonians became diseased, regardless of whether vibrios were isolated from diseased or healthy colonies. Bacteria associated with diseased gorgonians produced proteolytic and cytolytic enzymes which damaged *E. verrucosa* tissue and may be responsible for the necrosis observed.

This gorgonian is on the international 'red list' of threatened species so it is fortunate that the incidence of disease diminished with new gorgonian recruitment at sites where disease was noted during 2003-2008. The outbreaks have so far not been as devastating to gorgonian populations as mass mortality events recorded in the Caribbean in 1994 and in the NW Mediterranean in 1999 where the effects have been long-lasting due to the slow growth of the gorgonians and their contribution to the three dimensional complexity of the benthic habitat. We report on the success of laboratory-reared coral transplants and further analyses of the microbial community associated with healthy and diseased corals, using non culture-based methods. Our observations indicate that coral diseases may be widespread in cold-water regions of the planet and that vigilance is required to assess their causes and effects.

Poster

15.09

CHIROSTYLID-DEEP SEA CORAL ASSOCIATIONS IN THE NE ATLANTIC

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Although there are no previous descriptions of the habits of chirostylids in the north Atlantic, it is likely that species in the genera Uroptychus, Eumunida and Gastroptychus have close ecological ties with deep-sea corals since they have all been recorded in trawl samples containing corals from >200 m depth. We analysed in situ invertebrate behaviour using ROV Victor at a range of NE Atlantic sites and found that *G.formosus* forms a close association with deep-sea corals, similar to the chirostylid-anthozoan associations reported in shallow Indo-Pacific waters.

We update the known distribution for G. formosus, confirming that it is a transatlantic species that occurs along the mid Atlantic Ridge at least as far south as the Azores and at least as far as north as Scotland at depths of 600-1700 m. The adults have very specific habitat preferences, being only found on gorgonian and antipatharian corals with a strong preference for *Leiophathes* sp. as a host. This highly restricted habitat preference is likely to render chirostylids vulnerable to the impacts of demersal fishing gear impacts both directly, as bycatch, and indirectly through habitat loss. The past 20 years have seen an increased intensity of deep-water fishing in the NE Atlantic. Although bottom-trawlers try to avoid gear contact with scleractinian reefs, due to the extensive damage this causes to their gear and their catch, antipatharians frequently attach to cobbles and boulders on sedimentary grounds. These boulders are difficult to avoid, and although not targeted by fishermen, their attached fauna is at high risk of destruction through accidental trawling.

Poster

15.10

FOOD WEB STRUCTURE OF A RECENTLY DISCOVERED DEEP MEDITERRANEAN CORAL REEF: A STABLE ISOTOPE INSIGHT

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Unlike their surface tropical counterparts that contain photosynthetic endosymbiotic zooxanthellae, deep cold water corals (CWC) entirely depend for their food on external inputs of organic matter. Corals are known to have a filter and microcarnivorous feeding behavior. Thus deep CWC likely feed on the decaying particulate organic matter that originate in the above euphotic zone as well as small pelagic preys such as zooplankton. However the nature of the organic matter and the relative proportion of the different food components that are assimilated are still debated. As a result, the trophic level of deep CWC species within the benthic food web associated with coral reef is unclear as well. These questions have been recently addressed by the use of stable isotope analysis for several deep CWC spots of the Atlantic Ocean, and now we use the same approach to investigate for the first time deep CW corals from the Mediterranean that exhibit very similar faunal assemblages.

In the framework of the HERMES program (MEDECO cruise, October 2007), the ROV Victor 6000 was deployed to collect macrofauna inhabiting the recently discovered coral reefs of Santa Maria di Leuca (eastern Ionian Sea; 600 m depth) colonized by *Lophelia pertusa*, *Madrepora oculata* and *Desmophyllum dianthus*. In order to describe the structure of the related benthic food web, 16 species of consumers (including scleractinian corals, benthic invertebrates and surrounding zooplankton) as well as suspended and sedimented organic matter have been sampled. Stable isotope analyses ($\delta^{13}C$ and $\delta^{15}N$) were performed for each of the food web component.

$\delta^{13}C$ data obtained for sedimented organic matter and most of consumers show that the overall food web is fuelled by carbon that originates from upward phytoplanktonic production. Primary consumers showed $\delta^{15}N$ values that ranged from 5 to 8‰ and overall $\delta^{15}N$ values obtained for benthic consumers suggests the existence of 2-3 trophic levels in the benthic food web related to the coral reef. Considering the $\delta^{15}N$ values of the scleractinian corals and gorgonians with respect to those obtained for potential food sources and zooplankton, it appears that small pelagic amphipods and Euphausiaceae whose dense swarms were observed during dives may significantly contribute to the diet of these two cnidarians in the investigated area. $\delta^{15}N$ data also reveal that the polychaete *Eunice norvegica* and the sea star *Ceramaster* sp. occupy the top of the benthic food web and seem to have a true carnivorous feeding behavior. The spider crab *Rochinia* sp. is more ^{15}N-enriched that the black coral *Leiopathes glaberrima* on which it lives, indicating that the decapod may significantly feed on its host.

Poster

15.11

CARNIVOROUS SPONGES ASSOCIATED WITH DEEP-SEA SCLERACTINIA FROM OFF SOUTHWESTERN ATLANTIC (BRAZIL)

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Carnivorous sponges (Cladorhizidae) are more frequently found in association to hard substrate in the deep sea, notoriously close to hydrothermal vents or cold water reefs. In Brazil, cold water coral reefs may occur from off the north-eastern to southern coasts, where important reef building species were found - *Dendrophyllia alternata, Enallopsammia rostrata, Lophelia pertusa*, *Madrepora oculata* and *Solenosmilia variabilis*. The carnivorous feeding habit has been discovered in Cladorhizidae sponges (Poecilosclerida, Demospongiae). The members of this mostly deep-sea family are generally erect, with a pinnate or symmetrical shape, and a fundamental shift in the Poriferan Bauplan - deletion or modification of the aquiferous system. Their various siliceous microscleres (spicules), hook-like in shape, show a special arrangement allowing the capture of hairy invertebrate prey. A similar overall pattern is present in several deep-sea representatives of other poecilosclerid families: Esperiopsidae, Guitarridae, Mycalidae and Phellodermidae. This is suggestive that a carnivorous habit could be more frequent in deep-sea sponges than thought hitherto. The deep-sea sampling effort off the Brazilian coast has mostly been undertaken in Campos Basin (southeast Brazil), where over 85% of the Brazilian crude oil and gas production originates from. In the face of the necessity of evaluating the environmental assets on exploration areas or potential exploration areas, CENPES, PETROBRAS´s Research Center has elaborated and coordinated the execution (ongoing) of Campos Basin Deep-Sea Environmental Assessment Project and Campos Basin Deep-Sea Corals Assessment Project. Both yielded samples of sponges and corals which are reported upon here. In total, 91 carnivorous sponges were obtained after examination of azooxanthellate coral samples. Materials were obtained from 867-1152m depth. The majority of the sponges was found on dead corals. Three genera have been identified: *Asbestopluma* and *Cladorhiza,* with a series of minute specimens (1-3mm high), and *Abyssocladia,* with four larger specimens (4-5mm high). With the exception of a single specimen of *Asbestopluma*, associated to *E. rostrata*, all the samples were found on *S. variabilis*, which is one of the dominant cold water reef-building species in Brazil. This coral is known from 03º20´S to 34º33´S, between 46 and 1157m depth. Contrastingly, *E. rostrata* is known only from 20º28´S to 30º03´S, between 270 and 1332m depth. A single *S. variabilis* sample yielded 20 small carnivorous sponges belonging to both *Asbestopluma* and *Cladorhiza*. The taxonomic study of the sponge samples is under way, and appears to suggest there is only a single species in each genus. On the other hand, additional taxa were found too, a few of which might turn out to be carnivorous too: *Esperiopsis* sp. and *Guitarra* "*Hoplakithara*" sp., associated to *S. variabilis*.

Poster

15.12

CUTICULAR SPINES OF *OXYNASPIS* SPP. (PEDUNCULATA: CIRRIPEDIA): AN INHERITANCE FROM ANTIPATHARIAN HOST

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Oxynaspis Darwin is a common genus of pedunculate cirripeds often reported from colonies of black corals (Antipatharia: Anthozoa: Cnidaria). Among 14 known species of this genus 11 were reported as associated with antipatharian hosts. Species of *Oxynaspis* are not confined to one particular genus of Antipatharia. From original and published data it follows that most infested antipatharian host species belong to the families Myriopathidae and Aphanipathidae. Species of *Oxynaspis* seem to be much affected by the depth range of hosts, for example symbionts never were reported from abyssal forms. Usually the base of a cirriped is covered by thin brownish or yellowish cuticle produced by antipatharian. Also a symbiont can induce a change in host growth forming a small cap in the place of attachment. Cuticle produced by antipatharian host can form small spines or even short densely set branchlets. Similar cuticular spines were reported on eunicid tubes attached to antipatharians from the *Antipathes cylindrica* group (Molodtsova, Budaeva, 2007).

We have studied fine morphology of cuticle spines using material in several species of *Oxynaspis* from the North-East Atlantic, West and South-West Pacific and Indian Ocean. It appears skeletal spines in cirripeds have smaller size but in morphology agree well with spines of antipatharian hosts. This suggests that spines originate from host and are not produced by cirripeds, as was repeatedly discussed in the literature (Aurivillius, 1894; Young, 1998; Poltarukha, Zvyagintsev, 2008).

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Poster

15.13

OBSERVATIONS ON SPECIES COMPOSITION AND DISTRIBUTIONAL ECOLOGY OF ECHINODERMS FROM *LOPHELIA* BANKS OFF THE SOUTHEASTERN UNITED STATES

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Extensive reefs of *Lophelia pertusa* occur on the middle continental slope (370-800 m) of the Blake Plateau off the southeastern United States (SEUS). Submersible observations revealed that these deep reefs support diverse fish and invertebrate communities. Although assemblage structure has been addressed to varying degrees for several higher level taxa (e.g., fishes, crustaceans, hydroids), many invertebrate groups associated with these deep reefs remain poorly studied. Whether species within this community are unique to reef habitats, or are more widely distributed and use reefs opportunistically is still largely unknown. Efforts to determine species composition, general distribution, and numerical abundance of the echinoderm fauna have begun. Preliminary analysis of collections, still photos, and videotapes taken from submersibles has revealed numerous species of sea stars (Asteroidea), sea urchins (Echinoidea), and brittle stars (Ophiuroidea) associated with these deep reefs. Of these, the brittle star *Ophiacantha bidentata*, the sea urchin *Echinus tylodes*, and the brisingid sea star *Novodinia antillensis* are dominant components of this assemblage. Other taxa, in particular several sea stars, are common but less abundant. Additionally, a new genus and species of hippasterine sea star was discovered among specimens of this assemblage. This group of sea stars is known for its corallivorous habits and this new species represents the first known occurrence of this group of asteroids associated with deepwater coral habitats in the Atlantic. Aspects of the echinoderm assemblage observed at the SEUS sites will be compared with those reported for assemblages observed at other *Lophelia* habitats in the Atlantic and also with assemblages reported from other major habitats on the adjacent middle-slope. We will attempt to assess the degree of association of the various echinoderm species with *Lophelia* and other deep-sea corals.

Poster

15.14

MAPPING BENTHIC HABITAT AND MEGAFAUNA ON A DEEPWATER CORAL MOUND OFF NORTH CAROLINA, USA

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Mapping the distribution of megafauna with respect to habitat is essential for understanding the role of habitat in shaping the spatial dynamics (including abundance and diversity) of organisms. However, determining habitat-faunal associations is challenging, particularly in the deep sea, given the lack of detailed bathymetric surveys (e.g., multibeam sonar) and direct observations. From 2000-2007, we used both multibeam sonar (10 m resolution) and the Johnson-Sea-Link (JSL) submersible to survey deep coral areas on the continental slope off the southeastern US. This combination of multibeam data with JSL video data (9 dives) allowed us to map and describe in detail the topography, substrata, and associated fauna of the Cape Fear coral mound, an extensively surveyed, isolated, deep (368-449 m) coral site off the coast of North Carolina. This coral mound has a surface area of 0.79 km^2, rises approximately 80 m from the seafloor, and exhibits slopes up to 80º. The Cape Fear mound, like others off NC, appears to be formed by the successive growth, collapse, and sediment entrapment of the scleractinian coral, *Lophelia pertusa*. We classified three general substrata types in the Cape Fear area: 1) sand with < 50% coverage of coral rubble (dead, unattached, broken pieces of *L. pertusa*), 2) sand with > 50% coverage of coral rubble, and 3) hard coral (intact branches, thickets, or bushes of dead or live *L. pertusa*). Hard coral habitat was further differentiated by vertical profile, percent bottom coverage, and percent live coral coverage. Low profile, dead, hard coral habitat was most frequently observed at this coral bank; very little live coral was observed. Habitats were plotted onto corrected submersible dive tracks (created from shipboard and JSL tracking) using ArcGIS and interpolated to a 30 m zone around each track line using an inverse distance weighted method. Video transect data, recorded on wide angle setting, were divided into standardized segments. Dominant megafauna, including the fish species *Beryx decadactylus, Conger oceanicus, Polyprion americanus,* and *Laemonema barbatulum* and invertebrates *Eumunida picta, Rochinia crassa, Novodinia antillensis,* and *Echinus tylodes*, were enumerated and abundances were plotted onto habitat maps. Habitat usage varied among species. *Beryx decadactylus* and *E. picta* occurred most frequently on or near the tops of the coral mounds. *Conger oceanicus* and *N. antillensis* were observed mostly in high profile, hard coral habitat, while *R. crassa* frequented sand/rubble substrata types next to the coral mound. *Laemonema barbatulum* appeared to be uniformly distributed across the coral mounds. Multivariate analyses further clarified the habitat-specific features that influenced the observed distribution patterns.

Poster

15.15

OBLIGATE COMMENSALISM OF THE BRITTLE STAR *OPHIOCREAS OEDIPUS* ON THE OCOTOCORAL *METALLOGORGIA MELANOTRICHOS* ON THE NEW ENGLAND AND CORNER RISE SEAMOUNTS

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While temperate-water coral ecosystems of seamounts have been gaining more attention in the last decade, the organisms that live within and rely upon these corals for survival are studied to a lesser degree. Throughout the New England and Corner Rise seamounts of the western North Atlantic, several ophiuroid species are conspicuously epizoic on octocorals. One objective of this study was to investigate the association between *Ophiocreas oedipus* and its host octocoral *Metallogorgia melanotrichos* on these seamounts. Coral colonies with their brittlestar epibionts were collected from 11 seamounts in 2003, 2004, and 2005 at depths between 1300 and 2200 m via submersible. *O. oedipus* is an obligate commensal on *M. melanotrichos*, leading a solitary existence on all octocorals observed. *O. oedipus* gains feeding and protective benefits while *M. melanotrichos* appears to neither benefit nor be disadvantaged by this commensalism. *M. melanotrichos* exhibits a distinct developmental pattern that can be categorized into three growth stages. The positive correlation between size of *O. oedipus* and growth stage of its host is highly significant suggesting the brittlestar may grow up with *M. melanotrichos*.

Poster

16.01

A PRECAUTIONARY APPROACH FOR MINIMIZING IMPACTS FROM HIGH SEAS FISHERIES ON VULNERABLE MARINE ECOSYSTEMS

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The 2006 United Nations General Assembly Resolution 61/105 "[c]alls upon States to take action immediately, individually and through regional fisheries management organizations and arrangements, and consistent with the precautionary approach and ecosystem approaches, to sustainably manage fish stocks and protect vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, from destructive fishing practices, recognizing the immense importance and value of deep sea ecosystems and the biodiversity they contain". Perhaps most importantly, the resolution requires that by 31 December 2008, RFMOs regulate fisheries to prevent significant adverse impacts to areas designated as vulnerable marine ecosystems. To provide States and RFMOs with guidance for implementing the resolution, FAO sponsored an Expert Consultation in Bangkok, Thailand in September 2007 which resulted in a draft set of "International Guidelines for the Management of Deep-Sea Fisheries in the High Seas". Here we describe a decision support diagram that was developed at the consultation to manage fisheries impacts to VMEs where information is limited and management decisions must be made in an adaptive fashion. The decision support diagram identifies the general types of questions, data, and alternative management pathways available to managers of fisheries taking place in areas with different levels of prior knowledge.

Poster

16.02

MANAGEMENT IMPLICATIONS FROM RECENT DEEP SEA CORAL/SPONGE FINDINGS IN THE OLYMPIC COAST NATIONAL MARINE SANCTUARY, USA

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Recent findings of deep-sea coral and sponge communities in the Olympic Coast National Marine Sanctuary (OCNMS) in the USA have contributed to fishery management decisions concerning additional protection for these biogenic habitats, such as closed fishing areas. For example data from a 2004 survey, during which a small patch of the scleractinian coral *Lophelia pertusa* was recorded at 271 m for the first time in the sanctuary, were used in a decision by the Pacific Fisheries Management Council (PFMC) and NOAA Fisheries (NMFS) to include the site in the boundaries of a proposed groundfish Essential Fish Habitat (EFH) conservation area called Olympic 2. In 2006, more extensive surveys found additional deep sea coral sites within the sanctuary, some within the proposed Olympic 2 boundaries, and others outside. NMFS formally designated the Olympic 2 conservation area shortly afterwards, which closed it to non-tribal bottom trawling. Distribution data for scleractinian and gorgonian corals from the 2006 survey were published in 2007 and presented to PFMC for consideration in the EFH process. The non-governmental organization Oceana also petitioned NMFS and PFMC requesting emergency rule-making for additional coral protection. Although denied, NMFS stated it would request status review at a future date by the soon to be established EFH review committee. Parallel to the PFMC process, the sanctuary also presented the coral distribution data to the newly formed Intergovernmental Policy Council (IPC), which consists of the four coastal Native American tribes (Makah, Quileute, Hoh, and Quinault) and the State of Washington. OCNMS is unique in the USA National Marine Sanctuary program in that the entire sanctuary is covered by tribal usual and accustomed fishing areas recognized under treaties between the tribes and the USA government since the 1850s. Tribal fisheries management is conducted on a government-to-government basis between the tribes and the USA government and then regulated by the individual tribal governments. In 2008 PFMC formally announced the creation of the EFH review committee to address new information in regards to conservation areas. The senior author was appointed to the committee to represent the sanctuary program with the first meeting scheduled for September 2008. In addition to the EFH links to deep corals, the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 also included new language that encourages and provides discretionary authority to the regional fishery councils (e.g., PFMC) to protect deep-sea corals in their own right and not just as inclusions under EFH.

Poster

16.03

DETERMINING THE DISTRIBUTION OF DEEP-SEA CORALS IN THE NORTHERN GULF OF ST. LAWRENCE (ATLANTIC CANADA)

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The deep-sea corals of Atlantic Canada have recently received attention due to concerns raised about the impacts of fishing activities on benthic ecosystems. While deep-sea coral distributions have been mapped for a number of regions in Atlantic Canada, no such records exist for the Northern Gulf of St. Lawrence. The numerous deep troughs found in the Gulf provide suitable habitat for a number of deep-sea coral species. Species such as *Keratoisis ornata*, *Acanella arbuscula*, and a variety of sea pens and soft corals are likely to occur in the Northern Gulf of St. Lawrence. The active groundfish, pelagic and invertebrate fisheries in the area threaten deep-sea corals in terms of physical damage, habitat alteration and coral bycatch. While groundfish surveys and fisheries observer records from the Canadian Department of Fisheries and Oceans (DFO) will be used, there will be an emphasis on using the local ecological knowledge (LEK) of area fishermen in mapping deep-sea coral distribution. Determining the distribution and diversity of deep-sea corals in the area is important and results should be considered in future conservation and fisheries management decisions.

Poster

16.04

NEW ZEALAND'S PROTECTED CORALS: WHAT DO WE KNOW?

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Many of the life history characters of cold-water corals (e.g. slow growing, long-lived, low natural mortality, short dispersal distance as well as being restricted to certain habitats) could increase their susceptibility to anthropomorphic threats. Yet despite growing concerns about the long term impacts of human activities on cold-water corals, both within and outside New Zealand's Exclusive Economic Zone, our global understanding of cold-water corals remains limited. To move beyond speculation requires a concerted research effort pertaining to the life histories and distribution of cold-water corals, including their role in the wider ecosystem e.g. habitat and refugia for other organisms.

The New Zealand Wildlife Act 1953 protects all "black corals" and "red corals"; the definition of the latter is currently being revised. This paper presents (1) a comprehensive overview of the current state of knowledge of Antipatharian (the so called "black" corals) and "red" corals (currently legally classed as "coelenterates of the order Stylasterina), as well as *Paragorgia* spp. (including the proposed protected species *Paragorgia arborea*) and (2) distributional information for the main protected taxa, and an examination of likely factors that determine their distribution in the New Zealand region.

Good management practice requires a better understanding of all cold-water corals, and recognising that protected species cannot be considered in isolation the paper will also consider additional dominant cold-water coral fauna (including Scleractinian reef formers, and Octocorallia) and review national cold-water coral research programmes. To date such have broadly focused on four core research themes (1) Biodiversity (including taxonomy) and biogeography (2) Reproduction and Recruitment (3) Growth and ageing and (4) Anthropogenic impacts e.g. trawling, mining.

The paper will end by considering the future of coral research in the New Zealand region and make recommendations such that we might move forwards towards implementing informed conservation and management measures to maintain cold-water coral biodiversity, and prevent population collapse. Because of their ecological importance, by protecting such corals we may also help to maintain habitats important to commercial fish species.

Poster

16.05

DAMAGE AND DISTURBANCE TO CORAL AND SPONGE HABITAT OF THE ALEUTIAN ARCHIPELAGO

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A unique feature of the benthic environment of the Aleutian Archipelago is a highly diverse and abundant coral and sponge community. Coral abundance far exceeds that reported for other high latitude areas of the world and there are many endemic species. Video footage of the seafloor was examined to directly observe damage and disturbance to coral and sponge habitat in relation to observed fishing intensity in the central Aleutian Islands. Corals and sponges were classified as damaged if they consisted of broken skeletons, had missing or broken branches, were torn (i.e., for sponges) or had other evidence of injury, were detached from the seafloor, or were attached but overturned and lying in contact with the seafloor. Disturbance was defined as any alteration to the seafloor or biota caused by fishing gear or natural events. Overall 11% of the corals and 21% of sponges were damaged, and disturbance was widespread and evident on most video transects. For all fishing gear types that use bottom contact gear, the least disturbance and damage coincided with areas and depths with no observed fishing activity. There was a consistent positive relationship between damage/disturbance levels and intensity of bottom trawling, whereas for other gear types results varied. For gorgonian corals, 6% were damaged in not trawled areas, and 22% were damaged in the heaviest trawled areas. For hydrocorals, damage increased from 11% in not trawled areas to 58% in trawled areas. Hydrocorals were absent in the areas with the heaviest intensity of bottom trawling. About 40% of sea whips were damaged in the heaviest trawled areas compared to less than 2% in other areas. While some protective measures have been implemented to halt the expansion of bottom trawl fishing to unfished areas, the conservation of coral and sponge habitat in fished areas is still of primary concern.

Poster

16.06

THE APPLICATION OF A FEDERAL MANDATE TO PROTECT AND CONSERVE ESSENTIAL FISH HABITAT AND DEEPSEA CORALS IN REVIEW OF COASTAL CONSTRUCTION PROJECTS OFF SOUTHEAST FLORIDA, USA.

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The Essential Fish Habitat provisions of the Magnuson Steven's Fishery Conservation and Management Act provide a mechanism to protect and conserve Essential Fish Habitat, including deepsea corals and other deepsea habitats. Activities in the United States that require a federal license trigger the need to consult with the National Oceanographic and Atmospheric Administration's National Marine Fisheries Service. The National Marine Fisheries Service is charged with conducting Essential Fish Habitat consultations if an adverse affect to Essential Fish Habitat is likely to occur as a result of the action. The consultation provides a framework to assess habitat impacts, alternative actions, and mitigation of impacts. As a proactive fishery management initiative, the South Atlantic Fishery Management Council recently proposed a coral Habitat Area of Particular Concern off the east coast of Florida, USA that includes the Miami Terrace and Escarpment. This feature supports corals and other important deepsea habitats. Non-fishing gear activities, i.e., coastal construction projects, may be a threat to this unique and diverse deepsea habitat. This paper reviews the Essential Fish Habitat consultations for three projects proposed to be constructed through deepsea habitats, including a telecommunication cable project, a natural gas pipeline project, and a liquefied natural gas deepwater port. This paper also synthesizes the scientific information applied through the consultation process. Regulatory issues and management challenges through working with other agencies, academic institutions, and industry are also evaluated.

Poster

16.07

INTERNATIONAL REGISTRY OF CORAL PATHOLOGY

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An International Registry of Coral Pathology (IRCP) has been established by NOAA at the Cooperative Oxford Laboratory in Oxford, Maryland, USA to serve as a research tool and resource of voucher materials for the coral research community. An important function of the coral registry is to facilitate the sharing of histology materials and related information among coral pathologists worldwide to better understand the causes and mechanisms of disease. More than 2500 specimens of healthy and diseased scleractinian and soft corals representing over 30 warm water species from 20 geographic locations have been accessioned resulting in a collection of over 8000 microscope slides. IRCP is endeavoring to expand the collection to include cold water and deep sea corals. Disease outbreaks are known to occur in cold water populations of coral but the effects of disease on deep sea corals remain largely unknown. Expansion of IRCP tissues archives to include cold water and deep sea corals will provide a baseline for studies on the biology, growth, and reproduction of corals and valuable insights into the effects of stress, including disease, on coral ecosystems. Information gained from the utilization of IRCP products is useful to researchers, students, and managers and provides a better understanding of the causes and mechanisms of coral disease and the measures needed to preserve and protect coral reef ecosystems.

Poster

16.08

CHALLENGES IN THE MANAGEMENT OF CORAL REEFS IN THE SEAS AROUND INDIA

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The wide varieties of coral reefs that contribute nearly 10% of the total marine fish catch in India are under threat from the environmental degradation and climate changes, with impacts on food security and economic development. Adjacent to the mainland, river input of sediments hamper reef growth in many places. Coral area has been decreasing considerably due to dredging and coral mining. Pollution and overfishing also contribute much to the damage of the coral reefs. The strait between India and Sri Lanka famous for the diversity of reefs face a challenge from the proposed shipping channel, and the disputes mixed with belief, environmental issues, practicability and economic benefits are going on. However, the most important coral reef resources of India are the islands of the Andaman and Nicobar in the Bay of Bengal and the Laccadives (Lakshadweep) in the Arabian Sea. Even these reefs are being degraded due to increased sedimentation, pollution, and unsustainable utilization. Changing climate is a major challenge for the existence of reefs. Changes in ocean circulation and water temperature and wave characteristics may adversely affect the reefs. Increase in rainfall intensity may lead to more sedimentation. Human interference on the rivers and watersheds add to this. Rapid industrialization, and flourishing shipping industry and tourism release tremendous loads of pollutants into the marine environment. Destruction of coral reefs is likely to increase the vulnerability to natural hazards such as tsunamis and storm surges. This paper is a comprehensive study of the various issues endangering the existence of the coral reefs around India and the relevance of existing rules and regulations, their implementation mechanism and the current management practices. Suggestions for a better conservation and management policy and an adaptation strategy have been provided, considering the existing socio-economic, environmental, and political conditions.

Poster

16.09

DISTRIBUTION OF PRECIOUS CORALS IN THE RYUKYU ARCHIPELAGO

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Species of the family Coralliidae (Octocorallia: Alcyonacea, Scleraxonia) have been known since antiquity as precious corals. In Japan, the harvest of precious corals began during the 19th century (Kosuge, 1993), and has continued to the present in the Kochi, Kagoshima and Okinawa regions. However, to date there have been very few studies of their natural history (Nonaka et al., 2006). Although it is generally thought that overharvesting has likely decreased their abundance and biomass, to date there have been no studies assessing the resource in Japan. Our studies aim to fill that information gap, with the ultimate goal of contributing to their conservation.

During 2005, the Okinawa Churaumi Auarium (Okinawa, Japan) collected 86 samples of precious corals in the Ryukyu Archipelago. Samples were collected using submarine and ROV, from 120 m to 316 m deep. Date, location, water temperature, depth, transparency, substratum, and direction and speed of water current were recorded for each sample. Samples were given tentative identifications, and the width, height and basal diameter of whole colonies were calculated from photographs.

Of the 86 samples collected, 49 appear may be *Paracorallium japonicum*, 26 may be *Corallium elatius*, and 11 may be *C. konojoi*. (The group is renowned for difficulty in identification to species level. It is highly likely there are species new to science among the samples collected.) Although the depth-ranges found in this study are not yet definitive, the data suggest that all these species live deeper at lower latitudes (in Okinawa) than in higher latitudes (in Kagoshima). Depth distribution appears to be correlated with temperature. Comparing species, colonies of *P. japonicum*, were generally found in water temperatures of 19 degrees C, whereas colonies of *C. elatius* and *C. konojoi* were most often in cooler waters, 17 degrees C. The maximum width colony recorded was 1.143m for a specimen of *C. elatius*. Colonies of *C. elatius* were generally much larger than those of *P. japonicum*. Moreover, colonies of the same species were larger at low latitudes compared to the same species at higher latitudes. Possible explanations for the observed deeper habitats and larger size at lower latitudes are offered.

Poster

16.10

NOAA'S DEEP-SEA CORAL AND SPONGE STRATEGIC PLAN: A 5-YEAR OUTLOOK

Karen Palmigiano[1], John Tomczuk[2], Tom Hourigan[1], Kimberly Puglise[2], Elizabeth English[1], Tracy Parsons[1], Steve Gittings[3], Robert Brock[1]

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The National Oceanic and Atmospheric Administration (NOAA) is responsible for the management of the United States marine living resources, including deep-sea coral and sponge ecosystems. Recent research has revealed the abundance of these remarkably complex and fragile deep-sea coral communities in the deeper waters of the ocean off the coasts of the United States. In response, NOAA has increased activities to locate, study and protect these communities, including the development of NOAA's *Deep-Sea Coral and Sponge Research and Management Strategic Plan* (the Plan) for fiscal years 2009 through 2013.

The Plan identifies goals, objectives and approaches to improve the understanding and management of these ecosystems. The Plan integrates research and conservation needs and addresses our developing understanding of new management challenges, issues and priorities, as they relate to deep-sea coral and sponge ecosystems. It also provides a framework for implementing the Congressionally mandated Deep-Sea Coral Research and Technology Program, as well as other actions authorized under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006.

The Plan is presented in three sections: (1) exploration and research; (2) conservation and management; and (3) international cooperation. Each section provides goals and objectives to guide NOAA's deep-sea coral research, management, and international activities. The Plan's primary goal is to improve research, conservation, and management of deep-sea coral and sponge communities. Presented is an overview of the goals and objectives outlined for each section, as well as linkages to current mandates and future actions NOAA will take part in to meet the Plan's objectives.

Poster

16.11

CLASSIFICATION GUIDE FOR POTENTIALLY VULNERABLE INVERTEBRATE TAXA IN THE ROSS SEA LONG-LINE FISHERY

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The Commission for the Conservation of Antarctic Marine Living Resources has implemented Conservation Measure 22-06, which requires specific actions to be taken when evidence of a Vulnerable Marine Ecosystem (VME) is encountered in the course of fishing operations. Monitoring fishing operations for encounters with evidence of a VME entails identification of specific taxonomic groups of invertebrates, such as sponges or corals. Identification of these organisms to the appropriate taxonomic grouping has not been a standard procedure, and no identification guide specific to both VME taxa and Antarctic species has been developed. The objective of this guide is to provide observers on New Zealand long-line vessels with a VME-taxa specific, quick, on-deck guide to aid in the classification of selected invertebrate bycatch into the appropriate groupings. The format of the guide is a “compare and contrast table”, using photographs and key characteristics to correctly classify VME taxa. It also identifies those commonly mistaken for other taxa. It is printed as an A2 waterproof poster for display in the vessel factory or on deck for easy reference. Once classified, these observations can be used for monitoring for evidence of a VME. Additional invertebrate identification guides are still needed for fine taxonomic resolution for all invertebrate bycatch.

Poster

16.12

A FRAMEWORK FOR DEEP-SEA CORAL MANAGEMENT UNDER THE MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT REAUTHORIZATION ACT (P.L. 109-479)

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The National Oceanic and Atmospheric Administration (NOAA), in cooperation with eight Regional Fishery Management Councils, has responsibilities for managing fisheries in federal waters of the United States Exclusive Economic Zone (EEZ) under the Magnuson-Stevens Fishery Conservation and Management Act (P.L. 94-265). In December 2006, the United States Congress passed the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA) (P.L. 109-479) with several provisions related to deep-sea coral research and management. These new provisions, coupled with past fishery management tools, provide the current framework and expand opportunities for management and conservation of deep-sea coral resources.

This poster presents the changes to legislation, including Section 408 which mandates the development of a Deep Sea Coral Research and Technology Program, and the resulting framework afforded Fishery Management Councils and NOAA for conserving deep-sea corals in the United States EEZ. This framework provides for deep-sea coral conservation through Essential Fish Habitat mandates, bycatch reduction mandates, and several discretionary provisions in the MSRA. One such discretionary provision, section 303(b)(2)(B), offers managers a unique opportunity to designate deep coral zones to protect deep-sea corals from physical damage and protect fishing gear from becoming damaged.

Poster

16.13

THE CORAMM (CORAL RISK ASSESSMENT, MONITORING AND MODELLING) PROJECT

Laurenz Thomsen [1], Raeid Abed [3], Elke Allers [3], Melanie Bergmann [5], Dirk de Beer [3], Ståle Johnsen [7], Frederik de Laender [4], Ann Larsson [2], Tomas Lundälv [2], Tim Nattkemper [6], Ingunn Nilssen [7], Dick van Oevelen [4], Jörg Ontrup [6], **Autun Purser** [1], Ingeborg Rønning [7], Mathijs Smit [7], Vik Unnithan [1], Hannes Wagner [1] and Tao Wang [3]

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The CORAMM project is aimed at improving the understanding of the impacts of high suspended sediment loads and drill cuttings on cold water coral communities. The project is multidisciplinary in approach, with sedimentologists, biologists, modellers and representatives from Statoil all involved in furthering the current understanding of these ecosystems. The project has four workpackages. WP1 concentrates on the development of new video and image analyses to better and faster evaluate coral community structure and varying health status. WP2 assembles and further develops sensor systems for environmental monitoring with special emphasis on particle dynamics. These systems can be used as autonomous stand-alone units or can be linked to the internet. WP3 carries out specific experiments with live coral colonies to better understand and predict the effect of different particle size and microbial composition. WP4 will build advanced ecosystem models for cold water corals and use a physiological- based model to predict the effect of different sediment loads on the performance of cold water corals. This poster presents the first insights of the project after 15 months of research.

Poster

16.14

CITES – A CONSERVATION MECHANISM FOR DEEP-SEA CORALS

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The Convention on International Trade in Endangered Species (CITES) is considered to be one of the more effective multilateral environmental treaties. A species is listed under the Convention when the commercial trade in a wildlife product is proven to be detrimental to its survival. There are over 200 coral species listed under Appendix II of the Convention, requiring importing and exporting countries to monitor the trade via a system of permits. One example is *Antipatharia*, a valuable deep-sea species that is traded commercially as a jewelry and decorative item. The listing has improved the ability to monitor the trade and has helped countries strengthen the management of the species. The seven commercially traded *Corallium* and *Paracorallium* species are by far the most valuable and widely traded of all coral species, yet are afforded no international trade protection. Best estimates put the global *Corallium* trade at 30 to 50 metric tons per year. By comparison, the *Antipatharia* trade is approximately five metric tons.

This presentation explores *Corallium* and *Paracorallium* species' commercial trade, life history characteristics, distribution and habitat, population data and current management strategies as they relate to the conservation and policy needs of these genera.

Poster

16.15

THE TRANS-ATLANTIC CORAL ECOSYSTEM STUDY 'TRACES'

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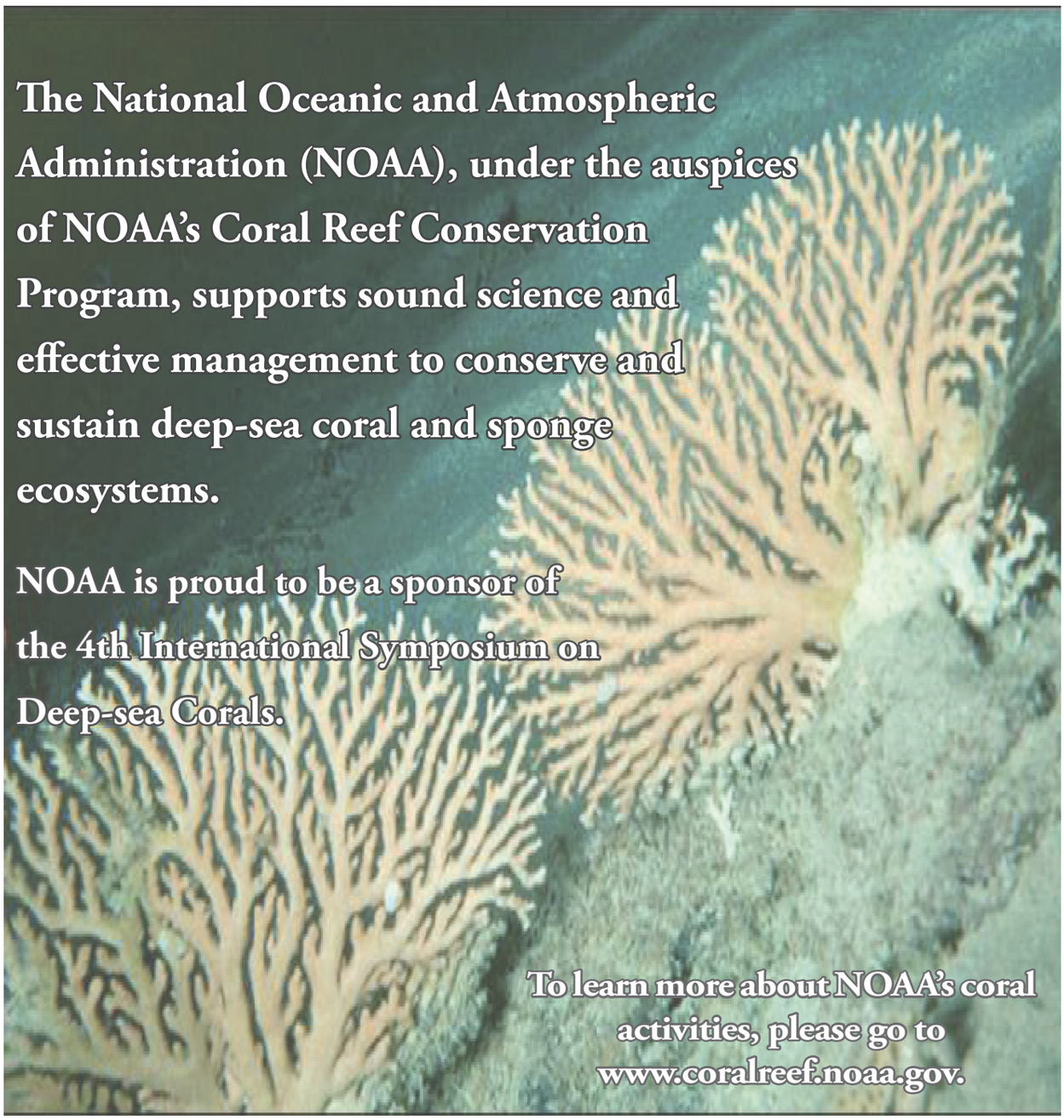
Our present understanding of cold-water coral habitats relies to a large extent on studies designed and targeted to specific study sites and topics. Research along the Atlantic margins of Europe and North America has now shown that cold-water coral habitats occur extensively on both sides of the Atlantic but we understand little of how these habitats are linked and connected. Certain cold-water corals have also emerged as key palaeoceanographic archives but no study has yet attempted to use coral temperature and water mass proxies at the scale of an ocean basin. The Trans-Atlantic Coral Ecosystem Study ('TRACES') is currently half way through a two year development period designed to create the first such ocean basin-scale study. In 2008 cold-water coral researchers from North America and Europe discussed their priorities at two workshops and a TRACES Science Plan has been developed. The TRACES team now plan a series of integrated research proposals in Canada, Europe and the USA in 2009 and 2010 organised into four themes: (1) Linkages & connectivity, (2) Biodiversity & biogeography, (3) Coral biology & reproduction and (4) Climate change & palaeo records. A major goal of this broad-based effort is to apply standardised methods to similar research questions throughout the Atlantic so allowing us to address ocean scale hypotheses.

Poster

Author Index

Bold numbers = presenter



NOAA coral reef
CONSERVATION PROGRAM

Ministry of
Fisheries
Te Tautiaki i nga tini a Tangaroa

New Zealand Government

The Ministry of Fisheries (MFish) strives to maximise the value that New Zealander's obtain through the sustainable use of marine resources and protection of the marine environment.

New Zealand's Exclusive Economic Zone includes a highly diverse range of undersea plateaus, seamounts and the 10,000 metre deep Kermadec Trench. These habitats support more than 15,000 marine species.

About 35% of this area lies in trawlable depths shallower than 1500 metres. To protect the seabed from the impacts of bottom fishing, industry and government agreed in 2007 to close 17 Benthic Protection Areas to bottom trawling, providing protection to 1.2 million km² of seabed. These protected areas include seamounts, hydrothermal vents and other underwater topographic features specifically identified by the United Nations as potentially vulnerable habitats.

MFish continue to work together with the Department of Conservation and stakeholders to learn more about the effects of bottom fishing on sea bed communities, and to determine whether any additional protected areas may be required.

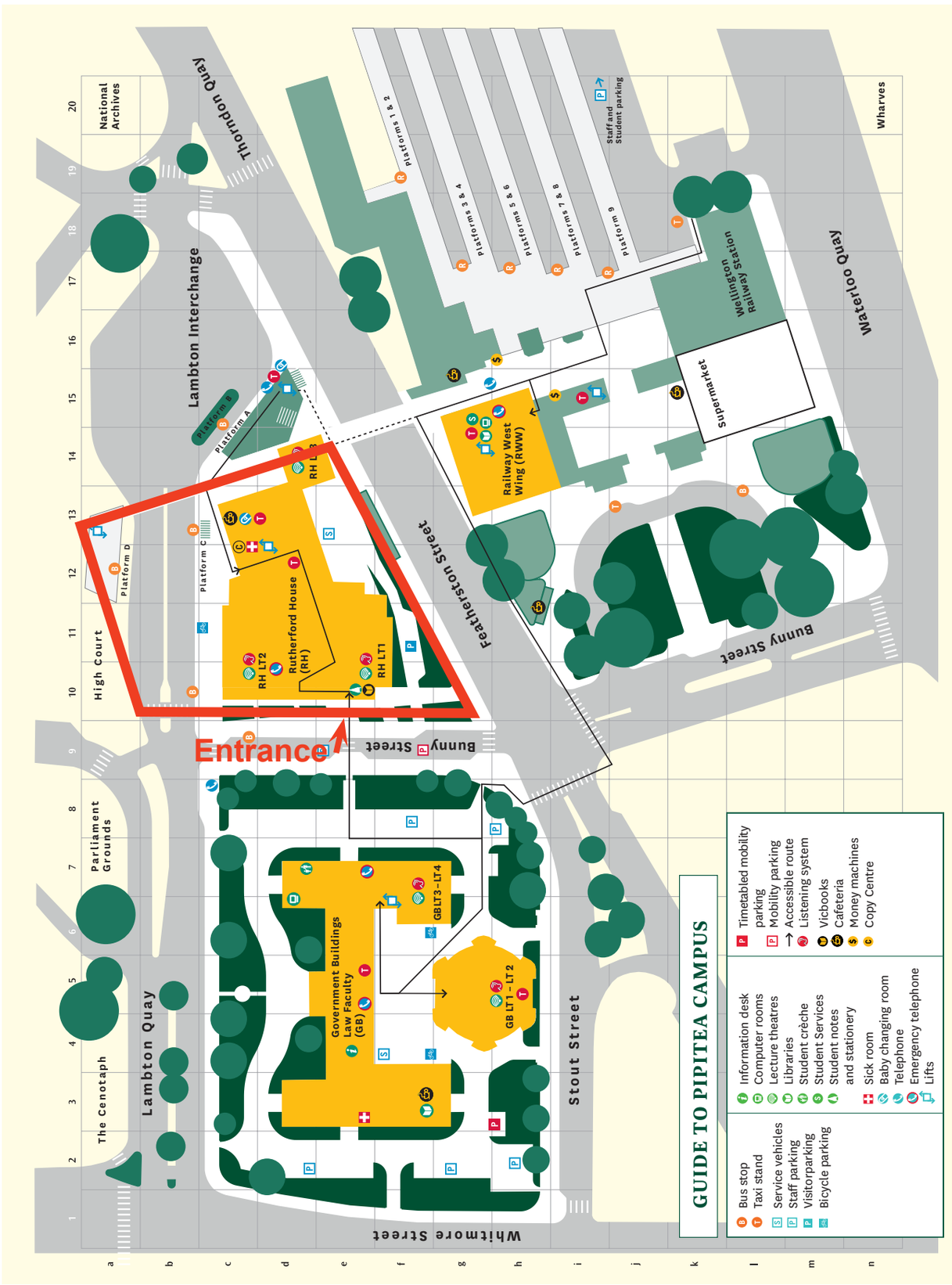
To find out more about the MFish please visit our website:
fish.govt.nz



Ocean Sciences and the Search for Energy


MMS U.S. Department of the Interior
Minerals Management Service
www.mms.gov

Pipitea Campus Map



Wellington City Map

City Attractions

1. Colonial Cottage Museum
2. National War Memorial & Carillon
3. Cricket Museum/Basin Reserve
4. Mount Victoria Lookout
5. Embassy Theatre
6. The Film Archive
7. St James Theatre
8. Kura Gallery
9. Downstage Theatre
10. Bats Theatre
11. Freyberg Pool
12. Overseas Terminal
13. Museum of New Zealand Te Papa Tongarewa
14. Circa Theatre
15. The Opera House
16. Department of Conservation Visitor Centre
17. Wellington Convention Centre/ Michael Fowler Centre/ Wellington Town Hall
18. Wellesley Boat
19. Civic Square/City Gallery/ Capital E/Wellington City Library/ **Wellington i-SITE Visitor Centre**
20. Adam Art Gallery
21. Helipro
22. TSB Bank Arena
23. Museum of Wellington City & Sea
24. New Zealand Academy of Fine Arts
25. Cable Car/To Cable Car Museum/ To Carter Observatory/To Botanic Garden
26. Botanic Garden
27. Government Buildings Historic Reserve
28. Parliament Buildings/Beehive
29. Archives New Zealand
30. Wellington Cathedral
31. National Library/ Alexander Turnbull Library
32. Old St Paul's
33. Thorndon Pool
34. Katherine Mansfield Birthplace

Accommodation Providers

35. Brentwood Hotel
36. Mercure Hotel Willis Street
37. Mercure Hotel Wellington
38. Comfort Hotel Wellington
39. Wellywood Backpackers
40. Base Backpackers Wellington
41. YHA Wellington
42. The Bay Plaza Hotel
43. Copthorne Hotel Oriental Bay
44. Museum Hotel
45. At Home Wellington City
46. Duxton Hotel Wellington
47. Nomads Capital
48. West Plaza Hotel
49. Central City Apartment Hotel
50. Abel Tasman Hotel
51. Central Stratford Apartment Hotel
52. Copthorne Hotel Wellington Plimmer Towers
53. Central Terrace Heights Apartments Wellington
54. CityLife Wellington
55. James Cook Hotel Grand Chancellor
56. Lambton Heights
57. InterContinental Wellington
58. Hotel Ibis Wellington
59. Novotel Capital Wellington
60. Quest on Johnston
61. The Atrium Wellington
62. Holiday Inn Wellington
63. Downtown Backpackers
64. Bolton Hotel
65. Kingsgate Hotel Portland Wellington

Public Toilets
Public Showers
Car Parking
To Wellington Zoo
To Wellington Airport
Railway Station
Interislander courtesy shuttle leaves from here and Intercity Terminal
One Way Streets
To Wellington Hospital
To Karori Sanctuary
Pedestrian Access

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For more information on what to see and do in Wellington, check out **WellingtonNZ.com**